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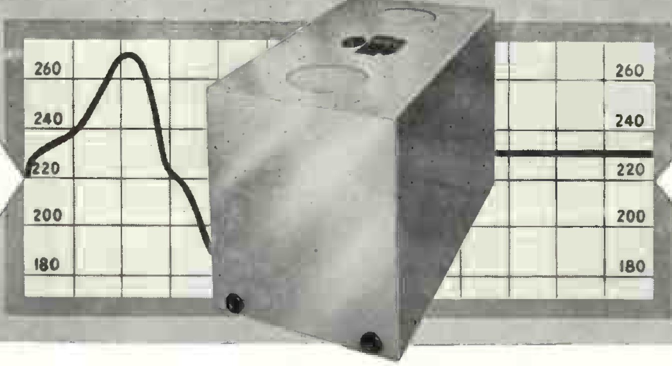

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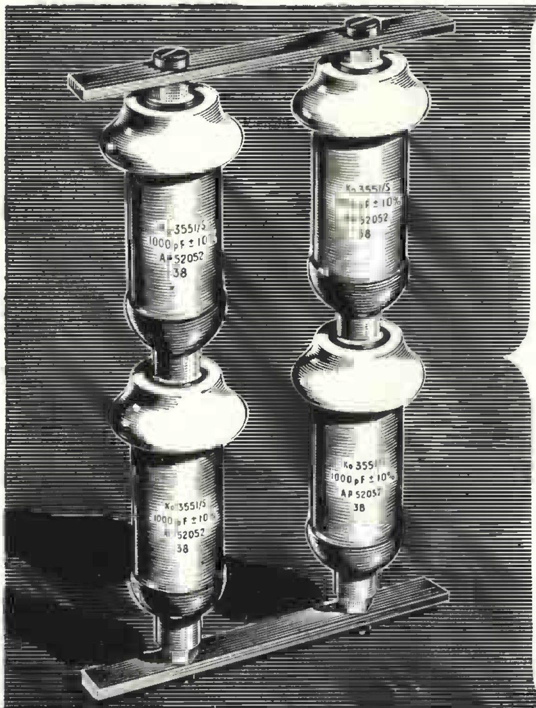

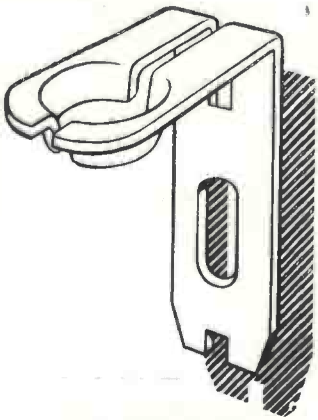

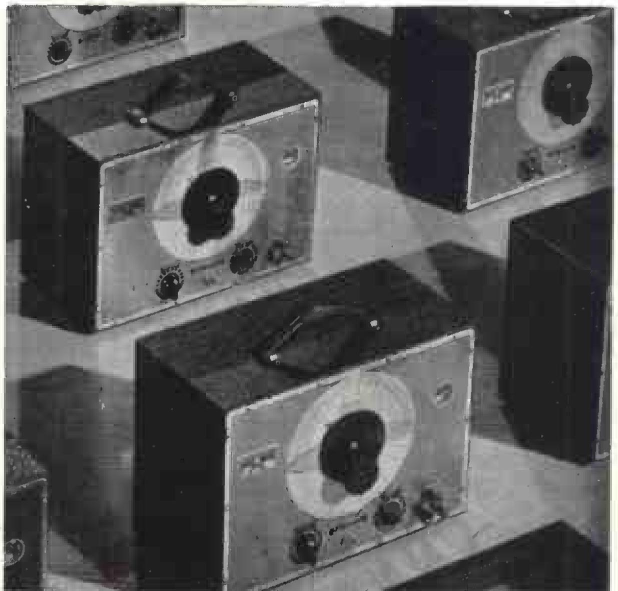

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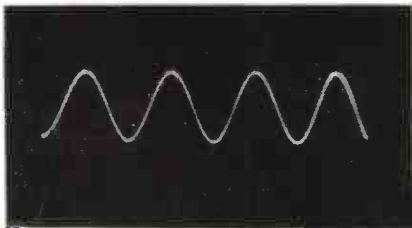

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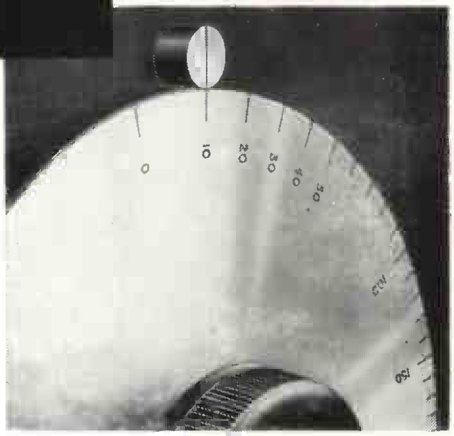

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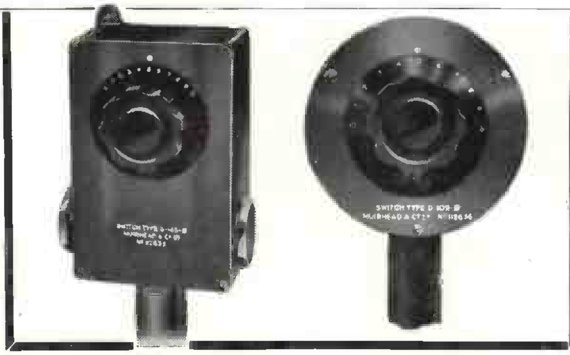

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WIRELESS ENGINEER

Editor HUGH S. POCOCK, M.I.E.E. Technical Editor Prof. G. W. O. HOWE, D.Sc., M.I.E.E.

VOL. XXII JUNE, 1945 No. 261

The Phase Convention of Currents and Voltages in Valve Circuits

THIS was the title of the Editorial in March, 1940, which was inspired by some correspondence in which a radio engineer had sought an authoritative opinion on a statement that occurs in some of Terman's books and which he regarded as incorrect. We pointed out that its correctness depended entirely on the conventions adopted. We also pointed out that whatever convention is adopted there is bound to be some difficulty with the signs either of voltage or current for " one cannot pretend that the valve and not the battery is the source of power without paying the penalty somewhere." In the May issue of *Wireless World* (p. 140), Dr. K. R. Sturley returns to this same problem in an article entitled " Valve Vectors," and arrives at some peculiar results by methods that we must confess we do not understand. In the simple valve amplifier with a resistance load we are told that " the most important fact to grasp is that the grid input A.C. voltage and the voltage generated imagined to exist inside the valve are 180° out of phase." Surely a much more important fact to grasp is that they may be assumed either in phase or 180° out of phase, depending on the convention adopted as to which direction around the anode circuit is to be regarded as positive.

In Fig. 1(a) a steady current flows around the circuit in an anti-clockwise direction. Nobody would suggest that this is a negative current; hence for direct currents the anti-clockwise direction is positive. If the grid is now made more positive this current increases, i.e., a small current δI is superimposed on the original current I_0. Now how shall we represent this? We have assumed the anti-clockwise direction as positive for E_b and the steady current I_0; which direction shall we call positive for small changes of the current and for the fictitious e.m.f. $\mu\delta E_g$ producing them? We can either stick to the anti-clockwise convention and say that the new current is $I_0 + \delta I$ or adopt the opposite convention

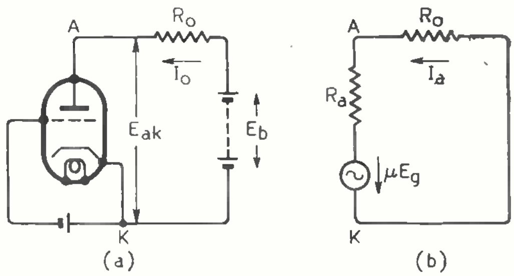


Fig. 1.

for the variations of current and write $I_0 - \delta I$. The first convention assumes that a positive δE_g applied to the grid is equivalent to a positive $\mu\delta E_g$ in the valve, which produces a positive δI, whereas the second convention assumes that a positive δE_g applied to the grid is equivalent to a negative $\mu\delta E_g$, i.e., 180° out of phase in the A.C. case, which produces a negative current which is then substracted from I_0, giving an increased resultant. It is this second convention that we are told is the most important fact (!) to grasp. We must confess that, although it is often employed and leads, of course, to the correct results, to us it has an air of topsy-turvydom. In explanation Dr. Sturley says

"The current I_a' is the A.C. current produced by the generated voltage μE_g and must not be confused with the actual A.C. change I_a superimposed upon the D.C. current I_0 taken from the H.T. source." Whatever does this mean ? Surely there is only one alternating current in the circuit, viz., that which is pictured as being produced by an e.m.f. in the valve, and it is this current which is superimposed upon the direct current. As the result of this confusion he arrives at Fig. 2, which is an exact reproduction of his Fig. 4 (a) showing voltage/time relationships. According to this diagram

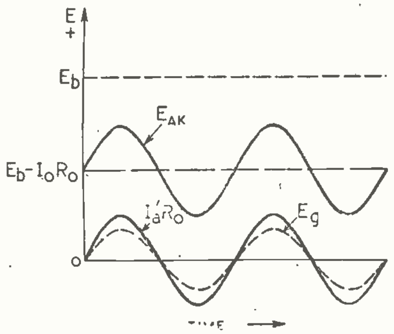


Fig. 2.

at the moment of maximum positive E_g applied to the grid, the voltage E_{ak} across the valve reaches its maximum value, which is simply contrary to the facts. He then says, "Two important points arise from this analysis regarding the valve as a generator of μE_g volts, (1) the generated voltage is 180° out of phase with the input voltage E_g and (2) the A.C. current produced in the anode load by the generated voltage μE_g is 180° out of phase with the actual current variation superimposed upon the D.C. anode current." The first point, as we have already shown, is a matter of choice and convention, and so far as one can judge, Dr. Sturley's convention appears to be that the alternating current is positive when it flows in the opposite direction to the steady current ; if one adopts the other convention, i.e., the same direction as positive for both D.C. and A.C., the fictitious generator voltage is in phase with E_g. With regard to the second point, surely if the assumed e.m.f. μE_g does not produce the actual alternating current flowing in the circuit, but one 180° out of phase with it—and presumably of the correct amplitude—there is something radically wrong and the obvious thing to do is to reverse μE_g. There is only one alternating current flowing in the circuit, and in the equivalent circuit this can be pictured as being produced by an e.m.f. μE_g acting in the valve. Dr. Sturley appears to picture two equal and opposite alternating currents I_a and I_a' ; one of them must surely be a figment of his imagination, as otherwise they would annul each other and leave only the D.C. component.

The simple facts are as follows. Under steady conditions, the currents and voltages are as shown in Fig. 1(a). When an alternating voltage is applied to the grid, an alternating current is superimposed upon I_0, and at the moment of positive maximum grid voltage, the superimposed currents and voltages are as shown in Fig. 1(b). Now this is exactly what would happen if the valve contained a source of e.m.f. μE_g acting around the circuit in the same direction as I_0, I_a and E_b. When the two diagrams are superimposed the currents and voltages in the one are simply added to those in the other, with one exception, viz., the P.D. across the valve. In the D.C. diagram $E_{ak} = E_b - I_0 R_0$ and is positive, whereas in the A.C. diagram it is E_{ka} and not E_{ak} which is equal to $I_a R_0$ and positive.* Hence the resultant E_{ak} is the difference, viz. $(E_b - I_0 R_0) - I_a R_0 = E_b - (I_0 + I_a) R_0$. It should be noted that this is simply a statement of the facts. That the voltages across the valve are of different sign follows, of course, from the fact that in the left-hand diagram the valve is merely absorbing power whereas in the right-hand diagram it is the source of the A.C. power. Although all the power, if traced to its source, comes from the battery or the H.T. supply, we can regard the valve as a grid-controlled converter supplied with D.C. power as shown in the left-hand diagram and giving out A.C. power as shown in the right-hand diagram. It differs from most other converters by having one common circuit for both input and output. The mean output of the H.T. source is always $E_b I_0$, of which $I_0^2 R_0$ goes to the load and the remainder as D.C. input to the valve ; of this the valve returns $I_a^2 R_0$ as A.C. output to the load, which therefore gets a total of $(I_0^2 + I_a^2) R_0$. The grid control is expressed by the formula $I_a = \mu E_g / (R_a + R_0)$. We have employed Dr. Sturley's symbols in order to simplify reference to his article.

G. W. O. H.

* E_{ak} means the potential at A minus that at K, whereas E_{ka} means the potential at K minus that at A.

POLAR DIAGRAMS*

Experiments with a Half-Wavelength Receiving Aerial and a V-Type Wire-Netting Reflector

By J. S. McPetrie, D.Sc., M.I.E.E., L. H. Ford, M.Sc., A.M.I.E.E., and J. A. Saxton, B.Sc., A.M.I.E.E.

(Radio Division, National Physical Laboratory)

ABSTRACT.—Experimental measurements have been made of the polar radiation diagram of a receiving system comprising a half-wavelength aerial associated with a V-type reflector, used on a wavelength of 50 cm. The reflector consisted of two screens of galvanised iron wire netting of ½in. mesh; polar diagrams were measured for various angles of the V between 80° and 330° and distances of the aerial of quarter, half and three-quarter wavelengths from the apex of the reflector. Gains up to 13 decibels over a half-wavelength dipole aerial were obtained with this simple aerial system.

Experiments using a half-wave dipole aerial in the plane of a flat sheet reflector, corresponding to a V-type reflector of 360°, are also described. The results show that in this case a polar diagram having almost uniform sensitivity over an arc of 180° can be obtained combined with a single minimum in the direction of the transmitter. Such a system may be of use for direction finding purposes.

1. Introduction

REFLECTORS are frequently used to improve the performance of aerials, and obtain highly directive aerial systems. In particular, at the high-frequency end of the radio spectrum, such a system can be devised without the arrangement becoming cumbersome in its linear dimensions. An experimental investigation has been made of the properties of an aerial system consisting of a reflector, formed by two similar conducting sheets hinged at one of their edges to form a V, which partially enclosed a half-wave dipole aerial.

The present paper describes experiments in which polar diagrams have been measured under a variety of conditions; some have been taken with the aerial parallel to the apex, or hinged edge of the V, others with the aerial perpendicular to the apex of the V; they have been taken in the equatorial plane of the V, and also in the plane bisecting the angle of the V. The angle of the V on the side enclosing the aerial has been varied over the range 80° to 330°, and in addition experiments have been made with an aerial in the plane of a flat sheet, a condition corresponding to an angle of the V of 360°.

The wavelength at which the experiments were conducted was 50 cm., with a few exceptions noted in the text.

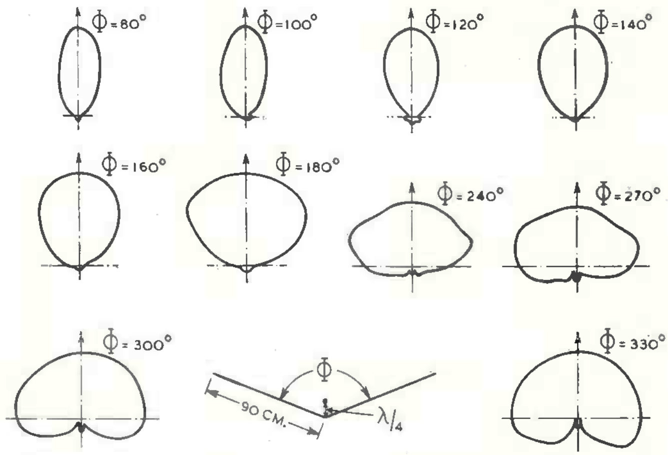


Fig. 1. *Polar diagrams obtained with a V-type reflecting screen, for various angles (Φ) between screens forming V, in the equatorial plane. Wavelength = 50 cm.; size of each screen = 60 cm. × 90 cm. of ½″ mesh wire netting. λ/2 aerial parallel to line of intersection of screens and at a distance λ/4 from vertex.*

* MS. accepted by the Editor, January, 1945.

2. Experimental Procedure

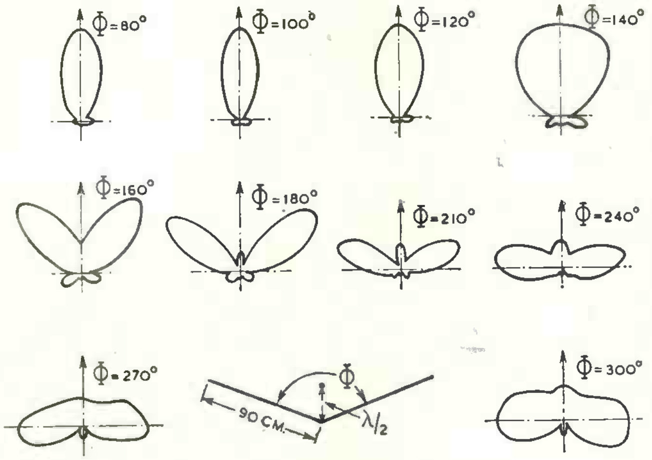
The reflector used in the majority of the experiments consisted of two similar wooden frames covered with ½in. mesh galvanised iron wire netting. The sides were each 60 cm. × 90 cm., the apex of the V being formed by the hinged junction of their shorter edges. Any alterations made in this arrangement are noted at the appropriate places in the text.

In all cases the half-wave dipole aerial used was symmetrically disposed with respect to the reflecting system under test. In the case of V reflectors, the centre of the aerial was in the plane bisecting the angle of the V and the plane bisecting the ends and apex of the V, or equatorial plane. In the case of the flat sheet reflectors the centre of the aerial was in the plane of the sheet and the plane bisecting the appropriate opposite edges of the sheet.

The receiver used was a field-strength measuring set, similar to that described by Colebrook and Gordon-Smith;* this set, together with the aerial system under test, was mounted on a turntable, in such a way that the axis of rotation passed through the centre of the aerial. The sender used was a 50 cm. oscillator of constant output, the aerial of which was set, as required, to be parallel to the receiving aerial. When measuring a polar diagram the turntable was rotated and observations made of the field strength from the sender, at a succession of angles between the direction of the axis of the receiver aerial system and the direction of the transmitter.

* F. M. Colebrook and A. C. Gordon-Smith, *Journ. I.E.E.*, 1943, Vol. 90, Part III, p. 28.

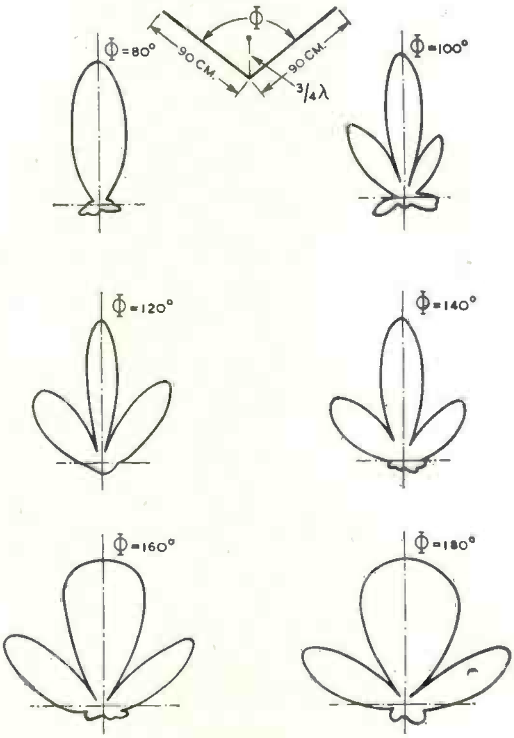
Preliminary experiments showed that small alterations in the disposition of the apparatus (*e.g.* height above ground, distance between sender and receiver) produced only minor changes in the polar diagrams obtained, and did not affect their general shape.



Polar diagrams obtained with V-type reflecting screen, for various angles (Φ) between screens forming V, in the equatorial plane. Wavelength = 50 cm.; size of each screen = 60 cm. × 90 cm. of ½″ mesh wire netting.

Fig. 2 (Left). *λ/2 aerial parallel to line of intersection of screens and at a distance λ/2 from vertex.*

Fig. 3 (Below). *λ/2 aerial parallel to line of intersection of screens and at a distance ¾λ from vertex.*



3. Experimental Results

(A) *V Reflector.*

Figs. 1 to 5 show a representative selection of the polar diagrams obtained, in the equatorial plane of the aerial system, for various values of the angle Φ between the sides of the V enclosing the aerial, in the range 80° to 330°; while Figs. 6 and 7 show

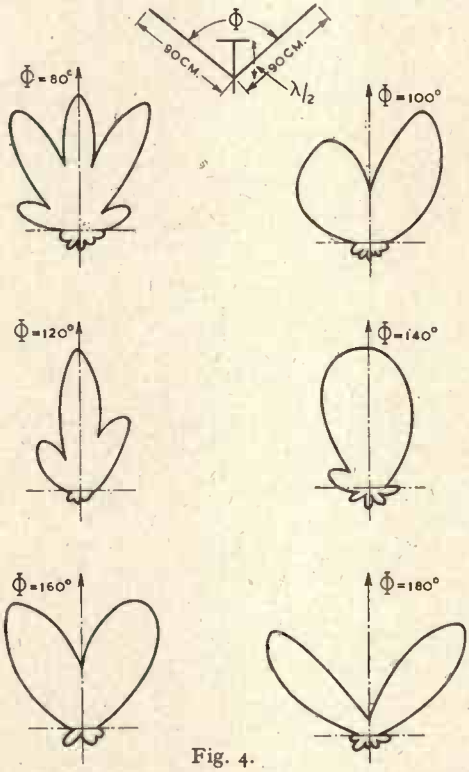


Fig. 4.

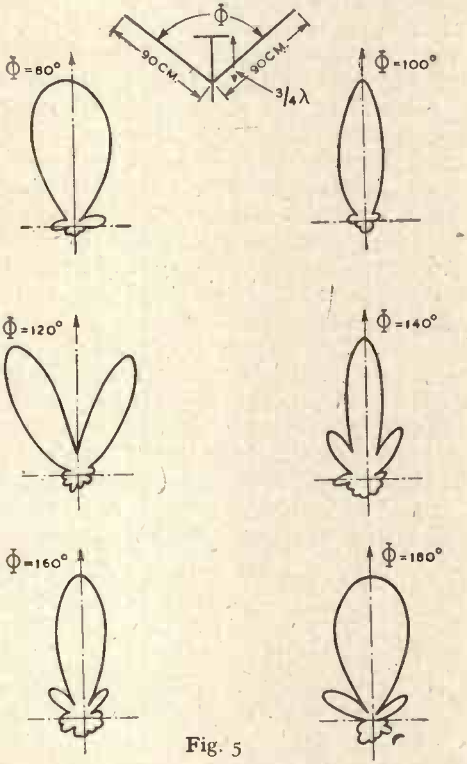


Fig. 5

Polar diagrams obtained with V-type reflecting screen, for various angles (Φ) between screens forming V, in the equatorial plane. Wavelength = 50 cm; size of each screen = 60 cm. × 90 cm. of $\frac{1}{2}$" mesh wire netting.
Fig. 4. *$\lambda/2$ aerial perpendicular to line of intersection of screens and at a distance $\lambda/2$ from vertex.*
Fig. 5. *$\lambda/2$ aerial perpendicular to line of intersection of screens and at a distance $\frac{3}{4}\lambda$ from vertex.*

polar diagrams in the plane bisecting the angle of the V for values of Φ in the range 60° to 180°. The distance between the aerial and the apex of the V was $\lambda/4$, $\lambda/2$ or $\frac{3}{4}\lambda$, as indicated on the figures.

The gain of the aerial system measured in the direction of maximum received signal over that of a half-wavelength dipole is given in Fig. 8. High accuracy cannot be obtained for the latter measurement as there was inherently some doubt as to the comparison half-wavelength aerial being uninfluenced by, for example, the metal boxes of the receiver. In order to reduce this effect to a minimum measurements were made with the simple dipole at a series of distances from the receiver and an average value taken as correct. It is estimated that the gains given in Fig. 8 are correct to 2 decibels and their relative magnitudes to 1 decibel.

A method has been evolved from which the reflection coefficient of a reflector such as the screen used in these experiments can be determined from the polar diagram obtained for an angle of V of 180° and a distance of $\lambda/2$ of the aerial from the screen. This method is not described in the paper, but it showed that the modulus of the reflection coefficient of the $\frac{1}{2}$in. mesh screen used was greater than 0.9. This result is in agreement with those obtained by another method* on a wavelength of 1.5 m.

(B) *Flat Sheet Reflector*

A representative selection of the polar diagrams obtained, using a flat sheet reflector with a half-wave dipole in the plane of the sheet, is shown in Figs. 9 and 10. With the exception of Fig. 9 (f) the diagrams were taken in the equatorial plane and over a range of sizes of sheet, wavelengths and

* J. S. McPetrie, *Proc. Phys. Soc.*, 1934, Vol. 46, pp. 637–648.

distances of the aerial from the edge of the sheet. The diagram shown in Fig. 9 (f) was taken in the plane of the sheet. For this purpose the sheet, with the aerial attached, was mounted in a horizontal plane; the shape of the diagram is likely to have been affected by the presence of the earth, since the reflected ray would not be obscured by the sheet, as is the direct ray at certain angles. A number of diagrams (not shown) were obtained with the aerial perpendicular instead of parallel to the edge of the sheet; the results gave a figure-of-eight diagram which, within the limits of experimental error, was the same as that which would be given by a horizontal dipole in the absence of the sheet.

A comparison of the diagrams of Fig. 10 (d) and (e) shows that the relative dimensions of the sheet used considerably affect the shape of the curve in the region of the minimum. With the aerial parallel to the longer side of the sheet a single minimum is obtained in the direction of the transmitter, and with the aerial parallel to the shorter side of the sheet there are two minima close together. For this reason, a number of polar diagrams were taken using a V reflector with the same size sides as before, but with

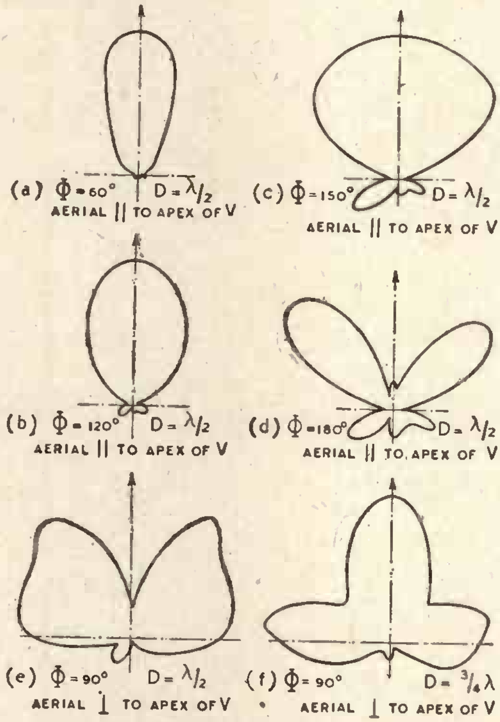


Fig. 7. *Polar diagrams obtained with V-type reflecting screen, in the plane bisecting the angle, Φ, of the V, for various values of Φ and of the distance, D, between the aerial and the apex of the V. Sides of V screen each 60 cm. × 90 cm. of ½" wire netting. λ = 50 cm.*

the apex formed by 90 cm. edges. These are shown in Fig. 11; the angle of the V varies between 180° and 330°.

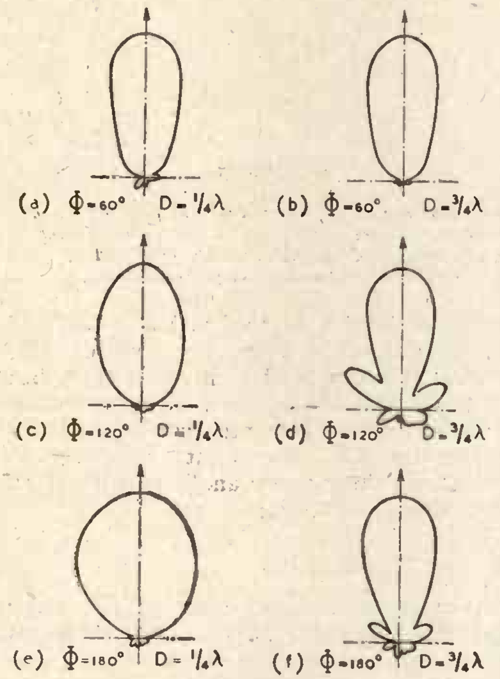


Fig. 6. *Polar diagrams obtained with V-type reflecting screen, in the plane bisecting the angle, Φ, of the V, for various values of Φ and of the distance, D, between the aerial and the apex of the V. Aerial parallel to the apex of the V. Sides of V each 60 cm. × 90 cm. of ½" wire netting. λ = 50 cm.*

4. Conclusions

(A) *V Reflector*

Darbord* has shown that the theoretical gain of a sheet reflector in the form of a paraboloid with the source in the focus is given by $\frac{\pi R}{\lambda}$ where R is the radius of the aperture. It will be noted from Fig. 8 that the maximum gain over a half-wavelength dipole is obtained with the aerial parallel to the line of intersection of the screens for a spacing $\lambda/2$ between aerial and reflector apex and an angle of the V of 75°. The

* R. Darbord, *J. de Phys. et Radio*, 1932, Vol. 3, pp. 105-115.

gain under this condition is over 13 decibels whereas the gain derived from Darbord's formula for a paraboloid having the same aperture is 11 decibels. The V-type reflector, therefore, can have a gain comparable with that of a paraboloid of comparable dimensions.

Various other conclusions can be drawn directly from an inspection of the figures.

(1) For all spacings between aerial and reflector the backward radiation decreases as the angle of the V is decreased to the minimum of 80° for which polar diagrams were measured. This is particularly evident in the case in which the aerial is parallel to the line of intersection of the screens.

(2) For a given angle of V the backward radiation increases with increase in distance of the aerial from the apex of reflector.

(3) For the case in which the dipole is parallel to the line of intersection of the two screens forming the V and for angles of V in the neighbourhood of 80° to 100° there is no appreciable change in the polar diagram or gain with change in distance of aerial from apex of V over the range $\lambda/4$ to $\frac{3}{4}\lambda$. This means that an aerial system incorporating a V-type reflector can be used over an appreciable wave-range without important change due to the reflector in the resulting polar diagram or gain over a $\lambda/2$ dipole.

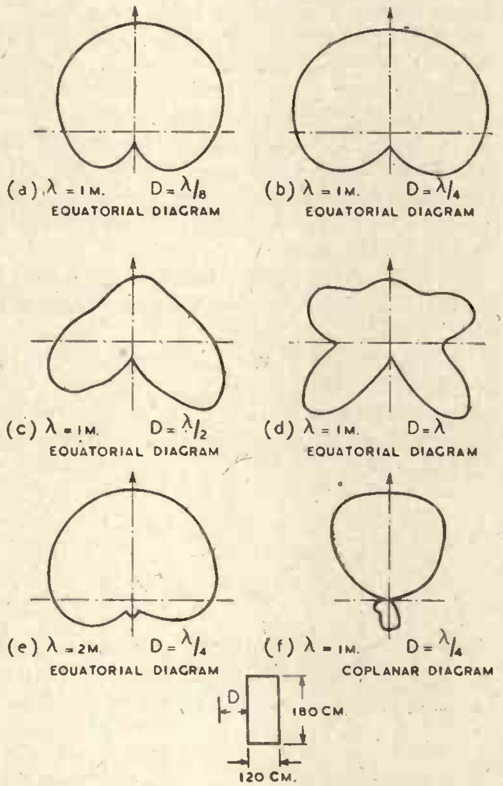
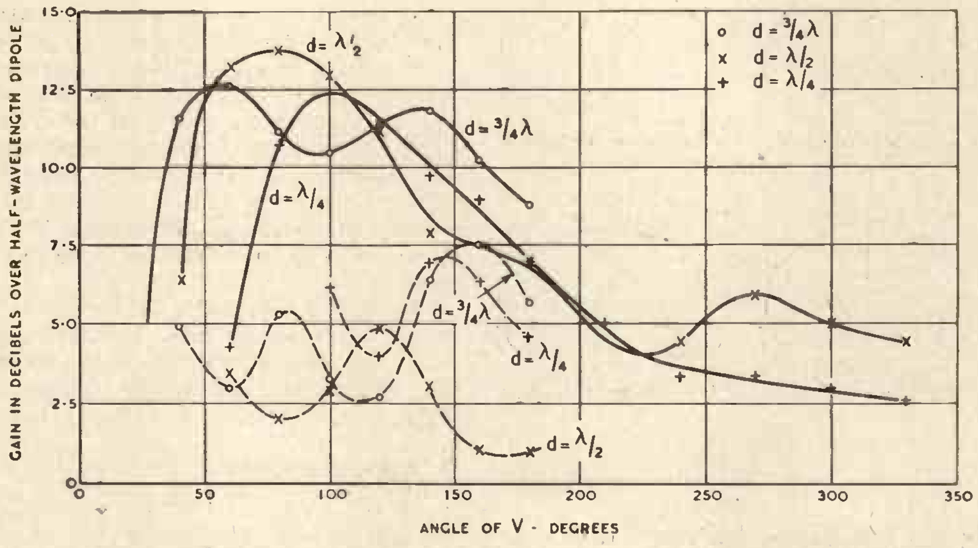


Fig. 8 (Below). *Variation of gain measured in direction of maximum received signal with angle of V for three distances (d) between aerial and apex of V. Full line = aerial parallel to line of intersection of sides of V; dotted line = aerial perpendicular to line of intersection of sides of V.*

Fig. 9 (Right). *Polar diagrams obtained with a ½" wire netting flat sheet reflector, 180 cm. × 120 cm., with the aerial in the plane of the sheet at a distance, D, from the 180 cm. edge.*



(4) The gain with the aerial perpendicular to the line of intersection of the screens is less than that when the aerial is parallel to that line, particularly for small angles of V.

(B) *Flat Sheet Reflector*

The polar diagrams of Figs. 9 and 10 show that by using an aerial in the plane of a flat sheet reflector it is possible to obtain a polar diagram showing an almost uniform sensitivity for a signal received from any direction over an arc of 180°, combined with a reasonably sharp minimum when the sheet is in the plane connecting the transmitter and receiver. This property might be of use for direction finding purposes. In this connection the following points emerge from the diagrams :—

(1) The edges of the sheet parallel to the aerial should be greater than a wavelength (Fig. 9 (e)).

(2) The edges of the sheet parallel to the aerial should be not less than the other edges (Figs. 10 (b) and (c) and Figs. 10 (d) and (e)).

(3) The aerial should be less than $\lambda/2$ from the edge of the sheet (Figs. 9 (c) and (d)).

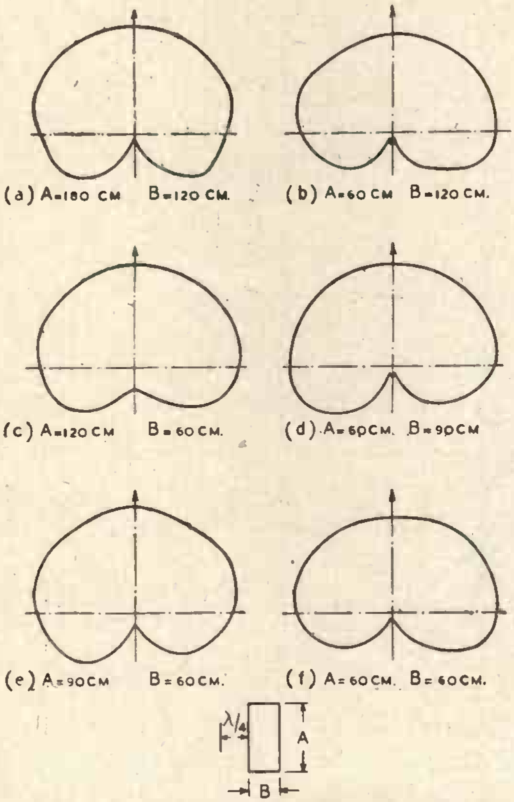


Fig. 10. *Polar diagrams obtained with a flat sheet reflector, sides A × B, with the aerial in the plane of the sheet at a distance of* $\lambda/4$ *from the edge A.* $\lambda = 50$ *cm. Diagrams in equatorial plane. Diagrams (a), (d), (e) ½" wire netting sheet ; (b), (c), (f), copper sheet.*

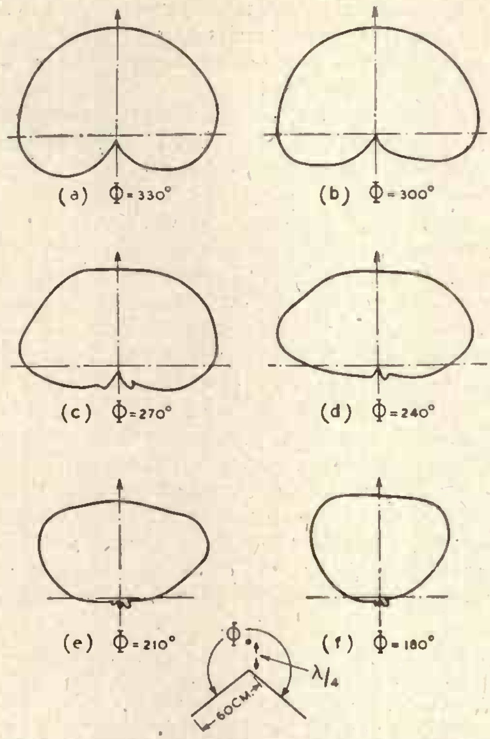


Fig. 11. *Polar diagrams obtained with a V reflecting screen, in the equatorial plane, for various values of the angle, Φ, of the V. Aerial parallel to the apex of the V at a distance of* $\lambda/4$. *Sides of V each 90 cm. × 60 cm. of ½" wire netting.* $\lambda = 50$ *cm.*

(4) Provided the above three conditions are observed the wavelength may be varied over a range of at least two to one without any alteration in the size of the sheet or the spacing between the sheet and the aerial.

(5) If conditions (1) and (2) are not satisfied the minimum in the direction of the transmitter disappears and is replaced by two minima at about 150° on either side of this direction with a subsidiary lobe between them.

The results obtained on a V reflector with longer edges of the sides forming the apex show that the desirable properties shown by the flat sheet reflector are retained provided that the angle of V is greater than 270°.

5. Acknowledgment

The work described above was carried out as part of the programme of the Radio Research Board, to whom this paper was first circulated in March, 1941. It is now published by permission of the Department of Scientific and Industrial Research.

Essay in RADIO-FREQUENCY HEATING*

By T. C. Macnamara and H. T. Greatorex

THE problem with which the writers were faced was to produce eddy-current heating apparatus to flash the getter in a small neon tube approximately two centimetres in length and half a centimetre in diameter. The getter medium was metallic and consisted of a small disc about two millimetres in diameter and 0.002in. thick.

The tube electrodes were of about No. 20 S.W.G. wire just over a centimetre in length and placed axially at a distance of about two millimetres apart. It was quite clear from the outset that the introduction of comparatively few watts into the metallic disc of getter would produce sufficent heating to cause the requisite flashing, but owing to the extremely small size of the tube it was not easy to bring about this desired effect.

A complication existed in that, whereas there was no objection to the heating of the electrodes themselves—in fact it was advantageous from the degassing point of view — excessive heating had to be avoided otherwise there was danger of the seal, through which the lead-out wires emerged, being damaged. A further complication existed in that no heating must be induced into the sealing wires themselves at the point where they passed through the glass, otherwise the chances of damage would be greatly increased. This meant that the heating effect had to be strictly localised, as far as possible to the actual point where the getter was placed.

Choice of Operating Frequency

The writers frankly admitted that they had little experience of eddy current heating by means of high frequencies and were thus not in a good position to judge the merits of one frequency over another. They had read that where discreet depth of penetration was not a special feature there was no particular advantage in using an extremely high frequency because the magnitude of the heating effect is said to increase proportionally to the square root of the frequency.

As it did not seem worth while, therefore, the use of ultra-high frequencies was avoided because of the greater difficulties which would have been introduced into the design and operation of the valve generator. On the other hand it was thought that up to a point the higher the frequency the easier it would be to obtain an effective coupling between the heater coil and the work to be heated, not only because of the increase in the value of ω but also because the reactance of the heating coil (which would obviously have to be small, physically) would be more significant at higher frequencies and so render the circuit more manageable.

Bearing in mind these various considerations, it was decided that an attempt should be made to use a frequency just below the medium broadcast band and 0.5 Mc/s was chosen, quite arbitrarily. It must be confessed that the choice of such a frequency was partly influenced by the writers' experience of the manipulation of radio circuits in this band of frequencies, added to which, was the fact that almost any valve can be made to operate efficiently as an oscillator on such frequencies.

Question of Interference

The writers felt their responsibility in the suppression of interference very keenly because they had, in the past, encountered extensive troubles on the television band and elsewhere with interference from medical apparatus employing radio frequencies. It was, therefore, with a firm resolve that no appreciable radiation should occur, that the problem was tackled and this idea was kept in mind throughout. It must be mentioned in passing that in the writers' experience the majority of radio interference occurs in unsuspected ways. Most people, in designing radio-frequency apparatus, provide some form of screening box and let it go at that, with the usual result that the spurious radiation is almost as bad as if there were no screening at all. The usual reason for this result is that the screening is by no means complete, but even if it is apparently complete there are often leaks

* MS. accepted by the Editor, March, 1945.

down the various cables or sneak currents through indeterminate earth paths all of which are a contributory, if not the main cause of spurious radiation.

The G.P.O. who, of course, are the licensing authority for all types of high-frequency apparatus, very properly insist that the most obvious source of leakage, e.g., the incoming mains power cables, should be provided with effective high-frequency filters specified by them, but as they obviously cannot foresee all uses to which every piece of apparatus can be put, they cannot specify means whereby radiation can be eliminated from all the combinations of associated circuits which might be set up.

The G.P.O., however, has the final word because when equipment has been completed, and before they are prepared to grant a licence for its operation, they require to take field-strength measurements to satisfy themselves that radiation of both fundamental and harmonic frequencies has been reduced to a negligible value.

Early Attempts using Receiving Valves

In the present case, as previously stated, it was clear that only a very small wattage would be required to effect the flashing operation, provided that this wattage could be dissipated in the very small mass of the getter disc, or the closely associated portions of the electrodes. In consequence it was felt that, if an efficient generation of H.F. energy and effective concentration of a suitable magnetic field could be obtained, it was quite possible that an H.F. generator of comparatively low power, using receiving valves of the more robust type, would suffice.

For instance, if a power of 10 watts actually dissipated in the work would be sufficient, then, assuming the possibility of obtaining an overall efficiency of 10 per cent., a generator giving an output of 100 watts would suffice. The figure of 10 watts in the work was more or less guess-work, based upon reflection on the heat in a 6-watt low-voltage filament lamp such as a car side-lamp bulb.

As shown in Fig. 1, a simple oscillator employing four valves of the L.F. power-output pentode type was set up and arranged to oscillate at 0.5 Mc/s taking an input of 350 mA at 400 volts representing 140 watts. Assuming a conversion efficiency of 75 per cent. (which is usually obtainable on these frequencies) this should have given an output of 100 watts. It was found in practice that such an output could indeed be obtained without difficulty and the resultant oscillator easily lit a 100-watt gas-filled lamp to full brilliancy as measured by photometric methods.

Heating Coil Experiments

The obvious objective in designing the heating coil was to produce a high-frequency magnetic field of small dimensions yet having the maximum possible intensity within the limits of the power available. Two ways of producing this result suggested themselves, viz., a coil of many turns of comparatively fine wire through which a relatively small current passed, or, alternatively, a coil of few turns of thick wire carrying a high current.

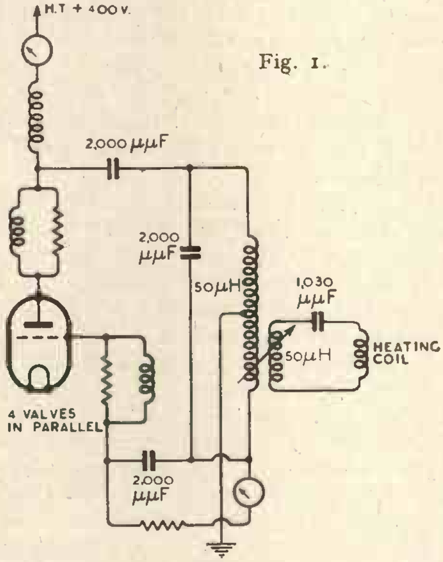


Fig. 1.

Although the writers had noticed that in most eddy-current heating installations it seems customary to use heating coils of the latter type, viz., of thick wire with many amperes flowing, they decided to try whether the technique of finer wire, more turns and smaller current, might not prove superior for the particular application with which they were concerned.

A coil was accordingly prepared consisting of 25 turns of 16 gauge D.C.C. wire pile-wound in three layers. The pile winding was adopted because, as radio engineers of the old school will remember, it has the advantage of enabling a number of layers of wire to be assembled in such a way that interturn capacitance is not significant, and interturn voltage is kept to a minimum. Although not much seen in present-day radio practice, pile winding has the pronounced advantage of enabling a large number of turns to be concentrated into a small space without disadvantages which would be inherent in other forms of winding, and it was this property that attracted the writers.

The resultant coil had an inductance of 25 μH and was arranged to form part of a series circuit including an additional coil of 50 μH and a condenser having a value of 1,030 $\mu\mu$F. The 50 μH coil was set up so as to provide a variable magnetic coupling to the oscillator circuit as shown in Fig. 1. The measured resistance of the closed circuit so formed, expressed as a series component, was just over 1 ohm, so that a current of about 10 amperes was produced by the dissipation of the rated 100 watt output of the generator.

This was pretty poor because the ampere-turns in the heating coil were only 250, and it appeared fairly clear that this would be insufficient. Also measurement of the H.F. resistance of the circuit showed that a negligible increase occurred when the neon tube was inserted into the coil indicating clearly that the coupling was very low even though the coil was a very close fit on the tube. Practical tests confirmed the inadequacy of the arrangement and it was scrapped.

Profiting by the failure of this experiment it was decided that the purely wasteful losses in the heating circuit must be radically reduced. An attempt was made to do this in two ways. First, the coil was rewound in similar form using a stranded conductor composed of 81 strands of 44 S.W.G., each strand separately insulated. This form of conductor, sometimes known as "Litzendraht," is widely used and noted for its low-loss properties on this order of frequency.

Secondly, it was decided that it was wasteful to take the current through the whole of the coupling circuit feeding it and, therefore, it was decided to resort to the use of a condenser in parallel with the heating coil itself and thus confine the high value circulating current to the shortest possible path. Accordingly, a condenser of 9,000 $\mu\mu$F was shunted across the terminals of the heating coil, using extremely short and heavy conductors.

The series H.F. resistance of this combination at 0.5 Mc/s was measured to be 0.4 ohm in series with a reactive component of $+j35$ ohms. It was encouraging to note that with this arrangement, when the neon tube was inserted into the coil the series resistance increased to 1.1 ohms which meant that, of the total power introduced into the coil, 60 per cent. was being usefully introduced into the load.

With the use of a shunt condenser, however, there arose the problem of feeding the heating coil because the shunt resistance of the condenser-coil combination was approx. 3,000 ohms in parallel with $+j35$ ohms which would call for the application of 550 volts in order to give the requisite 100 watts into the circuit. To produce such a voltage would be inconvenient as this would clearly be beyond the scope of any reasonable form of magnetic coupling, and in fact would have to be applied by tapping the condenser-coil combination directly across the tank circuit of the valve generator.

This was felt to be unsatisfactory from several points of view, especially in that the leads to the heating coil unit (which were required to be several feet long) would be subject to large potential differences between them which would be inconvenient, as it was desired to make them in the form of a twisted pair. Not only would this arrangement materially contribute to operating convenience, but if such a twisted pair could be terminated approximately in its own characteristic impedance (say 100 ohms) then radiation from it would be reduced to a negligible value.

Accordingly the arrangements shown in Fig. 2 were adopted using an *L* section to step down impedance to the feeder. The action of the *L* section, as given in Fig. 2, was as follows :—

(a) Shows equivalent circuit of heater coil expressed in shunt.
(b) Shows addition of a shunt condenser of value smaller in capacitance than for resonance, to leave a value of 177 ohms of shunt inductive reactance.
(c) Shows the effective circuit resulting from (b).
(d) Shows the equivalent of (c) expressed as a series circuit.
(e) Shows the effect of correcting the power factor by means of a series condenser, giving 100 ohms resistive to the feeder.
(f) Shows the practical form of circuit which results.

This arrangement worked according to plan and circulating currents of 20 to 30 amperes were produced in the heating coil, thus giving 700 ampere-turns.

The passage of this current rapidly resulted in the over-heating of the coil, because, although the resistance of the stranded conductor was very low its ventilation properties were so poor that the heat generated did not readily escape. This was not felt to be an insuperable disadvantage because the action of flashing the getter should only take a matter of one or two seconds, and as a reasonable time would elapse between operations, it was felt that the coil would not necessarily over-heat under practical conditions of operation.

Unfortunately the arrangement described was not successful for the following reason which had not been fully foreseen. On inserting the neon tube in the coil and switching on the power, heat was rapidly generated in the work and the load on the oscillator appeared as 100 watts. Owing, however, to the fact that the electrodes in the tube were of magnetic material, the moment they reached the "change temperature" the coupling between the coil and the tube fell to an almost negligible value and the load on the generator dropped off to almost nothing. Thereafter it was useless to keep the power on because the tube never got any hotter and the temperature at which the getter flashed was never reached, in fact, the only result was that the heating coil burned out. This proved conclusively that of the power dissipated in the tube, only a small fraction went to heat the disc of getter, the balance heating the electrodes.

An attempt was then made to construct a heating coil, having even lower resistance from a very finely stranded Litz wire which was of about 0.25in. diameter and was composed of several thousand strands of 44 S.W.G. wire, each strand separately insulated. A coil of similar inductance was wound and a similar circuit arrangement adopted but the experiments proved a failure because, with the larger diameter of wire, the mean diameter of the coil was much larger (although its internal diameter was the same) and consequently the coupling to the tube was very much less.

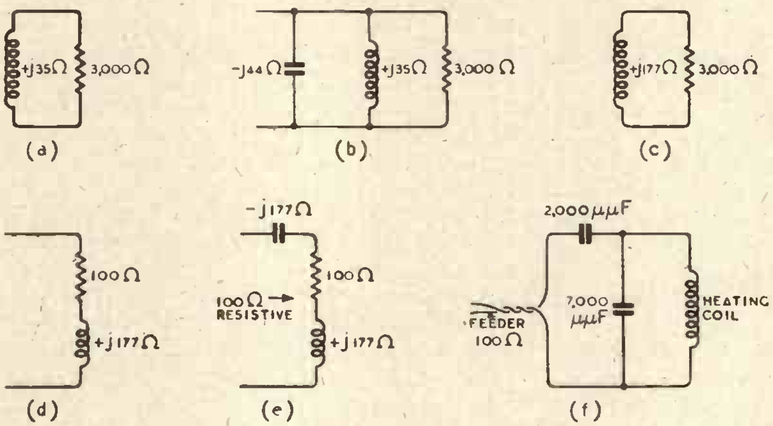


Fig. 2.

A final attempt to produce better conditions was made using an iron core composed of 0.001in. thick laminæ of ferrous alloy suitable for use at high frequencies. Calculations had shown that the air gap, which must of necessity be introduced into the core, would have the result of increasing reluctance of the magnetic circuit to a point at which the iron did not contribute much advantage with the exception of concentrating the total flux into a smaller area.

Measurement of the resistance of the resultant inductance, however, showed at once that the losses in the core were such as to put the scheme right out of court. It must be stated that the arrangement of core stampings was not such as to give the greatest freedom from eddy-current losses, nor was the cross section of the core sufficient to reduce the flux density to the value at which the lowest losses could reasonably be expected, but a bigger cross section of core could not be used because of the very small size of the work into which induction was to be effected.

The conclusion was reluctantly reached that owing to the difficulty of obtaining sufficient overall efficiency, particularly as a result of coupling troubles, it was not possible to obtain the desired effect by the use of 100 watts of energy, at any rate by any of the means which the writers could visualise at that time. In consequence it was decided to turn attention to the development of a more powerful generator, giving 600 watts.

This was felt to be rather an admission of inefficiency, but it appeared to be the only practical course.

Higher Power Equipment

Power Unit.—The design of the 600-watt generator was influenced by the components which were obtainable in the difficult circumstances of the present day. A power unit, consisting of H.T. transformer and rectifiers which had one time formed part of a public address system, was available giving an output of 1 ampere at 1,000 volts D.C.

R.F. Generator.—The unit consisted of a perfectly conventional arrangement of four valves in parallel operating into a split circuit as shown in Fig. 3. The closed circuit consisted of 40 turns of 10 gauge bare copper wire wound on a hexagonal polystyrene former built up from 6 slats slotted to receive the wire and supported by end cheeks. This gave an inductance of 100 μH. The condenser consisted of a ceramic pot of 1,000 μμF capacitance.

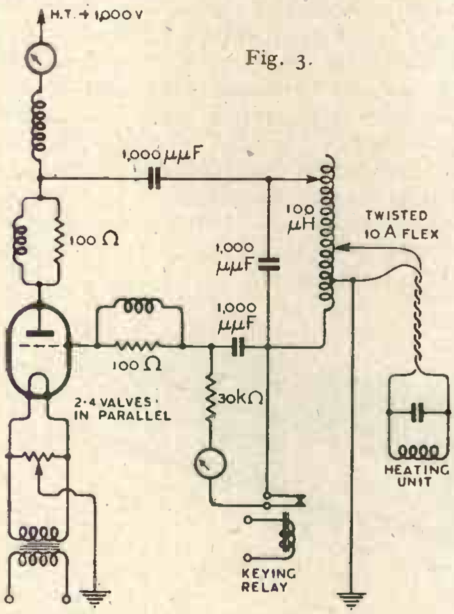


Fig. 3.

It was essential that the D.C. voltage should be kept off the tank circuit, and as an additional safeguard the circuit was split by means of an inductive tap which went to earth, consequently, in the event of a breakdown of any component it was quite impossible for H.T. voltage to appear on the tank coil, because, as will be disclosed, a mutual inductance tap arrangement was ultimately used to couple the heating coil and it was, of course, imperative that no danger of shock to the operator should arise.

In order to avoid short-wave spurious oscillation in the valves each grid and anode circuit included a 100-ohm 1-watt carbon resistance shunted by a small self-supporting coil of 16 gauge wire, the purpose of the latter being to carry the D.C. in the circuit.

The valves chosen for the R.F. generator consisted of four 100-watt valves designed for low-frequency amplification in public address systems which could be fairly readily obtained. These were not regarded as ideal valves for the purpose, but special valves for the R.F. working were much more difficult to obtain, and, as previously stated, almost any valve will operate as a generator at 0.5 Mc/s.

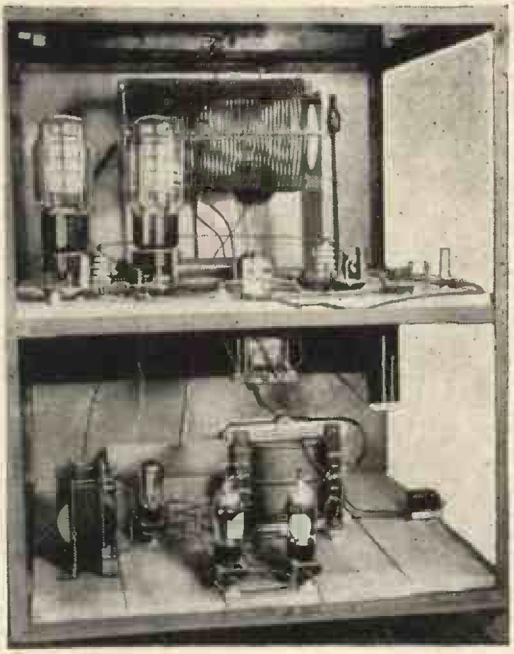
In order to obtain high conversion efficiency the valves were operated in the Class C condition of oscillation with a high value of negative bias on the grids, so as to make the anode operating angle very small. This bias was provided by the grid leak. Anode and grid current meters common to all valves were provided. In order to speed up the switching on and off as required for the particular operation a system of keying, much favoured by amateurs, was adopted, namely by interrupting the grid leak circuit by means of a relay and allowing the valves to back themselves off into the non-conductive region.

With the grid circuit open it was found that all oscillation ceased, and the static feed on the valves was very low. Test showed that the oscillator as described would comfortably light up six 100-watt household lamps to full brilliancy with an input of 0.8 ampere at 1,000 volts which represented a conversion efficiency of 75 per cent. Higher conversion efficiency might have been obtained but it was felt that the operation would tend to be critical if its efficiency was pushed any higher.

Final Design of Heating Coil

As a first attempt the coil previously described, constructed from ¼in. Litz conductor, was tried, and a measure of success was obtained, but the result was marred by the fact that the heating was too diffuse, so that the seal was heated up and frequently cracked.

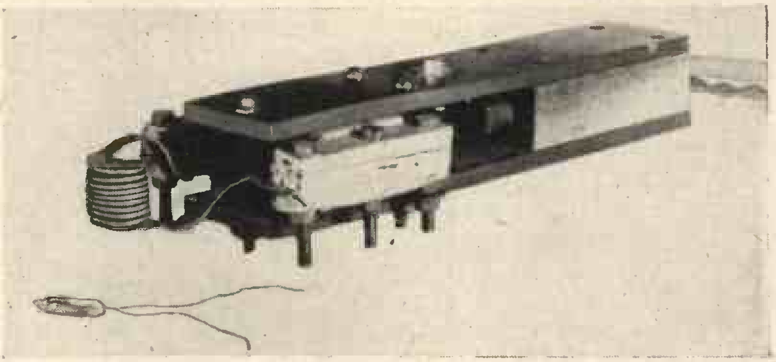
Attention was, therefore, turned to a fresh design of coil and it was decided to abandon the use of a stranded conductor because it was always liable to be burned out, and was not particularly robust. It was all very well for laboratory tests, but under practical



Interior view of H.F. generator with screens removed. Power unit is in lower section.

conditions, in the hands of not particularly skilled operators, it seemed likely to prove a source of trouble.

Moreover, the use of an L section to match the coil and its shunt condenser combination to the feeder proved over a period to be unsatisfactory, because, owing to the high Q of the circuit, the slightest change of frequency in the oscillator resulted in completely upsetting the loading conditions.



Complete heating coil and condenser unit. Note H.F. and relay cables coming into handle and press button to energise.

Further experiments directed to the production of a more practical coil revealed that if a circulating current of some 40 amperes was used, the required heating effect could be obtained with a heater coil of about 10 turns closely coupled to the work.* A coil was wound from 16 gauge bare copper wire, with the turns almost touching, and placed in series with a loading coil of some 10 μH to make the circuit more manageable. This coil was an immediate success in flashing the getter, but when several successive operations were carried out, the coil became red hot.

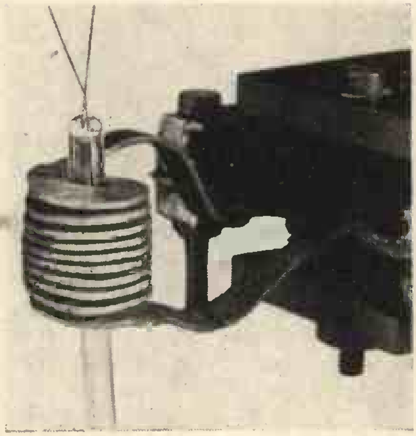
With this arrangement, the writers felt that all that remained was to produce a more rugged coil and to eliminate the loading coil which introduced unnecessary losses. Accordingly a coil was constructed consisting of 10 turns of $\frac{5}{16}$ in. $\times$ $\frac{1}{16}$ in. copper strip wound edgewise into a coil having an internal diameter of $\frac{5}{8}$ in. The turns of the resultant helix were separated by about $\frac{1}{32}$ in. so that the whole structure was no more than 1 in. in length and $\frac{15}{16}$ in. in outside diameter.

This coil was extremely rugged and of a pleasing design, but its inductance proved to be extremely low, viz., 0.35 μH. Nothing daunted, however, the writers shunted it by means of a 0.3 μF mica condenser which tuned it to resonance. The combination of coil shunted by condenser had a shunt resistance of 50 ohms which corresponded to an H.F. series resistance (composed of coil resistance, lead resistance and condenser losses) amounting to 0.02 ohm. This permitted a circulating current of 175 amperes for a dissipation of 600 watts, at which current the coil rapidly became red hot, but due to its rugged construction no harm was done. The final form of coil,

* (It should be noted that the resultant 400 A.T. was less than that produced in earlier experiments. The better coupling conditions to the neon tube, however, resulted in greater dissipation of energy in the work).

built with the shunt condenser into a convenient form for operation, is illustrated.

In actual practice, the resultant magnetic field caused the getter to flash in a fraction



Close-up of heating coil, gettering valve on pump.

of a second, so that it was found possible to reduce the number of valves in parallel in the generator from four to two. With the output thus reduced to 300 watts the desired flashing of the getter took place in about two seconds which was a convenient time. With the higher power there was danger of fusing the electrodes as well as cracking the seal.

Feeding the condenser-coil combination was simplicity itself, as having a shunt resistance of 50 ohms, it could be operated through a length of ordinary twisted 10 amp. flex, which was not too badly terminated. Moreover, being of negligible length compared with the wavelength, the radiation from it should be insignificant. The operating conditions for the flex were quite easy, as with a termination of 50 ohms a current of 2.45 amps, at a voltage of 120, flowed. Under these conditions I^2R and dielectric losses in the flex were extremely small and could be neglected.

Interference Tests

As previously stated a great deal of attention was paid, not only to screening, but to the arrangement of earth paths and to the inclusion of filters in all leads coming into the cabinet. The only leads which obviously could not be provided with filters were those comprising the twisted pair feeding the heating coil unit, but as explained, these leads were tolerably well terminated and carrying only a low voltage. The whole generator and power units were mounted in a cabinet consisting of an angle-iron framework with screwed-on copper panels. Ventilating apertures were screened with copper gauze of about $\frac{1}{16}$ in. mesh. Tests made by means of a calibrated receiver showed that radiation on the fundamental frequency was negligible and no appreciable trace of harmonics could be detected. This result was, needless to say, highly satisfactory and fully in keeping with the writers' recognition of the cardinal principle of avoiding interference at all costs.

Conclusions

Although the desired result had been fully realised and the experiment crowned with success from that point of view, the writers are far from satisfied with the very low overall efficiency of the device.

At the moment efficiency may not be a very serious consideration having regard to the effectiveness of the results obtained and considering the advantage under which the apparatus is operating in that it produces an effect which is difficult to obtain by any other means. In commercial terms, therefore, the process may be regarded as a success, at any rate in the present state of development of the technique of radio-frequency processing. As radio-frequency processes are introduced more widely into industrial activity, questions of efficiency, with their implications of power consumption and valve cost, will begin to assume serious significance.

Also the question of interference with radio communication, broadcasting and television will become more and more pressing. The writers, therefore, are convinced that the study of efficiency is most necessary even during the early days of radio-frequency processing, when its unique properties tend to outweigh all other considerations. If the efficiency of installations can be increased, then the powers required can be kept severely down with consequent advantage from both commercial and interference angles. With this aspect of the matter in view the writers hope to devote some time to the design of heating coils, as it is in this field that the most profitable line of advance seems to lie.

Such matters as the use of short-circuited step-down transformer features incorporated in the coils and the concentration of the magnetic field by means of low-resistance short-circuited turns, are some of the expedients that they hope to investigate.

SPACE CHARGE EFFECTS—

Between a Positive Grid and Anode of a Beam Tetrode

By G. B. Walker, M.A.

(Concluded from page 222, May 1945 issue.)

PART III

THE NATURE OF THE ELECTRON BEAM

Introduction

THE theory which we have developed is based on the assumption that in the electron beam there are no transverse electric forces, which in a valve of standard construction implies that there is no displacement of electrons in the direction of the y axis, i.e., parallel to the wires of the screen grid. In practice this can never be realised, for apart from the action of grid supports, earthed screens, etc., a spreading or scattering of the beam is caused by the mutually repulsive forces of the electrons.

We shall not endeavour to give a complete account of space charge effects in beams whose width is less than their length, but beam spread is of such importance to the working of ordinary valves that we must make at least a superficial study if the principal features in valve performance are to be appreciated.

Beam Spread due to Electron Mutual Repulsions

A simplified treatment of an electron beam of rectangular section has been given by Thompson and Headrick (*Proc. I.R.E.*, 1940). The following assumptions were made which, though too generous for the case in hand, allow some idea of the nature of the problem to be realised :

1. That there are no bodies in the vicinity of the beam, so that all electric forces with the exception of a longitudinal force are due only to the mutual repulsions of the electrons.
2. That the section of the beam is rectangular, the vertical side being very great compared with the width.
3. That at some plane normal to the beam all electrons have the same velocity and that normal to the plane. Further, it is assumed that the current density is constant over the section in this plane. We shall choose it as a reference plane.
4. That the speed v of an electron is given in the relation : $\frac{1}{2} . mv^2 = eV$.

Within the beam Poisson's equation must be satisfied, namely :—

$$\nabla^2 V = 4\pi\rho \qquad (61)$$

If the longitudinal force is neglected (the force in the x direction), then :

$$\frac{d^2V}{dy^2} = 4\pi\rho \qquad (62)$$

and so at the reference plane where ρ is constant we can integrate (12) and obtain :

$$\frac{dV}{dy} = 4\pi\rho y \qquad (63)$$ (where y is measured from the centre of the beam).

Let J be the total current per unit depth of the beam, then $J = 2y_0 i$ where $2y_0$ is the beam width, and we may write :

$$\rho = \frac{J}{2y_0\dot{x}} \qquad (64)$$

where $\dot{x}$ is the longitudinal velocity.

By substitution in (63) we obtain :

$$\frac{dV}{dy} = \frac{2\pi . J . y}{\dot{x} . y_0} \qquad (65)$$

We see at once (a) that the transverse force on the outermost electron does not depend on the width of the beam, and (b) that the transverse force at an internal point is proportional to y/y_0. We can deduce, therefore, that the charge density is constant over any parallel section of the beam in the subsequent motion (electrons being displaced in proportion to their initial distance from the centre of the beam). Thus equation (65) holds at any other plane parallel to the reference one. To determine the subsequent motion we may concentrate only on the outermost electrons for which throughout

$$\frac{dV}{dy} = \frac{2\pi J}{\dot{x}} \qquad (66)$$

Thompson and Headrick now introduce

the longitudinal force and assume that it affects $\dot{x}$ only. This is not correct, for it invalidates the integration of (61) which must now be written:

$$\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} = 4\pi\rho \quad .. \quad .. \quad .. \quad (67)$$

since V is a function of x and y. The magnitude of the error involved will be small only if the longitudinal force is small compared with the transverse force at the edge of the beam, and this presents an undesirable limit in further calculation.

To proceed we shall write that the longitudinal force on any electron is eF_x whence: $eF_x = m\ddot{x}$

and by integration and rearrangement:

$$\dot{x} = \dot{x}_0 + \frac{e}{m} \, . \, F_x \, . \, t$$

where $\dot{x}_0$ is the longitudinal velocity at the reference plane.

Returning now to equation (66) we can write the transverse equation of motion as follows:

$$\frac{dV}{dy} = m\ddot{y} = \frac{2\pi \, . \, e \, . \, J}{\dot{x}} = \frac{2\pi \, . \, e \, . \, J}{\dot{x}_0 + \frac{e}{m} \, . \, F_x \, . \, t}$$

which by integration subject to the condition $\dot{y} = 0$ when $t = 0$ provides the result:

$$\delta y = \frac{2\pi \, . \, m \, . \, J}{e \, . \, F_x^2} \, . \left[\dot{x}_0 - \dot{x} + \dot{x} \, . \, ln \frac{\dot{x}}{\dot{x}_0} \right] \quad .. \quad .. \quad (68)$$

where δy is the displacement of the outer electron when the longitudinal velocity changes from $\dot{x}_0$ to $\dot{x}$.

Let V_g be the potential at the reference plane and let V_a be the potential at a plane distance x_{2a}; then by (68) the displacement in travelling between these planes can be written:

$$\delta y = \frac{2\pi \sqrt{\frac{2m}{e}} \, . \, x_{2a}^2 \, . \, J}{(V_g - V_a)^2} \, . \left[\sqrt{V_g} - \sqrt{V_a} + \sqrt{V_a} \, . \, ln \sqrt{\frac{V_a}{V_g}} \right]$$

$$= \frac{190 x_{2a}^2 \, . \, J}{(V_g - V_a)^2} \, . \left[\sqrt{V_g} - \sqrt{V_a} + \sqrt{V_a} \, . \, ln \sqrt{\frac{V_a}{V_g}} \right] \quad .. \quad .. \quad (69)$$

where δy and x_{2a} are in mm.,

V_g and V_a are in volts,

J is in mA per mm. depth of beam.

If there is no longitudinal force,

$$\delta y = \frac{23.75 x_{2a}^2 \, . \, J}{V^{3/2}} \quad .. \quad .. \quad (70)$$

where V is the potential in the beam.

Formulae (69) and (70) are not enough to determine the spreading of the beam in an actual valve, but they give some indication of the amount to be expected.

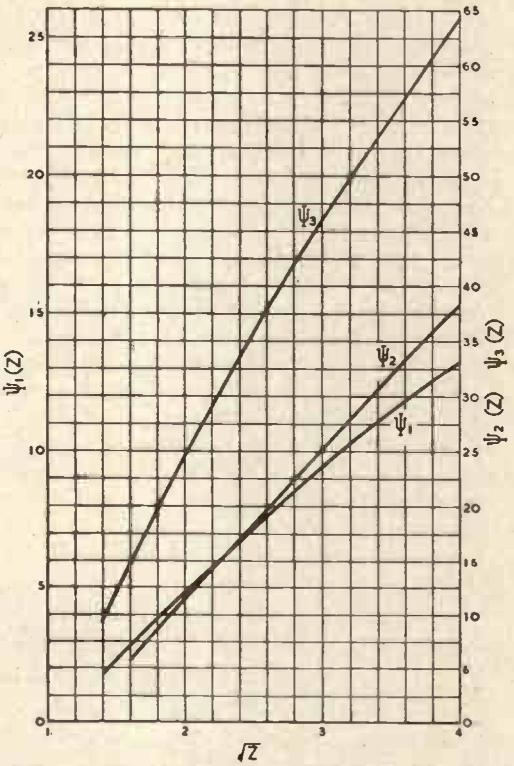


Fig. 14. *Graphs of the functions* Ψ_1, Ψ_2 *and* Ψ_3. *For:* Ψ_1 *and* Ψ_3, $Z = \frac{V_g}{V_T}$. *For:* Ψ_2, $Z = \frac{V_a}{V_T}$.

An objection has already been raised with regard to the treatment of the longitudinal force, and in this connection it is interesting to integrate (66) obtaining the relation:

$$\delta V = \frac{\pi J}{\dot{x}} \, . \, \frac{y^2}{y_0}$$

where δV is the potential difference between a point y and the centre of the beam.

In the previous units this can be written:

$$\delta V = \frac{47.5 \, J}{\sqrt{V^1}} \, . \, \frac{y^2}{y_0} \quad .. \quad .. \quad .. \quad (71)$$

where V^1 is the potential at the centre of the beam.

The value of δV in practical cases may be between 50 and 100 volts, which implies that the speed of the outermost electron is very different from that at the centre of the beam, and there is the possibility that the longitudinal velocity component at the edge may be greater or less than at the centre. If it be greater, then the beam spread should be less than as given by (69) and (70), but if it be less then it is possible for the outer electrons at some point to lose their forward velocity and return to the source. That is, the phenomenon of reflection which we have associated with the "knee" in the anode current characteristic may in certain cases be a feature of the electron beam brought about in quite a different way from that described in the earlier parts of this paper. The writer has seen no experimental evidence which supports this latter view, and indeed in all valves which have been examined it appears to be more likely that the outer electrons have a greater longitudinal velocity component than the inner ones, which being so allows the theory which has been developed to be applied at least to the centre portion of the beam, but the possible disintegration of the beam *per se* is a matter of too great importance to be dismissed without due consideration.

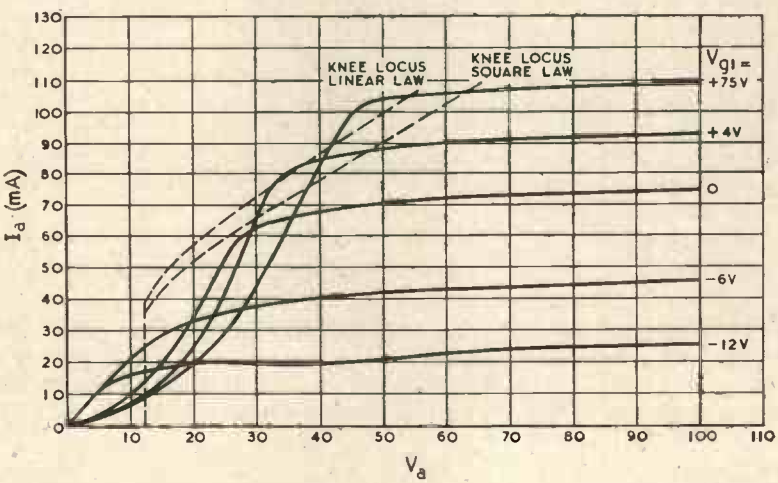


Fig. 15. *Calculated loci of the knee for the square and linear velocity distribution laws corrected for beam spread and superimposed on a family of $I_a - V_a$ characteristic curves for valve* (2).

Beam Spread at the Knee Anode Voltage

The condition under which we are most interested in the formation of the beam is when the anode voltage is at the "knee" value. By our previous hypothesis this implies that a potential minimum of value V_T is formed and there is no return of electrons to the screen. This still may be maintained, but it is necessary to realise that over a section of the beam parallel to the anode the potential is no longer constant, but increases toward the edge.

We shall assume that reflections first occur at the centre of the beam and endeavour to find an expression for the reduction in charge density due to beam spread.

In earlier parts of this paper we have only been concerned with electron displacement brought about by the deflecting action of the wires of the screen grid. Now we must consider displacements in a direction parallel to the wires of the screen brought about by the mutual electron repulsions. To distinguish between them, the former will be referred to as tangential displacements and the latter as transverse displacements.

We shall calculate the transverse displacement of an electron in much the same way as before, but there is a further factor worth taking into account, namely the effect of the screen and anode planes. At these planes the potential is constant throughout the beam and there can be no transverse field component, i.e., the planes act in such a way as to cancel to some extent the mutually repulsive forces of the electrons and therefore reduce the beam spread.

The following assumptions will be made:

1. That the longitudinal component of the field in the screen-potential minimum region is constant and has the value $\dfrac{V_T - V_g}{x_g}$.

In the potential minimum-anode region we shall again assume that the longitudinal component of the field is constant, but this time let its value be $\dfrac{V_a - V_T}{x_a}$.

2. To account for the transverse electric

force due to the interaction of the charge in the beam and the screen and anode planes we shall assume that a transverse force $F = \dfrac{2\pi e J}{x_g}$ acts on the outermost electron throughout the first region in opposition to the mutual repulsion forces. This value has been chosen since it is enough to cancel the transverse forces at the plane of the screen. In the potential minimum-anode region let F have the value $\dfrac{2\pi e J}{x_a}$ since this is enough to cancel transverse forces at the anode.

Proceeding as before, we can evaluate δy_g and δy_a the transverse displacements of the outer electron in the two regions. Strictly it is not the electron at the edge of the beam which we should refer to, but the outer electron of a central element in the beam, whence:

$$\delta y_g = \frac{95\, x_g^2 \,.\, J}{(V_g - V_T)^2} \cdot \left[\frac{V_g - V_T}{\sqrt{V_g}} - \sqrt{V_T} \,.\, ln \frac{V_g}{V_T}\right] \quad \ldots \quad (72)$$

and:

$$\delta y_g = \frac{190\, x_a \cdot J}{(V_a - V_T)} \cdot \left[\frac{x_a}{V_g - V_T}\left\{\sqrt{V_T} - \sqrt{V_a} + \sqrt{V_a} \,.\, ln\sqrt{\frac{V_a}{V_T}} - \tfrac{1}{2}\frac{(\sqrt{V_a} - \sqrt{V_T})^2}{\sqrt{V_a}}\right\}\right.$$

$$\left. + \frac{x_g}{V_g - V_T}\left\{ln\sqrt{\frac{V_g}{V_T}} - \frac{\sqrt{V_g} - \sqrt{V_T}}{\sqrt{V_g}}\right\}(\sqrt{V_a} - \sqrt{V_T})\right] \quad \ldots \quad (73)$$

To simplify (72) and (73) they have been rewritten:

$$\delta y_g = \frac{x_g^2 \,.\, I}{V_g^{3/2} \,.\, l} \cdot \Psi_1\left(\frac{V_g}{V_T}\right) \quad \ldots \quad (74)$$

$$\delta y_a = \frac{x_a \,.\, I}{l} \cdot \left[\frac{x_a}{V_a^{3/2}} \cdot \Psi_2\left(\frac{V_a}{V_T}\right) + \frac{x_g}{(V_g - V_T)(\sqrt{V_a} + \sqrt{V_T})} \cdot \Psi_3\left(\frac{V_g}{V_T}\right)\right] \quad \ldots \quad (75)$$

The functions Ψ_1, Ψ_2, Ψ_3 have been graphed, Fig. 14.

The Knee Locus corrected for Beam Spread

By means of δy_g and δy_a we may make a correction in the knee locus as calculated earlier.

Previously i was given as $i = \dfrac{I}{2lb}$, but now the beam broadens from b to $(b + 2\delta y_g)$ in the distance x_g, so it seems reasonable to take the current density in this region as

$$i_1 = \frac{I}{2l(b + \delta y_g)}$$

Likewise between the potential minimum and anode we may take as the corrected value of current density

$$i_2 = \frac{I}{2l(b + 2\delta y_g + \delta y_a)}$$

In evaluating δy_g and δy_a it is necessary to know x_g, x_a and V_a, whereas these quantities are themselves dependent on the beam spread. The uncorrected values may be used since they do not change by much, and a high degree of accuracy is not to be expected.

Corrected curves of the knee locus for valve (2) are given in Fig. 15. It will be noted that the slope is now nearer the observed slope.

The Effect of Beam Spread and Other Factors on the $I_a - V_a$ Characteristic Curve

The effect of beam spread on the shape of the $I_a - V_a$ curve below the knee is very much more difficult to determine. We have already remarked that the potential over a section of the beam at the potential minimum is not constant but increases toward the edge, and we are no longer able to state that the current reaching the anode is $\dfrac{V_m}{V_T} . I$ or $\sqrt{\dfrac{V_m}{V_T}} , I$ for the square and linear velocity distribution laws respectively when $V_m < V_T$. This is not an objection to the calculation of the knee anode voltage with beam spread, for it is still true that electrons begin to be reflected back to the screen when $V_m = V_T$; all that is in doubt is the quantity reflected.

To complicate matters further, those electrons which are reflected must receive a large transverse velocity component since at the instant of reflection their forward velocity component is zero. It is possible, therefore, that the greater part of the reflected electrons return to the screen outside of the main beam.

We shall not attempt to estimate these effects, but we can state with certainty that they must act in such a way as to allow a higher anode current to be passed than was given in the previous calculation.

When $V_m > V_T$ the effect of beam spread is less, for as V_m increases the time of transit of electrons becomes shorter, that is, they are under the influence of transverse forces for a shorter time and these forces themselves are diminished since the space charge density is less.

We may expect little change in the curve, Fig. 12 (Part II), to the right of the point A, but to the left, the maximum at B must be reduced and might even disappear. In terms of Fig. 13 (Part II) we may expect the points A and K to converge, the current curve below K to increase and the regression at B to disappear. That is, beam spread acts in such a way as to reduce the region of instability, and in certain cases there may be no discontinuity in the $I_a - V_a$ characteristic curve.

There are two other factors which are of importance to the shape of the $I_a - V_a$ characteristic curve, namely :

1. The internal resistance of the valve.
2. Secondary emission.

In all calculations it has been assumed that the anode voltage has no effect on the current crossing the screen in the anode direction, or, in other words, that the screen effectively shields the anode from the rest of the valve.

This in no way affects calculations of the knee locus, since at the knee all electrons reach the anode, and it is therefore of no consequence that the current crossing the screen is a function of the anode voltage. On the other hand, if we concentrate on a particular characteristic, it is important to the shape of the curve if the current crossing the screen is dependent on the anode voltage.

The equations (55), (56) and (57) set out previously can no longer be solved in a simple manner, for the first two now depend on V_a. A solution might still be effected if I were a linear function of V_a, which it is for V_a greater than the knee, but when electrons begin to be reflected I is related to V_a in a more complex fashion. Electrons then approach the screen in all directions, and there is the possibility that some may interlace between the wires of the screen before being collected by it, reducing the field at the cathode produced by the screen.

In the limiting case the potential minimum remains at the value V_T as the anode voltage is reduced below the knee value and $I_a - V_a$ curves have the knee locus as an envelope, approaching that line at points determined solely by the setting of the control grid bias (see Fig. 16). It is unlikely that this condition could ever be achieved in practice

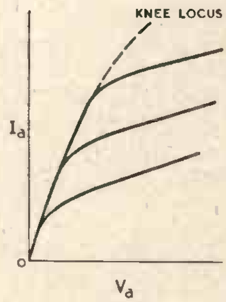


Fig. 16.

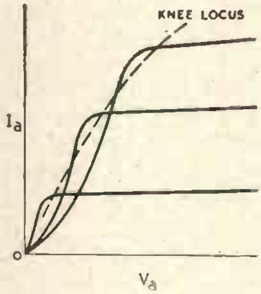


Fig. 17.

The effect of the internal resistance of the valve on the way in which the $I_a - V_a$ curves approach the knee locus. Fig. 16 shows a valve with a very low resistance, and Fig. 17 a valve with high internal resistance.

(involving, as it would, no increase in screen current below the knee anode voltage), but the fact remains that at an anode voltage below the knee a decrease in the current crossing the screen will cause an increase in the current reaching the anode, and calculations which do not account for the reduction of I with V_a must give low values of I_a below the knee.

In Fig. 17 a family of curves is sketched of the kind to be expected from a valve in which the anode potential has little effect on the cathode current. The knee locus is chosen to be the same as in Fig. 16.

The effects of secondary emission from the anode are well known at a low current density and low anode voltage, for it merely causes a depression in the observed anode current. This depression generally occurs near the knee anode voltage for the simple reason that there is no retarding field at the anode and secondary electrons are able to cross to the screen. With high cathode currents the knee anode voltage may be quite great and the potential minimum V_T considerably less than V_a. Secondaries now enter a retarding field and are returned to the anode whereby the observed anode current is not affected. The current value at which suppression begins to take place is the critical current value mentioned earlier when the knee anode voltage is equal to V_r. This current value is of supreme importance in the design of the valve, for whereas a low value is desirable for suppression, it marks the current above which the knee voltage increases, and to obtain power with high plate efficiency it is necessary that high currents can be passed at low anode voltages, that is, that the knee anode voltage is low.

The contribution of secondary electrons to the space charge near the anode tends to counteract the reduction in density due to beam spread. We may deduce therefore that at high values of anode current secondary emission from the anode is liable to promote the unstable situation before mentioned which, though not entirely due to secondary emission, is without doubt aggravated by it.

Acknowledgments

The work which is set out was done in the factory of the Mullard Radio Valve Co. Ltd., and the writer is indebted to many members of the staff for their kindness. In particular he would thank Dr. J. D. Stephenson for granting permission that the work be published and for his encouragement.

A debt of deep gratitude is owing to Mr. K. G. D. Williams for his untiring assistance at all stages in the preparation of this paper, in particular with regard to numerical integrations and the preparation of figures.

BOOK REVIEWS

Report of the Cambridge Joint Advisory Committee for Mathematics.

Syllabuses for Examinations taken by Sixth Form Pupils. Pp. 11. Cambridge University Press, 200, Euston Road, London, N.W.1. Price 6*d*.

This Report sets out four detailed syllabuses entitled respectively subsidiary, ordinary, further, and higher mathematics. These are all supposed to cover a two-year course following the ordinary school certificate and leading up to the higher school certificate. The subsidiary course is for Arts courses which "include mathematics for its cultural value." The ordinary course is suitable when mathematics is taken as a principal subject in the higher school certificate. Further mathematics is suitable for students with a special aptitude for the subject and who may compete for university scholarships in it. The same may be said of the higher course only more so ; it may be regarded as equivalent to two principal subjects. An interesting detail of the subsidiary and ordinary courses is that alternative syllabuses are given, the one being pure mathematics with mechanics and the other, pure mathematics with statistics ; although in the ordinary course some mechanics is included in the latter alternative. The report shows that the committee realise the undesirability of over-specialisation at school ; it expresses the hope that the Colleges will plan their mathematical scholarship examinations so as not to give too much weight to advanced work. There is one statement in the Report which might well have been printed in specially large type ; it is as follows : "We are led to believe that University teachers of mathematics prefer undergraduates who have had a broad course of sixth-form work ; an excess of mathematics at school is an evil if it excludes a good grounding in some other subject such as physics, facility in writing one's own language or the ability to read others."

G. W. O. H.

Quality Through Statistics

By A. S. Wharton, F.S.S., A.I.I.A. Pp. 60 + iv with 16 illustrations. Philips Lamps Ltd., Century House, Shaftesbury Avenue, London, W.C.2. Price 6s.

The author is Technical Adviser–Statistics to Philips Lamps, and this book is claimed to incorporate the results of experience in the factories of the Philips Group and elsewhere. It is stated that this is an attempt to deal with the subject from a new angle, and to explain Quality Control in a simple manner which will be understood by the inexpert reader.

In the opinion of the reviewer the attempt has failed. This small book is no easier to read than any of the other basic texts on Quality Control, and indeed the effort to avoid analysis leads to some confusion, as on page 11, where a simple formula is strung out in words. It is necessary at times to refer back to other works to find what the author means. Thus, in Part I, in the description of the Philips' Tables for use where the process average is not known, a quantity described as Control per cent. is introduced. It is not clear whether this is the "lot tolerance per cent. defective" or the "average outgoing quality limit." This failure to define the terms used persists throughout the book.

On page 18 a table is printed which does not agree with Table IV of Dr. Sealy's work *; the B.S.I. Committee has surely evolved rules for the selection of integers for this purpose. The diagram which follows, although substantially the same as Figure 23 of B.S.600 R, omits the lower curves. The table on page 34 appears to give instructions which conflict with Table 10 of B.S.600 R, and Table I of Sealy.

These examples of conflicts are of importance. It

* "A First Guide to Quality Control for Engineers." Ministry of Supply.

is important in introducing Quality Control that the foreman, inspectors and shop stewards should understand what is going on. If there is any confusion about detail the Works Relations problem is greatly accentuated.

In Part III there is an account of a Quality Bonus system which has been introduced. At first sight this is attractive, but the conflicting claims of Quality and Production Bonuses are not adequately discussed. The rates must be so adjusted that it is not possible to make more profit by abandoning the whole of one to gain a maximum of the other.

Perhaps the most serious omissions are these: there is no discussion of the necessary gauging accuracy, which may materially affect the working of a control system, and the special problems of machines which are too accurate or not accurate enough are not mentioned. Another special problem arises when a machined part can be salvaged if it fails on upper limits.

As a guide to Quality Control in the factory this book does not appeal to me, especially as the price is rather high. There is another aspect which demands some notice. The author attributes our failure to compete successfully in world markets in 1920–40 to a neglect of Quality. An alternative explanation is that our factories were overburdened with non-productive staff. Wholesale Quality Control may mean new armies of inspectors and clerks to swell the overheads. An economic survey of the cost of control is needed much more urgently than new elementary descriptions. H. J.

Books Received

Elementary Principles of Wireless

By W. E. Flood, M.A. An endeavour is made in this little book to explain, in a simple straightforward manner, the basic principles of wireless transmission and reception. At the end of some of the 13 chapters a few exercises are suggested. Pp. 88; 43 figures. Longmans, Green & Co., 43, Albert Drive, London, S.W.19. Price 1s. 6d.

Lewis's Medical, Scientific and Technical Lending Library (Catalogue)

The aim of this catalogue, the last edition of which was published in 1937, is to provide subscribers to Lewis's Lending Library with the titles of books available. Part I, the index to authors and titles occupies 714 pages, an increase of 164 pages on the previous edition. Part II, which occupies 208 pages, is a classified index of subjects with the names of authors who have written on them. It is estimated the catalogue includes about 24,000 titles. Pp. 922 + viii (Demy 8vo). H. K. Lewis & Co., Ltd., 136, Gower Street, London, W.C.1. Price 12s. 6d. to subscribers, 25s. to non-subscribers.

Literature

Metallised bushes for hermetically sealed components are described in leaflet No. 18 from Steatite and Porcelain Products, Stourport-on-Severn, Worcs.

A descriptive brochure of the operation and applications of some of the Clayflex flexible bearings has been compiled by Clayflex, Ltd., Teddington Road, Stratford-on-Avon.

Standard Frequency Transmissions

THE B.B.C. has announced that four of its transmission frequencies are now controlled within $\pm$ 1 part in 10^6 of the nominal frequency and can, therefore, be employed as reference standards.

The frequencies are 200, 6180, 9510 and 17,810 kc/s and reception of one or other of them should generally be possible anywhere in the world for a period each day. Transmission hours may change with alterations in B.B.C. services, but the present GMT schedule is:—

200 kc/s	0400—1330	1430—0045	
6,180 kc/s	0400—1330	1430—2215	2230—0045
9,510 kc/s	0400—0800	1730—0215	
17,810 kc/s	0900—1515		

Trigonometrical Tables

A NEW book on trigonometrical tables giving six-figure logarithms of numbers. antilogarithms and logarithms of the six trigonometrical ratios for every minute of the angle has been produced by the Trade School of the Ford Motor Company. Copies of this 128-page book are obtainable from the Ford Motor Company, Dagenham, Essex, price 3s., post free. A companion volume, giving the six-figure table of natural trigonometrical functions and formulae is also available, price 1s. 6d.

Power Level Indicators

MUIRHEAD and Company ask us to draw readers' attention to two errors which they regret appeared in their advertisement in the May issue. The accuracy of the power-level indicators mentioned is independent of waveform and frequency up to 50 kc/s (not 53 kc/s). The input resistance of Type D–152–A in the table should read 600 $\Omega \pm$ 1%.

Dr. E. B. Moullin

A CHAIR of Electrical Engineering has been established at Cambridge University and the first occupant is to be Dr. E. B. Moullin, who is at present Donald Pollock Reader in Engineering Science at Oxford University.

Dr. Moullin is an M.A. of both Cambridge and Oxford. He was a lecturer at the former from 1920–1929 during which time he laid out and equipped the electrical laboratory.

The Chair has been established under the auspices of the I.E.E. of which Dr. Moullin is a Vice-President. He is also a member of the Radio Research Board and was Chairman of the I.E.E. Wireless Section in 1939–40.

Bowen Trust

AS a result of a gift from Mr. W. Bowen, governing director of the Bowen Instrument Co., the Scientific Instrument Manufacturers' Association has founded a Trust Fund, the income from which is to be devoted to the "encouragement and development of invention, design, research, processes and manufacturing technique in the scientific instrument manufacturing industry."

Prizes will be awarded annually to employees of members of the Association submitting papers not exceeding 3,000 words, fulfilling the objects of the Trust.

For this year the Council will award a prize to the value of £25 in each of the five sections covering different types of instrument. Papers must deal with a new invention, an improvement of design, an improvement in manufacturing technique, or a new development or new process arising from research.

Further particulars are available from the Secretaries, Messrs. Binder, Hamlyn & Co., 12/13, South Place, London, E.C.2.

I.E.E. Report

IT will be seen from the Council's Report presented at the 73rd Annual General Meeting of the I.E.E. on May 10th that a considerable amount of work is being undertaken by special committees in preparation for post-war developments.

Among the new or reconstituted committees are those on Research, Radio Interference and Radio Requirements for Civil Aircraft.

Following recommendations from the Post-War Planning Committee, a permanent Research Committee has been set up with the following terms of reference :—

"To advise the Council in matters connected with electrical research which affect the Institution, to assist in the selection of Institution representatives on external bodies concerned with research, to help such representatives, and when necessary to provide liaison between them and the Council on matters of policy."

In response to a request from the Postmaster-General the Committee on Electrical Interference, whose Report as the Committee on Radio Interference was made in 1936, has been reconstituted. The chief task of the new committee is to review the recommendations contained in the earlier report ; and to consider the desirability of modifications resulting from the introduction of new forms of high-frequency equipment. The Committee will also consider whether the adoption of a system for the voluntary, as distinct from the compulsory, use of an interference-free mark will be likely to bring about a substantial control of interference with radio reception.

At the request of the Air Ministry the Council has set up a committee to formulate technical air-worthiness requirements for the design and installation of radio equipment in civil aircraft. The regulations will define the requirements to be met in the design and installation of this equipment.

The I.E.E. Report records that there has been a further increase in the number of members elected during the past year, the total for all classes being 2,639. There are at present 12,568 Corporate Members. The total membership is 26,665, an increase of 2,107. It is pointed out that the formation of local radio groups has resulted in a noticeable increase in the membership of the Radio Section, which is now over 2,600.

Back Numbers

COPIES of *Wireless Engineer* for the months of January, February and March, 1945, are urgently required by our Publishers. Will any readers who are prepared to dispose of these issues please communicate with our Publishers ?

CORRESPONDENCE

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

Frequency Modulation

To the Editor, "Wireless Engineer"

SIR,—My letter in your February issue was intended as a contribution to the controversy between F.M. and wide-band A.M. plus limiter. The point which I wished to make clear was that the popular generalisation, "F.M. is of no value if the interference is stronger than the signal," is not applicable to impulsive interference.

Messrs Gladwin and Thompson (April issue) are, of course, in agreement with me on this. The increase in audible output resulting from the increased duration of the rectified output from pulses of very large amplitude is a phenomenon which must occur in any system, whether F.M. or A.M., in which limiting takes place after the signal has passed through resonant circuits.

The only point at issue is whether the minimum noise output in the presence of carrier to which the receiver is accurately tuned is negligible. It was suggested at a recent I.E.E. meeting that there is a wide variation between the responses of different receivers to impulsive noise. It would be interesting to know whether the observations of Messrs. Gladwin and Thompson cover both wide-band and narrow-band receivers. It appears to me that the effect of a strong impulse superimposed on a carrier symmetrically placed in the pass-band of the receiver, can at most produce a phase change of 180 degrees. Regarded as a phase modulation, this will be of small amplitude in most practical systems. There will, of course, be a frequency modulation corresponding to the abrupt transition on the commencement of the pulse, but this will represent a very narrow pulse lasting perhaps one cycle of the intermediate frequency, and should therefore contain very little energy.

London, N.21. D. A. BELL.

Deflected Electron Beams

To the Editor, "Wireless Engineer"

SIR,—Mr. Harries, in your April issue, should not be surprised that I contend that the deflection power becomes zero when the frequency becomes zero, as it is a point which I have stressed in your columns several times. Its certitude is too impregnably founded on simple dynamical theory to admit any doubt.

New Barnet, Herts. S. RODDA.

Change of Address

THE address of the Radio Industry Council and that of Radio Manufacturers' Association, Radio Manufacturers' War Export Group, British Radio Equipment Manufacturers' Association and the Inter-Services Component Manufacturers' Council is now 59, Russell Square, London, W.C.1 ; telephone, Museum 6901–5.

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

566 162.—Microphone of the capsule type with a moulded plastic granule chamber provided with a metallic inset for the diaphragm.

Ericsson Telephones Ltd.; B. O. Anson; and S. H. D. Ward. Application date 14th July, 1943.

566 221.—L.F. transformer wound on a three-limbed core according to formulae which determine the relative proportions of core to core for given cross-sections.

P. F. Roberts. Application date 2nd July, 1943.

566 398.—Mounting and sealing the drive unit in the throat of a horned loudspeaker for out-door working.

G. R. Fountain Ltd.; H. J. Houlgate; and G. C. Wheeler. Application date 21st June, 1943.

566 524.—Circuit for testing the static or dynamic performance of push-pull variable-gain L.F. amplifiers.

Marconi's W.T. Co. Ltd. (assignees of J. W. Bayliss). Convention date (U.S.A.) 26th June, 1942.

566 551.—Valve circuit with a fixed-frequency interrupter or "chopper" in the input, for amplifying very small direct currents.

A. Graves; T. J. Dawes; and Alltools Ltd. Application date 16th Aug., 1943.

566 642.—L.F. transformer assembled from component parts which are all designed for compact storage in quantity.

C. Cutler and Metropolitan-Vickers Electrical Co. Ltd. Application date 11th October, 1943.

566 903.—Non-linear resistance element arranged to operate as a selective low-frequency relay.

Automatic Telephone and Electric Co. Ltd. and T. G. Rice. Application date 13th July, 1943.

DIRECTIONAL WIRELESS

566 114.—Optical system for evenly illuminating the dial, say, of a radio direction finder at night.

Marconi's W.T. Co. Ltd. and J. H. Moon. Application date 24th March, 1943.

566 169.—Means for exciting the different aerials of a radio-navigational transmitter in predetermined phase-relation.

Standard Telephones and Cables Ltd. and A. J. Maddock. Application date 3rd July, 1942.

566 172.—Phase-reversing switch for the aerials of a radio beacon giving a blind approach path (addition to 562 853).

Standard Telephones and Cables Ltd. and L. J. Heaton-Armstrong. Application date 10th November, 1942.

566 286.—Cathode-follower valve for coupling, matching, and balancing aerials, particularly in directional receivers of the Adcock type.

J. E. Rhys-Jones and The Plessy Co. Ltd. Application date 14th October, 1942.

RECEIVING CIRCUITS AND APPARATUS

(*See also under Television*)

566 100.—D.C.-A.C. converter in which the transformer is wound in such a way as to reduce sparking across the interrupter contacts, and consequent radio "noise."

Marconi's W.T. Co. Ltd. and H. Haywood. Application date 8th June, 1943.

566 135.—Switch-tuned receiver wherein the station selector automatically effects a change-over to band-spreading on the short-wave range.

Philips Lamps Ltd. (communicated by N. V. Philips' Gloeilampenfabrieken). Application date 6th May, 1940.

566 209.—Super-regenerative receiver in which the use of a high quenching frequency is combined with optimum amplification without signal distortion.

Ferranti Ltd.; M. K. Taylor; and I. N. Vaughan-Jones. Application date 1st June, 1943.

566 255.—Receiver for frequency-modulated signals wherein a local oscillator, operating at a sub-harmonic of the signal frequency, serves as a detecting device.

Philco Radio and Television Corp. (assignees of C. T. McCoy). Convention date (U.S.A.) 13th June, 1942.

566 540.—Receiver in which the selectivity of the input circuit is automatically varied with any adjustment of the gain or volume control.

Marconi's W.T. Co. Ltd. (assignees of A. D. Zappacosta). Convention date (U.S.A.) 29th June, 1942.

566 634.—Receiver for frequency-modulated signals in which an I.F. coupling transformer with a double-humped resonance curve is utilised to increase gain and selectivity.

Philco Radio and Television Corp. (assignees of the Administratrix of the late C. Travis). Convention date (U.S.A.) 2nd July, 1942.

566 703.—Variable condenser in which the periphery of one of the plates is formed with elements that can easily be broken-off to facilitate ganging.

The Mullard Radio Valve Co. Ltd. and C. E. Maitland. Application date 1st July, 1943.

566 895.—Valve circuit with feed-back and phase-change elements, for delivering a direct current free from random voltage fluctuations, and capable of wide adjustment by potentiometer control.

B. M. Hadfield. Application date, 10th June, 1943.

566 906.—Crystal-controlled wavemeter device adopted to be incorporated in a superhet receiver for checking or indicating the frequency of the incoming signal.

A. C. Cossor Ltd. and A. H. A. Wynn. Application date 14th July, 1943.

TELEVISION CIRCUITS AND APPARATUS

For Transmission and Reception

566 429.—Television system in which the studio is illuminated by fluorescent instead of incandescent lamps, without prejudice to the resulting picture.
Marconi's W.T. Co. Ltd. (assignees of O. H. Schade). Convention date 27th July, 1942.

566 669.—Reducing echo effects in television by periodically changing the carrier frequency so as to introduce alternate gains and losses in phase during the blanking interval.
Philco Radio and Television Corpn. (assignees of D. B. Smith). Convention date (U.S.A.) 5th May, 1942.

566 835.—Television scanning circuit in which the damping tube used for controlling the current in the deflection coils is combined with a passive network shunted across the coils.
Marconi's W. T. Co. Ltd. (assignees of O. H. Schade). Convention date (U.S.A.) 30th June, 1942.

566 877.—Saw-toothed oscillator for a C.R. tube in which the power supply is drawn from two separate D.C. sources under a regulated control to prevent waste of energy.
Marconi's W. T. Co. Ltd. (assignees of O. H. Schade). Convention date (U.S.A.) 30th May, 1942.

TRANSMITTING CIRCUITS AND APPARATUS

(*See also under Television*)

566 071.—A.C. regulating system in which valves reversely connected in parallel, operate automatically to offset voltage fluctuations in the supply line.
L. H. Paddle and M. E. Barth. Application date 5th March, 1943.

566 471.—Moving-contact converter for the smooth rectification of polyphase current.
M. Widakowich. Convention date (Sweden) 5th September, 1942.

566 556.—Frequency-modulating apparatus wherein the "flywheel" circuit comprises two critically-coupled and normally equally-tuned circuits, and a reactance which is varied by the signal.
The General Electric Co. Ltd.; M. R. Gavin; and V. A. Heathcote. Application date 27th August, 1943.

566 576.—Condenser-discharge circuit comprising a gas-filled valve and an iron-cored inductance for generating oscillations suitable, say, for diathermy.
Durham Cables Ltd. and N. Steel. Application date 1st April, 1943.

566 841.—Push-pull H.F. amplifier with a cross-coupling network for neutralising the effect of R. F. voltages induced across the connecting leads.
Standard Telephones and Cables Ltd. (assignees of H. Romander). Convention date (U.S.A.) 24th August, 1942.

566 844.—Impedance-inverting device, such as a quarter-wave transmission line, or a balanced T- or Pi-network, for preventing distortion in Class C modulating amplifiers.
Standard Telephones and Cables Ltd. (assignees of H. Romander). Convention date (U.S.A.) 16th November, 1942.

566 852.—Method of inter-connecting sections of H.F. coaxial transmission lines, and of making fixed or rotatable right-angled joints.
Bruno Patents Inc. Convention date (U.S.A.) 16th March, 1942.

566 987.—Impedance network for deriving quadrature voltages from an oscillator, particularly in frequency-modulating systems.
Philco Radio and Television Corpn. (assignees of the administratrix of C. Travis). Convention date (U.S.A.) 2nd July, 1942.

SIGNALLING SYSTEMS OF DISTINCTIVE TYPE

566 259.—Anti-fading signalling system in which an unmodulated wave of a given frequency and amplitude is mixed with a second modulated wave of different frequency and lower amplitude.
Marconi's W.T. Co. Ltd. (assignees of C. W. Hansell). Convention date (U.S.A.) 26th June, 1942.

566 278.—Device for detecting infra-red rays by their effect on the dielectric constant of zinc or cadmium sulphides.
S. Rothschild and Cathodeon Ltd. Application date 21st June, 1943.

566 785.—Removing undesired reflection effects from the desired echo signal in pulsed systems of radio exploration.
Standard Telephones and Cables Ltd. and E. H. Ullrich. Application date 11th April, 1941.

566 829.—Control device for a system in which an oscillator of variable frequency is regulated through a frequency discriminator by a second oscillator generating one or more standard frequencies.
The General Electric Co. Ltd.; B. C. L. Angell; and J. B. L. Foot. Application date 10th June, 1943.

CONSTRUCTION OF ELECTRONIC-DISCHARGE DEVICES

566 067.—Cathode-ray oscillation generator in which secondary electrons released by the main stream are caused to vibrate about an auxiliary grid in the Barkhausen-Kurz manner.
Flowerdale Ltd.; A. Perelmann; and L. Young. Application date 11th February, 1943.

566 225.—Means for attaching a lead-out conductor to an electrode of a vacuum tube.
Standard Telephones and Cables Ltd. (assignees of L. C. Goodale). Convention date (U.S.A.) 27th August, 1942.

566 300.—Construction of electric discharge tube, particularly designed to reduce the Faraday "dark space" before the positive-column glow.
The British Thomson-Houston Co. Ltd. Convention date (U.S.A.) 21st April, 1942.

566 364.—Electrode assembly of a transmitter valve of small dimensions for high-powered working.
Standard Telephones and Cables Ltd. (assignees of C. V. Litton). Convention date (U.S.A.) 6th June, 1942.

566 374.—Method of making multiple metal-to-glass seals, under non-oxidising conditions, in the manufacture of electron discharge tubes.
The Mullard Radio Valve Co. Ltd. and L. M. Myers. Application date 17th August, 1942.

566 542.—Construction of four-electrode discharge tube, incorporating a resonant cavity, for ultra-high-frequency work.
The British Thomson-Houston Co. Ltd. (communicated by The General Electric Co.). Application date 19th July, 1943.

566 651.—Construction, spacing, and alinement of the electrodes of a cathode-ray tube designed for velocity modulation.
Standard Telephones and Cables Ltd. (communicated by Western Electric Co. Inc.). Application date 28th March, 1942.

566 902.—Construction and assembly of the electrode system of a "metal" transmitting valve.
Marconi's W. T. Co. Ltd. (assignees of H. R. Seelen). Convention date (U.S.A.) 11th July, 1942.

SUBSIDIARY APPARATUS AND MATERIALS

566 021.—Multiple-contact electrode for reducing the shunt capacitance across a piezo-electric oscillator.
Marconi's W.T. Co. Ltd. (assignees of W. R. Koch). Convention date (U.S.A.) 4th June, 1942.

566 022.—Pulse generator and cathode-ray indicator for locating faults, by reflection effects, in signal transmission and other electric cables.
Standard Telephones and Cables Ltd. and L. E. Weaver. Application date 4th June, 1943.

566 031.—Stabilising a D.C. source by mixing the output from a standard local oscillator with that from a valve whose frequency varies with the voltage to be controlled.
G. S. P. Scantlebury. Application date 27th March, 1943.

566 102.—Frequency-dividing circuit in which the two control grids of a pentode are alternately biased to cut-off under the timing of a condenser discharge circuit.
R. Calvert; G. G. Gouriet; and E. Davies. Application date 23rd June, 1943.

566 105.—Wheatstone bridge for rapidly indicating whether a resistance falls within a tolerated margin of its reputed value.
Radio Gramophone Development Co. Ltd.; C. F. Marriott; and D. H. J. Taylor. Application date 23rd August, 1943.

566 156.—Impulse-counting circuit comprising a series of cold-cathode gas-filled three-electrode discharge tubes.
Standard Telephones and Cables Ltd.; F. H. Bray; and L. R. Brown. Application date 11th June, 1943.

566 200.—Resistance-capacitance integrating device, in which a cathode-follower valve serves to offset any non-linearity due to voltage build-up on the condenser.
F. R. Milsom; Furzehill Laboratories Ltd.; and S. Smith and Sons (Motor Accessories) Ltd. Application date 27th March, 1943.

566 215.—Biasing and regulating arrangement for a frequency-dividing or time-base circuit of the three-valve type.
R. Calvert; G. G. Gouriet; and E. Davies. Application date 23rd June, 1943.

566 279.—Coupling piece for metallic pipes in which provision is made for electrically bonding or earthing the system.
A. S. Green; T. Astley; and R. Birchenough. Application date 14th October, 1943.

566 465.—Push-pull frequency multiplier in which the grids are fed in quadrature, and are also dephased from the supply, to generate "even" harmonics.
Standard Telephones and Cables Ltd. (assignees of B. M. Charchian). Convention date (U.S.A.) 27th October, 1942.

566 449.—Magnetic stator and rotor elements of a device for giving remote indications of quantities or measurements.
Sangamo Weston Ltd. Convention date (U.S.A.) 18th February, 1942.

566 492.—Cement of powdered copper and a synthetic resin for making electric connection to condenser plates, or to graphite-coated resistance.
Philips Lamps Ltd. (communicated by N. V. Philips' Gloeilampenfabrieken). Application date 24th May, 1940.

566 515.—Piezo-electric oscillator with an inductive shunt which is designed to increase the natural impedance of the crystal at anti-resonance.
The General Electric Co. Ltd. and A. J. Biggs. Application date 12th May, 1943.

566 549.—Piezo-electric crystal mounted as a combined grip-and-electrode unit which allows the crystal limited movement.
Marconi's W. T. Co. Ltd. (assignees of E. M. Washburn). Convention date (U.S.A.) 12th August, 1942.

566 559.—Construction of non-inductive resistance, particularly for high-voltage circuits.
The British Thomson-Houston Co. Ltd. and H. E. Cox. Application date 8th September, 1943.

566 833.—Process for making a selenium cell wherein the so-called blocking layer is deposited electrolytically.
Standard Telephones and Cables Ltd. (assignees of A. von Hippel; M. C. Bloom; and J. H. Schulman). Convention date (U.S.A.) 24th June, 1942.

566 843.—Transmission-line device for measuring reactance and resistance values at ultra-high frequencies.
The British Thomson-Houston Co. Ltd. Convention date (U.S.A.) 15th September, 1942.

566 927.—Electrode system to permit large articles to be subjected to high-frequency fields.
B. Jablonsky. Application date 14th May, 1943.

566 945.—Circuit arrangement of a variable capacitance, a resistance, and an inductance, adapted to simulate a variable resistance for high-frequency bridge measurements.
C. G. Mayo. Application date 19th February, 1943.

GOODS FOR EXPORT

The fact that goods made of raw materials in short supply owing to war conditions are advertised in this journal should not be taken as an indication that they are necessarily available for export.

ABSTRACTS AND REFERENCES

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

Comparative Length of the Abstracts.—*It is explained to new readers that the length of an abstract is no sign, by itself, of the importance of the work concerned. An important paper in English may be dealt with by a short abstract, or even, if it is in a journal readily obtainable, by a square-bracketed addition to the title; while a paper of similar importance in a language other than English may be given a long abstract. In addition to these questions of language and accessibility, the nature of the work has, of course, a great effect on the useful length of its abstract.*

PROPAGATION OF WAVES

1717. THE NON-REFLECTING TERMINATION OF A TRANSMISSION LINE.—Smith: Willis Jackson & Huxley. (*See* 1744.)

1718. RESONANT COILED TRANSMISSION LINES [and Their Use for Study of Reflection at Low Radio Frequencies or (with Lumped Constants) at Audio Frequencies].—Paine. (*See* 1745.)

1719. VERY-HIGH-FREQUENCY "BURSTS" ANALYSED BY F.C.C. ENGINEERS.—F.C.C. (*Communications*, July 1944, Vol. 24, No. 7, pp. 61 and 88.) *See* also 390 of February.

1720. RADIO RECEPTION VARIES WITH THE PHASES OF THE MOON.—M.I.T. (*Sci. News Letter*, 30th Dec. 1944, Vol. 46, No. 27, p. 426: paragraph only.)

"It improves from the time of the moon's first quarter to shortly before full moon, and again from about the moon's last quarter until a few days before the new moon." For previous papers on the influence of the moon *see*, for example, Stetson, 2486 of 1944.

1721. NEW WEATHER MAPS FOR MAKING DX PREDICTIONS [Subscriptions now Accepted].—U.S. Weather Bureau. (*QST*, Nov. 1944, Vol. 28, No. 11, p. 21.)

1722. MECHANISM OF RADIO FADE-OUTS: A NEW THEORY [Summary of Jouaust's Paper, dealt with in 3788 of 1944].—R. Jouaust. (*Wireless World*, Feb. 1945, Vol. 51, No. 2, p. 49.) Over the initials "T. W. B."

1723. "ANOMALOUS" BEHAVIOUR OF THE F_2 REGION OF THE IONOSPHERE.—D. F. Martyn. (*Nature*, 24th March 1945, Vol. 155, No. 3934, pp. 363–364.)

"Two theories usually are jointly invoked" to explain the well-known anomalies. "According to the first, the low values of *N* in mid-summer are due to a great expansion of the upper atmosphere by solar heating . . . This view appears to be supported by the fact that *h* (max), the height at which *N* is found, is some 150 km greater in summer than in winter. The second theory explains the different type of variation in the northern and southern hemisphere as due to a superposed annual variation of ionisation, of unknown origin, which has a maximum throughout the world in December–January and a minimum in June–July.

"Simple calculation shows that the 'expansion' theorem demands a summer value for *T* of the order ten times greater than the winter value, which is highly improbable on any reasonable theory of radiative equilibrium in the ionosphere, so that it seems desirable to explore other possible explanations of F_2-region anomalies. Evidence in support of an alternative theory is supplied by the data shown in the accompanying graph, which compares the monthly mean minimum equivalent heights *h'* for north temperate, south temperate, and equatorial locations for the period 1937/41 . . .

"It will be seen from the graphs that the height variations in the northern and southern hemisphere are out of phase, showing a true seasonal variation, with maxima in mid-summer, as the 'heating' theory would predict. On the other hand, it is seen that *h'* at Huancayo does *not* show maxima when the sun is overhead (that is, in February and October), in disagreement with this theory. Inspection shows, however, that the Huancayo graph parallels that of Washington when the sun is north of Huancayo and parallels that for Australia when it is in the south. (The more complex graphs for *N* at the same stations, which are not reproduced here, show the same phenomenon.)

"This behaviour, which is similar to that of the diurnal variation of the magnetic declination at

Huancayo, suggests strongly that the variations of h' and N are controlled, as are the magnetic variations, by large-scale tidal movements in the upper air.

"Evidence for the existence of such a tide at these levels is presented in a separate communication. The different seasonal behaviour of N in the two hemispheres is believed to be due to a difference in the seasonal variation of the phase of the tides in the two hemispheres."

1724. PEACETIME USES FOR V2 [for Ionospheric Research, etc.].—Clarke. (*See* 2031.)

1725. POSSIBILITY OF AURORA IN A COMET'S TAIL.—Julia M. Vinter-Hansen. (*Nature*, 10th Feb. 1945, Vol. 155, No. 3928, p. 181 : summary only.)

1726. SUN, EARTH, AND SHORT-WAVE PROPAGATION : EFFECTS OF THE SOLAR SYSTEM UPON LONG-DISTANCE, SHORT-WAVE COMMUNICATIONS [Survey, with Maps, Charts, etc., from Various Sources].—H. E. Hallborg. (*Proc. Radio Club of America*, Dec. 1944, Vol. 21, No. 2, pp. 1–6.) A 1942 Radio Club paper : for other work *see* 2973 of 1941 and 365 of 1942.

1727. SUNSPOT MINIMUM : HAS IT ALREADY PASSED ?—T. W. Bennington. (*Wireless World*, March 1945, Vol. 51, No. 3, pp. 81–82.) Including a note on the magnetic disturbance of 16th/17th December, 1944.

1728. STRUCTURE OF SOLAR CORONA OF SEPTEMBER 21ST, 1941, FROM OBSERVATIONS WITH STANDARD CORONOGRAPHS [Investigation of Coronal Forms : Their Relation to the Formations on the Solar Surface : Study of Variation & Motion of Coronal Details].—E. J. Bugoslavskaya [Bougoslavsky]. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, 10th April 1944, Vol. 43, No. 1, pp. 7–9 : in English.)

"From such studies of coronal forms one may decide which stream of particles corresponds to some particular formation observed on the solar surface. They also throw light on the problem of the influence the active regions of the Sun have on the Earth." The report deals in turn with prominence systems, regions of spots, and polar rays. For previous work *see* 1014 of April and back reference.

1729. ASTRONOMICAL AND GEOPHYSICAL PERIODICITIES [Discussion].—Royal Astronomical Society. (*Nature*, 24th Feb. 1945, Vol. 155, No. 3930, pp. 224–227.)

1730. A STUDY OF TIME VARIATIONS IN THE COSMIC-RAY DIRECTIONAL INTENSITY-DISTRIBUTION.—M. L. Yeater. (*Phys. Review*, 1st/15th Feb. 1945, Vol. 67, No. 3/4, pp. 74–91.)

Leading to a relating of the variations with terrestrial magnetic fluctuations (which modify the allowed cones of certain primary cosmic-ray particles) and providing new support for Schremp's conclusion that positive and negative particles with the same e/m exist among the primary cosmic rays.

1731. THE ENERGY SPECTRUM OF THE PRIMARY COSMIC RADIATION.—S. Kusaka. (*Phys. Review*, 1st/15th Jan. 1945, Vol. 67, No. 1/2, pp. 50–51.) A summary was dealt with in 1395 of May.

1732. MEASUREMENT OF THE SPECIFIC IONISATION OF FAST MESOTRONS WITH AN IONISATION CHAMBER AND A LINEAR AMPLIFIER.—W. C. Dunlap, Jr. (*Phys. Review*, 1st/15th Feb. 1945, Vol. 67, No. 3/4, pp. 67–73.)

1733. EXTENSIVE PENETRATING SHOWERS [New Experimental Results, and Their Implications].—L. Jánossy, G. D. Rochester, & D. Broadbent. (*Nature*, 3rd Feb. 1945, Vol. 155, No. 3927, pp. 142–143.)

1734. ON A RAPID METHOD OF ATMOSPHERIC TRANSPARENCY DETERMINATION [using Fessenkow's Simple Formula for the Distribution of Brightness over a Diurnal Sky].—E. Piaskowskaia - Fessenkowa. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, 20th May 1944, Vol. 43, No. 5, pp. 199–201 : in English.)

1735. ON SCATTERING OF RADIATION BY CLOUDS [Comparative Measurements on the Various Cloud Forms in Similar Conditions].—N. N. Kalitin. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, 10th June 1944, Vol. 43, No. 7, pp. 289–291 : in English.)

1736. DIFFUSION OF LIGHT THROUGH SCATTERING MEDIUM OF LARGE OPTICAL THICKNESS [composed of Plane-Parallel Layers].—V. A. Ambarzumian. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, 30th April 1944, Vol. 43, No. 3, pp. 102–106 : in English.) With application to the distribution of light over a sky of uniform cloudiness.

1737. THE MULTIPLE SCATTERING OF WAVES : I—GENERAL THEORY OF ISOTROPIC SCATTERING BY RANDOMLY DISTRIBUTED SCATTERERS.—L. L. Foldy. (*Phys. Review*, 1st/15th Feb. 1945, Vol. 67, No. 3/4, pp. 107–119.)

The multiple scattering of *particles* by a random distribution of scatterers has been treated in some detail in the literature : the treatments are all based essentially on the Boltzmann integro-differential equation of conservation in phase space, and are thus classical rather than quantum-mechanical in foundation. On the other hand, to the writer's knowledge the multiple scattering of *waves*, by a consistent treatment based on the wave equation itself, has never been dealt with. Such treatments as have appeared (in the discussion, *e.g.*, of propagation of light through stellar atmospheres or turbid media) are based on the approximation of considering light rays as the trajectories of particles (photons) which are then treated on the basis of the Boltzmann equation : thus the interference phenomena characteristic of waves are neglected.

The writer begins by discussing various cases where such neglect may not be legitimate : these include the scattering of sound waves by the water droplets of fog, etc., and the scattering of electrons by aggregates of various kinds. "Finally, the connection between the so-called coherent scattering (leading to the macroscopic phenomena of refraction and specular reflection) and the incoherent scattering can only be appreciated through a consistent wave treatment of scattering from beginning to end."

In the present paper the writer develops a wave theory of multiple scattering for the case of scalar waves isotropically scattered by randomly distributed scatterers. The final Discussion indicates directions in which the theory may be generalised, such as the extension to vector waves, including electromagnetic; frequency changes of scattered waves produced through Doppler effect by moving scatterers; and non-steady-state scattering, in which the incident wave function does not have a harmonic dependence on the time.

1738. Contribution to the Theory of the Secci Disc [in Sea Optics: Derivation of Relation between Depth at which the Disc becomes Invisible and the Optical Constants of the Water, by Use of Kuznetzov's Approximate Equations for a Purely Scattering Medium].—B. V. Ovchinsky. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, 30th May 1944, Vol. 43, No. 6, pp. 244–248: in English.)

1739. Fresnel Reflection of Diffusely Incident Light.—A. Gershun. (*Journ. Opt. Soc. Am.*, Feb. 1945, Vol. 35, No. 2, pp. 162–163.)

"The reflectances for diffusely incident light on the plane boundary between two non-conducting media are connected by the relation $n^2(1-R) = n'^2(1-R')$, where R and R' are the reflectances for the light, coming from media having refractive indices n and n', respectively. This relation may be considered as a particular case of one general photometric invariant," $n^2\tau=n'^2\tau'$, for the transmission of the diffuse light by the layer contiguous to two different media. For other recent work by the same writer *see* 1024 of April.

1740. A Letter from Lord Rayleigh to J. Willard Gibbs, and His Reply [1892 Correspondence on the Dispersion of Light Waves].—E. B. Wilson. (*Proc. Nat. Acad. Sci.*, Jan. 1945, Vol. 31, No. 1, pp. 34–38.)

1741. The Projection of Light [Theory of Beam Formation: Lenses: the Paraboloid Mirror: the Hyperboloid: the Ellipsoid: Sectional Mirror: Combination Paraboloid–Ellipsoid: Suppression of Filament Images].—F. Benford. (*Journ. Opt. Soc. Am.*, Feb. 1945, Vol. 35, No. 2, pp. 149–156.) *Cf.* also Woodson, 2117, below.

PROPERTIES OF CIRCUITS

1742. The Admittance Coefficient [Generalised Conception & Applications].—Harries. (*See* 1808.)

1743. Diode Modulation.—G. H. Fett & A. D. Bailey. (*Phys. Review*, 1st/15th Jan. 1945, Vol. 67, No. 1/2, p. 62: summary only.)

"It is shown analytically [and confirmed experimentally] that a perfect diode in series with a pure resistance load is capable of producing frequency components required in amplitude modulation, either when the effect of the diode is considered as a series of pulses analysed by means of Fourier series, or when the diode is considered as a synchronous commutator . . ." Among other results it is shown that with a parallel-resonant-circuit load the diode behaves like a variable effective resistance whose magnitude is controlled by the magnitude and sign of the modulating signal in series with the carrier. When the Q of the load is high, complete modulation is obtained with about half of the signal voltage required with a resistance load.

1744. The Non-Reflecting Termination of a Transmission Line.—D. H. Smith: Willis Jackson & Huxley. (*Proc. Phys. Soc.*, 1st March 1945, Vol. 57, Part 2, No. 320, pp. 90–96.)

Authors' summary:—"In a recent paper (1031 of April), Willis Jackson & Huxley have presented some experimental results which appear not to agree with the theory of the non-reflecting termination of a transmission line when the latter is terminated by a thin film. The present paper shows that their results may be explained by the partial transparency of a very thin conducting film to electromagnetic waves, and that there is no real disagreement with the usual theory."

The writer concludes: "Jackson & Huxley's terminating device is non-reflecting for one frequency only. The ideal non-reflecting termination for a coaxial line would be a length of distortionless line, with high attenuation, having the same physical dimensions and characteristic impedance as the line to be terminated, but it is doubtful whether this could be set up with known materials."

1745. Resonant Coiled Transmission Lines [and Their Use for Study of Reflection at Low Radio Frequencies or (with Lumped Constants) at Audio Frequencies: for Selective Couplings between Valves in an Amplifier: etc.].—R. C. Paine. (*Communications*, June 1944, Vol. 24, No. 6, pp. 46..52.)

"Somewhat similar 'wave-resonant coils' for more selective tuning of receivers were described by Louis Cohen" (1930 Abstracts, p. 44 [and pp. 43 & 214]).

1746. Rigorous Methods of solving Long Transmission-Line Problems [Two Methods avoiding Use of Charts or Tables of Hyperbolic Functions of Complex Angles].—R. H. Paul. (*Journ. I.E.E.*, Part II, Feb. 1945, Vol. 92, No. 25, pp. 20–22.)

1747. Complex Transmission Line Network Analysis.—N. Marchand. (*Elec. Communition*, No. 2, Vol. 22, 1944, pp. 124–129.)

"This paper outlines a method of reducing a complex transmission line network to a conventional transmission line circuit, permitting application of the ordinary equations with which the reader is assumed to be familiar. The method employs a number of theorems concerning the currents in coaxial and balanced transmission lines and on their shields. From these theorems the currents flowing in the lines are determined and the equivalent circuits obtained."

An example of such a complex network is that shown in Fig. 10, joining two transmission lines. The problem is to find the input impedance at the point J at a given distance from a break A (in the inner shield) which couples the input transmission line to another coaxial line whose inner conductor is the shield of the input line and whose outer conductor is a large shielding cylinder.

1748. THE THEORY OF TRANSMISSION LINES [Tutorial Paper "for Students and for Engineers Not Regularly Confronted with Transmission-Line Problems"].—E. N. Dingley, Jr. (*Proc. I.R.E.*, Feb. 1945, Vol. 33, No. 2, pp. 118–125.)

1749. INFLUENCE OF FEEDBACK ON SOURCE IMPEDANCE ["Analysis of the Use of Negative Feedback to reduce Source Impedance in Amplifier Stages and Transmission Lines, as required in Video Design & Other Applications where High-Frequency Response must be Improved or Loudspeaker 'Hangover' must be Eliminated"].—R. W. Crane. (*Electronics*, Sept. 1944, Vol. 17, No. 9, pp. 122–123.)

1750. INFLUENCE OF THE NOISE OF VACUUM TUBES ON THE ACCURACY OF LINEAR AMPLIFIERS.—J. M. W. Milatz & K. J. Keller. (*Physica*, Jan. 1942, Vol. 9, p. 97 onwards.)

A 16-page paper mentioned in *Review Scient. Instr.*, Dec. 1944. For a summary see *Physik. Berichte*, No. 6, Vol. 24, 1943, pp. 473–474. "The noise spectrum of an RCA 57 amplifier pentode with free grid is investigated in the range 50–1000 c/s in the working conditions which have been found favourable for use in combination with an ionisation chamber . . ."

1751. SIGNAL/NOISE RATIO [Letter on Burgess's Paper (1038 of April): Possible Misconceptions from One of His Conclusions as to Relative Merits of Direct & Transformer Connections of Source to Valve: also the Further Complication due to Effective Temperature of R_g being usually 2–3 Times Room Temperature owing to Transit-Time Effects].—M. V. Callendar: Burgess. (*Wireless Engineer*, April 1945, Vol. 22, No. 259, pp. 181–182.)

1752. CATHODE BIAS IN PUSH-PULL STAGES: IS A BY-PASS CONDENSER NECESSARY?—Cocking. (*See* 1792.)

1753. PRACTICAL APPLICATIONS OF SIMPLE MATHEMATICS: PART VII—PUSH-PULL OPERATING CHARACTERISTICS: PART VIII—CLASS B AMPLIFIER DESIGN.—E. M. Noll. (*QST*, Nov. & Dec. 1944, Vol. 28, Nos. 11 & 12, pp. 39–41 and 90: pp. 40–42.)

1754. VIDEO-AMPLIFIER DESIGN: A DISCUSSION OF THE BASIC PRINCIPLES OF WIDE-BAND AMPLIFIERS.—C. H. Merritt. (*QST*, Dec. 1944, Vol. 28, No. 12, pp. 24–28.)

1755. THE CATHODE FOLLOWER: A SIMPLE MATHEMATICAL DISCUSSION OF DESIGN FACTORS.—W. H. Minor. (*QST*, Dec. 1944, Vol. 28, No. 12, pp. 18–19.)

1756. LOW-FREQUENCY AMPLIFICATION: PARTS I, II, AND III.—K. R. Sturley. (*Electronic Eng:g*, Nov. & Dec. 1944 and Jan. 1945, Vol. 17, Nos. 201/203, pp. 236–238 and 247: 290–293: 335–338: to be contd.)

"The purpose of this series of articles is to discuss the characteristics needed of an amplifier with special reference to low frequencies down to 1 c/s, not forgetting, however, the effect which the low-frequency design may have on the performance at high frequencies."

1757. A NOTE ON AMPLIFIERS FOR ELECTROCARDIOGRAPHY.—G. D. Dawson. (*Electronic Eng:g*, Dec. 1944, Vol. 17, No. 202, p. 293.)

Sturley (1756, above), quoting Donovan (2606 [and 3435] of 1943), states that such amplifiers need to have a l.f. response from about 5 c/s upwards. The present writer, with the help of the records *a–d*, shows that a response which attenuates sine waves of 3 c/s by only 5% introduces considerable distortion of the "T" wave and produces a form similar to one which may occur in disease. Such an amplifier should have a frequency response flat down to at least 0.5 c/s.

Secondly, record *a* shows signs of another form of distortion due to the fact, mentioned by Lewis in his book on electrical counting (45 of 1944), that an *R-C*-coupled amplifier with roughly equal time constants in all its inter-stage couplings, used near the lower limit of its flat response, tends to produce an oscillatory response to a single pulse input. Thus "the best type of amplifier for electrocardiography would seem to be one having an over-all time constant of two seconds, preferably with this all concentrated in a single inter-valve coupling, the other couplings being direct."

1758. RADIO DATA CHARTS: NO. 18—TRANSMISSION AND PHASE SHIFT OF *RC* COUPLINGS.—J. McG. Sowerby. (*Wireless World*, March 1945, Vol. 51, No. 3, pp. 84–85.)

1759. PARALLEL "*R*" AND SERIES "*C*" ON THE [Ordinary 4-Scale] SLIDE RULE [by Reversing the Slider].—"H.E.S." (*Wireless World*, March 1945, Vol. 51, No. 3, p. 74.) For the graphical method *see* "Diallist", April issue, No. 4, p. 126.

1760. CHARACTERISTICS OF THE TRANSITRON OSCILLATOR.—C. Brunetti. (*Communications*, June 1944, Vol. 24, No. 6, pp. 40–44 and 87..89.)

Based on the writer's work at Lehigh University. "The simplicity of the circuit coupled with its versatility makes it a practical solution to many laboratory problems [*cf.* Mitchell, 1873, below]. While the theory and general properties of the device have been covered in earlier papers, occasionally an experimenter is confronted with the realisation of having a circuit set up directly as described in the literature and yet refusing to function. A careful review of the situation will generally show, however, that some essential feature has been overlooked . . ." Hence the present paper: a later one will deal particularly with the effects of varying the plate and control-grid voltages.

1761. THE DESIGN AND APPLICATION OF MULTIVIBRATORS, EMPLOYING THE ABRAHAM–BLOCH SYSTEM AS A BASIS OF PLANNING.—Abbott. (*See* 1879.)

1762. SUSTAINED SUBHARMONIC RESPONSE IN NON-LINEAR SERIES CIRCUITS [of Resistance, Inductance, & Capacitance: Experimental Analysis].—C. F. Spitzer. (*Journ. Applied Phys.*, Feb. 1945, Vol. 16, No. 2, pp. 105–111.)

Among other results, "the hysteresis loop during subharmonic response consists of a major loop, to which minor loops are attached. Also, the inductor voltage appears to consist of only two sinusoidal components, one of subharmonic frequency and one of the frequency of the applied voltage. Thus subharmonic response could be simulated by superposition on the inductor of two sinusoidal voltages of proper frequency ratio and amplitudes."

1763. SEMI-STABILISED H.T. SOURCE: USE OF A SMALL AUXILIARY VALVE FOR RIPPLE SUPPRESSION [and Removal of All but the Slowest of Variations due to Mains-Voltage Fluctuations: an "Almost Traditional" (but Untraced) Circuit for Electronic Smoothing, and a Variant suitable for Any Value of Fixed Load, without Further Adjustment].—E. A. Hanney. (*Wireless World*, April 1945, Vol. 51, No. 4, p. 124.)

1764. ELECTRICAL DIFFERENTIATION AND INTEGRATION OF CURRENT AND VOLTAGE WAVEFORMS [Fundamental Aspects, and the Departures from Mathematical Rigour occurring in Practical Applications].—G. B. Hoadley & W. A. Lynch. (*Communications*, July 1944, Vol. 24, No. 7, pp. 48..58.)

1765. TRANSIENTS IN HOMOGENEOUS ELECTRICAL LADDER NETWORK OF FINITE LENGTH.—W. Nijenhuis. (*Physica*, Sept. 1942, Vol. 9, p. 817 onwards.) A 15-page paper mentioned in *Review Scient. Instr.*, Dec. 1944. For a summary see *Physik. Berichte*, No. 10, Vol. 24, 1943, pp. 730–731.

1766. FREQUENCY-COMPENSATED DELAY NETWORK [for delaying Pulse Signals].—E.M.I. Laboratories. (*Electronic Eng:g*, Jan. 1945, Vol. 17, No. 203, p. 345.)

1767. WAVETRAPS WITH INFINITE Q: USE OF A SIMPLE BALANCED FILTER CIRCUIT.—Roddam. (*See* 1789.)

1768. ON THE REPEATING RESISTANCE OF SYMMETRICAL UNIFORM CHAIN SCHEMES [New Result, and Its Application to Determining the Maxima of the Resonance Curve].—P. L. Kalantarov & L. A. Zeitlin. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, 10th June 1944, Vol. 43, No. 7, pp. 283–285: in English.)

"One of the essential characteristics of a four-pole is the repeating resistance which means that, having closed the leading-out terminals of the four-pole through such a resistance, one obtains an identical resistance between the leading-in terminals. Considering a uniform chain scheme whose leading-out terminals are closed through a resistance equal to the repeating resistance of the link, we readily come to realise that this resistance is also the repeating resistance of the whole scheme. However, as will be shown later, the repeating resistance of the whole scheme can in addition take values different from the repeating resistance of the link."

If the output terminals of the chain scheme are closed by a resistance Z, it is shown that the condition that this terminating resistance Z should be the "repeating" (iterative) resistance of the scheme is that $B_n/Z = ZC_n$. This condition is fulfilled if $Z = \sqrt{B_n/C_n}$ (or in the case of a single link, if $Z = \sqrt{B_1/C_1}$). These conditions are well known; it need only be remarked here that they are independent of the number of links.

But the above condition is also satisfied if $B_n = 0$ and $C_n = 0$ (or for a single link, $B_1 = 0$ and $C_1 = 0$)! The existence of these second conditions "does not appear ever to have been called to attention. Let us therefore discuss these conditions in greater detail. It follows from eqn. 7 that if the conditions of the second kind are fulfilled for a single link, they also hold good for the chain scheme as a whole. But it may be seen from the same relations (eqn. 7) that the conditions of the second kind for the whole scheme can be satisfied even if the respective conditions for a link are not satisfied, and we have $F_n(a) = 0$. Thus, unlike the conditions of the first kind, those of the second kind depend upon the number of links but not upon the value of terminal resistance of the scheme, and if they are fulfilled, any terminal resistance is a repeating resistance."

1769. TENSOR ALGEBRA AND ITS APPLICATION IN THE SOLUTION OF NETWORK PROBLEMS.—C. F. Davidson. (*Electronic Eng:g*, Oct. & Dec. 1944, Vol. 17, Nos. 200 & 202, pp. 205–106 & 299–301.)

1770. A LOW-IMPEDANCE-COUNTER CIRCUIT [Dependable, Easy to get Working, up to at least 30 Counts per Second: specially designed for Use with Low-Impedance Counters such as Cenco: requires Positive Pulse around 35 V].—E. L. Langberg. (*Review Scient. Instr.*, Jan. 1945, Vol. 16, No. 1, p. 14.)

TRANSMISSION

1771. A GENERATOR OF DAMPED MICRO-WAVES ["Spark Discharges between 460 Series–Paralleled Metallic Spheres develop ½ Watt of Power at 7000 Mc/s"].—Montani. (*See* 2056.)

1772. ULTRA-SHORT-WAVE TRANSMITTER FOR THE CAPE-CHARLES/NORFOLK MULTIPLEX SYSTEM [Design Features of Unattended U.S.W. Double-Sideband Multiplex Transmitter].—R. J. Kircher & R. W. Friis. (*Proc. I.R.E.*, Feb. 1945, Vol. 33, No. 2, pp. 101–106.) For other papers on this system *see* 1779 and 1945/6, below.

1773. F.M. AND A.M. TRANSMITTER ANALYSIS BASED ON A RECENT STUDY OF "ON-THE-AIR" OPERATING AND MAINTENANCE CHARACTERISTICS [and the Many Favourable Features offered by Frequency Modulation].—S. Helt. (*Communications*, July 1944, Vol. 24, No. 7, pp. 36 and 85..88.)

1774. DIODE MODULATION.—Fett & Bailey. (*See* 1743.)

1775. PULSE TIME MODULATION [Outline of Its Development: General Theory: Important Advantages].—Deloraine & Labin. (*See* 1947.)

1776. CHARACTERISTICS OF THE TRANSITRON OSCILLATOR.—Brunetti. (*See* 1760.)

1777. Power Amplifier Pi-Network Tank Design: a Discussion of R.F. Coupling Methods: Typical Application Problems Analysed [and a Simplified but Exact Method of Calculating the Network Parameters].—H. A. Brown. (*Communications*, June 1944, Vol. 24, No. 6, pp. 36–38 and 92..95.)

RECEPTION

1778. Very-High-Frequency "Bursts" analysed by F.C.C. Engineers.—F. C. C. (*Communications*, July 1944, Vol. 24, No. 7, pp. 61 and 88.) *See* also 390 of February.

1779. Ultra-Short-Wave Receiver for the Cape-Charles/Norfolk Multiplex Radio-telephone Circuit [Design & Performance of Receiver to accept A.M. Double-Sideband Signal & to deliver the Signal consisting of 12 Single-Sideband Channels at 12–60 kc/s to Telephone Cable Pair].—D. M. Black, G. Rodwin, & W. T. Wintringham. (*Proc. I.R.E.*, Feb. 1945, Vol. 33, No. 2, pp. 95–100.) For other papers on this system *see* 1772, above.

1780. Frequency Modulation [Letter on Bell's Account of the Performance of F.M. Receivers to Impulsive Interference (1218 of April): "a Little Over-Simplified"].—A. S. Gladwin & G. T. Thompson: Bell. (*Wireless Engineer*, April 1945, Vol. 22, No. 259, p. 181.)

1781. The Frequency Discriminator [Simple Discriminator: the Foster–Seeley Circuit: Phase Relations: Effect of Frequency: Provision for A.V.C: the R.C.A. Valve Phase-Splitter Circuit].—R. A. Lampitt. (*Electronic Eng:g*, Oct. 1944, Vol. 17, No. 200, pp. 196 and 201..204.)

1782. Calibrated Response-Curve Tracer [for the Alignment of R.F. & I.F. Band-Pass Amplifiers: of Special Value for F.M. Receivers, Vestigial-Sideband Amplifiers, etc.].—Hamburger. (*See* 1874.)

1783. Signal/Noise Ratio [Letter on Burgess's Paper].—Callendar. (*See* 1751.)

1784. Discussion on "Noise Figures of Radio Receivers" [3457 of 1944 (and 1457 of May): "Noise Factor" *versus* "Noise Figure": Formulation of "Absolute Sensitivity": Need for Revised Definition of Noise Factor (Difficulty of Superheterodyne Receiver with Image-Frequency Response: Pawsey & Payne-Scott): etc.].—D. O. North: H. T. Friis. (*Proc. I.R.E.*, Feb. 1945, Vol. 33, No. 2, pp. 125–127.)

1785. Very-High-Frequency Radio-Noise Elimination [on Aircraft].—T. B. Owen. (*Elec. Engineering*, Dec. 1944, Vol. 63, No. 12, Transactions pp. 949–954.) A summary was dealt with in 459 of February.

1786. Electric Lamp Failures: a "Thermionic" Fault [Lamp continues to Burn Brightly with Severed Filament, emitting a Slight Noise: Suggested Explanation].—"K.G.B.": C. Atherton. (*Wireless World*, Feb. 1945, Vol. 51, No. 2, p. 49.)

This appears to be the secret of the lamp which seems to be "quite all right when it is switched off and appears to die cold." A letter from Atherton in the March issue, pp. 92–93, describes an exactly similar experience and reports that "interference with a small receiver in the same room was sufficient to drown the local broadcast almost to extinction": *see* also "Diallist", pp. 94–95.

1787. The Mechanism of the Contamination of Porcelain Insulators.—W. G. Thompson. (*Journ. I.E.E.*, Part II, Aug. 1944, Vol. 91, No. 22, pp. 317–327.)

1788. Filtering Genemotors used to supply Receivers [including the Super-Regenerative Type].—H. C. Haines. (*QST*, Nov. 1944, Vol. 28, No. 11, p. 52.)

1789. Wavetraps with Infinite Q: Use of a Simple Balanced Filter Circuit [Article prompted by Amos's Paper (1458 of May): Improvement of Rejection-Efficiency by "Cancellation Resistance" from Coil Centre-Tap to Earth, and Variations: etc.].—T. Roddam: Amos. (*Wireless World*, April 1945, Vol. 51, No. 4, pp. 118–119.)

1790. Superheterodyne Whistles [and Their Origin: with Tables and Charts showing Frequencies at which Interference may be experienced, for Various Intermediate Frequencies: etc.].—C. C. McCallum. (*Electronic Eng:g.*, Dec. 1944, Vol. 17, No. 202, pp. 281–284.)

1791. Transverse Magnetic Permeability [including Some Applications].—Gorelik. (*See* 1942.)

1792. Cathode Bias in Push-Pull Stages: Is a By-Pass Condenser Necessary? [Investigation taking Valve Non-Linearity into Account.].—W. T. Cocking. (*Wireless World*, March 1945, Vol. 51, No. 3, pp. 75–78.)

"Textbooks are usually silent on the subject and, in the rare cases when they do refer to it, are apt to conflict in their advice." The following conclusions are reached: "in all push-pull stages but the output it is usually desirable to use a common cathode-bias resistance without a by-pass condenser because of the self-balancing action then obtained. Distortion is increased by a negligible amount. In a Class A and 'light' Class AB output stages the by-pass condenser can also normally be omitted with advantage. It should not be omitted, however, in a true Class AB stage. The omission of the condenser makes it less important to use matched valves, and in the case of a resistance-coupled stage it becomes more important to match the coupling resistances than the valves."

1793. "New Thoughts on Contrast Expansion" [Reply to Rudkin's Letter, 1089 of April].—T. Roddam. (*Wireless World*, Feb. 1945, Vol. 51, No. 2, pp. 58–59.)

1794. A New Versatile Tone-Control Circuit: I—Basic Principles of Tone Control: II—Bass and Treble Lift without Variation of Middle Frequencies.—Patchett. (*See* 1840.)

1795. Future of Miniature Radio [Matter of Great Social Concern—the Over-Noisy Wireless Set—and the Failure of Engineers & Sociologists to find a Solution: also the Problem of Divided Interests in the Family: Both solved in Writer's Household by Use of "Pocket" Sets & Midget Earpieces requiring No Headbands].—C. M. R. Balbi. (*Wireless World*, April 1945, Vol. 51, No. 4, p. 110.)

1796. Our New Receivers [Manufacturers asked to call a Halt to the Inexplicable Tendency towards Smaller & Still Smaller Chassis: the Service-Man's Nightmare].—S. Gould. (*Wireless World*, April 1945, Vol. 51, No. 4, p. 110.)

"Perhaps, too, with the advent of a reasonably sized chassis, the weakest link in the modern receiver—the high-voltage electrolytic condenser—might give way to the larger but more reliable paper type, and so eliminate at least 20% of all breakdowns."

AERIALS AND AERIAL SYSTEMS

1797. V.H.F. "V" Antenna for Aircraft.—Jasik. (*See* 1817.)

1798. A New Studio-to-Transmitter Antenna [for 343.6 Mc/s Link from Schenectady to Helderberg Mountains (12 Miles): Choice of Structure based on Physical Requirements: Theory (Usefulness & Application of Southworth's Relationships, 1931 Abstracts, pp. 41 & 211): Practice (and the Reasons for the "Rather Odd" Physical Structure)].—M. W. Scheldorf. (*Proc. I.R.E.*, Feb. 1945, Vol. 33, No. 2, pp. 106–112.) *Cf.* 3472 of 1944.

1799. A High-Gain Coaxial Antenna [Vertical Metal Pipe Structure constituting Four "Western Electric 51 A" Coaxial Aerials: primarily for Transmission to Vehicles with Whip-Type Aerials].—A. B. Bailey. (*Bell Lab. Record*, Feb. 1945, Vol. 23, No. 2, pp. 62–64.)

1800. Ultra-High-Frequency Directive Antennas [Account of Development of Rotatable Aerial System for Frequencies around 224 Mc/s, for Radiation in a Direction confined to a Few Degrees in Horizontal & Vertical Planes: 16 Sets of 2 Stacked Elements arranged in 4 End-Fire Arrays].—H. N. Maxwell & C. Alway. (*Communications*, July 1944, Vol. 24, No. 7, pp. 33–35 and 59, 60.)

1801. Aerial Systems for [Ultra-Short and] Short Radio Waves [Summaries of "Theory and Performance of Corner Reflectors for Aerials" *and* "The Measured Performance of Horizontal Dipole Transmitting Arrays" (for 15–20 m Waves: used by B.B.C.)].—E. B. Moullin: H. Page. (*Nature*, 20th Jan. 1945, Vol. 155, No. 3925, pp. 88–89.) For previous summaries *see* 47 of January.

1802. The Radiation Resistance of a Half-Wave Dipole Aerial.—G. W. O. H. (*Wireless Engineer*, April 1945, Vol. 22, No. 259, pp. 153–156.)

"This Editorial contains no new discovery but describes step by step the calculation from fundamental principles of the radiation resistance of a half-wave dipole aerial or of a quarter-wave vertical earthed aerial. It is hoped that it will prove of interest to those engaged in teaching the fundamental principles of radio telegraphy."

1803. Impedance Relationships of Broadcast Antenna Arrays [Direct Method, independent of Aerial Heights & Methods of Excitation, for the Adjustment of Multi-Element Arrays].—W. Pritchett. (*Communications*, Sept. 1944, Vol. 24, No. 9, pp. 54..62.) Concluded from the August issue.

1804. Remote Monitor for Directional Broadcasting [Continuously Operating Receiver at 1½ Miles in Null-Point Direction actuates (over Telephone Line) Microammeter on Operator's Console at Transmitter: Tuned-R. F. Receiver better than Superheterodyne: Accuracy within 3%).—M. A. O'Bradovick. (*Electronics*, Sept. 1944, Vol. 17, No. 9, pp. 131 and 270, 272.)

VALVES AND THERMIONICS

1805. New Tubes [Characteristics of Some of the "Lighthouse" Series of V.H.F. Valves].—(*QST*, Nov. 1944, Vol. 28, No. 11, p. 44.) Supplement to 1477 of May.

1806. Transit Time and Space Charge in a Plane Diode.—L. Brillouin. (*Elec. Communication*, No. 2, Vol. 22, 1944, pp. 110–123.)

"Exact formulas are developed for the beginning and the end of the discharge when the space charge does not completely occupy the cathode/anode interval but moves towards the anode (beginning of discharge) or recedes towards the cathode (end of discharge). So far as the present author is aware, this problem has not previously been completely and accurately considered, notwithstanding the fact that its solution should prove valuable in the comprehension of triode phenomena. The problem is, essentially, the one discussed by C. C. Wang (3338 of 1941), but his theory is hard to follow and seems open to very serious shortcomings . . ."

The second part of the paper deals with the problem of the dispersion of transit times for diodes without and with space charge. Whereas the curves of Fig. 3 show that "tubes with small space-charge effects may exhibit almost constant efficiency for a large frequency interval corresponding to (12)", a comparison of Figs. 3 and 4 shows that "the space-charge effect results in very serious increase in phase shifts, and does not exhibit any tendency towards the flat maximum of Fig. 3. It is evident, therefore, that the efficiency of tubes with large space-charge effects should decrease continuously with increasing frequency."

1807. Space-Charge Effects between a Positive Grid and Anode of a Beam Tetrode: Part I.—G. B. Walker. (*Wireless Engineer*, April 1945, Vol. 22, No. 259, pp. 157–169.)

"Space-charge effects beyond a positive grid have acquired a new importance in the last few years . . . So far as the author is aware, only simple cases of space-charge have been treated, and there is a very urgent need for further information, both qualitative and quantitative, on the effects which arise in an actual valve.

"The most important omission in previous theories is that no account is taken of the trajectories of the electrons, and writers tend to over-simplify the problem by the assumption that electrons cross a positive grid all with the same velocity directed normally to the grid. This quite definitely is not true in practice, nor is it even approximately so, and the primary concern of the paper is to analyse space-charge in beams formed by electrons whose motions differ . . . Although we attempt no more than a simple analysis of a particular valve type, it is hoped that the findings may throw some light on the behaviour of electrons in other valves and that the method of attack may prove to have wider applications . . ."

Part I has the following sections: General Survey: the Mechanism of the Knee (of the I_a/V_a characteristic): Outline of the Space Charge: the Velocity Distribution: Primary Effect of Space Charge on the Knee: the Effect of the Temperature Velocity Distribution of Electrons on Space-Charge Density: Appendices.

1808. The Admittance Coefficient [Generalised Conception, and Application to (i) Simple Voltage & Current Relationships, (ii) Voltage & Current in a Circuit having Variable "Constants", and (iii) "Displacement Coefficient" of a Cathode-Ray Tube or Deflection Valve].—J. H. O. Harries. (*Electronic Eng:g*, Nov. 1944, Vol. 17, No. 201, pp. 257–258.)

1809. Secondary-Electron Radiation [Survey, with 89 Literature & Patent References].—J. H. O. Harries. (*Electronics*, Sept. 1944, Vol. 17, No. 9, pp. 100–108 and 180, 184.)

"A thorough survey of existing American, British, and other information on the subject, arranged for maximum usefulness to electronic engineers engaged in designing electron multipliers, dynatrons, beam tetrodes, pentodes, and other tubes in which secondary electrons resulting from electron bombardment are either utilised or suppressed." In the section dealing with "critical-distance" beam tetrodes the lack of any satisfactory published theory is discussed: the writer hopes to present an approximate theory, taking the various essential factors into account, when war-time matters permit. As regards the emission time of secondary electrons, the only conclusion the writer can find in the literature is that it is less than 10^{-9} second.

1810. Deflected Electron Beams [Reply to Rodda's Letter (1072 of April), particularly His Statement that Deflection Power becomes Zero when $f = 0$: Equations for Ratio of Power used to Deflect the Electrons to Power carried by Electron Beam, for Cases when f Is & Is Not Zero].—J. H. O. Harries: Rodda. (*Wireless Engineer*, April 1945, Vol. 22, No. 259, p. 182.)

1811. Influence of the Noise of Vacuum Tubes on the Accuracy of Linear Amplifiers.—Milatz & Keller. (*See* 1750.)

1812. Sizes of Electron Tubes useful for Magnifying the Weakest Signal.—W. Engbert & others. (*Physica*, Feb. 1942, Vol. 9, p. 248 onwards.) Letter, mentioned under the above translated title in *Review Scient. Instr.*, Dec. 1944, which is presumably a continuation of the correspondence dealt with in 1102 of 1943. For previous work *see* 816 of March.

1813. Some Technical Aspects of Valve Standardisation: Radio Section I.E.E. Discussion.—A. H. Cooper & others. (*Wireless World*, April 1945, Vol. 51, No. 4, p. 125.)

1814. Renewing Burnt-Out Tubes [of High-Voltage Type used in A.C.–D.C. Broadcast Receivers, when Heater is Burnt-Out: Renewal by "snapping" High Voltage across Heater Pins: Months More of Service often obtained].—J. S. Ferland. (*QST*, Dec. 1944, Vol. 28, No. 12, pp. 46–47.)

1815. A Device attached to an Optical Pyrometer of Disappearing-Filament Type to Extend Its Scale over Low Temperatures.—Freivert. (*See* 2078.)

DIRECTIONAL WIRELESS

1816. Radio Direction Finding at a Wavelength of 1.8 Metres [Investigation of Accuracy attainable with Adcock-Type Aerials, with Special Attention to Errors due to Polarisation & to Nearby Parasitic Radiators].—W. H. Pickering, J. David, & W. F. Hornyak. (*Phys. Review*, 1st/15th Jan. 1945, Vol. 67, No. 1/2, p. 66: summary only.)

"The antenna consisted of two vertical quarter-wave rods spaced three-quarters of a wavelength. The effects of various types of grounding plane have also been investigated. With favourable conditions an accuracy of 0.2 degree is attainable, but polarisation errors may be as large as 10 degrees. For best determination of the null direction, the receiver output is recorded on a paper slip synchronised with the rotation of the antenna."

1817. V.H.F. "V" Antenna for Aircraft [replacing the Horizontal-Loop Type for Localiser & Radio-Range Work: Theoretical & Experimental Studies].—H. Jasik. (*Communications*, Sept. 1944, Vol. 24, No. 9, pp. 33–35 and 83..86.)

1818. Wright Field's Ham-Built Direction Finder: a Home-Made Beam Antenna Guides Lost Planes to Safety [Three-Element V.H.F. Rotary Array].—(*QST*, Nov. 1944, Vol. 28, No. 11, pp. 42–43 and 90.)

1819. "It Can Now Be Revealed . . .": Some Achievements of the British Radio Industry [during the War: Extracts from Chairman's Speech, Radio Industry Council's Inaugural Luncheon: with Special Reference to Various Types of Radiolocation].—F. B. Duncan. (*Wireless World*, March 1945, Vol. 51, No. 3, p. 87.) For "Monthly Commentary" Notes *see* p. 65.

1820. "Echolocation" by Blind Men, Bats, and Radar [and the Advantage of a Single Unifying Term].—Griffin. (*See* 2028.)

1821. Addendum to "Marine Navigation Aids: the Radio Direction Finder and the Gyro-Compass" [825 of March].—E. H. Price & W. J. Gillule. (*Elec. Communication*, No. 2, Vol. 22, 1944, p. 167.) Refers the reader to Kolster & Dunmore's Bur. of Stds. paper (published 1922) for a historical treatment of the radio direction finder.

1822. A CATHODE-RAY UNIVERSAL "FLIGHT ATTITUDE" INSTRUMENT: A PROPOSAL FOR A NOVEL FORM OF ELECTRONIC AIRCRAFT INSTRUMENT WHICH WOULD SIMPLIFY CIVILIAN FLYING.—F. Postlethwaite. (*Electronic Eng:g*, Nov. 1944, Vol. 17, No. 201, pp. 229–235.)

Thus a typical indication (Fig. 8, "g") shows that the nose of the machine is pointing down while descending at a rate which can be read off a scale. The aircraft is also side-slipping to the right. Indication "j" shows among other things that ice is forming on the wings.

1823. CIVIL AVIATION DISCUSSION [including Some Requirements of Radio Operation].—Royal Aeronautical Society. (*Journ. Roy. Aeron. Soc.*, Feb. 1945, Vol. 49, No. 410, pp. 55–98.) For the section on radio *see* pp. 92–93.

1824. DETERMINATION OF ALTITUDE BY MEASUREMENT OF AIR PRESSURE AND TEMPERATURE.—W. G. Brombacher. (*Journ. Franklin Inst.*, Dec. 1944, Vol. 238, No. 6, pp. 453–454: summary only.)

ACOUSTICS AND AUDIO-FREQUENCIES

1825. THE MULTIPLE SCATTERING OF WAVES: I—GENERAL THEORY OF ISOTROPIC SCATTERING BY RANDOMLY DISTRIBUTED SCATTERERS.—Foldy. (*See* 1737.)

1826. RECORDING LISSAJOUS' FIGURES [by a Refined Method using Compound Pendulum carrying Light-Beam Device recording on Bromide Paper: Some Specimens].—W. B. Hales. (*Journ. Acous. Soc. Am.*, Jan. 1945, Vol. 16, No. 3, pp. 137–146.)

1827. THE DIPOLE MICROPHONE [Design, Theory, and Various Applications].—B. Olney, F. H. Slaymaker, & W. F. Meeker. (*Journ. Acous. Soc. Am.*, Jan. 1945, Vol. 16, No. 3, pp. 172–177.)

A summary was dealt with in 73 of January. "The use of tubes makes it possible to remove the microphone transducer element from a location directly in front of the talker's mouth, and yet retain the acoustical advantage of a close-talking microphone . . ." "If it should be desirable, for example in a distant-talking microphone, the directional characteristics could be changed from the cosine type to cardioid by changing the length of one tube by an amount equal to the dipole spacing. It might even be possible to construct a microphone in which one tube had an adjustable crook, like a trumpet tuning slide, and thus obtain a variety of directional patterns.

"The small size of the tubes which can be used suggests the additional possibility of applying some form of tube microphone to an acoustic wattmeter, or an impedance-measuring device, where it is desirable to make measurements without disturbing the sound field . . ."

1828. WHY LOW-LEVEL MICROPHONES? SOME ADVANTAGES OF THE NEGLECTED CARBON MICROPHONE.—McM. Silver. (*QST*, Dec. 1944, Vol. 28, No. 12, pp. 32–33.)

1829. ON THE THEORY OF THE DIRECTIONAL PATTERNS OF CONTINUOUS SOURCE DISTRIBUTIONS ON A PLANE SURFACE.—R. Clark Jones. (*Journ. Acous. Soc. Am.*, Jan. 1945, Vol. 16, No. 3, pp. 147–171.)

A summary was referred to in 72 of January. "The subject is very closely related to the problems of the directionality of antenna arrays [refs. "4"–"6"] and of optical systems" [no reference is given, but *cf.* 1706 of May]. Part I gives the general theory (among other things, "an interesting relation between linear distributions and those with circular symmetry is pointed out," so that if one is given the other can be calculated): Part II deals with numerical results for specific source distributions and superposition of distributions: and Part III contains 22 tables, of which table II, more detailed than the others, is that of the directional pattern of a circular piston.

1830. THE PRODUCTION OF INHARMONIC SUBFREQUENCIES BY A LOUDSPEAKER [Letter prompted by Olson's Paper, 69 of January].—R. V. L. Hartley: Olson. (*Journ. Acous. Soc. Am.*, Jan. 1945, Vol. 16, No. 3, p. 206.)

"Thus the subharmonics mentioned in the paper may be regarded as a special case of a more general class of subfrequencies," indicated in the theory of multi-resonant non-linear systems (Hartley, 3712 of 1936).

1831. SUB-CRYSTALLINE CHANGES OF STRUCTURE ACCOMPANYING THERMAL TRANSITIONS IN ROCHELLE SALT, AND IN POTASSIUM DIHYDROGEN ORTHOPHOSPHATE.—A. R. Ubbelohde & I. Woodward. (*Nature*, 10th Feb. 1945, Vol. 155, No. 3928, pp. 170–171.)

1832. DESIGN OF CROSS-OVER NETWORKS FOR LOUDSPEAKER UNITS: DIVIDING FILTERS FOR "WOOFER"–"TWEETER" COMBINATIONS.—E. N. Sieder. (*QST*, Dec. 1944, Vol. 28, No. 12, pp. 35–38.)

1833. ACOUSTIC CONSIDERATIONS IN TWO-WAY LOUDSPEAKER COMMUNICATIONS [Talk-Back Systems].—A. J. Sanial. (*Communications*, June 1944, Vol. 24, No. 6, pp. 33–35 and 84..86, 90.)

1834. TRENDS IN COMPONENT DESIGN: REVIEW OF A WARTIME EXHIBITION.—Radio Components Manufacturers' Federation. (*Wireless World*, April 1945, Vol. 51, No. 4, pp. 98–105.) This is the exhibition mentioned in 1494 of May.

1835. GRAMOPHONE RECORDS [Serious Complaint about Gold-Coloured Metallic Dust used in printing Labels (lodges in Groove & is almost Impossible to Remove): Plea for Stroboscopic Edge to All Labels: etc.].—L. G. Woollett. (*Wireless World*, April 1945, Vol. 51, No. 4, p. 112.)

1836. TAPE *versus* DISC [Note on R. C. A. Victor News-Letter to Dealers & Distributors: Arguments in Favour of the Conventional Disc Record].—R. C. A. (*Review Scient. Instr.*, Dec. 1944, Vol. 15, No. 12, p. 359.)

1837. "THE TECHNIQUE OF MOTION PICTURE PRODUCTION" [Symposium: Book Review].—Society of Motion Picture Engineers. (*Journ. Acous. Soc. Am.*, Jan. 1945, Vol. 16, No. 3, p. 211.) Three of the eleven chapters are on "sound recording", "re-recording", and "prescoring and scoring."

1838. "NEW THOUGHTS ON CONTRAST EXPANSION" [Reply to Rudkin's Letter, 1089 of April].—T. Roddam. (*Wireless World*, Feb. 1945, Vol. 51, No. 2, pp. 58–59.)

1839. "SCALE DISTORTION" AND VISUAL ANALOGIES.—P. Stevenson. (*Electronic Eng:g*, Oct. 1944, Vol. 17, No. 200, pp. 207–208.)

"When the effect of normal perception is called 'scale distortion' . . . and an effect of abnormal perception is held to be free of 'scale distortion', it is time to call a halt and endeavour to clear away the mists of confusion . . ."

1840. A NEW VERSATILE TONE-CONTROL CIRCUIT: I—BASIC PRINCIPLES OF TONE CONTROL: II—BASS AND TREBLE LIFT WITHOUT VARIATION OF MIDDLE FREQUENCIES.—G. N. Patchett. (*Wireless World*, March & April 1945, Vol. 51, Nos. 3 & 4, pp. 71–74 & 106–109.)

For high-quality reproduction only: the merits of the circuit (which includes a phase-splitting triode and an amplifying twin triode) cannot be obtained if the remainder of the equipment has a poor frequency response, produces distortion, or is very limited in output power.

1841. CORRESPONDENCE ON "ACOUSTIC FILTRATION AND HEARING AIDS" [83 of January]: ANSWER TO SCHIER'S LETTER TO THE EDITOR [497 of February].—F. M. Grossman & C. T. Molloy: Schier. (*Journ. Acous. Soc. Am.*, Jan. 1945, Vol. 16, No. 3, pp. 207–208.)

1842. THE CONSIDERATION OF HEARING AIDS AND AUDIOMETERS BY THE COUNCIL ON PHYSICAL MEDICINE [including the Consideration of Advertising Matter, and Its Difficulty].—H. A. Carter. (*Journ. Acous. Soc. Am.*, Jan. 1945, Vol. 16, No. 3, pp. 203–205.)

1843. AIR- AND BONE-CONDUCTION AUDIO TESTING ASSEMBLY.—N. A. Watson. (*Journ. Acous. Soc. Am.*, Jan. 1945, Vol. 16, No. 3, pp. 194–196.) A summary was dealt with in 88 of January.

1844. SOME EXPERIMENTAL EVIDENCE FOR PERIPHERAL AUDITORY MASKING.—K. Lowy. (*Journ. Acous. Soc. Am.*, Jan. 1945, Vol. 16, No. 3, pp. 197–202.) A summary was referred to in 87 of January.

1845. "SPEECH READING—JENA METHOD" [Book Review].—Anna M. Bunger. (*Journ. Acous. Soc. Am.*, Jan. 1945, Vol. 16, No. 3, pp. 211–212.)

1846. CERTAIN APPLICATIONS OF PHYSICAL PRINCIPLES TO THE PLAYING OF MUSICAL INSTRUMENTS: PART I [Steel *versus* Gut Strings (and the Full Importance of the Effect of Humidity on the Latter): Pressure on the Bow, and Ways of Holding It: Psychological Matters in relation to Muscular Activity in the Playing of Stringed Instruments (Staccatos, Vibratos)].—W. F. G. Swann. (*Journ. Franklin Inst.*, Jan. 1945, Vol. 239, No. 1, pp. 1–26.)

1847. INTONATION OF THE BOEHM CLARINET [and Its Correction].—C. S. McGinnis & R. Pepper. (*Journ. Acous. Soc. Am.*, Jan, 1945, Vol. 16, No. 3, pp. 188–193.)

"The faults are not of merely academic interest but are so appreciable as to discourage the more universal use of an instrument which excels in beautiful tone quality and dynamic flexibility . . ." The corrected mechanism, "which requires no new fingering and is not complicated, should certainly be adopted by manufacturers for the use of symphonic players or those who desire to play in tune without resorting to various annoying and impractical adjustments while performing."

1848. THE FIRST SUBMERGED REPEATER [Construction & Operation of the Repeater laid in Irish Sea: suitable for Depths up to about 200 Fathoms].—R. J. Halsey & W. T. Duerdoth. (*P.O. Elec. Eng. Journ.*, July 1944, Vol. 37, Part 2, pp. 33–39.) Text partly taken from the I.E.E. paper dealt with in 1100 of April.

1849. THE EFFECT ON CROSSTALK OF REPAIRS TO 12-CHANNEL CARRIER CABLES.—D. W. Cherry. (*P.O. Elec. Eng. Journ.*, July 1944, Vol. 37, Part 2, pp. 54–58.)

1850. A WIDE-RANGE ADJUSTABLE ACOUSTIC IMPEDANCE.—W. F. Meeker & F. H. Slaymaker. (*Journ. Acous. Soc. Am.*, Jan. 1945, Vol. 16, No. 3, pp. 178–182.) A summary was dealt with in 79 of January.

1851. LOW-FREQUENCY PHOTO-MECHANICAL OSCILLATORS.—Baldock & Grey Walter. (*See* 2058.)

1852. DESIGN FOR A BEAT-FREQUENCY OSCILLATOR [with Attention to the Avoidance of Frequency Drift with Temperature Variation, of Distortion in the Detecting Device, of Interactions, etc.].—C. E. Cooper. (*Electronic Eng:g*, Nov. 1944, Vol. 17, No. 201, pp. 252–254.) From Radio Manufacturers' Service.

1853. LOW-FREQUENCY AMPLIFICATION.—Sturley. (*See* 1756.)

1854. SCREENED TESTING-BOOTHS: PROTECTION AGAINST ELECTRICAL AND ACOUSTIC INTERFERENCE.—Ultra Electric. (*See* 1872.)

1855. THE DEGASSING OF LIGHT METAL ALLOYS BY SONIC VIBRATIONS.—Esmarch & others. (*See* 2048.)

1856. A NEW PHENOMENON IN THE PIEZOELECTRIC OSCILLATIONS OF A QUARTZ CRYSTAL.—Parthasarathy, Pande, & Pancholy. (*Journ. of Scient. & Ind. Res.*, June 1944, Vol. 2, p. 1 onwards.) Referred to in *Journ. Acous. Soc. Am.*, Jan. 1945, p. 213.

1857. SOME APPLICATIONS OF ULTRASONICS IN HIGH-POLYMER RESEARCH [Production & Destruction of Suspensions: Temporary

Opening of van der Waals Bonds : Breaking of Chemical Bonds].—H. Mark. (*Journ. Acous. Soc. Am.*, Jan. 1945, Vol. 16, No. 3, pp. 183–187.) With a bibliography of 25 items.

1858. Apparatus for the Determination of Dispersion at Supersonic Frequencies.—L. N. Liebermann. (*Electronic Eng:g*, Jan. 1945, Vol. 17, No. 203, p. 348 : summary, from *Bull. Am. Phys. Soc.*, 1944.) A previous summary was referred to in 3908 of 1944.

PHOTOTELEGRAPHY AND TELEVISION

1859. Future of Television : Findings of Hankey Committee—Early Transmissions Recommended.—Hankey Committee. (*Electrician*, 16th March 1945, Vol. 134, No. 3485, pp. 229–230.) For a leading article *see* pp. 225–226.

1860. Engineer's Conscience [Are the Great Schemes for Bigger & Better Television Justified ?].—J. Harmon. (*Wireless World*, April 1945, Vol. 51, No. 4, pp. 111–112.)

"A fascinating activity for the designer. But what is the image to be ? No one has yet shown any reason why I should want television in my home . . ."

1861. Television Awards [for Outstanding Contributions to Development].—Television Broadcasters' Association. (*Proc. I.R.E.*, Feb. 1945, Vol. 33, No. 2, p. 127.)

1862. Television Reception : Highlights of A.I.E.E.–I.R.E. Television Lecture.—T. T. Goldsmith. (*Communications*, June 1944, Vol. 24, No. 6, pp. 60 and 89, 91.) From the DuMont laboratories.

1863. Swiss Television Large-Screen Projector [Account of the A.F.I.F. System (Amrein, 1511 of May) based on an Article from *Swiss Technics*, Feb. 1944].—T. M. C. Lance : Fischer. (*Electronic Eng:g*, Dec. 1944, Vol. 17, No. 202, pp. 294–296.) From the author's Television Society paper on "Some Aspects of Large-Screen Television."

1864. Frequency Modulation [Pros & Cons].—D. A. Bell. (*Wireless World*, Feb. 1945, Vol. 51, No. 2, p. 58.) *See* 1218 of April.

1865. Video-Amplifier Design : a Discussion of the Basic Principles of Wide-Band Amplifiers.—C. H. Merritt. (*QST*, Dec. 1944, Vol. 28, No. 12, pp. 24–28.)

1866. Calibrated Response-Curve Tracer [of Special Value for Vestigial-Sideband Amplifiers, etc.].—Hamburger. (*See* 1874.)

1867. Cathode-Ray Tube Manufacturing Problems.—J. R. Beers. (*Communications*, Sept. 1944, Vol. 24, No. 9, pp. 46..52 and 82.) From the North American Philips Company. *See* also 1900, below.

1868. The Multiplier Photocell : Its Advantages and Limitations.—A. Sommer. (*Electronic Eng:g*, Sept. 1944, Vol. 17, No. 199, pp. 164, 166.)

1869. A Note on Photocell Nomenclature.—W. Sommer. (*Electronic Eng:g*, Dec. 1944, Vol. 17, No. 202, p. 296.)

"In the writer's opinion many of the terms defined in B.S.S. 205 (Part 6, Sec. 8, 1943) relating to photoelectric cells are ambiguous and misleading . . ." A suggested terminology is put forward for criticism and discussion.

1870. Electro-Optical Effect in Colloids.—B. W. Sakmann. (*Journ. Opt. Soc. Am.*, Dec. 1944, Vol. 34, No. 12, pp. 774–775 : summary only.) *See* 3202 of 1944.

1871. Combinations of Spherical Lenses to replace Non-Spherical Refracting Surfaces in Optical Systems.—J. L. Houghton. (*Proc. Phys. Soc.*, 1st March 1945, Vol. 57, Part 2, No. 320, pp. 84–90.)

MEASUREMENTS AND STANDARDS

1872. Screened Testing-Booths : Protection against Electrical and Acoustic Interference [Booths used by Ultra Electric, Ltd., for Testing of U.H.F. Equipment].—Ultra Electric Company. (*Wireless World*, April 1945, Vol. 51, No. 4, pp. 116–117.)

1873. Single-Valve Modulated Test Oscillator: a Cheap and Compact Instrument with a Range of 250 kc/s to 15 Mc/s [using a Heptode Frequency Changer in Transitron R.F. Connection, allowing Use of Untapped Coils and simplifying Range-Switching].—K. W. Mitchell. (*Wireless World*, Feb. 1945, Vol. 51, No. 2, pp. 56–57.)

1874. Calibrated Response-Curve Tracer.—G. L. Hamburger. (*Wireless Engineer*, April 1945, Vol. 22, No. 259, pp. 170–181.)

Author's summary :—" An apparatus is described which greatly facilitates the alignment of r.f. and i.f. band-pass amplifiers. With its aid the response curve of the amplifier to be aligned is continuously traced on the screen of a cathode-ray tube in conjunction with a coordinate system of frequency and amplitude derived from a standard-signal generator."

Among the main applications of the apparatus are : (i) the testing of f.m. receivers with i.f. around 5 Mc/s : the advantages for the alignment of the frequency-discriminator are specially pronounced, since the linearity of its characteristic can be directly and instantly checked on the c.r.o. screen : (ii) the alignment of television i.f. amplifiers, particularly those for vestigial sideband : "the peculiar response curve strived at in vestigial-sideband reception, with its 50% response at carrier frequency, etc., has to be adjusted to rather close limits if overshoot distortions are to be kept at a minimum. The continuous and quantitative record afforded by the apparatus described should prove valuable in this instance."

In the amplitude-calibrator unit the throw-over switch, applying the f.m. signal for one half-period and the constant-frequency signal for the other, takes the form of a circuit with two h.f. pentodes : this has proved extremely reliable.

1875. Shear Modes in Piezoelectric Crystal [Quartz & Tourmalin] Plates.—S. Bhagavantam & D. Suryanarayana. (*Nature*, 10th Feb. 1945, Vol. 155, No. 3928, p. 171.)

Investigations of the diffraction patterns in a liquid medium showed that besides the usual thickness longitudinal mode, patterns corresponding to thickness transverse or shear modes were present occasionally. Such patterns were facilitated when the plates were silvered in patches only, or prepared so that there was a deviation from the normal cut. With irregular silvering, not only did the odd harmonics of the shear mode appear but also the even harmonics of all the modes began to show up.

Such results were used for determining the elastic constants corresponding to the shear modes: details are being published elsewhere. "These observations mean that particular shear modes cause longitudinal strains in the crystal plates, resulting in corresponding longitudinal ultrasonic waves in the liquid. The phenomenon is presumably connected with the coupling between the longitudinal and shear modes, produced either by the finite size of the plate, or the cut of the plate, being such that the modes themselves are inherently coupled."

1876. Elastic Constants of Quartz [calculated from Resonance-Frequency Determinations using Supersonic Diffraction of Light Technique: Correction for Forces arising from Polarisation produced by Vibrations (Lawson, 2493 of 1941): Comparison with Values due to Voigt (Static Method) and Atanasoff & Hart (1452 of 1941)].—B. R. Rao. (*Current Science* [Bangalore], Jan. 1945, Vol. 14, No. 1, p. 17.) For the C_{33} constant the transmission method evolved in the same laboratory (Bhagavantam & Bhimasenachar, ref. "3" and 99 of January & 511 of February) was used with a *Z*-cut plate.

1877. Adjusting the Frequency of Quartz Oscillator Plates [X-Ray Equipment for U.S. Army Signal Corps].—North American Philips Company: C. Frondel. (*Journ. Franklin Inst.*, Jan. 1945, Vol. 239, No. 1, pp. 74–75.) *See* also 1529/30 of May.

1878. A New Phenomenon in the Piezoelectric Oscillations of a Quartz Crystal.—Parthasarathy, Pande, & Pancholy. (*Journ. of Scient. & Ind. Res.*, June 1944, Vol. 2, p. 1 onwards.) Referred to in *Journ. Acous. Soc. Am.*, Jan. 1945, p. 213.

1879. The Design and Application of Multivibrators, employing the Abraham–Bloch System as a Basis of Planning.—W. R. Abbott. (*Communications*, July 1944, Vol. 24, No. 7, pp. 38–40 and 84.)

"While the amplifier concept shows that oscillations will exist, it gives no information concerning the output frequency or wave-shape. Since both of these are important, further analysis is desirable . . ." High-frequency operation is not considered.

1880. On the Measurement of Small and Slow Potential Variations by means of Frequency Modulation.—C. A. Beevers & R. Fürth. (*Journ. of Scient. Instr.*, March 1945, Vol. 22, No. 3, pp. 48–50.)

The writers' "Encephalophone," for the investigation by an acoustical (change of pitch) method of the rhythmic potential changes produced on the scalp by the activity of the nerve cells of the brain, was dealt with in 2041 of 1943 and back reference. The present paper describes the latest improved and compact form of the apparatus, after mentioning some of its advantages over the standard method of oscillographic recording: it ends by outlining some other applications. These include the investigation of piezoelectric phenomena (routine testing of quartzes, etc.), the measurement (in conjunction with a piezoelectric pick-up) of very small slow mechanical oscillations, and the measurement (in conjunction with a photocell or a thermopile, respectively) of light-intensity or temperature variations.

The potential changes on the scalp are of the order of 1–100 μV, their frequency between 1 and 10 c/s. With the present apparatus (with a six valve *RC*-coupled amplifier and two 5 Mc/s Hartley oscillators each with its frequency-modulating variable-mu pentode) a potential variation of 10 μV produces a change of pitch of about one octave in the note.

1881. A New Type of Magnetometer, the "Oersted-Meter," based on the Interaction of Two Perpendicular Fields.—Berstein. (In paper dealt with in 1943, below.)

1882. A New Type of Electron-Optical Voltmeter.—L. Jacob. (*Journ. I.E.E.*, Part II, Dec. 1944, Vol. 91, No. 24, pp. 512–515: Discussion pp. 515–516.) Already dealt with in 2665 of 1944 and back reference.

1883. A Valve Voltmeter for Higher Voltages.—J. F. Tönnies. (*Electronic Eng:g*, Sept. 1944, Vol. 17, No. 199, pp. 168–169.) An account, by R. Neumann, of the paper dealt with in 2442 of 1942.

1884. Electrostatic Voltmeters [the Rawson Type 518, offering "Many Features Not Previously Available in Commercial Instruments": Frequency Response "Very Good, without Appreciable Errors even at Low Radio-Frequencies"].—Rawson Elec. Instr. Company. (*Review Scient. Instr.*, Dec. 1944, Vol. 15, No. 12, pp. 352–353.)

1885. Moving-Coil Ammeters [and the Reduction of Temperature Effect by a Bridge Circuit: etc.].—G. W. Stubbings. (*Electronic Eng:g*, Dec. 1944, Vol. 17, No. 202, p. 304: summary, from *Electrician*, 1944.)

1886. Instrument Transformers [including the Writer's Compensated Transformer].—A. Hobson. (*Journ. I.E.E.*, Part II, April 1944, Vol. 91, No. 20, pp. 147–163: Discussion pp. 163–168.) Summaries were referred to in 543 and 874 of 1944. For another Discussion *see* December issue, No. 24, pp. 568–571.

1887. Voltage-Transformer Testing Set [providing a "Highly Sensitive Method of testing Voltage Transformers for Phase Angle & Ratio Errors"].—Elliott Brothers. (*Journ. of Scient. Instr.*, March 1945, Vol. 22, No. 3, pp. 55–56.)

1888. A Meter Test Set.—N. M. Gilbert. (*Bell Lab. Record*, Feb. 1945, Vol. 23, No. 2, pp. 57–61.)

1889. " Engineering Precision Measurements " [Book Review].—A. W. Judge. (*Engineering*, 2nd Feb. 1945, Vol. 159, No. 4125, p. 83.) A notice was referred to in 531 of February. " Always scientifically sound and reveals an exceptionally wide knowledge and personal experience of workshop and toolroom practice . . ."

1890. Metric or Beplam ? [Postscript to Letter dealt with in 1125 of April : Units of Length, with Special Reference to Cables].—A. L. Meyers. (*Wireless Engineer*, April 1945, Vol. 22, No. 259, p. 182.)

" After working through a Service specification containing no less than five different units of length, I have felt like quoting pressures in pennyweights per square hand, and attenuations in percentage diminutions per rod, pole, or perch . . . The great development of h.f. cables during the war is a golden opportunity to introduce the metric system in this field at least, and the good example might be contagious . . ." Regarding the inconvenience of decibels, " if we *must* retain our feet despite their paining us, then the mb/ft is easier to manipulate, besides shorter and more pleasing, than the db/100 ft."

1891. Services Components Standardisation [List of Specifications issued on behalf of the Inter-Service Components Technical Committee].—British Standards Institution. (*Wireless World*, April 1945, Vol. 51, p. 105: *Electronic Eng:g*, March 1945, p. 431.)

1892. Review of Recent Absolute Determinations of the Ohm and the Ampere [and Comparison of Results with Those of Other Recent Compilations].—H. L. Curtis. (*Journ. of Res. of Nat. Bur. of Stds.*, Oct. 1944, Vol. 33, No. 4, pp. 235–254.)

1893. Suggestions for the Reorganisation of the Instrument Industry after the War.—R. S. Clay. (*Journ. of Scient. Instr.*, March 1945, Vol. 22, No. 3, pp. 41–43.)

SUBSIDIARY APPARATUS AND MATERIALS

1894. Deflected Electron Beams [Reply to Rodda's Letter].—Harries. (*See* 1810.)

1895. The Recording of Stationary Patterns on the Cathode-Ray Oscillograph [without Use of Photography : Curved traced on Cellophane by Pin-Point].—Walton. (*Journ. of Scient. Instr.*, March 1945, Vol. 22, No. 3, p. 54.)

The tracing " is difficult to see in ordinary light, but if it is illuminated by a point source of light the depression in the cellophane . . . acts like a concave lens, causing the rays of light which strike it to diverge. A sharp shadow of the tracing is thus cast on a piece of paper held behind it, and the details may be drawn-in readily by a pen or pencil . . . The method is cheap to use and it has the advantage that records may be transferred rapidly to a notebook and studied during the course of a series of observations."

1896. Cathode-Ray-Tube Traces : Part I—Lissajous' Figures : Errata.—Moss. (*Electronic Eng:g*, Oct. 1944, Vol. 17, No. 200, p. 214.) The last correction refers to the August, not the September, issue. The series was referred to in 3946 of 1944 : for Part II (Straight-Line Time Bases) *see* issues for Dec. 1944 & Jan. 1945, Nos. 202 & 203, pp. 285–288 & 329–332.

1897. Beam Blanking Circuit for Oscilloscopes [having Control Grids].—Richter. (*Electronics*, Sept. 1944, Vol. 17, No. 9, pp. 128–130.)

" A three-tube electronic unit permits photographing a complete transient trace on a cathode-ray oscilloscope screen with high detail [*e.g.*, five sweeps to each transient] and no fogging [by scattered electrons, as with the usual " single-sweep " arrangement with beam biased off the screen]. Arrival of transient trips a trigger circuit, releasing the blanked beam, and provides a dotted '*Z*' timing wave."

1898. Slow-Time Sweeps for a High-Speed Cathode-Ray Oscillograph.—Oakeshott. (*Journ. of Scient. Instr.*, March 1945, Vol. 22, No. 3, pp. 50–52.)

Certain advantages of the spark-gap type of time base over the valve type are mentioned : the longest time sweep that can be produced with the ordinary circuit, however, is limited (mainly by spark-heating considerations) to the order of 1 ms or even less. " Occasions arise when it is desirable to use a longer sweep than this without changing over to an electromagnetic type of oscillograph, and the circuit described below, similar to that developed by Berger (2678 of 1944), has been designed for this purpose and successfully operated.

" It may be possible to apply the method to lower-voltage oscillographs by the use of low-voltage spark-gaps, but this has not been experimentally investigated." With the arrangement described, sweep times of 0.3 s, 30 ms, and 6 ms were obtained.

1899. Cathode - Ray Oscillographs [Letter prompted by Use of Amplitude Response to assess the Value of an Instrument for L.F. Work (1133 of April) : " Not a Satisfactory or Safe Criterion " for Most Mechanical-Engineering Purposes : the Importance of Phase Distortion].—Aughtie. (*Engineer*, 16th Feb. 1945, Vol. 179, No. 4649, p. 134.)

1900. Cathode - Ray Tube Development : Early History, Mathematical Concepts, Present-Day Problems.—Beers. (*Communications*, July 1944, Vol. 24, No. 7, pp. 43..46 and 89 : to be contd.) From the North American Philips Company. *See* also 1901, below.

1901. Cathode - Ray Tube Manufacturing Problems.—Beers. (*Communications*, Sept. 1944, Vol. 24, No. 9, pp. 46..52 and 82.)

1902. Photography with the Electron Microscope [Summary, with Interpolations, of a Paper read at a Meeting at the Royal Photographic Society's Rooms].—Chilton, Crook, & Sheffield. (*Nature*, 20th Jan. 1945, Vol. 155, No. 3925, pp. 68–69.)

1903. Crystal Interference Phenomena in Electron-Microscope Images [Survey, Further Data, & Dynamical Theory].—Heidenreich & Sturkey. (*Journ. Applied Phys.*, Feb. 1945, Vol. 16, No. 2, pp. 97–105.)

1904. Techniques in Applied Electron Microscopy [with Special Attention to Certain Phases "of Interest to Those working in Light Optics or Associated Problems": the Silica Replica: Stereoscopy: etc.].—Heidenreich. (*Journ. Opt. Soc. Am.*, Feb. 1945, Vol. 35, No. 2, pp. 139–148.)

1905. Phase-Difference Microscopy [Letter prompted by O. W. Richard's Recent Work (1140 of April) on Zernike's Phase-Contrast Method: the Techniques used by C. R. Burch & others at the H. H. Wills Physical Laboratory].—Linfoot: Burch. (*Nature*, 20th Jan. 1945, Vol. 155, No. 3925, p. 76.)

1906. Preliminary Experiments in Phase-Difference Microscopy, *and* Phase-Difference Microscopy as a Problem in Diffraction.—Jupnik: Osterberg. (*Journ. Opt Soc. Am.*, Dec. 1944, Vol. 34, No. 12, p. 773 pp. 773–774: summaries only.)

1907. "Spektralphotometrische Untersuchungen der lichttechnischen Eigenschaften helleuchtender Sulfidphosphore" [Book Review].—Schilling. (*Zeitschr. f. Instr:kunde*, Jan. 1943, Vol. 63, No. 1, pp. 37–38.)

1908. Automatic Töpler Pump [easily Improvised].—Mitra & Sivaramakrishnan. (*Current Science* [Bangalore], Dec. 1944, Vol. 13, No. 12, p. 320.)

1909. High-Vacuum Gauges [Comprehensive Survey].—Pirani & Neumann. (*Electronic Eng:g*, Dec. 1944 & Jan./March 1945, Vol. 17, Nos. 202/205, pp. 277–280, 322–326, 367–371, & 422–426.) With 94 literature references and many illustrations.

1910. A New Electronic Stabiliser and Regulator for D.C. Voltages, *and* Electronic Voltage Regulator for A.C. Voltages.—Glynne: Dietert Company. (*See* 2080 & 2081.)

1911. Semi-Stabilised H.T. Source: Use of a Small Auxiliary Valve for Ripple Suppression [and Removal of All but the Slowest of Variations due to Mains-Voltage Fluctuations].—Hanney. (*See* 1763.)

1912. A Cyclotron which allows the Accelerated Particles to Emerge in a Direction Parallel to the Dee Interface [for Work in which *Direct* Use is made of the High-Energy Ions, and in which the Ions are required to be Mono-Energetic to 1% or Less].—Kruger & others. (*Review Scient. Instr.*, Dec. 1944, Vol. 15, No. 12, pp. 333–339.)

1913. A New Method for the Acceleration of Relativistic Particles [Simple Generalisation of Resonance Method (used for Heavy Particles in the Cyclotron) makes It suitable for Acceleration of Relativistic Particles (Electrons) & Production of Arbitrarily High Energies]. — Veksler [Wechsler]. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, 20th June 1944, Vol. 43, No. 8, pp. 329–331: in English.)

It had been thought that the resonance method could not be used for electrons because the mass of the particles is relativistically variable with the velocity. The difficulty was circumvented by the accelerator with vortex field suggested by Wideröe (1929 Abstracts, p. 169) and developed by Kerst (3130 of 1941), and it appears that particles with an energy approaching 100 mev will shortly be available in this way. "However, further increase of the electron energy by Kerst's method is fraught with great technical difficulties": hence this Note. *Cf.* Dodd, 1914, below.

1914. Frequency Elimination in Spirotron Systems for accelerating Ions and Electrons.—Dodd. (*Phys. Review*, 1st/15th Jan. 1945, Vol. 67, No. 1/2, p. 65: summary only.) For the spirotron *see* 420 of February. "Constant potential avoids frequency difficulties from relativistic change of mass at higher velocities."

1915. The Use of the Electron-Diffraction Camera to detect Insulating Films.—Alessandrini. (*Journ. Applied Phys.*, Feb. 1945, Vol. 16, No. 2, pp. 94–96.) Simple method (without necessity of identifying the pattern obtained) of distinguishing between insulating and conducting surface films on conducting objects.

1916. Tracking Currents in Insulating Materials.—Rushton. (*Electronic Eng:g*, Dec. 1944, Vol. 17, No. 202, p. 304: summary, from *Chem. & Industry*, 1944.) *See* also 2972 of 1944.

1917. Power Transmission Systems: a Review of Progress during the War, with Special Reference to Post-War Developments [including the Possibilities of Vacuum Insulation and Synthetics.].—Scott. (*Journ. I.E.E.*, Part I, Jan. 1944, Vol. 91, No. 37, pp. 33–38: *Elec. Communication*, No. 2, Vol 22, 1944, pp. 138–146.) Chairman's address to the Transmission Section, I.E.E.

1918. Gas-Filled and Vacuum Capacitors [Properties & Applications: Some Types produced by Various Makers: Variable Gas-Filled Capacitors & Their Construction: etc.].—Michaelson. (*Electronics*, Sept. 1944, Vol. 17, No. 9, pp. 124–127 and 320..332.)

1919. Silicones [the Various Products & Their Properties].—Dow Corning Corporation. (*Review Scient. Instr.*, Dec. 1944, Vol. 15, No. 12, pp. 354–355.) *Cf.*, for example, 3980/1 of 1944 and 1583 of May.

1920. Polythene and Its Use as a Dielectric [Mechanical, Chemical, & Electrical Properties of "Alkathene 20": Increased Flexibility given by Mixture with Polyisobutylene: Use in Submarine & H. F. Cables, for H.F. Moulding, etc.].—Williams. (*P. O. Elec. Eng. Journ.*, July 1944, Vol. 37, Part 2, pp. 40–44.)

1921. Softening Temperature of Polymers [Theory & Experimental Confirmation].—Alexandrov & Lazurkin. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, 30th June 1944, Vol. 43, No. 9, pp. 376–379: in English.)

1922. Some Applications of Ultrasonics in High-Polymer Research.—Mark. (*See* 1857.)

1923. Polymer-Plasticizer Interaction [Preliminary Account covering Some of the Points raised at Soc. of Chem. Ind. Discussion].—Frith & Tuckett. (*Nature*, 10th Feb. 1945, Vol. 155, No. 3928, pp. 164–166.) "Previous ideas would seem to need revision as a result of recent advances in polymer thermodynamics . . ."

1924. Flame Resistance of Thermosetting Plastics [and the Superiority of Melamine Materials over Phenolic].—Gale & others. (*ASTM Bulletin*, Dec. 1944, No. 131, pp. 23–27.)

1925. Corrections to "Plastics: a Brief Review of Their Physical and Electrical Properties" [1183 of April].—Warner. (*Elec. Communication*, No. 2, Vol. 22, 1944, p. 123.)

1926. Thermoplastic Cables.—Barron, Dean, & Scott. (*Journ. I.E.E.*, Part II, Aug. 1944, Vol. 91, No. 22, pp. 297–309: Discussion pp. 309–316.) A summary was dealt with in 1681 of 1944.

1927. Symposium on Plastics Research [including Low-Pressure Extrusion made possible by R. F. Heating, and Its Possibilities: New Resorcinol Resins with Special Advantages: etc.].—Society of the Plastics Industry. (*Sci. News Letter*, 6th Jan. 1945, Vol. 47, No. 1, pp. 6–7.)

1928. Cellulose Ester Plastics treated against Warping [and Brittleness, on Long Exposure to Outdoor Conditions: Salol as Inhibitor, absorbing U.V. Rays and emitting Resultant Energy in Innocuous Form].—Kline. (*Sci. News Letter*, 13th Jan. 1945, Vol. 47, No. 2, p. 24.) From a paper by Meyer & Gearhart.

1929. Dielectric Permeability of Rutile Mixtures [and the Obtaining of a Mixture with Zero Temperature Coefficient of Dielectric Permeability].—Wul. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, 10th June 1944, Vol. 43, No. 7, pp. 292–294: in English.)

"It is only natural that Lichtenecker's relation [$\log \epsilon = \delta \log \epsilon_1 + (1 - \delta) \log \epsilon_2$: ref. "4"], stated for ordinary mixtures, breaks down in cases where rutile reacts chemically with the other components of the mixture." Thus when the concentration of TiO_2 in the compound TiO_2–MgO increases up to 45%, the dielectric permeability of the compound changes but little and remains comparatively small, not higher than 13. On the other hand, G. I. Skanavi has found that by using rutile dolomite compounds, substances with as high a dielectric permeability as about 70 can be obtained.

"Another difference between the TiO_2 compounds with dolomite and the magnesium titanates is that the former show a negative temperature coefficient of dielectric permeability, while the t.c. of the latter is positive. If we suppose that the reacting ability of TiO_2 is exhausted in compositions with MgO and dolomite, then we may hope that for the combination of these compounds Lichtenecker's relation holds again . . . The t.c. of dielectric permeability of a mixture is equal to the weighted arithmetical mean of the components . . ." Experimental curves support both these statements. The final equations give the condition for zero t.c. and the corresponding value of dielectric permeability.

1930. Synthesis and Study of Phlogopite [Mica].—Grigoriev. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, 20th April 1944, Vol. 43, No. 2, pp. 63–65: in English.)

"The phlogopites, synthetically prepared and described by this author in 1934/5, were produced in the presence of calcium fluoride, owing to which their chemical composition is distinguished by the presence of the calcium component. In this paper a method for producing purely magnesial fluor-phlogopite, without any admixture of the calcium compound, is described . . . The melts produced, in external appearance, consist completely of mica scales, with an area up to 10 mm² . . . Following the cleavage planes thin mica scales are split off, possessing flexibility and elasticity, but to a somewhat lesser degree than natural phlogopite; they can be cut with scissors . . ."

1931. Ability of Crystalline Quartz and of Glass melted from It to take Colour on Irradiation [Ability or Inability of Quartz to take on a Smoky Colour (*cf.* 1529 of May) seems Definitely Related to Its Different Properties: may serve as Useful Criterion in Selection of Suitable Quartz].—Laemmlein. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, 30th May 1944, Vol. 43, No. 6, pp. 234–235: in English.) Especially as quartz crystals that take colour are easily distinguished by their ability to emit cathode luminescence (unpublished result).

1932. Glass Cement Ceramics [and the Two Principles which should form the Basis of a Genuinely Scientific Theory of Ceramic Production].—Kitaigorodsky. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, 30th March 1944, Vol. 42, No. 9, pp. 393–394: in English.)

(i) It is necessary to secure a qualitative and quantitative constancy of the vitreous as well as of the crystalline phase in the product: (ii) the proportion of the vitreous phase should be reduced to a minimum and assigned the rôle of a cement. "The crystals of a ceramic specimen should be bound together by a micro-film of vitreous substance in which, just as in glass fibre, all the brittleness peculiar to the glass has vanished . . ."

1933. Preparing Refractory Oxides, Silicates, and Ceramic Materials for Analysis [by Treatment with Acid Mixtures at 200°–300° C].—Wichers & others. (*Journ. Franklin Inst.*, Jan. 1945, Vol. 239, No. 1, p. 52:

summary, from *Journ. of Res. of Nat. Bur. of Stds.*, Dec. 1944.) *See* also pp. 52–53.

1934. New Glass able to resist Hydrofluoric Acid [and Its Many Uses, including in the Manufacture of Fluorides and Ceramics].—American Optical Company. (*Sci. News Letter*, 6th Jan. 1945, Vol. 47, No. 1, p. 7.) Phosphorus pentoxide replaces the usual sand.

1935. Miracles in Glass [Some Recent Developments].—Stouffer. (*Sci. News Letter*, 13th Jan. 1945, Vol. 47, No. 2, pp. 26 and 27.) *See* also 1934, above.

1936. "Die Rohstoffe zur Glaserzeugung" [Book Review].—Schmidt. (*Zeitschr. f. tech. Phys.*, No. 9, Vol. 24, 1943, p. 220.)

1937. The Formation of Metal-Sprayed Deposits [Some Theoretical Bases for Observed Facts, and the Fundamentals involved].—Ballard. (*Proc. Phys. Soc.*, 1st March 1945, Vol. 57, Part 2, No. 320, pp. 67–83.)

1938. Vacuum Coating Unit [for the Metallizing of Piezo-Crystals, Plastics, etc: with Special Features].—Distillation Products. (*Review Scient. Instr.*, Jan. 1945, Vol. 16, No. 1, pp. 18–19.)

1939. Trends in Component Design: Review of a Wartime Exhibition.—Radio Components Manufacturers' Federation. (*Wireless World*, April 1945, Vol. 51, No. 4, pp. 98–105.) This is the exhibition mentioned in 1494 of May.

1940. Sustained Subharmonic Response in Non-Linear Series Circuits.—Spitzer. (*See* 1762.)

1941. An Improved Permanent-Magnet Material [Alcomax II].—Permanent Magnet Association. (*Journ. of Scient. Instr.*, March 1945, Vol. 22, No. 3, p. 56.)

"We are informed that the alloy is more easily magnetised than Alnico, although its magnetic energy is nearly three times as great." Other data are given.

1942. Transverse Magnetic Permeability.—Gorelik. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URRS*, 20th May 1944, Vol. 43, No. 5, pp. 196–198: in French.)

The work of Harrison & others and of Webb, on the impedance of longitudinally magnetised wires traversed by alternating currents, has given a special interest to the transverse magnetic permeability first studied by Gans. The variation of this permeability as a function of the longitudinal field has been used by Harrison & Rowe in their "impedance magnetometer" (2103 of 1938), and its variation as a function of the longitudinal and transverse fields is capable of various applications in radio-electricity, as mentioned by Webb (2727 of 1938: remote tuning, etc.). The present writer adds to these the realisation of systems with periodically varying parameters, frequency modulation, and frequency changing.

The note contains some theoretical considerations on the variation of transverse permeability as a function of the longitudinal and transverse fields, and a comparison with experimental results obtained with 40 cm wires (0.4 mm diameter) of high-permeability nickel alloy. They showed the following properties in the transverse direction: (i) permeability of the order of 1000 gauss/oersted, (ii) a high degree of linearity, and (iii) the possibility of varying the permeability within wide limits by varying the longitudinal field. "This combination of properties presents an obvious interest for the applications mentioned above."

1943. An Induction Phenomenon due to the Interaction of Perpendicular Magnetic Fields [and the Development of a New Type of Magnetometer ("Oersted-Meter") based on It].—Berstein. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, 30th June 1944, Vol. 43, No. 9, pp. 380–382: in French.)

A straight ferromagnetic wire, surrounded by a coil whose turns were perpendicular to it, was placed in a constant magnetic field parallel to the wire: an alternating current passing through the wire induced an alternating e.m.f. in the coil. This would not have occurred if the relation between the induction and the field in the coil had been linear, for then the flux traversing the coil would not have varied. "The phenomenon results from a non-linear interaction between two perpendicular magnetic fields: the variations of the transverse component (with respect to the axis of the wire) of the field, excited by the current, produces a variation of the longitudinal component of the induction, excited by the constant longitudinal field"; a phenomenon which is, in a certain sense, reciprocal to that dealt with by Gorelik, 1942, above.

The phenomenon is analysed. The "oersted-meter" constructed has two ranges, 0–0.6 and 0–2 oersteds. It measures, of course, the projection of the external magnetic field upon the axis of the wire, and permits its sense to be determined.

1944. Cathodic Protection and Applications of Selenium Rectifiers [Protection of Buried Structures, Pipe Lines, Cable Sheaths, etc: and for Checking the Formation of Scale].—Bonner. (*Elec. Communication*, No. 2, Vol. 22, 1944, pp. 130–137.)

STATIONS, DESIGN AND OPERATION

1945. Cape-Charles/Norfolk Ultra-Short-Wave Multiplex System [General: Radio Equipment: Carrier Terminal Equipment: Regulation: Control & Alarm Features: Other Alarms: Systems Tests].—Schlaack & Dickieson. (*Proc. I.R.E.*, Feb. 1945, Vol. 33, No. 2, pp. 78–83.) All channels are now in service, five between Norfolk and Cape Charles, four between Norfolk and Onancock, and three for "private-line" telephone circuits. *See* also 1622 of May, and 1946, below.

1946. Ultra-Short-Wave Multiplex [as used in the Cape-Charles/Norfolk Service (1945, above): Comparison with Other Systems: Distortion Requirements: Transmitter Design: Receiver: Distortion Measurements: Appendix (Cross Modulation resulting from Deviations of Gain—Phase/Frequency Characteristic from the Ideal)].—Burrows & Decino. (*Proc. I.R.E.*, Feb. 1945, Vol. 33, No. 2, pp. 84–94.) *See* also 1772 & 1779, above. Summaries were referred to in 1622 of May.

1947. PULSE TIME MODULATION [Outline of Its Development: General Theory: "Important Advantages include Improvement of Signal/Noise Ratio as Band-Width Increases, and Possibility of adding Repeaters without increasing Distortion": Specially Promising for Multi-Channel Radio & Coaxial-Cable Systems, U.H.F. Broadcasting & Television Sound Channels].—Deloraine & Labin. (*Elec. Communication*, No. 2, Vol. 22, 1944, pp. 91–98.)

"Pulse modulation has been proposed mainly for multi-channel operation. For such operation pulse modulation allows time selection as opposed to frequency selection, and it is expected that time selection may have merits when compared with frequency selection . . ."

1948. FREQUENCY MODULATION [Pros & Cons].—Bell. (*Wireless World*, Feb. 1945, Vol. 51, No. 2, p. 58.) *See* 1218 of April.

1949. FREQUENCY MODULATION [Performance of Receivers to Impulsive Interference].—Gladwin & Thompson: Bell. (*See* 1780.)

1950. FREQUENCY MODULATION FOR CARRIER-CURRENT COMMUNICATION: NOISE REDUCTION WITH A NARROW-BAND SYSTEM [Account of Tests at 69 kc/s].—Guill. (*QST*, Dec. 1944, Vol. 28, No. 12, pp. 29–31.)

1951. RAILWAY COMMUNICATIONS: A FREQUENCY-MODULATED CARRIER-CURRENT SYSTEM ["Union Inductive Train Communication System"].—Union Switch & Signal. (*Wireless World*, March 1945, Vol. 51, No. 3, pp. 79–80.)

1952. POST-WAR AMATEUR TRANSMISSION [Points from R.S.G.B. Statement].—Radio Society of Great Britain. (*Wireless World*, April 1945, Vol. 51, No. 4, p. 109.)

1953. THE FREQUENCY REQUIREMENTS OF THE AMATEUR RADIO SERVICE [Reproduction of Part of Testimony offered by League in F.C.C. Hearings]. — A.R.R.L. (*QST*, Nov. 1944, Vol. 28, No. 11, pp. 18–21.) For the I.R.A.C. proposal *see* pp. 17–18 and also the Dec. issue, pp. 15–16, and for President Bailey's testimony on "amateur radio and its contributions to the security & welfare of the Nation," *see* pp. 16–17 and 74..86 of that issue.

1954. COMMUNICATIONS AND THE FIRE FIGHTER [Analysis of Requirements of the Fire Service for More Adequate Communications Facilities].—Friede. (*Communications*, Sept. 1944, Vol. 24, No. 9, pp. 41..44, and 78, 79.)

1955. CIVIL AVIATION DISCUSSION [including Some Requirements of Radio Operation].—Royal Aeronautical Society. (*Journ. Roy. Aeron. Soc.*, Feb. 1945, Vol. 49, No. 410, pp. 55–98.) For the section on radio *see* pp. 92–93.

1956. SO YOU'RE ON A LIBERTY SHIP: SOME HINTS ON IMPROVING STANDARD CARGO-SHIP RADIO INSTALLATIONS.—Whittaker. (*QST*, Nov. 1944, Vol. 28, No. 11, pp. 22–25.)

1957. A PROPOSAL FOR A GLOBAL SHORT-WAVE BROADCASTING SYSTEM [with Twelve 200 kW Transmitters grouped at (*e.g.*) Washington & San Francisco, covering World Population Centres in Twelve Zones].—Federal Telephone & Radio. (*Elec. Communication*, No. 2, Vol. 22, 1944, pp. 154–166.)

1958. BRITISH COLUMBIA BROADCAST RELAY SYSTEM.—Olding. (*Electronics*, Sept. 1944, Vol. 17, No. 9, pp. 92–97 and 304.)

"Remote valleys in rugged western Canada are difficult to serve by conventional broadcast methods. The problem is solved by installing 25-watt transmitters [operating on standard broadcast channels] in local telegraph and telephone offices through which network audio flows, and feeding part of the r.f. output of these transmitters back into the wire lines, which serve as carrier conductors."

1959. BRAZILIAN INTERIOR RADIOTELEPHONE SERVICE [New Development: Decree of 31st May, 1944].—Jacob. (*Elec. Communication*, No. 2, Vol. 22, 1944, pp. 99–100.)

1960. COMPETITIVE BROADCASTING [Monthly Commentary], *and* REORGANISING BROADCASTING.—(*See* 1995 & 1996.)

1961. CORRECTIONS TO "THE USE OF FIELD-INTENSITY MEASUREMENTS FOR COMMERCIAL-COVERAGE EVALUATION" [3642 of 1944].—Felix. (*Proc. I.R.E.*, Feb. 1945, Vol. 33, No. 2, p. 83.) On certain charts, "microvolts" should be changed to "millivolts."

1962. REMOTE MONITOR FOR DIRECTIONAL BROADCASTING [Continuously Operating Receiver at 1½ Miles in Null-Point Direction].—O'Bradovick. (*See* 1804.)

GENERAL PHYSICAL ARTICLES

1963. STRUCTURE OF THE PHOTON [Behaviour of a Doublet consisting of an Electron & an "A-tron" (Particle of Mass & Charge both Equal to Those of Electron but Opposite in Sign) would be Very Similar to That of a Photon: Electromagnetic-Wave Properties of Photon paralleled by Those of Probability Waves of Doublet: etc.].—Charlesby. (*Nature*, 10th March 1945, Vol. 155, No. 3932, pp. 304–305.)

"Further consideration of a duality of positive and negative masses appears capable of furnishing information on the nature of the electric field."

1964. THE AGING OF LIGHT [and the Two Interpretations of Red-Shifts in Spectra of Galaxies (Doppler Effect consequent on Recession; Aging of Light, by which the Wavelength of Photon steadily Increases)].—Milne. (*Nature*, 24th Feb. 1945, Vol. 155, No. 3930, p. 234.)

"That the two interpretations are substantially equivalent can be seen from the following strikingly simple calculation . . ."

1965. Red Shift in the Anagalactic Nebulae.—Shneiderov. (*Nature*, 17th March 1945, Vol. 155, No. 3933, pp. 332–333.)

The writer's eqn. 6 shows that under an acceleration by the field of gravitation a photon keeps its velocity constant by adjusting its frequency so as to compensate for the variation due to the acceleration. The red shift of the "expanding universe" is an immediate corollary of eqn. 6.

1966. On Milne's Theory of Gravitation [*Not* Invariant under a Lorentz Transformation, and therefore Inconsistent].—Schild : Milne. (*Phys. Review*, 1st/15th Dec. 1944, Vol. 66, No. 11/12, pp. 340–342.)

1967. A Quantum Theory of the Origin of the Solar System.—Haldane. (*Nature*, 3rd Feb. 1945, Vol. 155, No. 3927, pp. 133–135.) Followed by a preliminary discussion, by Milne, on pp. 135–136.

1968. The Autonomous Field [Force Field Not Caused by Particles, but an "Autonomous Entity built up of Indivisible, Coherent Units defining Probabilities in Space & Time].—Strömberg. (*Journ. Franklin Inst.*, Jan. 1945, Vol. 239, No. 1, pp. 27–40.)

"With every new application, the field concept has grown in importance, it has become an *autonomous regulator of events*, and as a consequence we now begin to see not only the world of matter but also the world of life in a new perspective . . ." The paper ends with the following summing-up : "the theory of the autonomy of force fields leads to the result that such fields can be analysed into integral, coherent units, and that this theory then makes it possible to understand many phenomena which the classical field theory is unable to explain. Principal among these phenomena are the wave nature and particle nature of matter and radiation and the small-scale and the large-scale organisation in the living world. The theory has been shown to be a natural consequence of modern wave mechanics. It is also in harmony with recent discoveries in biology and gives us a new concept of life. It is directly opposed to the mechanical concepts which have until recently characterised natural science. It points directly to a world intimately connected with our own consciousness."

1969. Evidence for the Artificial Production of a New Neutral Radiation [by a Cyclotron : Evidence points to Radiation consisting of Neutral Particles of Low Mass (Low-Mass Mesotrons)]. — Groetzinger & others. (*Phys. Review*, 1st/15th Jan. 1945, Vol. 67, No. 1/2, p. 52.)

1970. Physics in 1944 [X-Rays : Cosmic Rays (Penetrating Component : Nuclear Disintegrations : Showers : Theory of Counters): Artificial Disintegration : Magnetic Lens Spectrometer : Newton's Rings (Tolansky's Multiple-Beam Interference, 2449/50 of 1944)].—Osgood. (*Journ. Applied Phys.*, Feb. 1945, Vol. 16, No. 2, pp. 61–76.)

1971. On Cumulative Excitation of Hydrogen and Helium by Electronic Impact [Further Step in the Investigations carried out by Massey & Mohr, who took the Unexcited State of the Atom as Its Initial State (ref. "2")].—Yavorsky. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, 10th May 1944, Vol. 43, No. 4, pp. 151–156 : in English.)

1972. "The Adsorption of Gases and Vapours : Vol. I—Physical Adsorption" [Book Review].—Brunauer. (*Nature*, 10th Feb. 1945, Vol. 155, No. 3928, pp. 154–155.) "A very fine account of a complex subject."

MISCELLANEOUS

1973. American Mathematics in the Present War.—Stone. (*Science*, 15th Dec. 1944, Vol. 100, No. 2607, pp. 529–535.) By the President of the American Mathematical Society : "in many respects a story of frustration . . . important lessons can be drawn . . . and this is the time to draw them."

1974. Correspondence on "Pity the Poor Student" [1253 of April : including a Plea for the Reprinting of de Morgan's Books].—Hardie : Calisch. (*Wireless World*, Feb. & March 1945, Vol. 51, Nos. 2 & 3, pp. 59 & 92.) "There is no short cut to mathematical knowledge . . ."

1975. Teaching Mathematics : Plea for Improved Methods. — Durack. (*Wireless World*, March 1945, Vol. 51, No. 3, p. 83.) *See* also 136 of January.

1976. On the Teaching of Mathematics.—Murnaghan. (*Science*, 1st Dec. 1944, Vol. 100, No. 2605, pp. 479–486.)

1977. "Höhere Mathematik für den Praktiker" [Third, Improved Edition : Book Review].—Joos-Kaluza. (*Zeitschr. f. tech. Phys.*, No. 9, Vol. 24, 1943, p. 220.)

1978. "A Guide to Tables of Bessel Functions" [Review of Special Number of Nat. Research Council's Quarterly *Mathematical Tables & Other Aids to Computation*].—Bateman & Archibald. (*Science*, 12th Jan. 1945, Vol. 101, No. 2611, pp. 39–41.)

1979. "Five-Figure Logarithm Tables" [Book Review].—Ministry of Supply. (*Proc. Phys. Soc.*, 1st March 1945, Vol. 57, Part 2, No. 320, pp. 145–146.)

1980. Tensorial Analysis and Equivalent Circuits of Elastic Structures.—Kron. (*Journ. Franklin Inst.*, Dec. 1944, Vol. 238, No. 6, pp. 399–442.)

"Equivalent circuits are developed for one-, two-, and three-dimensional elastic structures that enable their solution, by means of a Network Analyser, under steady small deformations and under forced or natural vibration . . ." The individual members of mechanical structures have in general not one degree of freedom but six : "one of the purposes of this paper is to extend the electrical analogy to mechanical structures in which each member has six, instead of one, degrees of freedom, retaining at the same time as much of the simplicity of the one-dimensional analogue as possible." *See* also 1981, below.

1981. NETWORK ANALYSER SOLUTION OF THE EQUIVALENT CIRCUITS FOR ELASTIC STRUCTURES [1980, above : Comparison of Measured & Calculated Values shows that Existing Analysers are Satisfactory for the Purpose].—Carter & Kron. (*Journ. Franklin Inst.*, Dec. 1944, Vol. 238, No. 6, pp. 443–452.)

1982. ELECTRIC-CIRCUIT MODEL SOF THE SCHRÖDINGER AMPLITUDE EQUATION [for One, Two, & Three Independent Variables, in Orthogonal Curvilinear Coordinate Systems : for Solution by A. C. Network Analyser or by Numerical & Analytical Circuit Methods].—Kron. (*Phys. Review*, 1st/15th Jan. 1945, Vol. 67, No. 1/2, pp. 39–43.) Followed by "A.C. Network Analyser Study of the Schrödinger Equation," by Carter & Kron, pp. 44–49.

1983. SOLUTION OF HOMOGENEOUS LINEAR EQUATIONS [particularly Those involved in the Problem of Small Oscillations of Mechanical Systems] BY AN ITERATION METHOD.—Hopstein. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, 30th June 1944, Vol. 43, No. 9, pp. 372–375 : in English.)

1984. NUMERICAL SOLUTION OF INITIAL - VALUE PROBLEMS [for Partial Differential Equations of the Hyperbolic Type (*see* also Kormes, 3589 of 1943)] BY MEANS OF PUNCHED-CARD MACHINES.—Kormes & Kormes. (*Review Scient. Instr.*, Jan. 1945, Vol. 16, No. 1, pp. 7–9.)

"For the sake of simplicity we describe the procedure for a second-order linear equation in two variables, but the process as such may be extended to more complex problems and to several variables. In fact, we believe that it can be used successfully for the solution of non-linear problems."

1985. SCIENTIFIC COMPUTING MACHINES [Letter prompted by Comrie's Article "Recent Progress in Scientific Computing" (275 of January [and *see* 1245 of April]) : the New Fundamental Conception embodied in the Mallock Calculator, and the Wide Possibilities of Its Application : Comrie's Reply].—Soper : Comrie. (*Journ. of Scient. Instr.*, March 1945, Vol. 22, No. 3, p. 54.)

1986. PUNCHED-CARD TABLES OF THE EXPONENTIAL FUNCTION, *and* PREPARATION OF PUNCHED-CARD TABLES OF LOGARITHMS. King : Thomas & King. (*Review Scient. Instr.*, Dec. 1944, Vol. 15, No. 12, pp. 349–350 : p. 350.)

1987. MISES' PROBLEM IN THE THEORY OF DIRECT CONTROL AND THE THEORY OF THE POINT-BY-POINT TRANSFORMATIONS OF SURFACES, *and* THE MOTION OF AN AIRCRAFT (WITHOUT RESTORING COUPLE) PILOTED AUTOMATICALLY, AND THE THEORY OF THE POINT-BY-POINT TRANSFORMATIONS OF SURFACES.—Andronow & Mayer : Andronow & Bautin. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, 20th April & 20th May 1944, Vol. 43, Nos. 2 & 5, pp. 54–58 & 189–193 : in English.)

1988. THE DIFFUSION PROBLEM AND THE THEORY OF CONNECTED EVENTS [Extension of One-Dimensional "Random Walk" (*cf.* 627 of February)].—Darling. (*Phys. Review*, 1st/15th Jan. 1945, Vol. 67, No. 1/2, p. 65 : summary only.) Some of the equations used in Brownian-movement problems are special cases of the integro-differential equation found here.

1989. THE DISTRIBUTION OF THE MEAN OF SAMPLES FROM A RECTANGULAR POPULATION.—Iyer. (*Current Science* [Bangalore], Jan. 1945, Vol. 14, No. 1, pp. 18–19.)

1990. "ELEMENTARY STATISTICS" [Book Review].—Blair. (*Science*, 29th Dec. 1944, Vol. 100, No. 2609, pp. 592–593.) "Can be said to bring the subject of statistical methodology to the reader as it was perfected up to the impact of Shewhart researches."

1991. "STATISTIOAL METHODS FOR RESEARCH WORKERS" [Ninth Edition, Revised & Enlarged : Book Review].—Fisher. (*Nature*, 3rd Feb. 1945, Vol. 155, No. 3927, p. 132.)

1992. ASTRONOMICAL AND GEOPHYSICAL PERIODICITIES [Discussion]. — Royal Astronomical Society. (*Nature*, 24th Feb. 1945, Vol. 155, No. 3930, pp. 224–227.)

1993. RECORDING LISSAJOUS' FIGURES [by a Refined Method].—Hales. (*See* 1826.)

1994. "THE ROYAL SOCIETY, 1660–1940" [Leading Article on Book].—Lyons. (*Engineering*, 9th Feb. 1945, Vol. 159, No. 4126, pp. 111–112.) *See* also *Nature*, 17th March 1945, Vol. 155, No. 3933, pp. 313–314.

1995. MONTHLY COMMENTARY : COMPETITIVE BROADCASTING [Urgency of Decisions : the Welcome Rejection of Commercial Broadcasting : Need for Competition : Inadequacy of B.B.C. "Regional Rivalry" Plan : *Economist* Proposals of Triple Scheme : the *Wireless World* Less Ambitious Proposal (3757 of 1942)].—(*Wireless World*, April 1945, Vol. 51, No. 4, p. 97.) "It seems inescapable that the stimulus of competition must be paid for, but, in an art like broadcasting, it seems to be worth something."

1996. REORGANISING BROADCASTING [Note on Booklet "The B.B.C.", published by Arts Advisory Committee of Communist Party].—(*Wireless World*, March 1945, Vol. 51, No. 3, p. 74.)

1997. SCIENCE IN THE FOREIGN SERVICE [Leading Article on Prof. Ashby's Appointment as Scientific Attaché to Australian Legation, Moscow].—(*Nature*, 17th Feb. 1945, Vol. 155, No. 3929, pp. 187–188.)

1998. SCIENCE IN THE MODERN STATE [Review of "Science and Administration in Modern Government"]. — Morrison. (*Nature*, 20th Jan. 1945, Vol. 155, No. 3925, pp. 86–87.) The L. T. Hobhouse Memorial Trust Lecture.

1999. SELECTION FOR HIGHER APPOINTMENTS [Leading Articles on Report of Committee appointed by Minister of Labour & National Service : the Reorganisation of the Appointments Department].—Hankey Committee. (*Engineering*, 12th Jan. 1945, Vol. 159, No. 4122, pp. 31–32: *Nature*, 24th Feb. 1945, Vol. 155, No. 3930, pp. 215–218.) *See* also 1660 of May.

2000. POST-WAR PLANNING [Leading Article on "Post-War Planning and Anglo-American Economic Relations"].—Whitehead, Ltd. (*Electronic Eng:g*, Dec. 1944, Vol. 17, No. 202, p. 271.)

2001. THE THREAT TO PURE SCIENCE [Continuation of Correspondence (1657 of May) on Stern's Note].—Alexander: Stern. (*Science*, 12th Jan. 1945, Vol. 101, No. 2611, pp. 37–38.)

2002. PRESIDENT ROOSEVELT'S LETTER ON THE OFFICE OF SCIENTIFIC RESEARCH AND DEVELOPMENT [asking for Vannevar Bush's Recommendations on Four Major Points relating to the Future].—Roosevelt. (*Science*, 15th Dec. 1944, Vol. 100, No. 2607, p. 542.) For a leading article on the third and fourth questions see *Review Scient. Instr.*, Jan. 1945, Vol. 16, No. 1, pp. 1–5.

2003. LETTER PROMPTED BY HARNWELL'S EDITORIAL "MILITARY RESEARCH FELLOWSHIPS IN THE PHYSICAL SCIENCES" [1270 of April]: FIVE POINTS FOR A POST-WAR MILITARY RESEARCH PROGRAMME.—Bowie: Harnwell. (*Review Scient. Instr.*, Jan. 1945, Vol. 16, No. 1, p. 15.)

2004. ORGANISATION OF RESEARCH IN THE U.S.S.R. INSTITUTE OF PHYSICAL PROBLEMS.—Kapitza. (*Nature*, 10th March 1945, Vol. 155, No. 3932, pp. 294–295.) Extracted by W. H. George from translated parts of Kapitza's very long report.

2005. ENGINEERING RESEARCH IN SWEDEN [and Its Organisation].—Velander. (*Engineering*, 23rd Feb. 1945, Vol. 159, No. 4128, pp.141–143.)

2006. A BONUS SYSTEM IN A RESEARCH ORGANISATION—McDonald. (*Journ. Franklin Inst.*, Dec. 1944, Vol. 238, No. 6, pp. 462–465.) Experience in the Biochemical Research Foundation since 1936.

2007. BRITISH ELECTRICAL AND ALLIED INDUSTRIES RESEARCH ASSOCIATION [Notes on 24th Annual Report].—E.R.A. (*Nature*, 17th March 1945, Vol. 155, No. 3933, pp. 342–343.)

2008. SUGGESTIONS FOR THE REORGANISATION OF THE INSTRUMENT INDUSTRY AFTER THE WAR.—Clay. (*Journ. of Scient. Instr.*, March 1945, Vol. 22, No. 3, pp. 41–43.)

2009. PATENT LAW [and Its Imperfections, especially the "Prior Publication" Difficulty: a Suggested Remedy].—Turnbull. (*Engineer*, 9th Feb. 1945, Vol. 179, No. 4648, pp. 113–114.) The sentence in the last paragraph, "Where a manufacturer (or patentee) could *not* agree . . ." should read "could *only* agree . . .": issue for 16th February, p. 135.

2010. WAR SURPLUS DISPOSAL [Disagreement with Clinch's Suggested Extension (1292 of April) of Writer's Proposal].—Cazaly. (*Wireless World*, Feb. 1945, Vol. 51, No. 2, p. 59.) For a letter supporting the Government plan to sell through normal Trade channels *see* March issue, No. 3, p. 92.

2011. DISPOSAL OF SURPLUS CONSUMER GOODS [American Policies & Procedures].—Olrich. (*Review Scient. Instr.*, Dec. 1944, Vol. 15, No. 12, pp. 356–359.)

2012. "SCIENCE AND SALVAGE" [from the German "Verwertung des Wertlosen": Book Review].—Ungewitter (Edited by). (*Nature*, 24th Feb. 1945, Vol. 155, No. 3930, pp. 219–220.)

"It is to directors to large laboratories and research institutions, and not least to economists and 'business executives', that the book will make a special appeal . . ."

2013. PHYSICIST AND THE PUBLIC [Letter on W. E. Wickenden's Address],—Yarros: Wickenden. (*Review Scient. Instr.*, Dec. 1944, Vol. 15, No. 12, p. 351.)

"The scientist is also a citizen and a soldier. He must work and fight for freedom, for civilisation, for decency, and for human dignity. . ." One duty overlooked by Wickenden is that of "impressing upon our business leaders and politicians the necessity and feasibility of using the method of science in the fields of economics and politics."

2014. "ART AND SCIENTIFIC THOUGHT" [Differences & Likenesses between Scientific & Artistic Attitudes to Life: Possibility of, and Need for, a Shedding of the Traditions of Mutual Antagonism: Book Notice].—Johnson. (*Journ. of Scient. Instr.*, March 1945, Vol. 22, No. 3, p. 59.)

2015. SCIENTISTS AND INDUSTRY [Letter on Remarks by Bragg, Hartley, and the Writer at B.A. Conference].—Devereux. (*Engineer*, 16th Feb. 1945, Vol. 179, No. 4649, pp. 133–134).

"For some reason, the modern young scientist, and perhaps the young physicist in particular, seems to possess extreme individuality and an immoderate amount of the artistic temperament to which Sir Lawrence referred. They do not seem to fit easily into the industrial team. . . Time is short and we in industry are very anxious to know if anything is really being done to solve the problem . . ."

2016. INDUSTRY AND UNIVERSITY EDUCATION [Conference on].—Imperial College. (*Engineering*, 16th Feb. 1945, Vol. 159, No. 4127, p. 132.)

2017. SCIENCE AND POST-WAR INDUSTRY [Leading Article criticising Parliamentary & Scientific Committee's Memorandum].—Parliamentary & Scientific Committee. (*Engineer*, 29th Dec. 1944, Vol. 178, No. 4642, p. 510.)

2018. PART-TIME EDUCATION: I.E.E. REPORT ON "EXTENSION" COURSES [Short Summary].—I.E.E. (*Wireless World*, Feb. 1945, Vol. 51, No. 2, p. 55.)

2019. "EDUCATION AND TRAINING FOR ENGINEERS: SECOND REPORT" [Book Notice].—I.E.E. (*Journ. of Scient. Instr.*, March 1945, Vol. 22, No. 3, p. 58.)

2020. RADIO ENGINEERING EDUCATION: A PLEA FOR MORE TRAINING "ON THE JOB".—Roddam. (*Wireless World*, Feb. 1945, Vol. 51, No. 2, pp. 53–55.)

"A large proportion of today's recruits are coming from the polytechnics and from Hankey courses in the universities. The training in these places leaves much to be desired; it is a purely trade training, an unbalanced forcing of a restricted technical talent . . ." "There is an awful danger that we are about to do the wrong thing for the wrong reason. Technical education does not breed technicians; a change of outlook will." For a "Monthly Commentary" *see* p. 33, and for correspondence, indignant and otherwise, *see* March issue, No. 3, pp. 91–92. For the views of "Diallist" *see* February issue, pp. 60–61, and March, p. 94, and for the writer's reply to the correspondence, and letters from Sturley and Bell, *see* April issue, No. 4, pp. 110–111.

2021. MORE TRAINING [Editorial on Freeth's Opening Address to Institute of Physics' Discussion on Selection & Training of Personnel for Industry].—Freeth. (*Electronic Eng:g*, Jan. 1945, Vol. 17, No. 203, p. 315.)

2022. FREE RADIO TRAINING AVAILABLE TO EX-SERVICEMEN [Extracts from Servicemen's Readjustment Act of 1944].—(*QST*, Dec. 1944, Vol. 28, No. 12, pp. 38 and 42.)

2023. THE "DEVELOPMENT PHYSICIST" AND HIS NEED FOR A BRANCH SOCIETY AND A MAGAZINE OF PROFESSIONAL CHARACTER.—Jacobs. (*Review Scient. Instr.*, Jan. 1945, Vol. 16, No. 1, p. 15.)

2024. "WHAT IS THIS MANAGEMENT?" [Book Review].—Puckey. (*Engineering*, 2nd Feb. 1945, Vol. 159, No. 4125, p. 83.) "Distinctive in style and often in outlook": the writer is a director and general works manager of Messrs. Hoover, Ltd.

2025. LABORATORY TECHNIQUES DEVELOPED FOR E.S.M.W.T. Communication Courses [at Haverford College].—Benham. (*Communications*, June 1944, Vol. 24, No. 6, pp. 62 . . 68.) Initials stand for "Engineering Science Management War Training".

2026. THE ROYAL SIGNALS: AN ACCOUNT OF THE WORK AND TRAINING OF ONE OF THE MOST IMPORTANT BRANCHES OF THE ARMY IN THE FIELD.—(*Electronic Eng:g*, Nov. 1944, Vol. 17, No. 201, pp. 239–245.)

2027. "IT CAN NOW BE REVEALED . . .": SOME ACHIEVEMENTS OF THE BRITISH RADIO INDUSTRY [with Special Reference to Various Types of Radiolocation].—Duncan. (*See* 1819.)

2028. ECHOLOCATION BY BLIND MEN, BATS, AND RADAR.—Griffin. (*Science*, 29th Dec. 1944, Vol. 100, No. 2609, pp. 589–590.)

For echolocation by bats *see* 1107 of April. Other known examples of the principle covered by the suggested term are the sonic fathometer (also used to locate schools of fish) and submarine detection. "Unsuspected forms of echolocation may be found in nature or developed by human technology, and the use of a single unifying term can help clarify our ideas and stimulate such future developments."

2029. THE ODOGRAPH [Device for Instantaneous Map-Making on the Field, Position-Plotting, etc: including Electronic Unit for Correcting the Magnetic Compass against Effects of Iron & Steel in Vehicle].—Monroe Calçulating Machine. (*Journ. Franklin Inst.*, Jan. 1945, Vol. 239, No. 1, pp. 76–77.)

2030. A CATHODE-RAY UNIVERSAL "FLIGHT ATTITUDE" INSTRUMENT: A PROPOSAL FOR A NOVEL FORM OF ELECTRONIC AIRCRAFT INSTRUMENT WHICH WOULD SIMPLIFY CIVILIAN FLYING.—Postlethwaite. (*See* 1822.)

2031. PEACETIME USES FOR V2 [for Ionospheric Research, etc.].—Clarke. (*Wireless World*, Feb. 1945, Vol. 51, No. 2, p. 58.) For "Free Grid's" revelations on this subject *see* March issue, No. 3, p. 86: for a serious treatment *see* review of W. Ley's book, in *Scient. Monthly*, Dec. 1944, pp. 477–478.

2032. TRENDS IN COMPONENT DESIGN: REVIEW OF A WARTIME EXHIBITION.—Radio Components Manufacturers' Federation. (*Wireless World*, April 1945, Vol. 51, No. 4, pp. 98–105.) This is the exhibition mentioned in 1494 of May.

2033. MAQUIS RADIO: A PERSONAL STORY FROM FRANCE.—Aisberg. (*Wireless World*, April 1945, Vol. 51, No. 4, pp. 122–123.) An editorial note mentions that Aisberg's own journal *Toute la Radio*, and also *L'Onde Électrique*, are due to resume publication as soon as paper is available.

2034. THE LEGHORN GANG: AN ACCOUNT OF HAM RADIO IN ITALY UNDER THE FASCIST RÉGIME [after the Crash of the Airship *Italia*].—Anon. (*QST*, Nov. 1944, Vol. 28, No. 11, pp. 30–32.)

2035. PHYSICS IN 1944.—Osgood. (*See* 1970.)

2036. SURVEY OF THE YEAR'S PROGRESS IN SCIENCE AND TECHNOLOGY.—Science Service. (*Sci. News Letter*, 23rd Dec. 1944, Vol. 46, No. 26, pp. 405–411.)

2037. "PRODIGAL GENIUS: THE LIFE OF NIKOLA TESLA" [Book Review].—O'Neill. (*Journ. Franklin Inst.*, Jan. 1945, Vol. 239, No. 1, p. 68.)

The author states that in 1898 Tesla "demonstrated in Madison Square Garden a boat operated by radio control, and the first practical system of wireless transmission . . . described fully in 1893."

2038. "RADIO AMATEURS' HANDBOOK" [Book Notice].—A.R.R.L. (*Wireless World*, April 1945, Vol. 51, No. 4, p. 119.)

2039. THE TENTH ANNIVERSARY OF THE CREATION OF THE CENTRAL INFORMATION SECTION (Z.W.B.) OF THE GERMAN AIR MINISTRY.—Simon. (*Journ. Roy. Aeron. Soc.*, Jan. 1945, Vol. 49, No. 409, p. 36: an RTP3 abstract.)

Originally part of the D.V.L. but independent since 1940, working in close conjunction with the

Lilienthal Society. Among its many activities (it is "responsible for passing on to the industry the results of all research work carried on in the Reich") the Z.W.B. issues the journal *Luftfahrtforschung*.

2040. DOCUMENTATION [with Particular Attention to the Work of the German "Society for Documentation" (formed in 1941 under the auspices of Ministry of Science & Education: *see* also 911 of 1942): the Impracticability of a Single Central Organisation: etc.].—Rahts & Joachim. (*Journ. Roy. Aeron. Soc.*, Jan. 1945, Vol. 49, No. 409, pp. 35–36: an RTP3 abstract.)

2041. PAN-AMERICAN BIBLIOGRAPHY [Notice of Directory of Journals dealing with Natural, Physical, & Mathematical Sciences published in Latin America].—Pan-American Union. (*Review Scient. Instr.*, Dec. 1944, Vol. 15, No. 12, p. 359.) For another step towards "intellectual cooperation" *see* 1650 of May.

2042. "THE SCHOLAR AND THE FUTURE OF THE RESEARCH LIBRARY" [Micro-Card Republication Proposal: Book Review].—Rider. (*Science*, 22nd Dec. 1944, Vol. 100, No. 2608, pp. 572–573.) A long critical review by Seidell: *see* also 1299 of April.

2043. INTERNATIONAL LANGUAGE [and Bodmer's Views (in "The Loom of Language": Previously Constructed Languages were "One-Man Affairs": International Committee of Experts should construct a Language acceptable to All Nations)].—Gowdey: Bodmer. (*QST*, Nov. 1944, Vol. 28, No. 11, p. 55.)

2044. TRANSLITERATION OF RUSSIAN NAMES [Continuation of Correspondence (292 of January): Criticism of Kosolapoff's Advocacy of *Chemical Abstracts* System: etc.].—Hoare. (*Science*, 15th Dec. 1944, Vol. 100, No. 2607, p. 547.)

2045. WHAT'S IN A NAME? THOUGHTS FOR THE RISING RADIO GENERATION [Defence of "New-Fangled" Terms when More Logical (Capacitance & Capacitor, Inductor, etc.) but Adhesion to Frequency-Changer (against Mixer) and Earthed-Grid (Except for Americans): Denunciation of Common Use of Electrostatic, Non-Linear Distortion: the Difference between Coaxial & Concentric: etc.].—"Cathode Ray." (*Wireless World*, April 1945, Vol. 51, No. 4, pp. 113–115.)

2046. CODING COMPONENTS [Letter & Editorial Note on Hurran's Proposals, 4053 of 1944].—Telcs: Hurran. (*Electronic Eng:g*, Oct. 1944, Vol. 17, No. 200, p. 214.)

2047. ELECTROMAGNETIC AND MECHANICAL EFFECTS IN SOLID IRON DUE TO AN ALTERNATING OR ROTATING MAGNETIC FIELD.—Pohl. (*Journ. I.E.E.*, Part II, June 1944, Vol. 91, No. 21, pp. 239–248.) Of interest in connection with (among other things) recent methods of surface hardening.

2048. THE DEGASSING OF LIGHT METAL ALLOYS BY SONIC VIBRATIONS [generated Directly (without a "Dipper") inside the Melt: in H.F. Furnace, with Superposed Steady Magnetic Field].—Esmarch & others. (*Journ. Roy. Aeron. Soc.*, Jan. 1945, Vol. 49, No. 409, pp. 43–44: an RTP3 abstract of the German paper referred to in 2924 of 1941.)

2049. THE PRINCIPLES OF HIGH-FREQUENCY HEATING [and Its Development, Capabilities, & Limitations].—Hartshorn. (*Electronic Eng:g*, Dec. 1944, Vol. 17, No. 202, p. 304: summary, from *Chem. & Industry*, 1944.) For other papers by the same writer *see* 1332 of April.

2050. FREQUENCY CONTROL IN RADIO HEATING [Circuit for Automatic Compensation of Capacitance-Variation due to Changes in Dielectric Constant of Material during Heating].—Gilbert. (*Wireless World*, March 1945, Vol. 51, No. 3, p. 82: summary, from *Electronics*, Dec. 1944.)

2051. ON A MODE OF AREAL SEISMIC PROSPECTING BY THE "CORRELATION REFRACTION" METHOD [which has largely relieved the Defects of the "Isotime" Method].—Gamburzev. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, 30th May 1944, Vol. 43, No. 6, pp. 239–241: in English.) For a paper by Lustikh "On the Use of Gravitational Survey Data of Reconnoitring Nature" *see* pp. 242–243: also in English.

2052. ELECTRONICS IN PETROLEUM PLANTS [Analytical Methods using Mass Spectrometry, Infra-Red Absorption & Raman Spectrography, Emission Spectrography, Electron Micrography, etc.].—Hochgesang & Schlesman. (*Electronics*, Sept. 1944, Vol. 17, No. 9, pp. 116–121 and 308..318.)

From the Socony–Vacuum Oil Company. Regarding electron microscopes the writers remark: "A 'reflecting' electron microscope seems to be the next step in this field": but *cf.* Mahl & Pendzich, 3116 of 1943.

2053. THE MASS SPECTROMETER: A NEW ELECTRONIC AID TO ANALYSIS [with Special Attention to Hipple's Instrument, 1808 of 1944 & Back References].—Hart: Hipple. (*Electronic Eng:g*, Oct. 1944, Vol. 17, No. 200, pp. 185–188.)

2054. THIXOTROPY AND DIELECTRIC CONSTANT OF PRINTING INKS [Preliminary Results].—Parts. (*Nature*, 24th Feb. 1945, Vol. 155, No. 3930, pp. 236–237.)

2055. EFFECT OF ADSORBED AMMONIA ON TRIBO-ELECTRIC POTENTIAL OF COMPRESSED GASES [Experiments to prevent Static Charges liable to cause Explosion when Gases are released through Nozzle].—Furman & others. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, 20th May 1944, Vol. 43, No. 5, p. 202: in English.)

2056. A GENERATOR OF DAMPED MICRO-WAVES ["Spark Discharges between 460 Series–Paralleled Metallic Spheres develop ½ Watt of Power at 7000 Mc/s for the Irradiation &

Stimulation of Cells in Biological Studies"].—Montani. (*Electronics*, Sept. 1944, Vol. 17, No. 9, pp. 114–115 and 306.)

These radiations, falling between the centimetric waves and heat rays, were used to irradiate mice having transplantable sarcomas. 18 out of 28 mice recovered, the dessication of the tumour occuring without any apparent thermal effect outside or inside the body. 13 out of 15 control mice, not irradiated, died.

2057. A NON-MECHANICAL INTERRUPTER FOR CONTROLLED SPARK CIRCUITS [primarily for Spectrographic Analysis: Auxiliary (Series) Spark-Gap through which a Stream of Air is passed at High Velocity: Direct Control of Number of Sparks per Cycle, and Other Advantages].—Fowler & Wolfe. (*Journ. Opt. Soc. Am.*, Feb. 1945, Vol. 35, No. 2, pp. 170–174.)

2058. LOW-FREQUENCY PHOTO-MECHANICAL OSCILLATORS [and a Variable-Frequency Wave Synthesiser with Adjustment of Amplitude & Phase of the Harmonic Components: primarily for the Phase Analysis of Wave-Forms of Biological Oscillations].—Baldock & Grey Walter. (*Electronic Eng:g*, Jan. 1945, Vol. 17, No. 203, pp. 327–328.)

2059. A LUMINOMETER FOR MEASURING BACTERIAL LUMINESCENCE [A.C.-Operated Photocell Instrument for Quantitative Studies of Effect of Antibiotics & Other Inhibitors, and of Nutritional Factors affecting Luminescence].—Griner & others. (*Review Scient. Instr.*, Jan. 1945, Vol. 16, No. 1, pp. 10–14.)

2060. A NOTE ON AMPLIFIERS FOR ELECTROCARDIOGRAPHY.—Dawson. (*See* 1757.)

2061. BRITISH GEAR FOR STALINGRAD [Electrocardiograph Equipment].—Cossor, Ltd. (*Wireless World*, Feb. 1945, Vol. 51, No. 2, p. 42.) For corrections to two points *see* April issue, No. 4, p. 112 (letter from K. Richards, of A. C. Cossor, Ltd.).

2062. ON THE MEASUREMENT OF SMALL AND SLOW POTENTIAL VARIATIONS BY MEANS OF FREQUENCY MODULATION [Latest Form of the "Encephalophone," and Its Various Applications, including the Measurement of Very Small & Slow Mechanical Oscillations, etc.].—Beevers & Fürth. (*See* 1880.)

2063. "WHAT IS LIFE?" [Book Review].—Schrödinger. (*Proc. Phys. Soc.*, 1st March 1945, Vol. 57, Part 2, No. 320, p. 146.)

From his discussion of the Delbrück model of the gene, the writer draws the general conclusion that living matter, while not eluding the "laws of physics" as established up to date, is likely to involve "other laws of physics" hitherto unknown, which, however, once they have been revealed, will form just as integral a part of this science as the former. "The final chapters are concerned with clarifying this conclusion, which, we are told, provided the only motive for writing the book."

2064. "TELEPATHY: AN OUTLINE OF ITS FACTS, THEORY AND IMPLICATIONS" [Book Notice].—Carington. (*Journ. Scient. Instr.*, March 1945, Vol. 22, No. 3, p. 59.) The author claims that his Association Theory explains the basic phenomena and is supported by experimental and other observations. For another recent book on the same subject *see* 1349 of April.

2065. MEASUREMENTS ON SELF-QUENCHING GEIGER–MÜLLER COUNTERS.—van Gemert & others. (*Physica*, June & July 1942, Vol. 9, pp. 556 & 658 onwards.) Mentioned in *Review Scient. Instr.*, Nov. 1944. *See* also 2066, below.

2066. SOME FLUCTUATION PROBLEMS CONNECTED WITH THE COUNTING OF IMPULSES PRODUCED BY A GEIGER–MÜLLER COUNTER OR IONISATION CHAMBER.—van der Velden & Endt. (*Physica*, July 1942, Vol. 9, p. 641 onwards.) A 17-page paper mentioned in *Review Scient. Instr.*, Nov. 1944. Other *Physica* papers are mentioned on the same page (Supp. p. 48).

2067. A LOW-IMPEDANCE-COUNTER CIRCUIT.—Langberg. (*See* 1770.)

2068. SUMMER SCHOOL IN X-RAY CRYSTALLOGRAPHY: REPORT OF CAMBRIDGE MEETING.—Voce. (*Electronic Eng:g*, Nov. 1944, Vol. 17, No. 201, p. 262.)

2069. X-RAY EQUIPMENT FOR CRYSTALLOGRAPHY [Meeting of X-Ray Analysis Group].—Institute of Physics. (*Nature*, 24th Feb. 1945, Vol. 155, No. 3930, pp. 244–245.)

2070. A ROTATING-ANODE X-RAY GENERATOR [the Astbury Generator of the Textile Physics Research Laboratory, University of Leeds].—MacArthur. (*Electronic Eng:g*, Dec. 1944 & Jan. 1945, Vol. 17, Nos. 202 & 203, pp. 272–276 & 317–321.) With 48 literature references.

2071. DOUBLE BRAGG REFLECTIONS OF X-RAYS IN A SINGLE CRYSTAL [Phenomenon observed by Writers in Quartz is Identical with Renninger's "Indirect Excitation" in Diamond].—Davisson & Haworth. (*Phys. Review*, 1st/15th Feb. 1945, Vol. 67, No. 3/4, p. 120.)

2072. "HANDBOOK OF INDUSTRIAL RADIOLOGY" [Book Review].—Crowther (Edited by). (*Nature*, 24th March 1945, Vol. 155, No. 3934, p. 350.)

2073. ON THE THEORY OF THE DIRECTIONAL PATTERNS OF CONTINUOUS SOURCE DISTRIBUTIONS ON A PLANE SURFACE.—Clark Jones. (*See* 1829.)

2074. PAPERS ON PHASE-DIFFERENCE MICROSCOPY.—Linfoot, Jupnik, & others. (*See* 1905/6, above, and 1140 of April.)

2075. MOLECULAR DICHROISM [Survey of the Work of the Writer & Others, with 35 Literature References].—Nikitine. (*Schweizer Arch. f. angew. Wiss. u. Tech.*, June 1943, Vol. 9, No. 6, pp. 176–184: in French.) *See* also 2254 of 1944.

2076. Radiating Characteristics of Tungsten and Tungsten Lamps.—Forsythe & Adams. (*Journ. Opt. Soc. Am.*, Feb. 1945, Vol. 35, No. 2, pp. 108–113.)

2077. A Note on Photocell Nomenclature.—Sommer. (*See* 1869.)

2078. A Device attached to an Optical Pyrometer of Disappearing-Filament Type to Extend Its Scale over Low Temperature [Image of Filament in Infra-Red Rays is projected upon Surface of Photocathode of Holst's Electron-Optical Converter (1934 Abstracts, p. 331)].—Freivert. (*Comptes Rendus (Doklady) de l'Ac. des Sci. de l'URSS*, 30th May 1944, Vol. 43, No. 6, pp. 237–238: in English.) Applications mentioned are to the control of temperature in the thermal treatment of metals and in the glass industry.

2079. An Electronic Potentiometer Pyrometer [Honeywell–Brown Pyrometer on the "Continuous Balance" System: with Oscillating Metal-Reed Converter and Balancing Motor].—Fraser. (*Electronic Eng:g*, Jan. 1945, Vol. 17, No. 203, pp. 340–344.)

2080. A New Electronic Stabiliser and Regulator for D.C. Voltages, *and* The Use of a Simple A.C. Potentiometer for the Precision Testing of Instrument Transformers.—Glynne. (*Journ. I.E.E.*, Part II, June 1944, Vol. 91, No. 21, pp. 174–177: pp. 177–181: Discussion pp. 182–184.) *See* also 1264 of 1944.

2081. Electronic Voltage Regulator [for Photoelectric Densitometers, etc., requiring Highly Stabilised A.C. Voltages from Commercial Mains: Output 160 W at 110 V, Voltage adjustable from 100 to 120 V: using Variable Impedance of Two Power-Amplifier Valves controlled by Phototube exposed to Illumination of Two Lamps].—Dietert Company. (*Review Scient. Instr.*, Dec. 1944, Vol. 15, No. 12, p. 352.)

2082. A New Transmission Photometer [for Accurate Measurement of Amount of Light transmitted through Very Small Areas of Spectrographic Plates].—General Electric. (*Review Scient. Instr.*, Jan. 1945, Vol. 16, No. 1, pp. 17–18.)

2083. A New Form of Photoelectric Ultra-Violet Spectrophotometer [with Special Attention to the Very Stable Amplifier].—Drabkin. (*Journ. Opt. Soc. Am.*, Feb. 1945, Vol. 35, No. 2, pp. 163–169.) "The good performance [over several years] may be ascribed not only to a properly balanced circuit, but also to a number of unique methods of mounting the photocell, electrometer tube, electrical circuit, and controls . . ."

2084. Small-Prism Infra-Red Spectrometry.—Barnes & others. (*Journ. Applied Phys.*, Feb. 1945, Vol. 16, No. 2, pp. 77–86.)

2085. "Infra-Red Spectroscopy" [in the Laboratory and the Production Line: Book Review].—Barnes & others. (*Journ. Franklin Inst.*, Dec. 1944, Vol. 238, No. 6, p. 469.)

2086. Direct-Reading Instrument for Spectrochemical Analysis.—Hasler & Dietert. (*Journ. Opt. Soc. Am.*, Dec. 1944, Vol. 34, No. 12, pp. 751–758.) A summary was dealt with in 2429 of 1944.

2087. Measuring Flash-Bulb Intensity with a [Photocell and] Cathode-Ray Oscillograph.—Ankersmit. (*Electronic Eng:g*, Oct. 1944, Vol. 17, No. 200, p. 204.)

2088. A Photoelectrically Controlled Kymograph [with No Damping due to Stylus Friction].—Feitelberg. (*Electronic Eng:g*, Oct. 1944, Vol. 17, No. 200, p. 195.)

2089. The Aniseikon [Balanced-Photocells Device with Gratings].—Sommer. (*Electronic Eng:g*, Oct. 1944, Vol. 17, No. 200, pp. 189–191.)

"Aniseikonia is a pathological condition in which the images which reach the consciousness through the two eyes are not of identical shape and size. This effect, although highly undesirable in the human visual system, is an efficient means of detecting moving objects in open or enclosed spaces . . ." *Cf.* Fitzgerald, 435 of 1937.

2090. Comparison of Watt-Hour Meters [by Phototube & "Magic Eye" Equipment].—Bull. (*Electronic Eng:g*, Dec. 1944, Vol. 17, No. 202, p. 304: summary, from *Elec. World*, 1943.)

2091. Phototube Control of Fluid Flow.—McNickle. (*Electronics*, Sept. 1944, Vol. 17, No. 9, pp. 110–113.)

"Flow rates as constant as $\pm \frac{1}{2}$% are achieved by a system which combines a rotameter for light-source interruption with phototubes, amplifiers, and thyratrons to control a motor-driven regulating valve."

2092. An Electronic Recording Flow-Meter [for Small Steady Liquid Flows or Mean Value of Small Pulsating Liquid Flows: primarily for Physiological Work].—Crittenden & Shipley. (*Review Scient. Instr.*, Dec. 1944, Vol. 15, No. 12, pp. 343–346.) For the new Fischer & Porter flow-ratio controller for liquids or gases *see* p. 352.

2093. Schlieren and Shadowgraph Equipment for Air-Flow Analysis.—Barnes & Bellinger. (*Journ. Opt. Soc. Am.*, Dec. 1944, Vol. 34, No. 12, p. 775: summary only.) *See* also 1710 of May.

2094. Electronic Tachometer [Photocell Pick-Up & Electronic Frequency-Meter: Ten Frequency Ranges, up to 3 000 000 r.p.m.].—Hewlett-Packard Company. (*Review Scient. Instr.*, Jan. 1945, Vol. 16, No. 1, p. 16.) *Cf.* 1716 of May.

2095. Photoelectric Crack Detector for Glass Food-Containers.—General Electric. (*Gen. Elec. Review*, Jan. 1945, Vol. 48, No. 1, p. 32: paragraph only.)

2096. A Photoelectric Method for the Determination of the Average Diameter of Fine Wires, Filaments, Fibres, etc.—Ahmad & Iyengar. (*See* 1547 of May.)

2097. A New Indicator [for Titration: Aqueous Extract of Hollyhock Flower superior to Methyl Orange and Phenolphthalein].—Datar & Kulkarni. (*Current Science* [Bangalore], Oct. 1944, Vol. 13, No. 10, p. 257.)

2098. The Ribbon-Frame Camera [High-Speed Camera primarily for Rocket Research: Special Method of preventing Blurring due to Continuous Motion of Film].—Reck. (*Bell Lab. Record*, Feb. 1945, Vol. 23, No. 2, pp. 40–45.)

2099. Quantum Theory of Exposure tested Extensively on Photographic Emulsions.—Silberstein & Trivelli. (*Journ. Opt. Soc. Am.*, Feb. 1945, Vol. 35, No. 2, pp. 93–107.)

2100. The Resolving Power in Photographic Recording.—Roeder: Hansen. (*Zeitschr. f. Instr:kunde*, Nov. 1942, Vol. 62, No. 11, pp. 365–367: Aug. 1943, Vol. 63, No. 8, p. 295.)

2101. American Standards for Photography [Dimensions of Plates & Films].—American Standards Association. (*Journ. Opt. Soc. Am.*, Oct. 1944, Vol. 34, No. 10, pp. 626–632.)

2102. Photo-Layout Materials [for Simplified Method of printing Working Drawings directly on Metal].—Kodak Company. (*Review Scient. Instr.*, Dec. 1944, Vol. 15, No. 12, p. 355.)

2103. Surface Replicas [for Surface Inspection & Comparison by Optical Projection: "Faxfilm" Plastic Film].—McDill. (*Review Scient. Instr.*, Nov. 1944, Vol. 15, No. 11, p. 331.) *See* also 1330 of April.

2104. A Photo-Receptor Mechanism for the Modulation Theory of Colour Vision.—Fry. (*Journ. Opt. Soc. Am.*, Feb. 1945, Vol. 35, No. 2, pp. 114–135.)

Based on Troland's concept of modulation of the optic nerve current: it is proposed that five different types of exciting substances exist in each photo-receptor, one determining the basic frequency of impulses and the other four modulating the frequency.

2105. A Modified Photochemical Theory of Vision.—Moon & Spencer. (*Journ. Opt. Soc. Am.*, Jan. 1945, Vol. 35, No. 1, pp. 43–65.)

2106. Persistence of Vision [Facts explained by Hypothesis that the Photochemical Stimulus in Vision is in Liquid Form, Cones being stimulated Indirectly by These Products, and Not by Direct Action of Light].—Edridge-Green. (*Nature*, 10th Feb. 1945, Vol. 155, No. 3928, p. 178.)

2107. Contrast Sensitivity of Central Vision as affected by Preliminary Light Stimulation ["Additional Lighting"] of Different Areas of Retina.—Kravkov & Semenovskaja. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, 10th June 1944, Vol. 43, No. 7, pp. 318–320: in English.)

2108. Absolute Photopic Sensitivity of the Eye in the Ultra-Violet and in the Visible Spectrum.—Pinegin. (*Nature*, 16th Dec. 1944, Vol. 154, No. 3920, p. 770.

2109. The Absolute Scotopic Sensitivity of the Eye in the Ultra-Violet and in the Visible Spectrum.—Pinegin. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, 10th Dec. 1943, Vol. 41, No. 7, pp. 285–287: in English.) *See* also letter to *Nature*, 6th Jan. 1945, Vol. 155, No. 3923, pp. 20–21.

2110. Corrigendum: "A Mean Scotopic Visibility Curve" [3339 of 1944].—Stiles & Smith. (*Proc. Phys. Soc.*, 1st Jan. 1945, Vol. 57, Part 1, No. 319, p. 66.)

2111. Contribution to the Theory of Image Formation on the Retina [Note on "the Principal Agent impairing the Resolving Power of the Eye," namely the Optical Heterogeneity of the Lens ("given No Due Attention by Writers on the Subject, except Helmholtz"): Measurement of Effective Aperture].—Maksutov. (*Comptes Rendus* (*Doklady*) *de l'Ac. des Sci. de l'URSS*, 10th June 1944, Vol. 43, No. 7, pp. 295–297: in English.)

For further development *see* the writer's paper "Resolving Power of Unaided and Armed Eye" in issue for 20th June 1944, Vol. 43, No. 8, pp. 338–341. The importance of the subject for the adequate designing and computing of visual optical instruments is stressed at the end of this.

2112. Electro-Optical Effect in Colloids.—Sakmann. (*Journ. Opt. Soc. Am.*, Dec. 1944, Vol. 34, No. 12, pp. 774–775: summary only.) For previous work *see* 3202 of 1944.

2113. Explanation of the Joshi Effect [the New Light Effect, 1709 of May and Back References: Explanation based on Kramers' Quantum-Mechanical Dispersion Formula].—Parshad: Joshi. (*Nature*, 24th March 1945, Vol. 155, No. 3934, pp. 362–363.)

2114. The Photo-Conductance of Evaporated Bismuth Films [Investigation indicating that *True* Photo-Conductance is Not Present, the Observed Photo-Conductance being attributed to Photoelectric Emission between Film Patches].—Weber & Friedrich. (*Phys. Review*, 1st/15th Nov. 1944, Vol. 66, No. 9/10, pp. 248–252.)

2115. Practical Applications of Metallic and Non-Metallic Films on Optical Elements [Properties of Silver, Aluminium, & Rhodium: Usefulness of Zinc Sulphide as a Beam Splitter: Magnesium Fluoride specially suitable for Anti-Reflection Coatings].—Lyon. (*Journ. Opt. Soc. Am.*, Feb. 1945, Vol. 35, No. 2, pp. 157–161.)

2116. The Deposition of [Satisfactorily Permanent] Lead-Sulphide Mirrors on Glass.—Smethurst. (*Journ. of Scient. Instr.*, March 1945, Vol. 22, No. 3, pp. 52–54.)

2117. COMA-FREE HIGH-APERTURE TWIN-ELLIPSOID MIRROR.—Woodson. (*Journ. Opt. Soc. Am.*, Dec. 1944, Vol. 34, No. 12, p. 774: summary only.) "Thus a hollow-cathode discharge tube can be imaged in a photoelectric tube with very high efficiency . . ."

2118. THE PROJECTION OF LIGHT [Theory of Beam Formation].—Benford. (*See* 1741.)

2119. A STUDY OF THE COMPARATIVE METHOD OF DETERMINING GASEOUS REFRACTIVITIES.—Craven. (*Proc. Phys. Soc.*, 1st March 1945, Vol. 57, Part 2, No. 320, pp. 97–107.)

Among other results, it is shown that the comparative method yields the ratio of the group (not phase) refractivities. In discussing this point the writer remarks: "It may be asked why the group index appears so little in ordinary optical measurements. It is suggested tentatively that this is because in general such measurements are concerned with angular deviation. As a dimensionless quantity, an angle has no relation to the mode of propagation of light in the medium, neither does it give any direct information as to the velocity of propagation. The group mechanism relates only to effects in the line of sight, and these are seldom examined."

2120. FRESNEL REFLECTION OF DIFFUSELY INCIDENT LIGHT.—Gershun. (*See* 1739.)

2121. COMBINATIONS OF SPHERICAL LENSES TO REPLACE NON-SPHERICAL REFRACTING SURFACES IN OPTICAL SYSTEMS.—Houghton. (*Proc. Phys. Soc.*, 1st March 1945, Vol. 57, Part 2, No. 320, pp. 84–90.)

2122. A PROPOSED METHOD OF SPECIFYING APPEARANCE DEFECTS OF OPTICAL PARTS.—McLeod & Sherwood. (*Journ. Opt. Soc. Am.*, Feb. 1945, Vol. 2, pp. 136–138.)

2123. ELECTRONICS IN INDUSTRY.—White. (*Proc. I.R.E.*, Feb. 1945, Vol. 33, No. 2, pp. 75–77.) A summary was dealt with in 1309 of April.

2124. INDUSTRIAL APPLICATIONS OF ELECTRONIC DEVICES.—Annett. (*Electronic Eng:g*, Dec. 1944, Vol. 17, No. 202, p. 304: summary, from *Power*, 1944.)

2125. REMOTE SWITCHING BY SUPERIMPOSED CURRENTS.—Carr. (*Journ. I.E.E.*, Part II, Dec. 1944, Vol. 91, No. 24, pp. 535–542: Discussion pp. 542–547.)

2126. AUTOMATIC CONTROL OF STILLS [for Water of Highest Purity: *see* also Zeluff, 1697 of May].—Shrader & Wood. (*Electronics*, Sept. 1944, Vol. 17, No. 9, pp. 98–99 and 242–250.)

"In addition to its use in the still system, the electronic relay described has been found ideal for use with sensitive thermo-regulators whose precision depends upon the maintenance of clean contactors. The exceedingly small currents drawn by the unit permit operation for long periods of time with mercury thermo-regulators."

2127. ELECTRONIC DEVICE MEASURES MUZZLE VELOCITY OF PROJECTILES [R.C.A. Electronic Time-Interval Counter].—Engstrom. (*Journ. Franklin Inst.*, Jan. 1945, Vol. 239, No. 1, pp. 75–76.) *See* also 1342 of April. For new mobile ordnance-calibration equipment for use on the battle-fronts see *Sci. News Letter*, 16th Dec. 1944, p. 388.

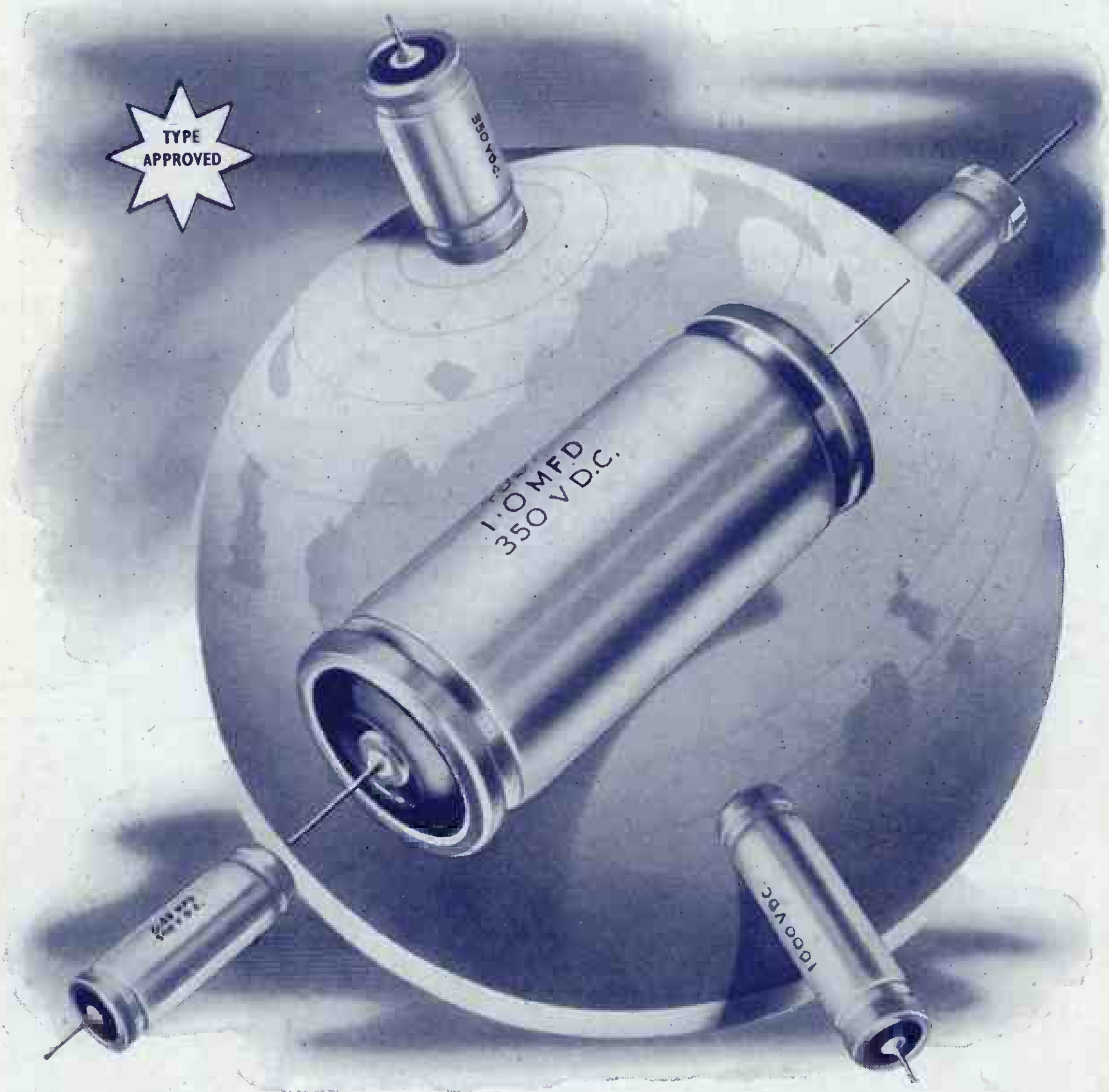
2128. AN ELECTRONIC WATER-IN-PETROL DETECTOR [for Aerodrome Installations].—Leland Instruments Ltd. and Wayne Tank & Pump Company. (*Electronic Eng:g*, Oct. 1944, Vol. 17, No. 200, p. 184.)

2129. VARIABLE-SPEED MOTOR AND ELECTRIC TACHOMETER [Shaded-Pole Reversible Induction Motor controlled by Autotransformer, giving Continuously Variable Speed from Plus to Minus the Rated Speed].—Miller. (*Review Scient. Instr.*, Dec. 1944, Vol. 15, No. 12, p. 348.)

As regards the tachometer, the problem was to construct one which would measure armature speeds down to only a few revolutions per second, and present a negligible load.

2130. THE USE OF WIRE-WOUND ELECTRICAL-RESISTANCE STRAIN GAUGES.—Dorey. (*Electronic Eng:g*, Jan. 1945, Vol. 17, No. 203, p. 348: summary, from *Shipbuilder*, 1944.) *See* also 3079 of 1944.

2131. CATHODE-RAY ARMATURE FAULT FINDING APPARATUS [Reduces Time for Locating & Analysing a Faulty Coil from 10 Minutes to 1 or Less].—Wilson. (*Electronic Eng:g*, Oct. 1944, Vol. 17, No. 200, p. 188.)



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