THE

WIRELESS ENGINEER

VOL. XVI. MAY, 1939 No. 188

Editorial

The Measurement of the "Quality" of Coils

THE ratio $\omega L/R$ is often used as a measure of the quality of a coil and represented by Q (In Germany by g or G = Gütezahl or goodness). The value of $\omega L/R$ can be determined in various ways, but in a recent number of *Hochfrequenz-technik und Elektroakustic** an apparatus is described for its direct measurement. The apparatus is entirely self-contained, the necessary generator and measuring apparatus being conveniently assembled in a single case. The method adopted is the well-known one in which the coil and a variable condenser form a circuit which is tuned to resonance with an injected e.m.f.; the ratio of the voltage across the condenser or coil to the injected e.m.f. depends upon the "quality" of the coil under test, assuming that of the variable condenser to be known. Although simple in principle the method involves measurements which are not easy to make without affecting the very things that we wish to measure. The circuit employed is shown in Fig. 1. The A.C. generator is connected across two condensers C_s and C_k in series which act as a potential divider, the circuit under test being connected across C_k, which acts as a coupling condenser between the two circuits.

In the apparatus described the A.C. is generated by a valve oscillator, the frequency of which can be varied between 10^5 and 10^7 c/s. It is important that the wave form should be free from distortion in order that the voltage U_1 may be accurately measured by means of a diode rectifier, which actually measures the peak value. The effective

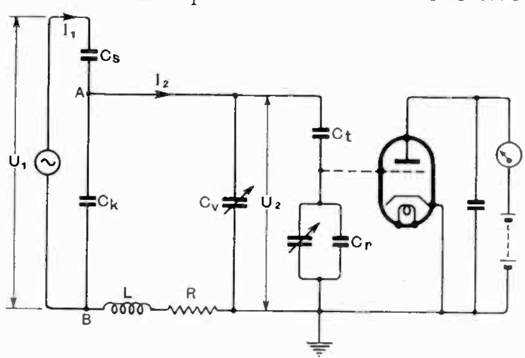


Fig. 1.

resistance of the rectifier must not be too low or it will cause distortion of the waveform. If these conditions are not fulfilled one will obtain indications of resonance

* January, 1939, p. 27.

when the test circuit is tuned to a harmonic frequency.

The output voltage U_2 is determined by means of a valve voltmeter, but not directly, because of the damping that would thereby be introduced into the circuit. The accuracy of the measurements and the upper limit of $\omega L/R$ which can be determined are dependent on the smallness of the losses in the condensers C_v and C_k and in the voltmeter connected across C_v. For this reason two condensers C_t and C_r are connected in series across C_v and the voltage, applied to the valve voltmeter is that across C_r, which is of course, a known fraction of U_2. In this way it is claimed that the valve loss can be reduced to a negligible amount so far as its effect on the test circuit is concerned, without the use of special valves. It should be noticed that the grid-cathode capacitance of the valve is in parallel with C_r and may affect the accuracy of the potential division; to avoid this C_r must be at least ten times the valve capacitance. It is actually about 30 $\mu\mu$F. In parallel with C_r there is a small variable condenser of about 3 $\mu\mu$F coupled mechanically to the main variable condenser C_v; this applies a correction to which we shall refer later. The valve voltmeter is calibrated so as to read directly the value of $\omega L/R$ over two ranges viz., 15 to 100 and 100 to 600. The range of inductance is from 0.5 μH to 20 mH and the accuracy claimed is ± 5 per cent. The variable condenser C_v has a maximum capacitance of 1,100 $\mu\mu$F and the coupling condenser C_k is of 11,000 $\mu\mu$F for the low range, and about a third of this for the high range.

As a first approximation one may regard the potential divider C_sC_k as supplying a fixed voltage $U_1 \dfrac{C_s}{C_s + C_k}$ to the circuit LRC_v and at resonance producing a current $I_2 = \dfrac{U_1}{R} \cdot \dfrac{C_s}{C_s + C_k}$ which gives a voltage $U_2 = I_2/\omega C_v$ across the condenser. Putting $1/\omega C_v R = \omega L/R = Q$, we have

$$U_2/U_1 = Q \,.\, C_s/(C_s + C_k)$$

This neglects any effect that the coupling condenser C_k has on the circuit under test, that is, it assumes it to have negligible impedance compared with that of the tuning condenser. The conditions may be determined more accurately as follows†:—

$$U_1 = I_1(Z_s + Z_k) - I_2 Z_k$$

$$\text{and} \quad 0 = I_2(Z_v + Z_k + Z_x) - I_1 Z_k$$

where Z represents the impedances of the various elements, Z_x being that of the coil under test. From these two equations we find

$$\frac{U_2}{U_1} = \frac{Z_v}{\dfrac{Z_s}{Z_k}(Z_v + Z_k + Z_x) + Z_v + Z_x}$$

$$\text{or} \quad \frac{U_1}{U_2} = \frac{C_k}{C_s} + \frac{C_v}{C_s} + 1 - \omega^2 LC_v\left(1 + \frac{C_k}{C_s}\right) + j\omega C_v R\left(1 + \frac{C_k}{C_s}\right)$$

Putting $\dfrac{C_s + C_k}{C_s} = \beta$, we have

$$\left|\frac{U_1}{U_2}\right|^2 = \beta^2 + C_v^2\left(\frac{1}{C_s} - \beta\omega^2 L\right)^2 + 2\beta C_v\left(\frac{1}{C_s} - \beta\omega^2 L\right) + \beta^2\omega^2 C_v^2 R^2$$

To find the condition for resonance, that is, for a minimum of this ratio, we differentiate with respect to C_v and equate to zero. This gives

$$2C_v\left(\frac{1}{C_s} - \beta\omega^2 L\right)^2 + 2\beta\left(\frac{1}{C_s} - B\omega^2 L\right) + 2C_v\beta^2\omega^2 R^2 = 0$$

which may be written

$$1 = \omega^2 LC_v - \frac{C_v}{C_s + C_k} + \frac{\omega^2 R^2 C_v^2}{\omega^2 LC_v - \dfrac{C_v}{C_s + C_k}}$$

In the last term, since it is only a small correction, we may put $\omega^2 LC_v = 1$ and $\omega^2 R^2 C_v^2 = 1/Q^2$, and write

$$\omega^2 LC_v = 1 + \frac{C_v}{C_s + C_k} - \frac{1/Q^2}{1 - \dfrac{C_v}{C_s + C_k}}$$

as the condition for resonance, but since C_v never exceeds a third of $C_s + C_k$, and Q lies between 15 and 600, the last term is quite negligible.

This result might have been anticipated since, having assumed the A.C. generator to have negligible impedance (U_1 constant),

† The treatment here is entirely different from that in the article referred to.

C_s and C_k are virtually in parallel between the points A, B, thus giving the circuit a resultant capacitance $\frac{C_v(C_s + C_k)}{C_v + C_s + C_k}$ and a resonant frequency given by the formula

$$\frac{\omega^2 L C_v(C_s + C_k)}{C_v + C_s + C_k} = 1$$

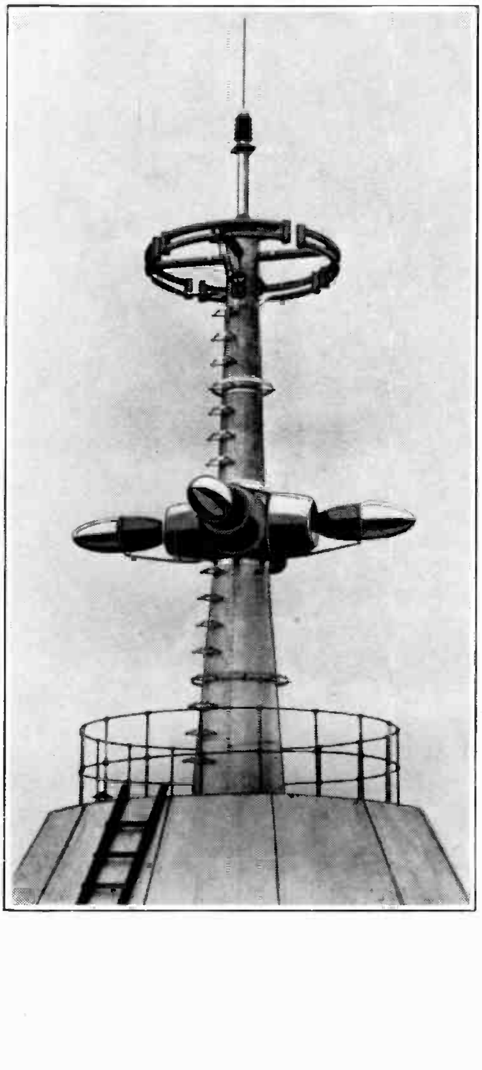
as found above.

Substituting this in the above formula we obtain

$$\left|\frac{U_1}{U_2}\right|^2 = \beta^2\omega^2 C_v{}^2 R^2.$$

Hence $$\frac{U_2}{U_1} = \frac{1}{\beta} \cdot \frac{1}{\omega C_v R} = \frac{1}{\beta} \cdot \frac{\omega L}{\omega^2 L C_v R}$$

$$= Q \frac{C_s}{C_v + C_s + C_k}$$



Hence to make the ratio of the voltmeter readings depend only on Q and to be independent of the variable C_v it would be necessary to make C_v, even at its maximum value, negligibly small compared with C_k. This would be very inconvenient and, as we have already said, in the apparatus described C_k is only three times the maximum value of C_v for one of the two ranges. The error that would thereby be introduced is corrected automatically by varying the ratio of the potential divider that feeds the grid of the valve voltmeter in the way already described.

In the article referred to reference is made to the difficulty of obtaining condensers free from inductance. It is stated that condensers sold as induction-free show a marked inductance at 10^7 c/s and that the makers of the apparatus were compelled to construct special condensers for the purpose. This is a subject on which one would like to have more information.

G. W. O. H.

A New Television Aerial

THE aerial array on the top of the Empire State Building, New York, for the National Broadcasting Company's 12-kW television transmitter, W2XBS, is, as can be seen from the accompanying photograph, a departure from the conventional type of short-wave radiator.

For the vision channel it has four torpedo-shaped radiators, which are the elements of two dipoles. The actual band to be accommodated by the vision carrier is 5.5 Mc/s. Above the vision radiator are four horizontal dipole elements arranged in the form of a loop ; these radiate the sound signals.

The shape of the vision dipoles was chosen following theoretical calculations which indicated an almost constant impedance over a wide band of frequencies. It is claimed that there is no mutual impedance between the sound and vision radiators.

Incorporated in the various elements of the aerial, which was designed by N. E. Lindenblad of R.C.A. Communications, is electrical de-icing equipment.

A New "All-Glass" Valve Construction*

By F. Prakke, J. L. H. Jonker and M. J. O. Strutt

(Laboratoria der N. V. Philips' Gloeilampenfabrieken, Eindhoven, Holland)

SUMMARY.—This article deals with the properties and advantages of a new valve construction, called "all-glass," abolishing the usual valve base. In the first section the general appearance of this new construction is dealt with, including a detailed discussion of the electrodes, their leads and screening, and of the valve pins and valve holder. Section II contains figures on the variation of the capacitances between valve electrodes due to the dielectric isolation between them as a function of the temperature. These figures show a marked improvement over those appertaining to the conventional construction with base for different types of valves, including mixer valves. In Section III the short-wave properties of the new all-glass construction are set forth. As the input and output impedances are dependent on the lengths of the electrode leads, marked improvement is shown by figures for the all-glass valve as compared with the conventional valve construction. An example for the mounting of the all-glass valves in a chassis is shown.

Section I

In the beginning the development of radio valves made use of the existing glass technique of the manufacture of incandescent lamps. The well-known pinch construction was again employed to bring the connecting wires through the glass envelope and these electrodes were con-

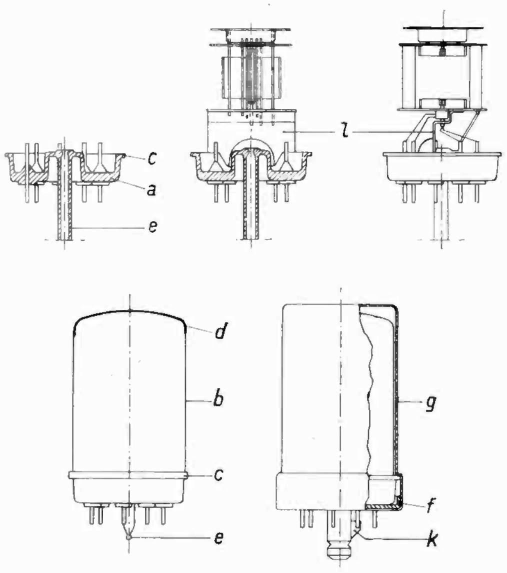


Fig. 1.—*Stages of the assembling of the all-glass valve EF50 showing the construction.*

nected to contacts on a base, which enclosed the pinch tube and protected the exhaust tube against breakage. This construction now proves to be not an ideal solution for radio valves, particularly for short-wave work. The connecting wires between valve electrode and base contact are inevitably rather long, resulting in unwanted inductance. The capacitance of the lead-out wires may give rise to disturbing variations due to temperature changes in the pinch and base. These disadvantages are to a great extent avoided in the new all-glass valve construction, which will be discussed further in this paper.

Fig. 1 gives a sketch and Fig. 2 a photograph of this new valve construction.

The sketch shows the connecting wires leading out directly through a bottom plate *a* which consists of pressed glass. The ends of the lead-out wires, which protrude through this glass bottom plate serve as contact pins of a base. Both functions of vacuum seal for the lead-out wires and base are combined in this bottom plate. Using this bottom plate the length of the connecting wires is considerably shortened. This construction has been made possible by the use of chrome iron for the lead-out wires, which material is known to fuse easily to glass.

For many different types of valves having the pinch construction it was necessary to have the signal grid brought out at the top of the valve, because the capacity of this electrode to others has to be exceedingly small. In receiving sets it proved to be more economical to have all electrodes brought out to one end of the valve. The usual pinch construction offered almost insur-

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

mountable difficulties in this respect, for the reason that all the connections in the pinch are very close to one another with resulting excessive capacitances between them. In the case of high-frequency pentodes this would lead to instability due to feed-back.

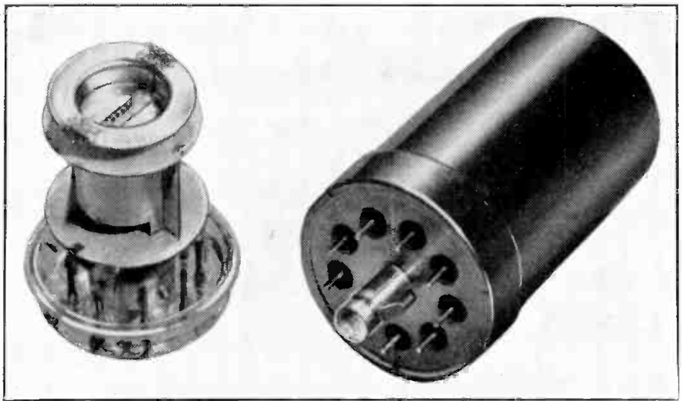


Fig. 2.—*The exterior and interior of an all-glass valve.*

The all-glass construction is ideal for bringing all lead-out connections at the one end. Fig. 3 shows that the distance between the lead-out wires in the bottom plate is much bigger than in the pinch and in addition a screen *l* of special form has been fitted between the base plate and the electrode assembly, which together with the screen *f* outside the valve divides the base electrostatically in two parts; the signal grid lead-out is located in the one part, the anode and heater lead-out wires in the other. If the valve holder has a corresponding screen, the capacity between the electrodes is comparable with the same in old type valves with grid to the top. The metallic enclosure *f*, *g* provides mechanical protection for the glass bulb *b* and the exhaust tube *e*, besides the electrostatic screening. The metal bottom plate *f* can also easily be fitted with a spigot *k*.

The advantages of the all-glass construction above the pinch construction will now be discussed in more detail.

(*a*) *Short connecting wires from valve electrode to soldering point of the valve holder*

Fig. 4 shows the connecting wires of the Mullard high-frequency pentode valve EF9. Their paths run in parallel over about 35 mm whereas in an all-glass construction this value would be only 15 mm. To compare both constructions Fig. 5 shows the total length of a connecting wire from an electrode to the soldering point of the valve holder. This comparison has been made for a normal EF9 valve and an all-glass television - amplifier pentode EF50.

Section III deals with the influence of these long connecting wires on the short-wave performance of the valve.

(*b*) *Small capacitance tolerances*

It is desirable for easy replacement of defective valves, and for convenient trimming of wireless sets in the manufacturing process that the capacitances of several samples of the same valve type are as nearly equal as possible. It has been proved that the differences which occur between the capacitances of valves of the pinch construction are chiefly due to variations in the position of the connecting wires, for instance, in the pinch. During the hot pressing of the glass bottom the lead-out wires are fixed in their exact position, which ensures that the capacitance differences are very small. Now

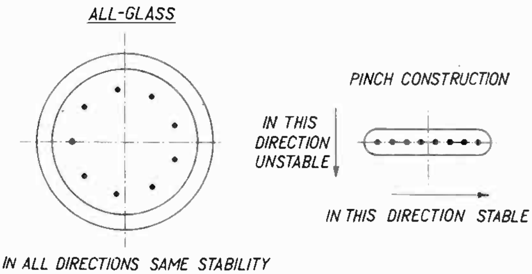


Fig. 3.—*Transversal section of a pinch and an all-glass bottom showing stability of the valve assembly and distance of the lead-out wires.*

that the top lead is omitted, it is possible to locate the getter mirror at the top of the bulb. This is important because the metallic deposit of the getter may cause unequal additional capacitances to the lead-out wires and so give rise to differences in the capacitances between similar valves. It proved to be possible to lessen the capacitance tolerances of valves of the pinch construction from $\pm$ 0.6 $\mu\mu$F to $\pm$ 0.2 $\mu\mu$F for all-glass valves.

(*c*) *Sturdy assembly*

In the pinch construction all leads and supporting rods are in one line on the pinch. Due to this the stability of many valves was insufficient and the system had to be supported in the dome by dome micas.

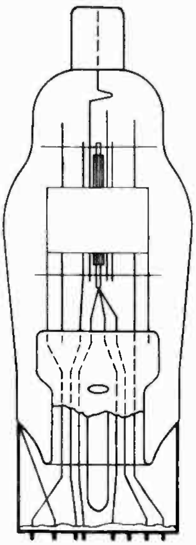


Fig. 4.—*Longitudinal section of a Mullard EF9 valve showing the connecting wires from electrode to base contact running in parallel over a considerable length.*

In the new construction the supporting rods are placed in a circle (Fig. 3) which method has increased the mechanical stability of the system to such an extent that supporting the system in the dome of the bulb is no longer necessary.

(*d*) *Good screening*

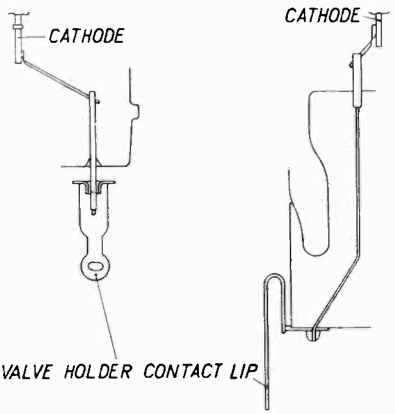
As discussed above, it is possible in the all-glass construction to keep the inter-electrode capacitances very low by using the internal screen together with a specially shaped external screen, in spite of the fact that all the lead-out wires are placed in one thick glass bottom-plate. It is important that the capacitances between the signal grid and the anode, and between the signal grid and the heater, should be low to avoid, on the one hand, excessive feed-back and, on the other, hum induction on the signal grid.

These capacitances are 0.002 $\mu\mu$F in the EF9 valve with grid to the top and 0.002 and 0.003 $\mu\mu$F respectively for the all-glass valve EF50, measured with the valve in the valve holder. It is clear from these values that although it seemed hardly possible, comparable capacitances have been achieved by the careful application of screens and a favourable location of the lead-out wires in respect to each other.

(*e*) *Valve holder*

The diameter of the pins of the all-glass base is smaller than those of other bases and without suitable precautions there is a danger that valves will drop out of their holders as a result of shocks, for instance, during transport. To prevent this, the spigot of the all-glass base has been supplied with means to keep the valves firmly in the holder (Fig. 6).

First, this purpose may be served by the projecting part *a* of the spigot. This key turns behind the pertinax plate of the valve holder *b* when the valve is rotated after the spigot is inserted in its hole. Then the contact pins are gripped firmly by the contact springs. Insertion and withdrawal of the valve from the valve holder may be accomplished by a slight pressure.



(A) (B)

Fig. 5.—*Showing the total length of the connecting wires from valve electrode to the soldering point of the valve holder. A, EF50; B, EF9.*

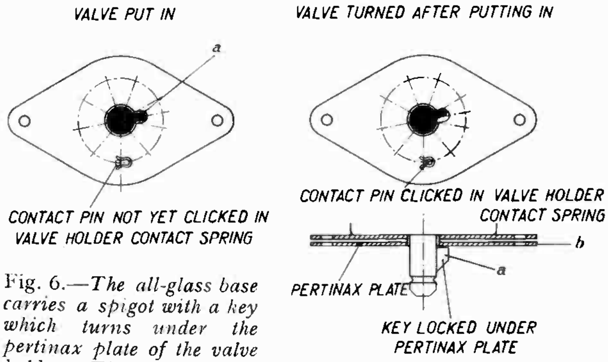


Fig. 6.—*The all-glass base carries a spigot with a key which turns under the pertinax plate of the valve holder. The contact pins are gripped firmly by the contact springs.*

When desired the constriction a of the spigot may be used to keep the valve in a valve holder, as shown in Fig. 7, but insertion and withdrawal requires considerable force. When the space in the set is too

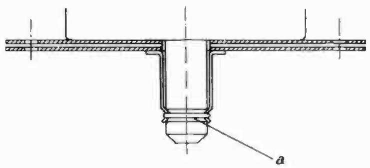


Fig. 7.—*In this valve holder the valve is kept firmly on the base by a constriction on the spigot.*

small to permit a strong pull, the first construction is more desirable.

(*f*) *Temperature effects*

The temperature of several parts of the valve may attain a rather high value, especially in rectifiers and output valves, owing to the energy which is dissipated within the bulb. This may have very undesirable results for the glass parts. For instance, the appearance of lead trees in the pinch, due to electrolysis of the glass which may lead to gas leakage in the pinch.

Carefully constructed valves have such dimensions that the cooling is sufficient to avoid this trouble, but the all-glass construction has distinct advantages in this respect over the pinch construction. With this latter construction the lead-out wires are confined in the pinch, inside the bulb. Cooling by convection is practically impossible, and radiation is diminished by the surrounding bulb. The all-glass valve on the contrary, has the lead-out wires on the exterior of the valve, distributed over a much larger radiating surface. Also the conduction of heat by the short pins to the valve holder proves to be very efficient.

To compare both constructions temperature measurements have been taken on similar valve types (see Table below).

TABLE.

Valve types	Temperature of the glass near the lead-out wires
EL6 18W pentode	200° C. above ambient temperature
EL6 (all-glass) ..	90° C. ,, ,,
AZ1 rectifier ..	150° C. ,, ,, ,,
AZ (all-glass) ..	83° C. ,, ,, ,,

The large difference in temperature of both constructions is obvious.

Besides the above-mentioned advantages, the low temperature has also electrical benefits, which apply specially to short-wave and band-spread receivers and will be discussed in Section II.

Section II

Variation of the capacitances of the valve owing to temperature effects

For oscillator and convertor valves the constancy of the oscillator frequency depends on the constancy of the capacitance and inductance of the oscillator circuit elements. The oscillator anode and grid form part of this circuit, and so their capacitances have to be constant. These capacitances are composed of the capacitance of the electrode assembly, pinch and base, or bottom plate.

The valve base consists of an artificial resin product and this material has rather unfavourable high-frequency losses. Another disadvantage is the variation of the dielectric constant with temperature. This means that the capacitance of the lead-out wires varies during the heating-up period of the valves, or when the ambient temperature varies. We will investigate to what extent the reception may be affected by this variation.

The capacitance between two contacts in a valve base is about 0.3 $\mu\mu$F. During the heating-up period the increase in temperature of the base is about 10° C. As the increase of the dielectric constant ϵ for synthetic resins is about 50×10^{-4} per degree centigrade, the capacitance increases by 0.015$\mu\mu$F. This variation in capacitance causes in an oscillator-circuit on 13 m wavelength and with 50 $\mu\mu$F tuning capacitance a frequency drift of

$$df = -\frac{dc}{2C}f = 3.4 \text{ kc/s}.$$

More serious than the increase in capacitance during the heating-up of the valve base is the capacitance change in the pinch of normal radio valves. The increase of ϵ for glass is smaller than for synthetic resin and about 5×10^{-4} per degree centigrade. In normal cases the capacitance between two lead-out wires in the pinch is larger than in the valve base and 1–1.5 $\mu\mu$F. The increase of temperature of the pinch is in most cases 100–200°C. Under these circumstances the variation of capacitance easily amounts to 0.09 $\mu\mu$F or in the case above mentioned a frequency drift of 20 kc/s. It is clear that this frequency drift may disturb the reception considerably.

The case is somewhat different when we consider the variation in capacitance for a change in ambient temperature.

We can suppose, approximately, that the pinch loses all its heat by radiation and that the valve base traces the temperature of its surroundings. If this temperature increases 10°C, the pinch will not follow the rise, but increase its temperature only a fraction $\left(\frac{\text{ambient temperature}}{\text{pinch temperature}}\right)^4$. For an ambient temperature of 300° K and a pinch temperature of 425° K the increase will be only 2.6° C corresponding to a variation of capacitance of 0.0015 $\mu\mu$F.

The benefit of the omission of the valve base which gives for the same 10° C rise of ambient temperature an increase in capacitance of 0.015 $\mu\mu$F, is clear.

Also the change from the pinch to the bottom plate construction has its advantages. For instance, the lead-out wires have a lower temperature than in a usual pinch giving together with the lower capacitances between them (0.8 $\mu\mu$F against 1.2 $\mu\mu$F) a smaller variation in capacitance.

Above that, because the temperature of

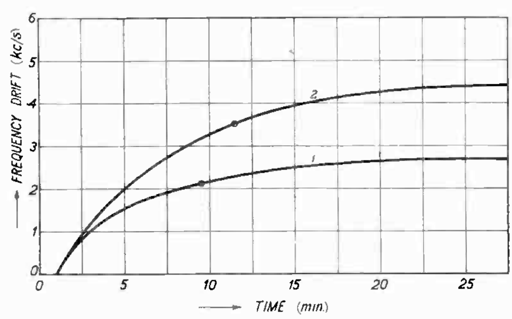


Fig. 8.—*Curves showing the frequency drift during the heating-up period of an all-glass convertor valve* (1) *and the same type of valves on pinch and all-metal construction* (2).

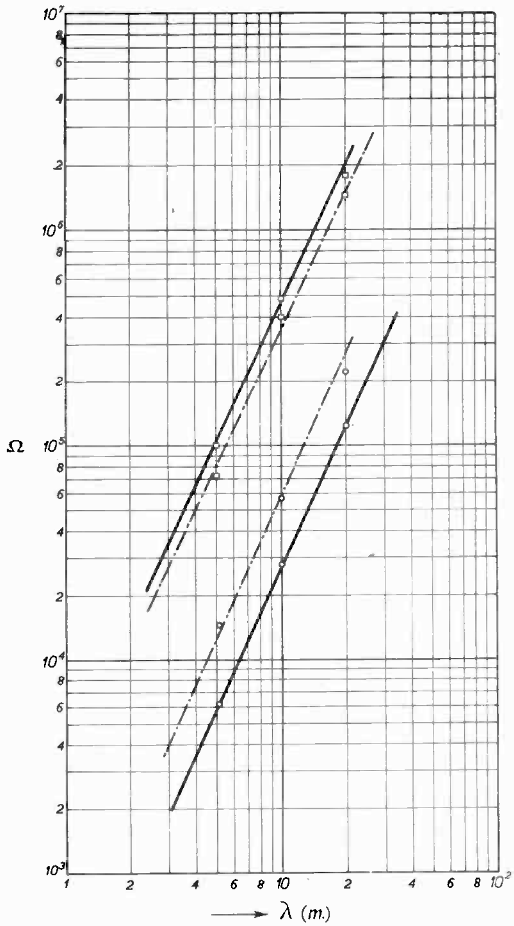


Fig. 9.—*Curves of the input resistance as a function of the wavelength for a H.F. pentode system EF9 at a bias corresponding at maximum anode current and at cut off for a valve with pinch and P-base (full line) and the all-glass valve (dotted line).*

the glass bottom is always high compared with the ambient temperature, variations in this temperature will not have much influence on the bottom plate temperature.

Due to the above-mentioned circumstances, the frequency drift during heating-up of the oscillator of an all-glass octode EK2 is only 2.7 kc/s, while for the same valve with pinch construction or all-metal construction, this amounts to 4.4 kc/s. These measurements are obtained at a wavelength of 20 m, the tuning capacitance was 75 $\mu\mu$F and the ambient temperature

25° C. These frequency drifts correspond to changes in capacitance of 0.044 and 0.027 μμF respectively.

It is also interesting to note how the course of the frequency drift curve will be in the period after switching on the valve. If, for instance, 80 per cent. of the frequency drift would occur in one minute after switching on a receiver, the effect would be rather unimportant because the tuning operation would not yet be finished. Fig. 8 gives the curves of the frequency drift as a function of the time after switching on, obtained for the above-mentioned valve types. The drawn curves give the average values for several samples.

80 per cent. of the frequency drift is obtained for the different types in the following periods.

Normal EK2 with pinch and valve base of synthetic resin	11.5 min.
All-glass EK2	9.5 ,,
All-metal EK2	11.5 ,,

It is clear that the figures do not differ widely but again the all-glass construction has an advantage over the other two.

Section III

Short wave performance

As we have seen in Section I (a) the all-glass valve construction affords possibilities for shortening the length of electrode leads inside and outside the valve. Recent investigations[1] have shown that the length of these leads is of primary importance for the short wave applications of valves. The output parallel resistance of H.F. valves is for the major part dependent on the mutual and self-inductances and the capacitances of the valve electrodes and their leads within and without the bulb, and the input parallel resistance also for an important part as far as short waves (e.g. shorter than 30 m wavelength) are concerned. Considering a number of H.F. valve stages in series, the output resistance of one valve as well as the input resistance of the next valve are parallel to the tuned interstage circuit (if a resonant circuit and no band pass filter circuit acts as interstage coupling element). With all valves hitherto measured, the output resistance was always considerably higher than the input resistance, say 5 to 10 times. Hence the most important limitation for the interstage circuit impedance and for the stage gain arises from the input resistance. The impedance of the resonant circuits themselves can be made much higher than the input impedance of practically any valve type. Because the input impedance is always much higher when measured at cut-off bias than at normal anode current, the major part of this damping cannot be attributed to bad insulation or dielectric losses.

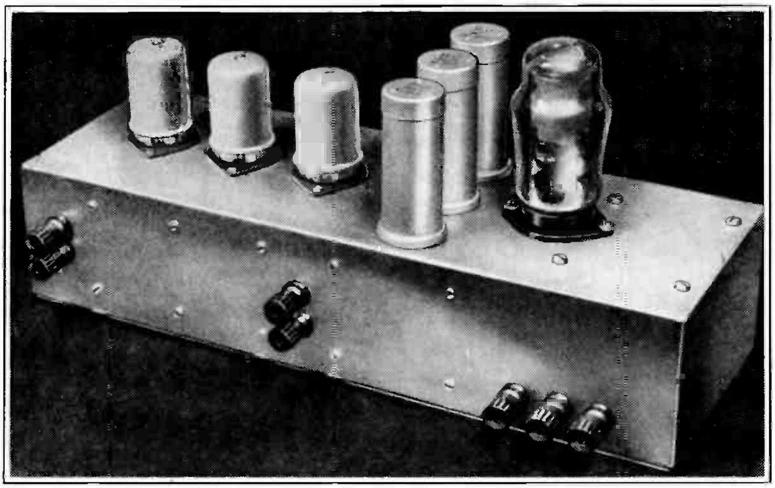


Fig. 10.—*Mounting of all-glass valves in a three-stage 7 m television amplifier.*

Curves of the input resistance as a function of the wavelength for the H.F. pentode system of type EF9 at a bias corresponding to maximum anode current (6 mA) and at a large negative bias, are given in Fig. 9. The full curves correspond to this valve with the pinch construction, a P-base (side contact) valve and the other curves to the same valve in all-glass. For the input impedance at maximum anode current these

[1] *Wireless Engineer*, Sept., 1937, Vol. 14, pp. 478–488 and *Proc. Inst. Rad. Eng.*, Aug., 1938, Vol. 26, pp. 1011–1032.

curves show a marked improvement for the all-glass valve as compared with the P-base valve. At 5 m wavelength the figures are 13,000 ohms and 6,000 ohms respectively. Hence we owe this important improvement to the short connecting wires.

On the other hand, the input resistance for the P-base valve is higher at large bias values than the resistance of the all-glass valve. This results from the fact that the dielectric path between the grid connection (at the top) and earth (cathode) is much longer for the P-base valve than for the all-glass valve. Curves similar to those shown in Fig. 9 have been measured for other valve systems, always with similar results. Hence, preference ought to be given to the all-glass valve for short-wave work.

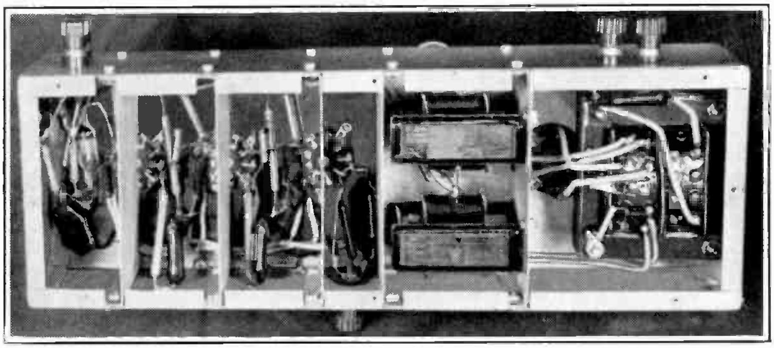


Fig. 11.—*The short connections between valves and circuit elements when using all-glass valves are clearly shown.*

The single-ended construction of the all-glass valve gives even more benefit in this respect.

It was found theoretically[2] that a mutual inductance between the input grid lead and the cathode lead may tend to increase the input parallel resistance at full anode current. Whereas the valves having a top connection to the input grid afford no practical possibilities to realise this feature, it may be easily incorporated in all-glass valves. Referring to the EF50 valve, an increase of 30 per cent. was found at 7 m wavelength for the input resistance at full anode current (10 mA) by constructing the grid lead close to the cathode lead inside the valve.

Figs. 10 and 11 show the mounting of all-glass tubes in a three stage 7 m television amplifier. In Fig. 11 the very short connections between the valve holder electrodes and the interstage coupling elements, such as circuit coils, are clearly shown. The separation between two successive stages runs right across the bottom side of the valve holder, separating the grid side from the anode side. Measurements have shown that a sufficiently small feed back value may be obtained at 7 m wavelength. With the EF50 the effective feed-back capacitance at 7 m was about 0.001 $\mu\mu$F in this chassis.

[2] M. J. O. Strutt, "Moderne Mehrgitter-Elektronenröhren," Vol. II, p. 76, Springer, Berlin, 1938.

Fundamental Electronics and Vacuum Tubes

By Arthur Lemuel Albert, M.S. Pp. 422 + ix. Published by Macmillan and Co., Ltd., St. Martin's Street, London, W.C.2. Price 20s.

In his preface Professor Albert states that his book is primarily written for the use of students of electrical engineering from whom, in the U.S.A., a knowledge of communication engineering is required.

In reading the book it is well to keep this fact in mind; otherwise, the professional reader may feel a little exasperated to find the particular point in which he is interested treated somewhat superficially. For this type of reader, however, a reasonably long bibliography to be found at the end of each chapter will probably make amends.

The field covered by the book is a large one. Early chapters introduce the reader to the laws of electron and vacuum physics and then lead him to the consideration of diode, triode and multi-electrode valves of all categories. They are treated from the standpoint of their theory of operation, rather than from that of their application. The latter aspect of the case is considered from Chapter 7 onwards where rectifiers, voltage amplifiers, power amplifiers, oscillators, modulators and detectors are covered. The book ends with two chapters on photo-electric devices, cathode-ray tubes and electronic measuring apparatus.

The author's touch appears perhaps to be more sure in his treatment of applications of valves than of their fundamental properties. This is probably occasioned by the fact that the rigorous mathematical presentation of facts, so inseparable from thermionics, is not undertaken, graphical or descriptive methods being preferred where possible.

The book is to be recommended to those who wish to obtain a general, unspecialised knowledge of the subject as a whole. Students, in particular, will find good exercise in the questions at the end of each chapter. F.M.W.

The Input Impedance of Self-Biased Amplifiers*

By F. C. Williams, M.Sc., D.Phil., and A. E. Chester, M.Sc.

(Manchester University)

I. Introduction

THE circuit of a self-biased pentode amplifier is shown in Fig. 1. Basically similar circuits have been used for various purposes; it was first proposed as a convenient means of obtaining negative grid-bias, but since then it has been used as a rectifier,[1] when a triode replaces the pentode, and also as a frequency corrected wide-band amplifier for television. The authors were, in the first place, concerned only with this last application of the circuit. The physical explanation of its operation is as follows. At high frequencies the stray anode-earth capacitance C_1 shunts the anode resistance R_1 and reduces the amplification obtained; however, if the values of C_2 and R_2 are suitably chosen an opposing tendency exists. For at low frequencies a voltage is developed across R_2 which reduces the effective input voltage to the grid and thus reduces the amplification. At high frequencies this back voltage is reduced by C_2 shunting R_2. Thus the tendency of C_2 and R_2 is to increase the frequency range over which a uniform amplification is obtained.

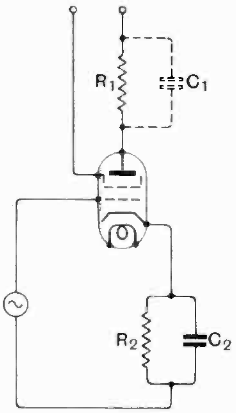


Fig. 1.

Experimental tests only verified the simple theory for a single stage. When two similar stages in cascade were tested the amplification at high frequencies exceeded the expectation. In predicting the frequency response the input capacitance of the second stage, which in effect shunts R_1, was supposed equal to the grid-earth capacitance with the cathode cold. The discrepancy was traced to departure of the working input capacitance from this value. The new value depended markedly on the values of R_2 and C_2 used in the second stage. The investigation described in the following sections was therefore undertaken, and was made as general as possible in view of the several applications of the circuit noted above.

In the interests of simplicity a triode valve with zero anode load impedance is considered; conditions then differ insensibly from those obtaining in a screened tetrode or pentode; the anode of the triode being equivalent to the screen of either of these other valve types. This circuit is also essentially that used for rectification, for then the anode load is shunted by a condenser whose impedance to high frequencies is negligible.

Since this investigation was undertaken, a general theorem relating to the input impedance of "feed-back" amplifiers has been noted by G. S. Brayshaw.[2] The present discussion is a special case of this general theorem, but remains worthy of detailed analysis in view of its numerous applications.

II. Analysis

The full circuit to be considered is shown in Fig. 2; where C represents the grid-cathode inter-electrode capacitance and K is supposed large enough to have negligible impedance at the frequency of E_1. The grid-anode and grid-earth capacitances are omitted since they merely shunt E_1 and can be added without difficulty later. With the symbols as defined in Fig. 2, potentials and currents relating to alternating com-

*MS. accepted by the Editor, October, 1938.

ponents only, it follows that

$$I_1 = g(E_1 - E_2) - cE_2 \quad \ldots \quad \ldots \quad (1)$$

$$I_2 = (E_1 - E_2)jC\omega \quad \ldots \quad \ldots \quad (2)$$

$$E_2 = Z(I_1 + I_2) \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

where g is the grid conductance and c is the anode conductance.* From equations (1), (2) and (3),

$$\frac{E_2}{E_1} = \frac{g + jC\omega}{\frac{1}{Z} + c + g + jC\omega} \quad \ldots \quad \ldots \quad (4)$$

The input admittance presented to E_1 is

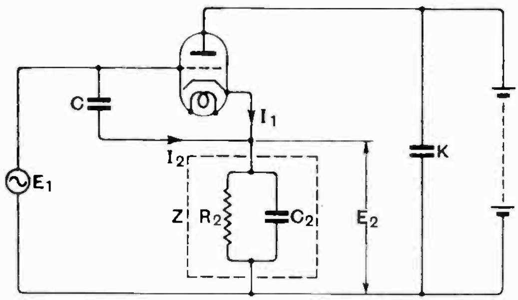


Fig. 2.

from equation (2)

$$A = \frac{I_2}{E_1} = \left(1 - \frac{E_2}{E_1}\right)jC\omega$$

or, substituting from equation (4),

$$A = \left(1 - \frac{g + jC\omega}{\frac{1}{Z} + c + g + jC\omega}\right)jC\omega \ldots \quad (5)$$

And substituting for Z the value

$$\frac{R_2}{1 + jR_2C_2\omega},$$

it follows after reduction that $A = a + jb$. Where :—

$$a = -\frac{\frac{(C_2 + C)\omega}{g} - \alpha\frac{C\omega}{g}}{\alpha^2 + \left[\frac{(C_2 + C)\omega}{g}\right]^2} . C\omega \quad \ldots \quad (6)$$

and

$$b = \left[1 - \frac{\alpha + \frac{C(C_2 + C)\omega^2}{g^2}}{\alpha^2 + \left[\frac{(C_2 + C)\omega}{g}\right]^2}\right] . C\omega \ldots \quad (7)$$

* Or screen conductance in the case of tetrodes or pentodes.

where $\alpha = 1 + \frac{1}{gR_2} + \frac{1}{\mu} \quad \ldots \quad \ldots \quad (8)$

and $\mu = \frac{g}{c}$ = amplification factor. Inspection of equation (8) shows that α always exceeds unity but will approach unity if μ and gR_2 are large, a condition which often applies in practice. It follows from equations (6) and (7) that the equivalent input circuit loading E_1 is as shown in Fig. 3 where

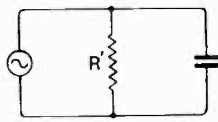


Fig. 3.

$$R' = -\frac{\alpha^2 + \left[\frac{C_2 + C}{g}\omega\right]^2}{\frac{(C_2 + C)\omega}{g} - \alpha\frac{C\omega}{g}} \cdot \frac{1}{C\omega} \quad \ldots \quad (9)$$

$$C' = \left[1 - \frac{\alpha + \frac{C(C_2 + C)\omega^2}{g^2}}{\alpha^2 + \left[\frac{(C_2 + C)\omega}{g}\right]^2}\right] C \quad (10)$$

These components refer only to the simple circuit of Fig. 2 and any physical impedances also shunting E_1, for example, the grid-anode capacitance, must be added thereto.

III. Effective Input Capacitance

Consider first the capacitance term, when ω is small equation (10) becomes

$$C' = \left(1 - \frac{1}{\alpha}\right)C \quad \ldots \quad \ldots \quad \ldots \quad (11)$$

Since α can approximate to unity the effective input capacitance can be much less than C. Substituting for α equation (11) becomes

$$C' = \left[1 - \frac{1}{1 + \frac{1}{gR_2} + \frac{1}{\mu}}\right] C.$$

$$= \left[\frac{\frac{1}{gR_2} + \frac{1}{\mu}}{1 + \frac{1}{gR_2} + \frac{1}{\mu}}\right] C \quad \ldots \quad (12)$$

Hence as gR_2 varies from 0 to ∞ C' varies from C to $\frac{1}{1 + \mu}C$, thus with gR_2 and μ great the component of input capacitance contributed by C practically vanishes. The discrepancy noted in the introduction is thus explained.

Further, consideration of equation (10) shows that this reduction of input capacitance is not maintained at really high frequencies. For it follows that when $\frac{(C_2 + C)\omega}{g}$ exceeds α, C' approaches $\frac{C_2 C}{C_2 + C}$, which differs but little from C since C_2 is usually $> C$. This frequency dependence of the input capacitance is illustrated in Fig. 4 where the ratio C'/C is plotted against the frequency factor $\frac{(C_2 + C)\omega}{g\alpha}$, for several values of α. When $\alpha > 10$ the effect is very small at all values of ω. It was assumed that $C \ll C_2$, so that $\frac{C\omega}{g}$ is very small within the range of interest, and accordingly the variation of the numerator of equation (10) with ω was neglected. The importance of this variation of input capacitance with frequency can only be assessed for given component values and hence will not be discussed here.

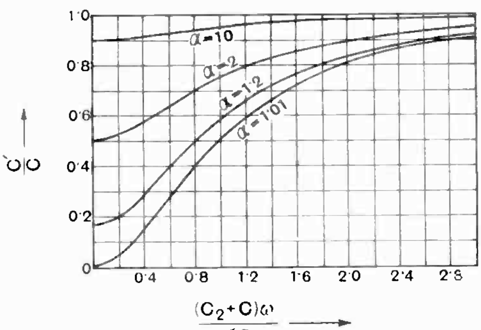


Fig. 4.

Experiments verifying equation (11) are described in section **V.** *A*. Attention was confined to conditions where $\frac{(C_2 + C)\omega}{g\alpha}$ was small since this is the range of greatest interest.

IV. Effective Input Resistance

Equation (9) gives the resistive component of input impedance as

$$R' = -\frac{\alpha^2 + \left[\frac{(C_2 + C)\omega}{g}\right]^2}{\frac{(C_2 + C)\omega}{g} - \alpha\frac{C\omega}{g}} \cdot \frac{1}{C\omega}$$

$$= -\frac{1 + \left[\frac{(C_2 + C)\omega}{g\alpha}\right]^2}{\frac{1}{\alpha} \cdot \frac{(C_2 + C)\omega}{g\alpha} - \frac{C\omega}{\alpha g}} \cdot \frac{1}{C\omega} \quad \ldots \quad (13)$$

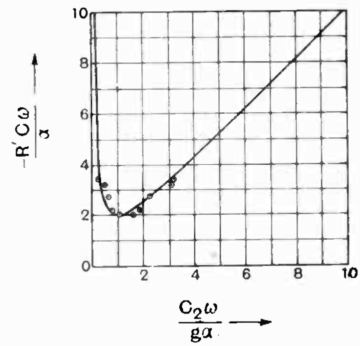


Fig. 5.

Since C_2 will usually be much greater than C, this may be written approximately

$$R' = -\frac{1 + \left(\frac{C_2\omega}{g\alpha}\right)^2}{\frac{1}{\alpha} \cdot \frac{C_2\omega}{g\alpha}} \cdot \frac{1}{C\omega}$$

$$= -\frac{\alpha}{C\omega}\left(\left[\frac{g\alpha}{C_2\omega}\right] + \left[\frac{C_2\omega}{g\alpha}\right]\right) \quad \ldots \quad (14)$$

It can be shown that this has a minimum value of $-\frac{2\alpha}{C\omega}$ when $\frac{g\alpha}{C_2\omega} = 1$. The general form of R' is illustrated by the curve of Fig. 5, which shows $\frac{R'C\omega}{\alpha}$ as a function of $\frac{C_2\omega}{g\alpha}$. Outside the limits of this graph R' can be written within 1 per cent. as

$$R' = -\frac{1}{C} \cdot \frac{C_2}{g} \text{ with } \frac{C_2\omega}{g\alpha} > 10$$

and $R' = -\frac{\alpha^2 g}{C_2 C\omega^2}$ with $\frac{C_2\omega}{g\alpha} < 0.1$.

It is of interest now to note the extremely low numerical values of R' that can occur in practice. Consider first the approximate expression for R'. In the application of the circuit to wide-band amplifiers typical values are $C = 12\mu\mu F$, $\omega_{max.}$ the maximum frequency passed $= 2\pi \times 2 \times 10^6$ radians/sec., and α will approach closely to unity. From equation (14) using these values the minimum possible numerical value of R' is approximately $-$ 13,000 ohms; this occurs when $g = C_2\omega$.

Consider now the full expression for R', that is equation (13) which holds if C_2 is not much greater than C; putting $\alpha = 1$ this becomes

$$|R'| = \frac{1 + \left[\dfrac{(C_2 + C)\omega}{g}\right]^2}{\dfrac{C_2\omega}{g}} \cdot \frac{1}{C\omega} \quad \ldots \quad (15)$$

This has a minimum when

$$\frac{C_2\omega}{g} = \sqrt{1 + \frac{C^2\omega^2}{g^2}} \quad \ldots \quad \ldots \quad (16)$$

Substitution in equation (15) does not lead to a concise expression; but it follows from equation (16) that the approximate minimum condition, namely $\dfrac{C_2\omega}{g\alpha} = 1$, holds fairly well provided $\dfrac{C\omega}{g} \ngtr .3$, i.e. using typical values ($g = 10^{-2}$, $C = 10\mu\mu F$) provided $\omega/2\pi \ngtr 50$ Mc/s; at this limit R' is about $-$ 1,000 ohms. If, however, $\dfrac{C\omega}{g}$ exceeds unity considerably $\left(\text{say } \dfrac{C\omega}{g} = 3 \text{ or } \omega/2\pi = 500 \text{ Mc/s}\right)$ equation (16) reduces to

$$C_2 = C$$

and substituting in equation (15)

$$|R'|_{min.} = 4/g.$$

Or if $g = 10^{-2}$ a negative resistance of about 400 ohms is possible. It follows, therefore, that with typical small valves negative resistance values of about $2/C\omega$ can be obtained subject to a minimum attainable value of $4/g$ at really high frequencies.

An approximate experimental check of the curve of Fig. 5 has been carried out and is described in section **V.** *B*.

V. Experimental Results

A.—Verification of equation (11).

Measurements of effective input capacitance were limited to conditions where $\dfrac{(C_2 + C)\omega}{g\alpha}$ was small; that is $\dfrac{(C_2 + C)\omega}{g\alpha} \ll 1$, and thus equation (11) is relevant. In practice, C' is not measurable alone since the total input capacitance will include a direct grid-earth capacitance plus a grid-anode capacitance. Thus if C_e is the sum of these other components the measured input capacitance will be

$$C'' = C' + C_e = C_e + \left(1 - \frac{1}{\alpha}\right)C \quad \ldots \quad (17)$$

To measure C'' an amplifier was built with provision for inclusion of any desired resistance R_2 in the cathode of the first stage. Provision was also made for connecting a resistance in series with the grid of this stage. The input circuit is shown in Fig. 6, where R_3'' is the added resistance and

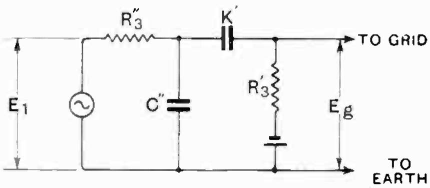


Fig. 6.

R'_3 is the grid leak; the impedance of the coupling condenser K' is assumed negligible. With alternating voltages defined as in Fig. 6 it follows that the response at any frequency ω is given by

$$m = \frac{E_g}{E_1} = \frac{R'_3}{R''_3 + R'_3} \cdot \frac{1}{1 + \dfrac{R'_3 \,.\, R''_3}{R'_3 + R''_3} jC''\omega}$$

or that the fractional response of the circuit is given by

$$\left|\frac{m}{m_0}\right| = \sqrt{\frac{1}{1 + T_3{}^2\omega^2}} \quad \ldots \quad \ldots \quad (18)$$

where m_0 is the response at zero frequency and

$$T_3 = R_3C'' = \frac{R'_3 \,.\, R''_3}{R'_3 + R''_3} \,.\, C''$$

The apparatus used is shown in the block diagram of Fig. 7. The oscillator provided an output of measured and adjustable magnitude at any one of eleven known frequencies distributed approximately exponentially between the limits 10 kc/s and 3.5 Mc/s. The attenuator had an output impedance negligibly small compared with the input impedance of the amplifier. A frequency

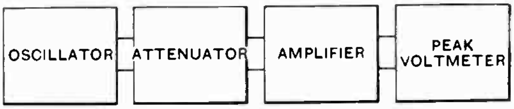


Fig. 7.

characteristic of the amplifier was first taken with R''_3, R_2 and C_2 zero; a second characteristic was then taken with $R_3 =$ 50,000 ohms and R_2 and C_2 still zero. The frequency characteristic of the input circuit was obtained by dividing the ordinates of the second characteristic by the corresponding ordinates of the first. The ordinates of this "quotient curve" were divided by its ordinate at the lowest frequency, thus obtaining a curve of the form of equation (18). Experimental comparison with this equation yielded a value for T_3; the value of $C'' \left(= \frac{T_3}{R_3}\right)$ was then determined. The test was repeated for several values of R_2, and a curve of C'' against gR_2 plotted; the results are shown by the circles of Fig. 8. C_2 remained zero throughout so that $\frac{(C_2 + C)\omega}{g\alpha}$ was always small.

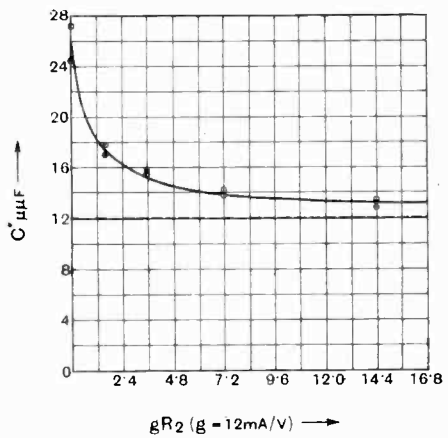


Fig. 8.

These measurements were checked by direct capacitance measurement using a heterodyne substitution method. This second set of results is shown by the squares on Fig. 8; they are seen to be in close agreement with the first set. It may be seen at once that the results are of the form required by equation (17), for α approaches unity as gR_2 increases.

Some assumption is necessary before a quantitative check of equation (17) is possible, for the relative values of C_e and C were unknown. Accordingly g and c were measured and the value of α relevant to $R_2 =$ 10,000 ohms calculated; it was 1.03. By assuming equation (17) valid for $R_2 = 10{,}000$ ohms, a value for C_e was obtained; it is indicated by the dotted horizontal line of the figure. The value of C was then inferred from the mean of the two results with R_2

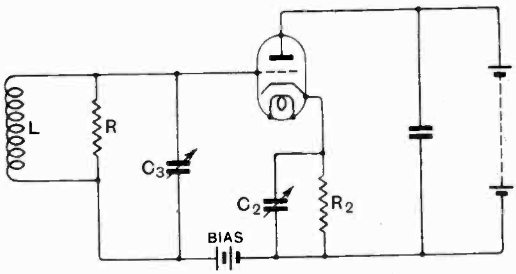


Fig. 9.

zero, for then $C'' = C_e + C$. Using these values the full predicted curve on Fig. 8 was drawn in according to equation (17) and lies always very close to the two sets of experimental results. Despite the necessary assumption of the validity of equation (17) at the two extreme points, the agreement found is felt to verify the equation completely.

B.—Verification of equation (14).

In order to estimate the resistive component of the input impedance the circuit of Fig. 9 was set up. A cursory examination of this circuit suggests that self-oscillation is most unlikely; experiment showed, however, that with suitable components it did oscillate, thus substantiating qualitatively the prediction of Section II. Such oscillation has been observed before; W. T. Cocking has discussed its occurrence in negative feed-back rectifiers[3] which, as previously noted, use a circuit similar to Fig. 9. He explained this result physically by redrawing the complete circuit diagram, and showed it to be a form of Colpitt's oscillator. He concluded that self-oscillation was least likely when C_2 was great and the resonant frequency of the circuit small. Referring to equation (15) it will be seen that these findings are in agreement with the present analysis, which however adds that self-oscillation can be prevented by a sufficient *reduction* of C_2.

The condition for self-oscillation of the resonant circuit is that

$$R' \leqslant R \quad \ldots \quad \ldots \quad \ldots \quad (19)$$

where R is the rejector resistance of the circuit. Reference to Fig. 5 shows that other factors being kept constant, there are two limiting values of C_2 between which self-oscillation will occur, for between them equation (19) holds. The resonant frequency of the LC_3 circuit was 1.4 Mc/s. The two limiting values of C_2 were determined for each of several values of damping resistance placed across the tuned circuit.

In order to compare the experimental results with the curve of Fig. 5 some assumption had to be made, as the inherent positive resistance R of the circuit was unknown. Thus, referring to Fig. 5 it is possible to determine the value of $\frac{R'C\omega}{\alpha}$ which corresponds with any ratio of limiting capacity values. Thus it was possible to assign, from the curve, values of $\frac{R'C\omega}{\alpha}$ for each observed ratio of capacitance limits. $C\omega/\alpha$ being known this permitted evaluation of R' for each value of added shunt resistance, and hence permitted several estimations of inherent coil loss resistance: the average of these was taken to be the true coil loss resistance and values of $\frac{R'C\omega}{\alpha}$ for each value of damping resistance were calculated by its use. These values are plotted on Fig. 5 against the known values of $\frac{C_2\omega}{g\alpha}$, and are reasonably close to the curve.

The above research was carried out in the Electro-Technics Department at Manchester University, and the authors wish to express their thanks to Professor R. Beattie for the facilities placed at their disposal.

References

(1) W. N. Weeden, *Wireless World*, Jan. 1st, 1937.
(2) G. S. Brayshaw, *Wireless Engineer*, Nov. 1937.
(3) W. T. Cocking, *Wireless World*, Oct. 15th, 1937.

The Industry

A NEW company has been formed to take over the goodwill and continue the manufacture of Hartley Turner radio apparatus and loud speakers. Enquiries should be addressed to the Hartley Turner Radio Company, 92, Queensway, London, W.2.

British Mechanical Productions Ltd., 79a, Rochester Row, London, S.W.1, have issued their 1939 catalogue of "Clix" electrical and radio accessories. The latter include valve holders, pins and sockets, terminals, ceramic trimmers and cartridge fuses.

A range of high-grade 2-inch moving coil meters have been developed by Salford Electrical Instruments, Ltd. They are fitted with knife-edge pointers and conform to the requirements of British Standard Specification No. 89. For use with external shunts the volt drop has been standardised at 75 mV. and the voltmeters are adjusted at 200 ohms per volt.

"High Frequency, Mixing and Detection Stages of Television Receivers"

ERRORS unfortunately appeared in two of the figures in the above article by Dr. Strutt published in last month's issue. In Fig. 1 the tuning frequency of the resonance curve should correspond to the frequency of 43.25 Mc/s on the scale in the upper part of the figure. The micro-ammeters A in Fig. 11 should be connected in series with the batteries B.

Electron Optics

A NEW Cambridge Physical Tract, "Electron Optics" (Pp. 107 + x), prepared by the Research Staff of Electric and Musical Industries Limited, and compiled and written by Otto Klemperer, has recently been published by the Cambridge University Press, Bentley House, Euston Road, London, N.W.1, price 6s.

The fundamental principles of electron optics are dealt with in the first chapter of this book and the discussion then goes on to the cardinal points of an electron lens system. A chapter on field plotting and ray tracing then follows.

Electrostatic and magnetic lenses are discussed as well as lens errors, and there is a chapter on electron optical applications among which are the electron microscope, the electron gun, and the electron multiplier. The book concludes with an appendix on fields having cylindrical symmetry, which find application in certain types of valve.

A wide range is covered and the treatment of the individual items is necessarily somewhat brief. The explanations are clear, however, and the treatment is not unduly mathematical. W. T. C.

An Electrically "Cold" Resistance*

By W. S. Percival, B.Sc.

(Research Laboratories, Electric and Musical Industries, Ltd.)

IT is well known that the noise voltage developed across a solid resistance is a function of its temperature. It is also convenient by analogy to speak of an effective temperature of a valve in terms of the noise voltage which it produces on open circuit. This temperature is normally considerably above air temperature.

However, it appears that with the aid of negative reaction a circuit can behave over a finite band of frequencies as if its temperature were considerably below that of the air. Before describing the experimental work it will be necessary to introduce a certain amount of theory.

Definition of Effective Temperature

Let the impedance of a two terminal network be substantially constant and equal to that of a resistance R over the range of frequencies Δf at a mean frequency f. Then by measuring the r.m.s. noise voltage ΔE across R over the frequency range Δf an effective temperature T can be assigned to R with the aid of the formula

$$T = \frac{(\Delta E)^2}{4kR\Delta f} \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

in which k is Boltzmann's gas constant. This procedure can be carried out irrespective of the nature of the network which may therefore contain thermionic valves.

There is, however, an important difference between a network at a uniform temperature containing only solid resistances, and one containing thermionic valves. In the former case the effective temperature T as given by equation (1) is also the true temperature as measured with a thermometer. The effective temperature of a thermionic valve cannot, however, be measured directly with a thermometer.

It might be thought, therefore, that for a network containing thermionic valves the effective temperature, while useful as a measure of the noise voltage, has no significance in the thermodynamic sense. Now in thermodynamics a body is assumed to be at the same temperature as another body with which it is in thermal equilibrium. Hence if it were possible to arrange that the network is in thermal equilibrium with a body the temperature of which can be directly measured, and if this were found to be the same as the effective temperature given by equation (1), then a wider significance could be attached to the term effective temperature.

Consider a two-terminal electrical network containing thermionic valves. Let its resistance be R over the range of frequencies Δf, and T be its effective temperature. Now connect this network via a loss-free band-pass filter of band-width Δf to a solid resistance of magnitude R at the same temperature. Then the r.m.s. voltage and current generated by the network will be the same as those generated by the solid resistance, and electrical equilibrium will be established.

If the apparatus could be completely insulated electrically and thermally, except for the heat required for the heaters of any thermionic valves and the cooling required for their anodes, then the initial temperature of the solid resistance would be immaterial as energy would flow into it, or from it, until its temperature became the same as the effective temperature of the network. In particular, if the effective temperature of the network were below air temperature, then the temperature of the solid resistance would also fall below air temperature, i.e. refrigeration would be produced.

Unfortunately, the necessary thermal insulation would be quite impracticable, although this does not, of course, affect the principle involved.

It must be pointed out that the frequency range over which the noise voltage ΔE is constant may be quite narrow. Hence it is necessary to speak of effective temperature

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

at a given frequency, or within a certain band of frequencies.

Effective Temperature of a Valve

Measurements have been given in a previous article* which indicate that the lowest effective temperature of a diode, or of a triode in which the anode is connected through a large capacity to the grid, is half the cathode temperature. Subsequent experiments have tended to confirm this. Thus an MH41, with careful adjustment of the grid and anode voltages, gave an effective temperature differing from half the cathode temperature by no more than the limits within which this temperature could be estimated. Under no circumstances could a lower effective temperature be obtained.

At the other extreme there is no upper limit to the effective temperature, for with temperature limited emission a diode gives a finite noise current ΔI on closed circuit and has an infinite slope resistance. The effective temperature must therefore be infinite as can be seen by substituting $R\Delta I$ for ΔE in equation (1) giving

$$T = \frac{(\Delta I)^2 R}{4k\Delta f} \quad \ldots \quad (2)$$

in which, if ΔI is finite, and R is infinite, T must also be infinite.

A Valve as Refrigerator

One question remains. Is it possible to connect a valve and other circuit elements so that the effective temperature between a pair of terminals is less than the temperature of the surroundings? In other words, can a valve be so connected as to act, theoretically, as a refrigerating device?

It is true that the source of electrons in a valve, i.e. the cathode, is at a much higher temperature than the air. Nevertheless—as a well known advertisement reminds us—a high temperature can indirectly produce refrigeration.

Let the noise current of a triode valve with no anode load be ΔI. The effective temperature of the valve will be given by equation (2). Now ΔI cannot be affected by the A.C. connection of the grid relative to anode and cathode since the anode and cathode are both at the same A.C. potential. The impedance of the valve, and hence its effective temperature, will however be controlled by the grid connection. We shall consider three cases.

Case (1).

Grid connected to anode for A.C. The valve impedance is approximately $\frac{1}{g}$ in which g is the mutual conductance of the valve, so long as $\mu \gg 1$. Thus, from equation (2) :—

$$T = \frac{(\Delta I)^2}{4k\Delta f g} \quad \ldots \quad (3)$$

It was shown in the article referred to above that under these conditions the minimum value for T is $\frac{T_c}{2}$ in which T_c is the cathode temperature.

Case (2).

Grid connected to cathode. The valve impedance is $\frac{\mu}{g}$ so that the minimum effective temperature is $\frac{\mu T_c}{2}$. Now the connection of the grid to the anode for A.C. in Case (1) can be considered as a form of negative feed back and it appears that this reduces the effective temperature μ times. It seems possible, therefore, that if we can employ still more negative feedback the effective temperature might be induced to fall lower than $\frac{T_c}{2}$.

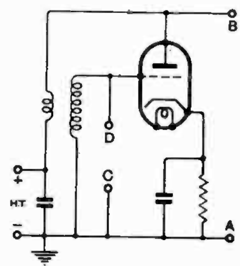


Fig. 1.

Case (3).

Anode circuit coupled to grid circuit via a step-up transformer with windings connected in such a way as to produce negative feed-back.

The circuit is shown in Fig. 1. Let the step-up of the transformer from anode circuit to grid circuit be σ. As viewed from the terminals AB the apparent mutual conductance of the valve will be increased σ times since the transformer will step up the grid

* "Background Noise Produced by Valves and Circuits." *Wireless Engineer*, 1938, Vol. XV, p. 129.

voltage in that ratio. Hence the impedance across the terminals AB will be $\frac{1}{\sigma g}$ and the effective temperature will be reduced σ times to a minimum value of $\frac{T_c}{2\sigma}$. This, if σ is made large enough the circuit should have an effective temperature as low as we please, and could therefore, in theory, act as a refrigerator.

Experimental Confirmation

It was found experimentally to be necessary to use a transformer of small leakage coefficient or oscillation took place at some short wavelength. The transformer core was of iron dust and the inductances of the windings were such as to tune approximately with the valve capacitances to 2.5 Mc/s. the frequency at which measurements were made. The final tuning was carried out with a small trimmer condenser, not shown in the diagram. The tuning was quite flat owing to the low parallel impedance of $\frac{1}{\sigma g}$ across the anode winding of the transformer.

Owing to this extremely low impedance from anode to earth it was more convenient to measure the noise voltage from grid to earth, i.e. across CD. The method employed for measuring the noise voltage and calculating the equivalent temperature was that given in the previous article (*loc. cit.*).

The lowest effective temperature was obtained with an MH41 and a transformer ratio of 1 : 16. The impedance from grid to earth was 2,900 ohms, and the effective temperature 70°K. Since the effective temperature of the valve itself with the anode connected capacitively to its grid was 700°K, the theoretical temperature was $\frac{700^\circ}{16} = 44^\circ$ K.

The discrepancy may have been due to the leakage of the transformer which would cause an undesired phase change. No special investigation was made on this point, but it was clear that some factor was limiting the reduction of temperature, since an increase in the transformer ratio led to no further fall in the effective temperature.

A transformer is not essential to step up from the anode to the grid circuit, a resonant circuit as shown in Fig. 2 providing an alternative method. In Fig. 2 C_a represents the grid-anode capacity of the valve, $C_b = 25\mu\mu$F., L is a variable inductance to tune to 2.5 Mc/s, and R is a large resistance. The lowest effective temperature attained with this circuit was 116° K.

It is interesting to note with this circuit

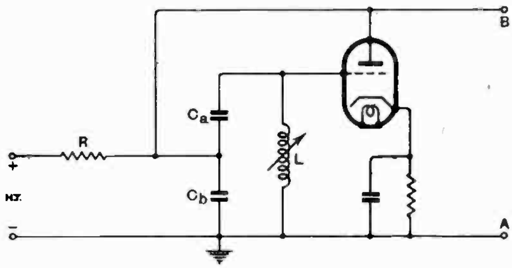


Fig. 2.

that, at a sufficiently low frequency, the grid would be at earth potential. The minimum effective temperature of the valve would then be $\frac{\mu T_c}{2}$. Thus the effective temperature of a circuit containing a thermionic valve may vary with frequency.

Possible Applications

In order to prevent reflection it is the usual practice to terminate a transmission line carrying high frequency signals with a resistance at its receiving end equal to its characteristic impedance. This terminating resistance reduces the voltage at the receiving end to about 0.5 of the value which it would have in the absence of the terminating resistance. The impedance also falls to about 0.5 so that, as can be seen from equation (1), the noise voltage is only reduced to about 0.71 of the value it would have on open circuit. Hence the effect of the terminating resistance is to reduce the signal to noise ratio in volts to 0.71 of its open circuit value. If the signal is very weak this may be of some importance.

Now, if the added resistance were entirely noiseless, i.e. at 0° K, the noise voltage would be reduced to 0.5, i.e. in the same ratio as the signal voltage. Hence, terminating a line with a noiseless resistance leaves the signal to noise ratio unaltered. Even if the terminating resistance were at an effective temperature of 70° K the signal to noise ratio would only be slightly reduced. Thus the circuit shown in Fig. 1 could be advantageously employed for terminating a line or filter in cases in which it is desirable to maintain the signal to noise ratio as high as possible.

Another application is to the input circuit of a high gain wide band amplifier in which it is necessary to add resistance to widen the pass band, but in which it is required to maintain the signal to noise ratio as high as possible.

It must be said, however, that the theoretical interest of the principle is probably greater than its practical importance.

Acknowledgment

Acknowledgment is due to Mr. W. L. Horwood, with whom the experimental part of the work was carried out.

Correspondence

Temperature Coefficient of Inductance

To the Editor, The Wireless Engineer.

SIR,—In spite of the numerous papers which have been published on this subject, I am not satisfied that the temperature coefficient of inductance of multi-turn coils can be predicted from the data so far available on this subject.

There are two accepted causes of change of inductance with temperature, namely, the "mechanical" change of the dimensions of the coil and the influence of skin effect on the "internal inductance" of the winding. The "mechanical" change is of course readily calculable, though, strictly speaking, in the design of coils in which compensation is effected by making the longitudinal expansion greater than the radial, allowance should be made for the change of Nagaoka's factor which results from change of the ratio of length to diameter. However, this only amounts to an extra correction corresponding to a temperature coefficient of inductance of 1 or 2 parts in 10^6 in most cases. The "internal inductance" is that part of the inductance which arises from the linking of the current with its own field within the same wire, whereas the "external inductance" is that part of the inductance which is due to the linking of the current with the field from other turns of the coil. The "internal inductance" is very little affected by the form in which the wire is wound, and is approximately the same as the inductance of the same length of wire stretched out in a straight line. It is a function of the current distribution within the wire, and at any given frequency it is therefore a function of the resistivity, and therefore of the temperature, of the wire. This factor has been discussed in detail by H. A. Thomas[1], from whose work it may be seen that the component of temperature coefficient due to this cause reaches a maximum at a frequency depending upon the wire diameter, and by choosing a sufficiently large diameter of conductor the frequency at which this maximum occurs may be made relatively low (*e.g.*, 129 kc/s for a wire diameter of 1 mm.). At higher frequencies the temperature coefficient should fall with increasing frequencies.

Yet experimental results from various sources persist in indicating a continually accelerating rise of temperature coefficient with rising frequency in coils having conductors of adequate diameter. Groszkowski[2] attributes this to irregular eddy currents induced in the conductor of the coil in a direction at right angles to the axis of the current flow, and gives experimental evidence to show that the temperature coefficient of inductance is a function of the temperature coefficient of resistance of the windings and of the number of turns. It appears to me that a more probable explanation is the phenomenon which gives rise to "proximity factor" in the R.F. resistance of a coil. Just as the redistribution of current in the skin effect due to the internal field of the conductor gives rise to a change of inductance, so the redistribution of current represented by the proximity factor, which is due to the external field from the other turns of the coil, will also give rise to a change of inductance in a multi-turn coil. Since the conductor section of a coil winding is frequently chosen so that skin effect and proximity factor shall have equal effects in raising the R.F. resistance of the coil above the D.C. value, it seems reasonable to suppose that the proximity factor may have an effect on the temperature coefficient of inductance which is at least equal to that of the skin factor. In this connection it should be remarked that in a multi-turn coil the internal inductance of the winding is only a fraction of the total inductance of the coil, so that even if the skin effect indicates an increase of 35 parts in 10^6 in the temperature coefficient of the internal inductance, the addition to the temperature coefficient of inductance of a multi-turn coil is likely to be less than 10 parts in 10^6.

Chelmsford. D. A. BELL.

A Multi-Channel Oscillograph Amplifier

To the Editor, The Wireless Engineer.

SIR,—I have read with great interest the paper by Dr. Williams and Mr. Beattie, in your issue of March, 1939. Might I point out that I have devised a very similar multi-channel oscillograph amplifier (patented early in 1938 and described at a meeting of the Société Française des Electriciens in November, 1938).

The switching voltage in this amplifier is derived from a chain of blocking oscillators which is believed to be particularly rigid in interlocking.

An account was published in the February, 1939, issue of the *Bulletin de la Société Française des Electriciens*.

Sceaux (Seine). THÉODORE VOGEL

[1] *Journ. I.E.E.*, Jan., 1939, Vol. 84, p. 101.
[2] *Proc. Inst. Rad. Eng.*, 1937, Vol. 25, p. 448.

Abstracts and References

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

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

PROPAGATION OF WAVES

1790. ULTRA-SHORT-WAVE PROPAGATION: COMPARISON BETWEEN THEORY AND EXPERIMENTAL DATA [General Agreement: Divergencies probably due to Inaccuracies of Measurement: Need for Further Development of Field-Strength-Measuring Technique and for Systematic Experiments].—R. L. Smith-Rose & A. C. Stickland. (*Wireless Engineer*, March 1939, Vol. 16, No. 186, pp. 111–120.)

1791. MEASUREMENTS ON THE PROPAGATION OF ULTRA-SHORT WAVES OVER WATER [Signals at 20 Miles when Transmitter's Horizon was only 10 Miles].—G. W. Potapenko & P. S. Epstein. (*Electrician*, 10th Feb. 1939, Vol. 122, p. 167.) *See* also *Sci. News Letter*, 26th Nov. 1938, Vol. 34, No. 22, p. 351, where wavelengths of 5 m and 1 m are mentioned, and the distance is given as 18 miles.

1792. THE PROPAGATION OF ULTRA-SHORT WAVES IN SWITZERLAND.—F. Tank & W. Gerber. (*Bull. Assoc. suisse des Élec.*, No. 3, Vol. 30, 1939, p. 75: summary only, in German.) A Zurich Conference paper.

1793. OBSERVATIONS ON SKY-WAVE TRANSMISSION ON FREQUENCIES ABOVE 40 MEGACYCLES.—D. R. Goddard. (*RCA Review*, Jan. 1939, Vol. 3, No. 3, pp. 309–315.) *See* 1344 of April.

1794. THEORETICAL RELATIONSHIPS OF DIELECTRIC GUIDES (CYLINDRICAL) AND COAXIAL CABLES.—A. G. Clavier. (*Elec. Communication*, Jan. 1939, Vol. 17, No. 3, pp. 276–290.) Based on the two French papers dealt with in 872 of March and back reference.

1795. POSTSCRIPT TO THE PAPER "THE PROPAGATION OF ELECTROMAGNETIC WAVES IN WATER" [Corrected Curves for Absorption Coefficient and Range].—K. Brüne. (*Hochf:tech. u. Elek:akus.*, Feb. 1939, Vol. 53, No. 2, p. 67.) *See* 38 of 1938.

1796. DISPERSION AND ABSORPTION OF SHORT ELECTRIC WAVES AND MOLECULAR STRUCTURE [Measurements on Alcohols and Glycerine over Range 18–130 cm: Rotation of OH Group and Not of Whole Molecule is responsible for Dispersion and Absorption of Alcohols].—E. Keutner & G. Potapenko. (*Physik. Zeitschr.*, 1st Feb. 1939, Vol. 40, No. 3, pp. 100–104.)

1797. THE DESIGN AND CONSTRUCTION OF A SHORT-WAVE [7–11 m] FIELD-STRENGTH MEASURING SET, *and* A FIELD-STRENGTH MEASURING SET FOR ULTRA-SHORT WAVES: CORRECTION TO ABSTRACT.—Colebrook & Gordon-Smith: Binshtok. (*See* 2029 & 2030.)

1798. SCATTERING OF RADIO WAVES IN POLAR REGIONS [Record of Reception of Medium-Delay Radio Echo at Tromsö showing Lateral Scattering from Centre in or below Normal Region F].—E. V. Appleton & R. Naismith. (*Nature*, 11th Feb. 1939, Vol. 143, pp. 243–244.) *See* also 13 of January (Harang & Stoffregen).

1799. THE IONOSPHERE [Historical: Electronic Structure: Ionisation Variations in Regions E, F_1 and F_2: Ionospheric Irregularities (the Three Types): Origin of Ionospheric Stratification (Wulf & Deming: Mitra & Bhar)].—E. V. Appleton. (*Occasional Notes of Roy. Astron. Soc.*, No. 3, Jan. 1939, pp. 33–41.)

1800. Non-Existence of Continuous Intense Ionisation in the Troposphere and Lower Stratosphere [Review of Direct Evidence (Huancayo Observations, *Explorer II* Flight into Stratosphere, Considerations of Rate of Supply of Energy) against Such Ionisation as Suggested Cause of Low-Level Reflection of Wireless Waves].—O. H. Gish & H. G. Booker. (*Proc. Inst. Rad. Eng.*, Feb. 1939, Vol. 27, No. 2, pp. 117–125.)

1801. Study of the Ionosphere at Shanghai: Observation of Frequency Changes of Waves Reflected by the Ionised Layers [deduced from Echoes, of Short Signals on a Frequency between 4.5 & 2.5 Mc/s, tuning to Different Frequencies, Some (up to 10) Kilocycles apart].—P. Lejay. (*Comptes Rendus*, 6th Feb. 1939, Vol. 208, No. 6, pp. 400–403.)

1802. Studies in the Propagation of Radio Waves in an Isotropic Ionosphere [Method of determining Reflection Coefficient and Equivalent Paths by Consideration of Limiting Form (Ratio of Horizontal Electric & Magnetic Components) of Wave at Boundary: Confirmation of Martyn's Equivalence Theorem (linking Vertical- & Oblique-Incidence Results) for Horizontal Polarisation: etc.].—W. G. Baker. (*A.W.A. Tech. Review*, Oct. 1938, Vol. 3, No. 6, pp. 297–319.) A Sydney World Radio Convention paper.

1803. Application of Graphs of Maximum Usable Frequency to Communication Problems [Highest Frequency, up to within a Variation Factor (usually about 15%) of the Max. Usable Frequency, is Best: etc.].—Smith, Kirby, & Gilliland. (*Journ. of Res. of Nat. Bur. of Stds.*, Jan. 1939, Vol. 22, No. 1, pp. 81–92.)

1804. Solar Activity and Cosmic Rays [Connection between Cosmic Rays, Rotation of Sun, and Active Solar Centres: Behaviour of Cosmic Ray Intensity may predict Coming Magnetic Storm Some Days Ahead].—W. Kolhörster. (*Physik. Zeitschr.*, 1st Feb. 1939, Vol. 40, No. 3, pp. 107–112.)

1805. Sunspots and Their Terrestrial Effects.—Spencer Jones. (*Sci. Progress*, July 1938, Vol. 33, No. 129, pp. 1–16.)

1806. "Étude Pratique des Rayonnements Solaire, Atmosphérique, et Terrestre: Méthodes et Résultats" [Book Review].—C. Maurain. (*Science*, 9th Dec. 1938, Vol. 88, pp. 548–549.)

1807. The Aurora Borealis and Short-Wave Reception: the Recent Ionosphere Storm, *and* A True-to-Form Aurora.—(*World-Radio*, 10th March 1939, Vol. 28, p. 14: p. 14.) Observations around 24th Feb. 1939.

1808. Ionospheric Observations carried out in Rome from August to November, 1938: an Ionospheric Storm of Auroral Type.—I. Ranzi. (*La Ricerca Scient.*, Jan./Feb. 1939, 10th Year, No. 1/2, pp. 32–38.)

Records were made on frequencies 5.5–10 Mc/s. The gyromagnetic frequency was calculated, by Schmidt's formula, for a height of 250 km over Rome, to be 1.10 Mc/s, and the separation of the two critical frequencies to be 0.55 Mc/s. The mean of some 100 observations gave 0.57 Mc/s. The mid-day decrease of electronic density in the F_2 layer (Appleton's thermal expansion phenomenon) was in evidence. The critical frequencies were appreciably higher (*e.g.* 6.6 Mc/s compared with 5.6 Mc/s) than those observed at Washington by Best, Farmer, & Ratcliffe (1747 of 1938). The anomalies of the E region (sporadic reflections) are discussed; the lowest frequency employed was too high to give all these, but the more marked were observed (p. 36). The writer refers to his original establishment of the correlation between these effects and the meteorological situation (1932 Abstracts, p. 632). Finally he discusses the F_2-region disturbances, of which he defines four classes; only the last two ("ionospheric storm" and "ionospheric storm of auroral type") were observed. "In the present state of our knowledge, the phenomena in question can only be explained by admitting one of the two following hypotheses: (1) that between 140 and 220 km the atmosphere presents a profound change in its properties with regard to the absorption of corpuscular radiation arriving from outside; or (2) that the abnormal regions below 140 km are formed by the horizontal diffusion of ionised masses generated in regions of higher latitude by auroral processes."

1809. The Aurora of 24th February and Some Observations [Northerly & North-Westerly Stations affected First and Most Seriously: Absence of Usual "Mushy Background" in between Medium-Wave Stations: etc.].—"Log-Roller." (*World-Radio*, 17th March 1939, Vol. 28, p. 10.) *See* also p. 13.

1810. Atomic [Nitrogen] Lines in the Auroral Spectrum.—J. Kaplan. (*Nature*, 18th Feb. 1939, Vol. 143, pp. 278–279.) *See* Vegard, 30 of January.

1811. Effect of Collisions on the Intensities of Nebular Lines, *and* Excitation of Nebular Lines [Notes on Increase in Intensity with Pressure of Forbidden Transitions in Nitrogen].—D. H. Menzel: J. Kaplan. (*Nature*, 8th Oct. 1938, Vol. 142, p. 644: 28th Jan. 1939, Vol. 143, pp. 164–165.)

1812. Luminous Discharge in Nitrogen in Presence of Sodium Chloride [Spectra Obtained: Presence of Active Nitrogen].—G. Déjardin. (*Comptes Rendus*, 13th Feb. 1939, Vol. 208, No. 7, pp. 510–513.)

1813. The Light of the Night Sky.—J. Cabannes. (*Sci. Progress*, Jan. 1939, Vol. 33, No. 131, pp. 435–446.)

1814. Distribution of Temperature and Humidity in the Upper Air over Karachi [Data up to 5 km Height].—P. R. K. Rao & K. L. Bhatia. (*Current Science*, Bangalore, Feb. 1939, Vol. 8, No. 2, pp. 71–73.)

1815. Analytical Study on the Propagation of Electromagnetic Waves in Homogeneous Circuits: Part I—Propagation on an Infinite Line: Part II—Propagation on a Finite Line [Defects of Previous Treatments: the Complete Solution of the Telegraphy Equations for Lines with or without Loss: Absolute Identity of Characteristics of Propagation of Incident & Reflected Waves: etc.].—S. Teszner. (*Rev. Gén. de l'Élec.*, 14th & 21st Jan. 1939, Vol. 45, Nos. 2 & 3, pp. 47–58 & 87–95.)

1816. Propagation of H.F. Oscillations along Networks for Transport of Electrical Energy [General Equations for *n* Uniform Parallel Lines].—F. Carbenay. (*Comptes Rendus*, 20th Feb. 1939, Vol. 208, No. 8, pp. 565–567.)

1817. On "Raster"-Shaped Reflection Gratings: Postscript.—K. H. Hellwege. (*Zeitschr. f. Phys.*, No. 7/8, Vol. 111, 1939, pp. 495–497.) Completion of formula in, and generalisation of, work referred to in 4009 of 1937.

1818. Seismology from a Mathematical Viewpoint.—W. D. Cairns. (*Science*, 10th Feb. 1939, Vol. 89, pp. 113–118.)

1819. Laboratory Analysis of the Selective Absorption of Light by Sea Water.—G. L. Clarke & H. R. James. (*Journ. Opt. Soc. Am.*, Feb. 1939, Vol. 29, No. 2, pp. 43–55.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

1820. Radioelectric Atmospherics [Survey, with Lengthy Bibliography].—R. Bureau. (*Rev. Gén. de l'Élec.*, 17th Dec. 1938, Vol. 44, No. 24, pp. 763–778.)

1821. Aircraft Static Suppressor installed on United Air Lines Ships [50-ft. Fine Steel Wire, including Suppressor Resistance].—(*Electronics*, Feb. 1939, Vol. 12, No. 2, pp. 42 and 44.) *Cf.* 43 of January (a different device).

1822. Lightning and Interior Electrical Installations [Effects in Switzerland].—Ch. Morel. (*Bull. Assoc. suisse des Élec.*, No. 1, Vol. 30, 1939, pp. 13–16.)

1823. Testing and Application of Lightning Arresters.—AIEE Subcommittee. (*Elec. Engineering*, Feb. 1939, Vol. 58, No. 2, Transactions pp. 68–71.)

1824. The Starting Process of the Electrical Discharge at Atmospheric Pressure [Action of Photoelectrons emitted from Cathode].—R. Schade. (*Zeitschr. f. Phys.*, No. 7/8, Vol. 111, 1939, pp. 437–449.)

1825. Electrical Discharges in Air at Atmospheric Pressure: the Nature of the Positive and Negative Point-to-Plane Coronas and the Mechanism of Spark Propagation [Summarising Account].—L. B. Loeb & A. F. Kip. (*Journ. of Applied Phys.*, March 1939, Vol. 10, No. 3, pp. 142–160.)

1826. The Influence of Air Density according to the New I.E.C. Mean Values for Spark Gaps between Spheres [Correction Factor to Spark Voltage].—S. Franck. (*Arch. f. Elektrot.*, 16th Jan. 1939, Vol. 33, No. 1, pp. 54–59.)

1827. The Determination of Electrical Charges in the Atmosphere [Simple Graphical Construction to find the Position and Magnitude of an Electrical Point Charge from a Knowledge of the Electric Fields due to It at Four Stations].—E. Medi. (*La Ricerca Scient.*, March 1939, 10th Year, No. 3, pp. 124–129.)

1828. Electric Charge on Soft Hail [Measurements bearing on Maintenance of Negative Charge on Earth's Surface].—J. A. Chalmers & E. W. R. Little. (*Nature*, 11th Feb. 1939, Vol. 143, p. 244.)

1829. Instantaneous Determination, without Calculation, of Every Altitude of a Radio Sounding Balloon.—J. Lugeon. (*Comptes Rendus*, 20th Feb. 1939, Vol. 208, No. 8, pp. 591–593.)

1830. An Improved Radio-Meteorograph on the Olland Principle.—Curtiss & others. (*Journ. of Res. of Nat. Bur. of Stds.*, Jan. 1939, Vol. 22, No. 1, pp. 97–103.)

1831. U.S. Weather Bureau re-names the Radiometeorograph [in future, "Radiosonde"].—(*Sci. News Letter*, 28th Jan. 1939, Vol. 35, No. 4, p. 56.)

1832. Electromagnetic Induction in Non-Uniform Conductors, and the Determination of the Conductivity of the Earth from Terrestrial Magnetic Variations [General Theory: Deduced Changes in Composition of Earth with Increasing Depth: Increase of Conductivity at Depth of about 700 km].—B. N. Lahiri & A. T. Price. (*Phil. Trans. Roy. Soc. Lond.*, Series A, 20th Jan. 1939, Vol. 237, No. 784, pp. 509–540.)

PROPERTIES OF CIRCUITS

1833. Negative Feedback [of Amplifier with Arbitrary Eight-Pole: Theory].—B. D. H. Tellegen & J. Haantjes. (*E.N.T.*, Dec. 1938, Vol. 15, No. 12, pp. 353–358.)

The theoretical considerations here given hold for positive regeneration as well as for negative feedback. Properties of the general equations of networks which only act in one direction are discussed in § 2. A valve amplifier (Fig. 3) is one example of such a network; four equivalent circuits are given for this. In § 3 it is shown that every linear eight-pole can be dissected into four parts (Fig. 5), two eight-poles of special type which only act in one direction, and two quadripoles. The general case of an amplifier with negative feedback through a linear eight-pole (Fig. 1) gives the circuit of Fig. 6a when the eight-pole is replaced by its four parts; further analysis (Figs. 6b, 7) shows that there are four types of negative feedback: (a) of the output voltage of the amplifier to the input voltage, (b) of the output current to the voltage, (c) of the output voltage to the input current, and (d) of the output current to the input current. Considerations of the input and output impedance of the amplifier with negative feedback (§ 5) lead to "the conditions to be fulfilled if (1) the amplifier is not to act backwards from the output terminals to the input terminals, even when the amplification of the original quadripole amplifier varies while the input and output impedance remain constant, and (2) in the latter case, the input and output impedances of the amplifier with feedback do not vary." This leads (§ 6) to negative feedback using two six-poles (Fig. 8) and the circuit given by Black (1934 Abstracts, p. 272, l-h col.). In § 7 the decrease of distortion and disturbances is briefly considered.

1834. THE FREQUENCY CURVE AND TENDENCY TO OSCILLATION OF NEGATIVE-FEEDBACK AMPLIFIERS FOR BROADCAST RECEIVERS.—Brück. (*See* 1868.)

1835. AN ANODE-BEND DETECTOR CIRCUIT WITH NEGATIVE FEEDBACK.—Köpke. (*See* 1869.)

1836. THE DIODE DETECTOR WITH POSITIVE BIAS.—Sturley. (*See* 1870.)

1837. COUPLED SELF-EXCITED ELECTRICAL CIRCUITS AND CRYSTAL OSCILLATORS.—K. Heegner. (*E.N.T.*, Dec. 1938, Vol. 15, No. 12, pp. 359–368.)

The linear theory of self-excited electrical oscillations in coupled circuits is first discussed with a view to its application to crystal oscillators. § I deals with secondary retroaction in which oscillating circuits connected to grid and anode are themselves connected by an element containing self-inductance and ohmic resistance (Fig. 1). The case of resistance coupling is considered in § II (circuit Fig. 2). The equations show that, when the circuits are tuned, their natural frequency is excited. Figs. 3a, b show the extension of the coupling resistance to a resistance circuit, formulae for which are given. It is found that "when both circuits have the same loss resistance, the coupled system has the natural frequency of the combination circuit formed by connecting in series the elements of both circuits." Various modifications of the circuit (Figs. 4–9) are given in § IV.

Crystal oscillators are derived from these circuits by replacing a series circuit of self-inductance and capacity by a piezoelectric crystal resonator, in which case the crystal is excited in its natural frequency with short-circuited electrodes (§ V). Some known crystal oscillators are discussed. The adverse effect of the attenuation in the electrical circuit can be reduced by using the circuit shown in Fig. 14 (§ VI), in which two tuned circuits are coupled to the crystal, one in the anode circuit and the other in the grid circuit of a valve. This gives the minimum effect of the capacity of the valve and leads on the crystal frequency; further advantage is obtained by using a screen-grid valve. Some simple adjustments of the arrangement and values of the elements make it possible to reproduce the crystal frequency very exactly, so that the oscillator fulfils all the requirements of a standard. § VII describes methods of measurement on crystal resonators and the determination of the equivalent circuit.

1838. OSCILLATION OF CLOSE-COUPLED CIRCUITS [Stable and Metastable Modes].—R. R. Ramsey, W. L. Chenault, & L. E. Long. (*Phys. Review*, 15th Jan. 1939, Series 2, Vol. 55, No. 2, p. 239: abstract only.)

1839. CARRIER-FREQUENCY WIDE-BAND AMPLIFIER WITH MUTUALLY DETUNED SINGLE CIRCUITS.—Schienemann. (*See* 2016.)

1840. THE PARALLEL-RESONANCE CIRCUIT, WITH LOSSES, AS AN A.C. RESISTANCE [Treatment by Reciprocal Representation: the Exact Formulae and Their Comparison with the Usual Approximations: Necessity for the Exact Formulae for Very High Frequencies (Television) and for Circuits with High Attenuation (L.F. Amplifiers): Examples].—E. de Gruyter. (*Bull. Assoc. suisse des Élec.*, No. 4, Vol. 30, 1939, pp. 99–109: in German.)

1841. THE VARIABLE-Q AMPLIFIER [Basic Circuit attributed to Boucherot, but is only an Example of Steinmetz's Tuned Quarter-Wave Line].—W. Cramp: Fairweather & Williams. (*Wireless Engineer*, March 1939, Vol. 16, No. 186, p. 135.) Prompted by the paper dealt with in 1387 of April. For a correction to a reference in this paper see *ibid.*, p. 136.

1842. ON THE BROWNIAN MOTION IN ELECTRIC RESISTANCES [Derivation, from Statistical Considerations, of Nyquist's Formula (derived by Thermodynamic Reasoning): Influence of Collision Frequency].—C. J. Bakker & G. Heller. (*Physica*, March 1939, Vol. 6, No. 3, pp. 262–274: in English.)

1843. EQUIVALENT MODULATOR CIRCUITS.—Peterson & Hussey. (*See* 1864.)

1844 RELAXATION OSCILLATIONS [Rocard's Solution, Rigorous for a Single Discontinuity: Meissner's Graphic Method, for *n* Discontinuities: the Use of a Simple Integraph].—J. J. Muller. (*Bull. Assoc. suisse des Élec.*, No. 20, Vol. 29, 1938, pp. 573–577.)

1845. THE CONSTRUCTION OF MODELS FOR OSCILLATION SYSTEMS.—Esafov & Teodorchik. (*Journ. of Tech. Phys.* [in Russian], No. 17, Vol. 8, 1938, pp. 1557–1561.)

1846. HIGH-FREQUENCY TRANSMISSION-LINE NETWORKS.—Alford. (*See* 1894.)

1847. CRITICAL CONDITIONS IN FERRORESONANCE [Reply to Criticism].—P. H. Odessey: Thomson. (*Elec. Engineering*, Jan. 1939, Vol. 58, No. 1, p. 49.)

TRANSMISSION

1848. New Radio Apparatus uses Waves only 4 Inches Long [" Klystron " Generator producing 10 cm Waves " at Efficiencies Not Hitherto Attained ": using Two " Rhumbatrons," One as " Buncher," the Other as " Catcher "].—Varian, Hansen, & others. (*Sci. News Letter*, 11th Feb. 1939, Vol. 35, No. 6, p. 89). For Hansen's rumbatron (or rhumbatron) *see* 722 of 1937. The new name is derived from the Greek " klyzo," meaning " waves breaking on a beach."

1849. An Ultra-High-Frequency Power Amplifier of Novel Design [Model Tube gives 110 Watts at 450 Mc/s when driven by 10 Watts from Magnetron : Efficiency about 35% : Transit-Time Effects reduced by Use of High-Velocity Electrons (Focusing and 6000-Volt Accelerating Electrodes), High Efficiency by " Collection " of Electrons at Low Velocity (Large 2000-Volt Collector) : Other Advantages].—A. V. Haeff. (*Electronics*, Feb. 1939, Vol. 12, No. 2, pp. 30–32.) From the RCA laboratories.

1850. Velocity-Modulated Tubes [for Ultra-Short Waves].—Hahn & Metcalf. (*See* 1901.)

1851. The Transitron Oscillator [Retarding-Field Negative-Transconductance Circuit, giving Sinusoidal Oscillations from Lowest Audio to 60 Mc/s by Change of Tuned-Circuit Constants : Advantages of Dynatron without Its Disadvantages (Secondary Emission Too Variable with Age) : etc.].—C. Brunetti. (*Proc. Inst. Rad. Eng.*, Feb. 1939, Vol. 27, No. 2, pp. 88–94.) Practical extension of the theoretical paper dealt with in 879 of 1938.

1852. Ultra-High-Frequency Oscillations of [Plane] Diodes and Triodes [Approximate Theory giving Conditions necessary for Oscillation : Oscillation possible even when Electrons which have passed Grid All reach Plate, and when All Electrons return to Grid after Repulsion from Region close to Plate].—K. Matsudaira. (*Electrot. Journ.*, Tokyo, Jan. 1939, Vol. 3, No. 1, pp. 19–21.)

1853. Wavelength of Electron Oscillation in Magnetron [Derivation of Formula, giving Better Agreement with Measured Values than That of Posthumus].—G. Hara & S. Mito. (*Electrot. Journ.*, Tokyo, Jan. 1939, Vol. 3, No. 1, pp. 23–24.)

1854. The Posthumus Oscillations in the Magnetron [Corrections].—F. Ollendorff : Fischer & Lüdi. (*Bull. Assoc. suisse des Élec.*, No. 4, Vol. 30, 1939, p. 117.) For Fischer & Lüdi's paper, corrections to which Ollendorff now gives, *see* 3265 of 1937.

1855. Modulation of H.F. Emitters [particularly of Dynatron, Retarding-Field, or Magnetron Type] by Amplitude Limitation.—F. W. Gundlach. (*Hochf:tech. u. Elek:akus.*, Jan. 1939, Vol. 53, No. 1, pp. 10–18.)

The various methods for modulating such transmitters—anode-voltage modulation, modulation of retarding field or magnetic field, etc.—have objectionable features. The principles governing the oscillation amplitude and the frequency of emitters with falling characteristic are analysed in § II, to show the modulation difficulties involved. Fig. 1 shows the equivalent circuit, Fig. 2 the determination of the oscillation amplitude from the energy relations, Fig. 3 the graphical determination of the course of the oscillation. It is found that the quantity determining the course of the oscillation is the effective reduction in damping (eqn. 18) ; as this increases, the voltage curve form becomes less sinusoidal and the frequency decreases. The known modulation methods are discussed (§ II 5) ; it is shown that none of those in common use give amplitude modulation which is free from objection.

Modulation by amplitude limitation is discussed in § III ; Fig. 6 shows the fundamental scheme for using the characteristics, Fig. 7 the fundamental circuits, based on two diodes connected in parallel in opposite directions. The basis of the scheme is to connect " a non-linear resistance in parallel with the negative resistance which produces the oscillations ; this non-linear resistance takes little or no current below a certain voltage but a large current above this voltage, so that it limits the h.f. amplitude to the point at which it takes this large current. Amplitude modulation then arises if this point can be displaced in time with the modulation." The working and advantages of this modulation are discussed (§ III 3) ; it is found to give a linear modulation line, very good constancy of frequency, low power in the modulation, and to retain the original efficiency of the emitter. § IV describes experimental results with an ordinary emitter with retroaction (§ IV 1 ; Fig. 10, a push-pull emitter with amplitude-limited modulation) and with a Habann generator (§ IV 2 ; Fig. 13).

1856. A 15-Watt Crystal-Controlled Five-Metre 'Phone.—G. H. Pickett. (*QST*, March 1939, Vol. 23, No. 3, pp. 48–51 and 118 . . 122.)

1857. Crystal Control for Portable and Semi-Portable Broadcast Pick-Up Transmitters [using Ultra-Short Waves, with Superheterodyne Reception to avoid Excessive Noise of Super-Regenerative Receivers].—S. T. Carter. (*Communications*, Jan. 1939, Vol. 19, No. 1, pp. 14 and 24, 25.)

1858. One Crystal—Two Tubes—Five Bands : Odd Harmonics as well as Even are Useful for Amateur Bands.—T. M. Ferrill, Jr. (*QST*, March 1939, Vol. 23, No. 3, pp. 42–45 and 108 . . 112.)

1859. Frequency-Controlled Oscillators [for Measuring Technique (*e.g.* for Frequency Shifting to More Suitable Part of Spectrum) : for Carrier Restoration, Reception of Frequency-Modulated Signals, etc : General Picture of Operation].—S. Sabaroff. (*Communications*, Feb. 1939, Vol. 19, No. 2, pp. 7–9 and 50, 51.)

1860. An Experimental Single-Sideband Transmitter [giving A.F. Band 100–8500 c/s : No Crystal Filters].—C. B. Aiken & W. S. Loh. (*Communications*, Feb. 1939, Vol. 19, No. 2, pp. 10–11 and 49, 50.)

1861. New Transmission System [at WHO, Des Moines: Polyphase Radiation with Amplitude Modulation: Reception with Conventional Receivers: Theoretical Minimum of Power Consumption and Valve Cost].—Collins Radio: Byrne. (*Communications*, Jan. 1939, Vol. 19, No. 1, p. 9.)

1862. Contribution to the Operation of Doherty's Output Stage with Ordinary Modulation and with Hapug ["Floating Carrier"] Modulation.—H. Bosse & H. Fricke. (*Hochf:tech. u. Elek:akus.*, Jan. 1939, Vol. 53, No. 1, pp. 19–27.)

For the Doherty circuit *see* 4020 of 1936; for the Harbich-Pungs-Gerth ("Hapug") form of floating-carrier operation, *see* 3343 of 1936. The theory of the Doherty stage is discussed in § 1, with special reference to "the change in steepness of the working characteristic during the modulation period, which necessitates limitation of the alternating voltage on the grid." The quantities determining this limitation are given. The power with alternating and direct current and the efficiency are also investigated theoretically (§ 1.5). In § II the practical construction of the stage is described (circuit Fig. 13). The possibility of combining the Doherty output stage with a Hapug transmitter is discussed in § III; this would "not only give increased energy economy [Fig. 14] but decrease the 'klirr' factor by displacing the working point to the linear part of the characteristic."

1863. Communication by Phase Modulation.—M. G. Crosby. (*See* 2137.)

1864. Equivalent Modulator Circuits [developed in form of Linear Resistance Networks: Deduction of Operating Features—Transfer Efficiency from Signal to Sideband, etc.].—E. Peterson & L. W. Hussey. (*Bell S. Tech. Journ.*, Jan. 1939, Vol. 18, No. 1, pp. 32–48.)

1865. High-Voltage [*e.g.* 5000 Volt] Smoothing: an Alternative to the Choke-Capacity Filter [when Price and Size of Smoothing Condensers exceed Those of a Triode: Use of a Valve Bridge Circuit].—(*Wireless World*, 16th March 1939, Vol. 44, p. 255.)

1866. Safety Technique in Transmitter Operation and Construction: the A.R.R.L. Safety Codes.—G. Grammer. (*QST*, March 1939, Vol. 23, No. 3, pp. 19–22 and 86 . . 90.)

1867. Iron Cores for Power Oscillators [Powdered-Iron Cores successfully applied to Transmission: Suitable for High-Q Circuits up to 3 Mc/s: Effective Permeability about 3].—Mallory Company. (*Proc. Inst. Rad. Eng.*, Feb. 1939, Vol. 27, No. 2, p. ii.)

RECEPTION

1868. The Frequency Curve and Tendency to Oscillation of Negative-Feedback Amplifiers for Broadcast Receivers.—L. Brück. (*Telefunken-Röhre*, Dec. 1938, No. 14, pp. 237–253.)

For previous work *see* 1381 of 1938. Author's summary:—"It is shown how, from the αV-curve of a negative-feedback amplifier [α = fraction of output voltage fed back to the input circuit; V = amplification without feedback], conclusions may be drawn as to its stability and a view obtained of the course of its amplification. The amplification V' of the negative-feedback amplifier can be calculated fairly simply, in magnitude and phase, by starting from the vector equation $1/V = 1/V' - \alpha$. . . . In order to develop as simply as possible a negative-feedback circuit, the amplifier is represented, in equivalent-circuit fashion, as a voltage divider. α and V can then be determined by the similar procedure. In the appendix it is shown how to measure the amplification as regards magnitude and phase" [cathode-ray-tube method].

1869. An Anode-Bend Detector Circuit with Negative Feedback [to avoid Diode Detection with Its Added Damping: Comparison between Diode and Anode-Bend Detection: the Need for Negative Feedback to give Constant & Adequate "Durchgriff" in the Latter: a Circuit with Two Negative-Feedback Paths, for A.F. and Slow Carrier Variations respectively, giving Better Results than a Diode].—H. Köpke. (*Funktech. Monatshefte*, Jan. 1939, No. 1, pp. 7–11.)

1870. The Diode Detector with Positive Bias [Survey of Detector Distortion and Recent Literature: Preference for This Particular Detector: Comparison with Anode-Bend Type with Negative Feedback].—K. R. Sturley. (*Wireless World*, 9th March 1939, Vol. 44, pp. 220–223.)

1871. Remote Frequency Changer [Philco Remote-Control System with Frequency-Changing Valve & Associated Components in Control Unit].—E. Martin: Philco. (*Wireless World*, 16th March 1939, Vol. 44, pp. 249–251.)

1872. Inductive Tuning: Theory and Application [Recent Development of New Basic Principle (2293 & 4319 of 1938): Frequency Ratios of 7 or 8 to 1, against 3 or 3½ to 1 with Condenser Tuning: Increased Amplification and Higher Resonant-Circuit Voltages].—O. J. Morelock: Ware. (*Communications*, Feb. 1939, Vol. 19, No. 2, pp. 12 and 42 . . 54.)

1873. Investigations on [Variable-Inductance] H.F. Coils with Iron-Ribbon Cores under Variable Superposed D.C. Magnetisation.—G. Maus. (*E.N.T.*, Dec. 1938, Vol. 15, No. 12, pp. 369–378.)

For previous work *see* 3650 (and 4068) of 1937. The conditions to be satisfied by these coils if they are to be used to tune h.f. oscillating circuits are (1) inductance variation in the ratio 9 : 1, (2) loss factor less than 2%, (3) two frequency ranges, 150 to 500 and 500 to 1500 kc/s, each to be covered with one fixed condenser, (4) power used for superposed magnetisation at most 2 watts. The coils used for these investigations are shown in Fig. 1; they are wound to avoid retroaction from the alternating onto the direct current circuit. Their construction is described in § I; § II gives relations between their inductance, winding capacity, loss resistance, etc., and the magnetic properties of the core. The measurement of the loss resistance is described in § III (dynatron circuit Fig. 3); results of attempts to lower this resistance by different core construction, etc., are given in § IV. The most successful results were obtained by making the ribbons very thin by chemical treatment (§ IV c). It was found that the required conditions could be satisfied after suitable mechanical and heat treatment (§ V). Investigations of coils in another arrangement (§ VI, Fig. 14) and of other magnetic materials (§ VII) are also described.

1874. CONTRIBUTION TO THE QUALITATIVE THEORY OF IRON-CORED CHOKE COILS WITH SUPERPOSED MAGNETISATION BY DIRECT CURRENT [based on Replacement of Static Magnetisation Curve by Power Series].—G. Hauffe. (*Arch. f. Elektrot.*, 16th Jan. 1939, Vol. 33, No. 1, pp. 41–47.)

1875. THE "FREQUENCY STROKE" OF AUTOMATIC SHARP TUNING [Automatic Tuning Correction: the Maximum Displacement (by ATC Device) of the Superheterodyning Frequency from the Hand-Set Value, and Its Importance in avoiding "Sticking": the Need for Its Constancy over the Whole Frequency Band: etc.].—O. Tüxen. (*Telefunken-Röhre*, Dec. 1938, No. 14, pp. 254–263.)

The word "Frequenzhub" (frequency stroke) is derived by analogy with the "stroke" of a piston. Author's summary:—"For the maximum detuning produced by the reactive back-coupled control valve, the expression $\Delta\omega = \frac{1}{2}XC$ is derived, C being the capacity of the oscillatory circuit detuned by the valve and X the reactance represented by the valve, which is itself equal to the reciprocal of the product of back-coupling coefficient and valve slope ($= 1/kS$ [where k is the fraction of the anode alternating voltage returned, with 90° phase displacement, to the grid]). In the case of capacitive tuning the frequency stroke is constant if the reactance formed by the control valve increases in magnitude with the square of the frequency; while in the case of inductive tuning the magnitude of this reactance must be independent of frequency if the frequency stroke is to be constant. Circuit examples [by which these conditions can be obtained] are given." The case of a mixed inductive-capacitive tuning is also considered (section E): here inductance and capacitance are varied simultaneously in the same sense and in the same degree, and a constant frequency stroke is obtained if the control valve is connected as an inductance. If it is connected as a capacity, the stroke increases with the square of the frequency; if as a reactance of constant value, a stroke increasing with the frequency is obtained.

1876. STABILISING CONDENSERS [in American Receivers: Use of Parallel Condensers with Opposite Temperature/Capacity Characteristic to That of Main Tuning Condenser].—(*Wireless World*, 16th March 1939, Vol. 44, pp. 245–246.)

1877. DUAL-DIVERSITY RECEPTION [American Commercially-Produced Unit to add to Ordinary Receiver]. — McMurdo Silver. (*Wireless World*, 2nd March 1939, Vol. 44, pp. 208–209.)

1878. THE "OFF-NEUTRALISED CRYSTAL-FILTER RECEIVER" FOR PHASE-MODULATED WAVES. —M. G. Crosby. (*See* 2137.)

1879. RECEIVER NOISE [Sources, and Suggestions for Reduction].—D. A. Bell. (*Wireless World*, 16th March 1939, Vol. 44, pp. 247–249.)

1880. RADIOELECTRIC INTERFERENCE CAUSED BY HIGH-TENSION INSULATORS: ASE TESTS.—M. Dick. (*Bull. Assoc. suisse des Élec.*, No. 22, Vol. 29, 1938, pp. 609–615: in French.)

1881. A NOISE SUPPRESSOR CIRCUIT FOR HETERODYNE RECEIVERS [originally for Telemetering by Changes in Frequency of Unmodulated R.F. Signal (Carrier Frequency on Power System): also for Impulse-Type Signalling and Automatic Controls where Heavy Interference occurs: Opposed Circuits Principle]. O. Richardson. (*Communications*, Jan. 1939, Vol. 19, No. 1, pp. 10 and 23.)

1882. THE LIMITING VALUES, FROM THE POINT OF VIEW OF SAFETY, FOR INTERFERENCE-SUPPRESSING CONDENSERS [and the CISPR and IFK Investigations: the Weber-Fechner Law].—H. Bühler. (*Bull. Assoc. suisse des Élec.*, No. 1, Vol. 30, 1939, pp. 11–13.)

1883. THE PEOPLE'S SET [and Its Effect on the German Radio Industry].—W. E. Felix. (*Wireless World*, 2nd March 1939, Vol. 44, pp. 204–206.)

1884. HIGH-FIDELITY RECEIVER FOR LOCAL RECEPTION.—Pacent Company. (*Electronics*, Feb. 1939, Vol. 12, No. 2, p. 64.)

1885. ERICSSON WIRELESS RECEIVERS FOR SEASON 1938/1939.—Arvidson & Fredin. (*Ericsson Review*, No. 3, 1938, pp. 123–127.)

1886. "SYSTEMATISCHE FEHLERSUCHE [Tracing of Faults] AN RUNDFUNKGERÄTEN" [Book Review].—R. Schadow. (*E.T.Z.*, 23rd Feb. 1939, Vol. 60, No. 8, p. 239.)

1887. POWER SUPPLY FOR THE RADIO RECEIVER [including Thermo-Generators]. — A. W. Beatt. (*World-Radio*, 24th March 1939, Vol. 28, p. 12.)

AERIALS AND AERIAL SYSTEMS

1888. METAL HORNS AS DIRECTIVE RECEIVERS OF ULTRA-SHORT WAVES [Wavelengths 10 and 15 cm: Receiver 30 or more Wavelengths away: Directive Gains of 20 db or more: No Critically Sharp Frequency Characteristics (unlike Tuned Aerial Arrays): Optimum Angle of Flare: Possibility of Arrays: etc.].—G. C. Southworth & A. P. King. (*Proc. Inst. Rad. Eng.*, Feb. 1939, Vol. 27, No. 2, pp. 95–102.) For an editorial by G. W. O. H., see *Wireless Engineer*, March 1939, Vol. 16, No. 186, pp. 109–110.

1889. Electromagnetic Horns [Continuation of Paper "Electric Resonance Chambers" (1340 of April): Experiments on Conical Horns on 4150–5100 Mc/s: Variation of Space Pattern with Taper and with Mouth/Throat-Diameter Ratios: etc.].—G. Reber. (*Communications*, Feb. 1939, Vol. 19, No. 2, pp. 13–15.)

1890. Directive Aerials for Very Short Waves [Metre, Decimetre, and Centimetre Waves: Survey, with Experimental Radiation Diagrams, etc.].—E. C. Metschl. (*Funktech. Monatshefte*, Jan. 1939, No. 1, pp. 11–21.)

The writer speaks only of "decimetre" and "centimetre" waves, but some results (*e.g.* Fig. 4) are on 440 cm waves: these, on the same system of nomenclature, would be "metre" waves. Among the aerial systems considered (Fig. 6) are the vertical beam arrays (a & b), the "horizontal line" system (c: a horizontal concentric line divided up into half-wavelength units with successive cross-connection of the inner conductors to the succeeding outer conductors), the "Sterba" and "fir-tree" arrays (d & e), the "Chireix-Mesny" saw-tooth array (f, wrongly referred to in the text as d), "partially screened harmonic dipoles" (g & h: Hollmann & Thoma, 3588 of 1938), the "Yagi" array (i, wrongly referred to as g), the "Marconi-Franklin" array (k), and the American "V" aerials (l & m). Quasi-optical beam projectors (paraboloidal reflectors made up of dipoles, metal-sheet reflectors, etc.) are also included.

From the author's summary:—"The possibility exists of constructing beam systems of almost any desired sharpness; but the consequently necessary multiplication of individual radiators and increase of the radiating surfaces bring with them an increase both in the number and the magnitude of the secondary maxima. If, as is usual, the radiation diagrams are measured with the help of detectors or 'Richtröhren' [thermionic detectors ?], curves are obtained which agree perfectly well physically but which give the engineer no information at all on whether the aerial is of any use when the sensitive receiver of actual practice is involved. It is quite possible for an array which gives, say, a desired 'quarter-value' width of $\pm 10°$ when measured at a distance of some 100 m with a detector-l.f. amplifier combination, with perhaps 5 secondary maxima on each side having an amplitude ratio of 1 : 30 or 1 : 40, to be audible 'all round' on a sensitive receiver at 30 km". The deductions from this fact, as they concern the practical investigation of directional characteristics, are discussed.

1891. Calculation of the Radiation Resistance of Some Dipole Aerials [Dipole with Reflector in Free Space: Vertical Dipole over Plane Earth without and with Reflector].—K. Fränz. (*E.N.T.*, Jan. 1939, Vol. 16, No. 1, pp. 24–26.)

The single radiators are considered to have a cosine polar radiation diagram; from this the radiation resistance of a dipole with reflector in free space (Fig. 1) and a vertical dipole above a plane earth (Fig. 3) are deduced. The final formulae obtained (eqns. 3, 4 respectively) contain only elementary functions. Values for the dipole with reflector in free space are compared with those found by Brown (1782 of 1937). Figs. 4a, b show the radiation resistance of a vertical dipole over a plane earth with the image out of phase and in phase respectively. Formulae for a vertical dipole with reflector above a plane earth (eqn. 5) and for a horizontal dipole over a plane earth (eqn. 6) are also given.

1892. Design of "Flat-Shooting" Antenna Arrays [Analysis leading to Conclusion that the Single-Ring J_n Array and the Multiple-Ring J_0 Array (dealt with in Previous Paper) are Superior to Intermediate Types now considered].—W. W. Hansen & L. M. Hollingsworth. (*Proc. Inst. Rad. Eng.*, Feb. 1939, Vol. 27, No. 2, pp. 137–143.) For the previous paper (Hansen & Woodyard) *see* 2309 of 1938.

1893. On the Impedance of Divergent Two-Wire Circuits [as represented particularly by the Rhombic-Type Aerial: the Question of Matching with Parallel-Wire Feeders, and the Calculation of the Terminating Resistance for the Far End].—J. Groszkopf. (*TFT*, Jan. 1939, Vol. 28, No. 1, pp. 8–16.)

1894. High Frequency Transmission-Line Networks [Re-entrant Types, used along Transmitting & Receiving Feeders, for Impedance-Matching, Separation of Frequencies, Filtering of Harmonics, Phase-Control, Division of Power, etc.].—A. Alford. (*Elec. Communication*, Jan. 1939, Vol. 17, No. 3, pp. 301–310.)

1895. WTAM [Cleveland] gets Aluminium Gas-Filled Coaxial Transmission Line.—(*Electronics*, Feb. 1939, Vol. 12, No. 2, p. 66.)

1896. The Twin-Tower Aerial System of the B.B.C. Start Point Station [with Inductance in Gap in Radiator Tower at Two-Thirds Height from Ground].—(*Wireless Engineer*, March 1939, Vol. 16, No. 186, p. 136: photograph & caption only.) "This is expected to provide a better radiator than the capacity-top aerials in use at some other B.B.C. stations."

1897. Masts for Transmitting Stations [Some Typical BBC Stayed Masts].—C. H. Hill. (*World-Radio*, 17th March 1939, Vol. 28, pp. 14–15 and 17.)

1898. Radio Tower Lighting Control [at Seattle: by 3 Photronic Photocells].—F. J. Brott. (*Communications*, Jan. 1939, Vol. 19, No. 1, p. 18.) Has never failed or required adjustment since installation in 1936.

1899. Wind Pressure on Tower Members.—Y. Shichiri & T. Kyuma. (*Electrot. Journ.*, Tokyo, Dec. 1938, Vol. 2, No. 12, pp. 271–275.)

1900. Vibrations of Power Lines in a Steady Wind: V—Resonance of Strings with Strengthened Ends: VI.—R. Ruedy. (*Canadian Journ. of Res.*, Dec. 1938, Vol. 16, No. 12, Sec. A, pp. 215–225: Jan. 1939, Vol. 17, No. 1, Sec. A, pp. 1–13.)

VALVES AND THERMIONICS

1901. Velocity-Modulated Tubes [Theoretical Investigation leading to New Valves for 5 cm–5 m Waves, including R.F. Power Amplifiers giving 50 W at 75 cm with Plate Efficiencies 20–30%].—W. C. Hahn & G. F. Metcalf. (*Proc. Inst. Rad. Eng.*, Feb. 1939, Vol. 27, No. 2, pp. 106–116.)

Simplified method of analysis of operation of valves at u.h.f: separation of effects of electron velocity, conduction current, and induced current: design of grid structure to vary velocity of stream: conversion of this velocity modulation into conduction-current (charge-density) modulation — deflection (unsatisfactory), "drift-tube," and retarding-field methods: experimental valves using second and third methods, for super-regenerative and superheterodyne reception, r.f. amplification and generation.

1902. The "Klystron" Generator for Micro-Waves, *and* An Ultra-High-Frequency Power Amplifier of Novel Design.—Varian, Hansen: Haeff. (*See* 1848 & 1849.)

1903. High-Efficiency Sentron [Number of Split Anodes Increased: Guard Rings to keep Thermal Electrons away from Short-Circuited End of Split Anodes: Output taken from Guard-Ring Circuit, utilising the Capacity Coupling].—Uda, Isida, & Shoji [Sioji]. (*Electrot. Journ.*, Tokyo, Dec. 1938, Vol. 2, No. 12, p. 291.) *Cf.* 990 & 991 of March.

1904. Radiation-Cooled Magnetron [4-Split-Anode, Type LD-54-G, with "Molybden-Block Anodes with Rough Surface, the Parallel Lead Wires being Short-Circuited within the Tube": Efficiencies 50% or over down to 32.5 cm, with Anode Overloaded].—Kobayashi, Uchida [Utida], Harashima. (*Nippon Elec. Comm. Eng.*, Feb. 1939, No. 15, pp. 537–539: *Electrot. Journ.*, Tokyo, Dec. 1938, Vol. 2, No. 12, p. 290.) *See* also 1460 of April.

1905. Correction to Diagram in "Sectionalised Magnetron."—K. Owaki & T. Suzuki. (*Electrot. Journ.*, Tokyo, Dec. 1938, Vol. 2, No. 12, p. 289.) *See* 989 of March.

1906. Cathode Overheating [due to Bombardment] in the Magnetic-Field Valve.—F. Hülster. (*Telefunken-Röhre*, Dec. 1938, No. 14, pp. 217–236.)

I. Overheating and the various attempts to explain it in the literature. II. Experimental investigation. Author's summary:—"The overheating phenomena found in magnetic-field valves in an oscillating condition can be reproduced in the non-oscillating condition by suitable adjustment of the gas pressure, when the cause is purely an effect of ions. Hence in the case of oscillations, particularly of a low order [*e.g.* the first-order oscillations of the two-slit magnetron: with the second-order oscillations of the four-slit valve the overheating danger is considerably smaller (*see* § IIIa)], ionisation is to be regarded as the main cause of overheating.

"In spite of a high vacuum (measurements were taken at pressures down to $p = 10^{-6}$ Torr [1 Torr = 1 mm Hg]) enough ionisation can occur as a result of the strong electron 'ring' current [a hypothetical current equivalent in its ionising action to the actual electron current flowing along the "quadruple-rosette" path—*see* pp. 230–231]. The formula for this is $I_r = 3.15 \times 10^{-6} l_a \times U_a^{3/2}/r_a$ ampere [for a voltage of 2000 v and an anode radius of 2 mm, I_r may amount to 1.1 ampere], and the impulse changes in the electrons produced by the ionising collisions enable them [to leave the rotating electron-cloud and] to land on the anode. The anode current shows the same variation with the working variables as does the electron 'ring' current, provided the increased emission from the cathode makes this possible (this is always the case with sufficiently thin cathodes and not too small an initial emission). The anode current varies less than linearly with the gas pressure. The maximum overheating occurs for a slight increase of B over B_{crit}; that is, in the region most used for low-order oscillations. Above an anode voltage which is approximately proportional to $\sqrt{r_a}$, the oscillation process becomes unstable owing to an avalanche-like mounting-up of anode current. Increasing the angle between magnetic field and cathode-axis causes a rise in anode current and favours the entrance of instability." The writer points out (p. 229) that his results do not imply that in the oscillating condition other factors besides ionisation may not cause additional overheating: in particular, Awender's measurements (3517 of 1938) seem to indicate overheating from bombardment by electrons accelerated in the field, since in some of his tests the magnetic field was several times greater than the critical value. For Vigdorchik's work on the subject *see* 923 of 1937.

1907. The Production of Large Ionic Currents in Gaseous Discharge Magnetrons ["Gasomagnetrons"], *and* the Theory of the Ion Current in a Magnetron used as a Source of Ions.—Vigdorchik: Sitnikov. (*See* 2084 & 2085.)

1908. On the Theory of the Operation of a Parallel-Plane Diode at High Frequencies.—G. A. Grünberg [Grinberg]. (*Journ. of Tech. Phys.* [in Russian], No. 12, Vol. 8, 1938, pp. 1137–1154.)

For previous work, on cylindrical diodes, *see* 4357 of 1938. A mathematical investigation is presented of non-linear effects occurring in a circuit with either distributed or lumped constants and containing a parallel-plane diode, when an e.m.f. of the form $E_0(1 + \epsilon \sin \omega t)$ is applied to the circuit (ϵ is assumed to be sufficiently small). A general solution determining the operating conditions of the circuit is found by expanding ϕ_a (the voltage across the diode) into a series of powers of ϵ. On the basis of the theory so developed, the operating conditions are determined for the cases: (a) when ϕ_a is applied directly to the diode, and (b) when ϕ_a is applied to a circuit consisting of an inductance, a resistance, and a diode, connected in series (Fig. 1). A table is appended giving values of auxiliary functions used in this investigation.

1909. HIGH-FREQUENCY, MIXING, AND DETECTING STAGES OF TELEVISION RECEIVERS [and the Philips 4696 (Modified) Secondary-Emission-Cathode Pentode, Special Diode MD4, etc.].—M. J. O. Strutt. (*Wireless Engineer*, April 1939, Vol. 16, No. 187, pp. 174–187.)
A Zurich Conference paper.

1910. NEW TELEVISION - AMPLIFIER RECEIVING TUBES [Types 1851, 1852 & 1853].—A. P. Kauzmann. (*RCA Review*, Jan. 1939, Vol. 3, No. 3, pp. 271–289.)
The first two types have given gains per stage, with practical circuits, of 3.5–7.0 at 50 Mc/s and of 20–45 at 11 Mc/s. Corresponding figures for the third type are 2–4 and 6.5–13.

1911. NEW ULTRA-HIGH-FREQUENCY PENTODE [developed in Tungsram Laboratories, Hungary: Three Cathode Leads (One for Earthing) to reduce Common Coupling and increase Input Impedance].—I. Zakariás. (*Wireless World*, 16th March 1939, Vol. 44, p. 246.)
A 3-stage amplifier is shown giving an amplification of about 50 000 at 40 Mc/s.

1912. TUNGSRAM EF8 INDIRECTLY HEATED LOW-NOISE SCREENED R.F. AMPLIFIER HEXODE, AND EF9 VARIABLE-MU I.F. OR A.F. AMPLIFIER PENTODE.—Tungsram Company. (*Journ. Scient. Instr.*, March 1939, Vol. 16, No. 3, pp. 95–96.)

1913. NOISE OF FREQUENCY-CHANGER VALVES [Disagreement with Bell's Acoustic Analogy and His Statement that "Signal-Frequency Spectrum does Not Exist at Any Point where It can be Heterodyned by Local Oscillator": Defence of Writers' Explanation].—Lukács, Preisach, & Szepesi: Bell. (*Wireless Engineer*, March 1939, Vol. 16, No. 186, pp. 135–136.) Continuation of argument dealt with in 1478 of April.

1914. "SPONTANEOUS FLUCTUATIONS OF VOLTAGE DUE TO BROWNIAN MOTIONS OF ELECTRICITY, SHOT EFFECT, AND KINDRED PHENOMENA" [Book Review].—E. B. Moullin. (*Electrician*, 24th Feb. 1939, Vol. 122, p. 252.)

1915. HIGH-POWER TRANSMITTING VALVES [Considerations in the Design of Their Filaments, Electrodes, Seals: Testing: Cooling Systems: etc.].—H. S. Walker & J. Tomlinson. (*World-Radio*, 10th, 17th & 24th February, 3rd & 10th March 1939, Vol. 28, pp. 16–17, etc.)

1916. ON DIFFERENCES AND PARALLELS IN RECEIVING- AND TRANSMITTING-VALVE TECHNIQUE.—K. Steimel. (*Telefunken-Röhre*, Dec. 1938, No. 14, pp. 159–163.)
Introduction to the two papers dealt with below: in future the journal will pay more attention to transmitting valves than in the past.

1917. THE VALVES IN A TRANSMITTER: PART I.—H. H. Plisch. (*Telefunken-Röhre*, Dec. 1938, No. 14, pp. 164–189.)
Theory, in classical form, of the amplifier valve in a transmitter. I: Current modulation: (a) linear characteristic-field, (b) linear field, the anode current limited by saturation, (c) linear field, over-voltaged condition [with too loose an aerial coupling, the anode current falls more than the anode alternating voltage rises], (d) i_a follows the space-charge law. II: Calculation of the current-flow angle θ_1, etc. III: Voltage utilisation ("Ausnutzung": ratio of peak value of anode alternating voltage to anode direct voltage) and efficiency. IV: The optimum working-point of the Class C amplifier. V: The max. useful output for a given anode direct voltage. VI: The max. useful output for a given anode voltage and modulation without grid current (*e.g.* grid-voltage modulation, or low-grid-current modulation in the linear first stages of large multi-stage transmitters).

1918. ON THE THEORY OF THE TRANSMITTING AMPLIFIER [Treatment based on the Anode-Current/Anode-Voltage Diagram, instead of the More Usual Anode-Current/Grid-Voltage Diagram, thus dispensing with Introduction of S, μ, and R_i].—H. Rothe. (*Telefunken-Röhre*, Dec. 1938, No. 14, pp. 190–216.) For previous use of this method *see* Babits (2791 of 1938) and Kósa (870 of 1938).

1919. THE RCA-1609 [Low Microphonic Pentode] AS A TRIODE [*e.g.* for Portable Amplifiers].—W. E. Stewart. (*Communications*, Jan. 1939, Vol. 19, No. 1, p. 19.)

1920. "LES TUBES À VIDE ET LEURS APPLICATIONS" [Vol. III—Oscillators and Retroactive Circuits: Book Review].—H. Barkhausen. (*Electrician*, 6th Jan. 1939, Vol. 122, p. 21.) For previous volumes *see* 999 of 1938, and for Vol. IV of the original German edition *see* 2347 of 1938.

1921. "GASEOUS ELECTRICAL CONDUCTORS" [Book Review].—E. L. E. Wheatcroft. (*Engineering*, 3rd March 1939, Vol. 147, p. 257.)

1922. THERMIONIC VALVES AS MEASURING INSTRUMENTS [Principles of Valves for measuring A.C. Voltages, Voltmeters and Electrometers for Direct Voltages: Measurement of Very Small Values of Current and Power].—E. G. James, G. R. Polgreen, & G. W. Warren. (*Nature*, 28th Jan. 1939, Vol. 143, p. 154: *Electrician*, 13th Jan. 1939, Vol. 122, p. 36: summaries of a recent I.E.E. paper.)

1923. BRIDGE-TYPE SET FOR MEASURING VACUUM-TUBE PARAMETERS.—J. R. Pernice. (*Communications*, Jan. 1939, Vol. 19, No. 1, pp. 11–13 and 27..35.)

1924. ON THE MEASUREMENT OF SECONDARY EMISSION IN VALVES.—A. Pinciroli: Treloar. (*Wireless Engineer*, March 1939, Vol. 16, No. 186, pp. 133–135.) Prompted by Treloar's paper (660 of February). The writer describes his own method (3046 of 1935), not quoted by Treloar.

1925. Secondary Electron Emission from Oxide-Coated Cathodes [of Thermoelectronic Type, (Ni)-BaO, Ba-Ba: General Character: Energy Distribution: Influence of Temperature].—N. Morgulis & A. Nagorsky. (*Tech. Phys. of USSR*, No. 11, Vol. 5, 1938, pp. 848–863: in English.) With 29 literature references.

1926. The Secondary Emission of Electrons [from Metal Targets] due to Protons [Results].—Allen. (*Phys. Review*, 15th Jan. 1939, Series 2, Vol. 55, No. 2, p. 236: abstract only.)

1927. The Secondary Emission of Beryllium.—R. Warnecke & M. Lortie. (*Comptes Rendus*, 6th Feb. 1939, Vol. 208, No. 6, pp. 429–432.)

1928. The Oxide-Coated Filament: the Relation between Thermionic Emission and the Content of Free Alkaline-Earth Metal.—C. H. Prescott, Jr. & J. Morrison. (*Bell S. Tech. Journ.*, Jan. 1939, Vol. 18, No. 1, pp. 248–249: summary only: *Bell Tel. S. Tech. Pub.*, Monograph B–1117, 16 pp.)

1929. Calculation of the Temperature of Incandescent Filaments [Integration of Non-Linear Differential Equation to give Connection between Heating Current and Temperature Increase, Geometrical Dimensions, Physical Constants of Non-Linear Conductor: Numerical Examples: Fall of Temperature when Cooling not Exponential].—J. Fischer. (*Arch. f. Elektrot.*, 16th Jan. 1939, Vol. 33, No. 1, pp. 48–53.)

DIRECTIONAL WIRELESS

1930. Government Man patents Automatic Landing System.—F. W. Dunmore. (*Sci. News Letter*, 3rd Dec. 1938, Vol. 34, No. 23, p. 361: short note.)

1931. A Terrain Clearance Indicator [Radio Altimeter using Frequency-Modulated 450 Mc/s Waves].—L. Espenschied & R. C. Newhouse. (*Bell S. Tech. Journ.*, Jan. 1939, Vol. 18, No. 1, pp. 222–234.) The device referred to in 1491 of April.

1932. Automatic Radiogoniometers [with Continuously Rotating Frame Aerial]: Method of Measuring the Time Constants of Oscillating Circuits [Importance of First Derivative of Curve of Phase Displacements as Function of Frequency: Proportionality of This Derivative to Time Constant of Dephasing Circuit measured at Resonance: etc.].—J. Marique. (*Wireless Engineer*, March 1939, Vol. 16, No. 186, pp. 121–124.)

1933. The Calibration of Four-Aerial Adcock Direction Finders.—W. Ross. (*Electrician*, 3rd March 1939, Vol. 122, p. 275: summary only.) In a paragraph on an I.E.E. Symposium.

1934. 500/135 Watt Tone-Modulated Radio Beacon, Type HB.1.—(*Elec. Communication*, Jan. 1939, Vol. 17, No. 3, pp. 314–315.)

1935. Radio Fog Signals at Sea [Miniature Transmitter sealed into Buoy: Experimental Trial in Boston Harbour].—(*World-Radio*, 17th March 1939, Vol. 28, p. 5.)

ACOUSTICS AND AUDIO-FREQUENCIES

1936. Sound Pictures in Auditory Perspective [Bell Tel. Laboratories' Experiments: Striking Improvement of Feeling of Spaciousness & Reality].—F. L. Hunt. (*Bell S. Tech. Journ.*, Jan. 1939, Vol. 18, No. 1, p. 247: summary only.)

1937. The Indicial Acoustical Resistance of a Piston Diaphragm.—A. A. Kharkevitch. (*Journ. of Tech. Phys.* [in Russian], No. 16, Vol. 8, 1938, pp. 1468–1477.)

A new method is proposed for calculating the indicial acoustic resistance of a circular piston diaphragm provided with an infinitely large baffle. The method proposed does not presuppose any knowledge of the frequency characteristics of the system under investigation, and is based on the summation of the fields produced by elements dS of the radiating surface. The various stages of the calculating process are discussed, and a function (11) is derived representing the required resistance (a graph of the function is shown in Fig. 4). The accuracy of the method is checked by deriving from function (11) the frequency characteristics of the diaphragm, and comparing the results obtained with the well known formulae.

1938. On the Equivalent Values of Distributed Constants.—A. A. Kharkevitch. (*Journ. of Tech. Phys.* [in Russian], No. 13/14, Vol. 8, 1938, pp. 1283–1296.)

Methods are discussed for reducing systems with distributed constants to equivalent systems with lumped constants. The discussion is applied to the following examples: (a) a string, (b) a rod fixed at one end, (c) a circular diaphragm stretched radially, and (d) a circular plate fixed round the circumference.

1939. Method of Measurement of the Elastic Constants and the Phase Velocities of Transverse and Longitudinal Waves [Dynamic Method: Measurement of Natural Frequencies of Radial and Torsional Oscillations of Circular Plates].—F. Khol. (*Zeitschr. f. Phys.*, No. 7/8, Vol. 111, 1939, pp. 450–453.) For previous work *see* 1996 of 1938.

1940. Relaxation Methods applied to Engineering Problems: IV—Problems relating to Elastic Stability and Vibrations [Transverse Vibration of Straight Rod of Non-Uniform Mass and Flexural Rigidity].—K. N. E. Bradfield, D. G. Christopherson, & R. V. Southwell. (*Proc. Roy. Soc.*, Series A, 7th Feb. 1939, Vol. 169, No. 938, pp. 289–317.)

1941. Design for Exponential Horns of Square Cross Section.—G. H. Logan. (*Electronics*, Feb. 1939, Vol. 12, No. 2, p. 33.)

1942. DIRECTIVITY OF SOUND SOURCE BY IMPULSIVE WAVES: II [Some Results].—S. Chiba & S. Morita. (*Electrot. Journ.*, Tokyo, Nov. 1938, Vol. 2, No. 11, p. 268.) For I *see* 3660 of 1938.

1943. ELASTIC DEFORMATIONS IN ROCHELLE SALT. —Hinz. (*See* 2043.)

1944. EQUIVALENT NETWORK FOR THE IDEALISED RESISTANCE MICROPHONE.—Peterson & Hussey. (In paper dealt with in 1864, above.)

1945. A NEW UNDIRECTIONAL MICROPHONE [Shure Model 730A "Uniplex" Microphone, with Phase-Shifting Acoustical Networks coupled to Diaphragm-Type Crystal Element].—B. Baumzweiger. (*Electronics*, Feb. 1939, Vol. 12, No. 2, pp. 62 and 78.)

1946. RECORDING DISCS [and the Successful Development of Cellulose-Lacquer Discs].—E. Lindström. (*Ericsson Review*, No. 3, 1938, pp. 128–132.)

1947. AN OSCILLOSCOPE AS A "WOW" DETECTOR [for detecting Periodic Turntable-Speed Variation].—Travis. (*Electronics*, Feb. 1939, Vol. 12, No. 2, pp. 40 and 42.)

1948. B.B.C. RECORDING SERVICE—SIX YEARS OF DEVELOPMENT: THREE METHODS USED—STEEL TAPE, DISC, AND FILM.—(*Electrician*, 10th March 1939, Vol. 122, pp. 303–304.)

1949. ELECTRICAL MUSIC: SIR JAMES JEANS ON AN INDUSTRY WITH GREAT POSSIBILITIES.—Jeans. (*Electrician*, 3rd March 1939, Vol. 122, p. 283: summary of address.)

1950. THE NOVACHORD, A NEW ELECTRIC MUSICAL INSTRUMENT [72-Note Keyboard: Tone-Colour and "Envelope" both Variable].—L. Hammond. (*Science*, 10th Feb. 1939, Vol. 89, Supp. pp. 6–7.)

1951. ON A METHOD FOR OBTAINING FREQUENCY CHARACTERISTICS [of Musical Instruments with Sounding Boards].—A. V. Rimski-Korsakov & N. D. Shumova. (*Journ. of Tech. Phys.* [in Russian], No. 16, Vol. 8, 1938, pp. 1478–1485.)

The method is based on applying a complex periodic force to the instrument and observing the amplitudes of the sinusoidal components of the radiated field. The theory of the method is discussed and a report is given on experiments with a violin which was excited by a small steel ball striking the bridge supporting the strings. The ball was mounted on a spindle attached to the armature of a special electric bell. The radiated field was measured by a Siemens & Halske sound-pressure set connected either to a meter giving readings in bars or to a frequency analyser for the automatic recording of the frequency band.

1952. JETS MUSICALLY INCLINED.—G. B. Brown. (*Sci. Progress*, July 1938, Vol. 33, No. 129, pp. 29–51.)

1953. THE CORRECT MODE OF ACTION OF THE "DYNAMIC REGULATOR" [Automatic Contrast Expander].—R. Hildebrandt. (*Funktech. Monatshefte*, Jan. 1939, No. 1, pp. 25–29.)

The writer remarks in conclusion that many people must wonder why so much literature is published about contrast expansion and yet no apparatus on the market (with two exceptions at this year's Berlin Exhibition) is fitted with such a device. This may be due to the fact that the contrast limitation necessary at the broadcasting transmitter is not enough to make the ear (which has only a very poor sensitivity for differences in volume occurring at long time intervals) notice the reduced contrast. In gramophone reproduction the more drastic compression is often objectionable: but the ordinary commercial disc will not stand a greater volume expansion than a broadcast programme, since the accompanying rise and fall of needle scratch distracts the listener's attention. Further, the expander has always to be disconnected for speech. Nevertheless, the enjoyment of music can be increased by the expansion of contrast to a point beyond the actual performance, particularly for singers and pianists.

1954. WESTERN ELECTRIC PROGRAMME AMPLIFIER TYPE 110 A [embodying Automatic Level Control and producing Increase of Zone of Good Reception "corresponding to a Doubling of the Carrier Power"].—(*Bull. Assoc. suisse des Élec.*, No. 3, Vol. 30, 1939, pp. 82–83.)

1955. DEVICES FOR CONTROLLING THE AMPLITUDE CHARACTERISTICS OF TELEPHONIC SIGNALS [Vogad, Volume Limiter, Compandor, Peak Chopper, etc.].—A. C. Norwine. (*Elec. Engineering*, Feb. 1939, Vol. 58, No. 2, Transactions pp. 62–67.)

1956. AUDIO-FREQUENCY LEVEL INDICATORS [Considerations in Design: C.C.I.T. Specifications: Advantages of Negative Feedback: Testing the Ballistic Characteristics of Needle Indicating Meters: Some Suitable Valve Rectifier Circuits for Impulse and Volume Indicators].—G. Builder & J. E. Bailey. (*A.W.A. Tech. Review*, Oct. 1938, Vol. 3, No. 6, pp. 321–339.)

1957. A NEW "VI" [Volume Indicator] AND REFERENCE LEVEL [both agreed as Standard by Bell Tel. Laboratories, CBS, and NBC].—(*Electronics*, Feb. 1939, Vol. 12, No. 2, pp. 28–29.)

1958. TRANSMISSION TESTING APPARATUS FOR 30–10 000 c/s COMMUNICATION SYSTEMS.—R. E. Herrick & H. Melling. (*Elec. Communication*, Jan. 1939, Vol. 17, No. 3, pp. 239–255.)

1959. AUDIO-FREQUENCY OSCILLATORS [particularly for testing Lines for Simultaneous & Outside Broadcasts].—O. H. Barron. (*World-Radio*, 24th March 1939, Vol. 28, pp. 14–15 and 16.)

1960. Calculation and Construction of Note-Adjusting Condensers for Beat-Note Generators [to give Linear Calibration Curves].—G. Nüsslein. (*Funktech. Monatshefte*, Jan. 1939, No. 1, pp. 4–7.)

1961. A Low-Frequency Alternator [Variable-Condenser Device giving Sinusoidal Waves from Zero Frequency to about 50 c/s: to avoid Poor Wave Form usually given by Valve Oscillators at Such Frequencies].—E. B. Kurtz & M. J. Larsen. (*Proc. Inst. Rad. Eng.*, Feb. 1939, Vol. 27, No. 2, pp. 148–150.)

1962. Rayleigh Disc of Resonance Type [Construction & Theory: Advantages—No Disturbance by Air Flow or Outside Noise, etc: Sensitivity (for Intermittent-Wave-Form Modulation) 44 Times that of Static Type].—M. Kobayashi & T. Hayashi. (*Electrot. Journ.*, Tokyo, Dec. 1938, Vol. 2, No. 12, pp. 277–280.)

1963. Some Properties of the Resonance Disc and Its Application [including Use as Frequency Analyser (Wave-Form Analyser)].—M. Kobayashi & T. Hayashi. (*Elektrot. Journ.*, Tokyo, Jan. 1939, Vol. 3, No. 1, pp. 16–18.)

1964. Experimental Consideration on Sound-Intensity Measuring Set of Hot-Wire Type with Thermocouple [Easier & More Sensitive than Usual Resistance-Measuring Method].—M. Kobayashi & T. Hayashi. (*Electrot. Journ.*, Tokyo, Dec. 1938, Vol. 2, No. 12, pp. 284–286.)

1965. Apparatus for the [Rapid] Comparison of the Frequencies of Two Tuning Forks.—A. Bolle. (*La Ricerca Scient.*, 15th/31st Dec. 1939, Series 2, 9th Year, Vol. 2, No. 11/12, pp. 697–702.)

1966. More on Combination Tones: "Table for Power Series Calculations involving Independent Variables of Two Harmonic Components."—McFarland: Massa. (*Electronics*, Feb. 1939, Vol. 12, No. 2, p. 61.) Leading from Massa's article (209 of January).

1967. Noise and Noise Measurement: Bibliography on Physiological Effects, Application of Electrical Instruments to Study of Noise, and Methods of Correcting Undesirable Noise Conditions.—D. Silverman. (*Electronics*, Feb. 1939, Vol. 12, No. 2, p. 34.)

1968. A Method for measuring Sound Relaxation Coefficients [Sound Attenuation in Insulating Materials].—V. P. Kelberg. (*Journ. of Tech. Phys.* [in Russian], No. 16, Vol. 8, 1938, pp. 1486–1490.)

It is pointed out that since laboratory measurements of the sound-insulating properties of various materials are carried out under artificial conditions, the results so obtained are not very satisfactory. It is therefore suggested that all variable factors should be eliminated from these measurements and that transmission of sound by longitudinal oscillations, which depends only on the physical properties and mass of the material and on the frequency applied, should be used as a criterion of the insulation quality of this material. Accordingly, a method was developed for carrying out these measurements without transverse oscillations appearing in the sample under investigation. The method is described and results obtained with a number of different materials are shown in a table.

1969. Broadcast Studio Audio-Frequency Systems Design.—H. A. Chinn. (*Proc. Inst. Rad. Eng.*, Feb. 1939, Vol. 27, No. 2, pp. 83–87.) It is suggested that the term "audio-frequency facilities" employed in this paper is more truly descriptive than the usual "speech input equipment."

1970. The Acoustical Design of Broadcasting Studios: V [Some Recent Experiments on Combined Use of Resonant & Non-Resonant Absorbing Materials].—J. McLaren. (*World-Radio*, 20th Jan. 1939, Vol. 28, pp. 14–15.)

1971. Aphonic Room of the General Electric Research Laboratory [primarily for Study of Noise in Apparatus involving Flow of Air].—K. D. McMahan. (*Gen. Elec. Review*, Dec. 1938, Vol. 41, No. 12, pp. 523–528.)

1972. "La Pratique acoustique et électro-acoustique: Tome I" [Book Review].—P. Hémardinquer. (*Rev. Gén. de l'Élec.*, 28th Jan. 1939, Vol. 45, No. 4, p. 98.)

1973. The Velocity of Sound [in Air: Improved Measurements by Oscillographic Method: Results for Various Frequencies: Corrected Value for Zero Centigrade Temperature].—R. C. Colwell, A. W. Friend, & D. A. McGraw. (*Journ. Franklin Inst.*, Feb. 1939, Vol. 227, No. 2, pp. 251–255.) For previous work *see* 3264 of 1938.

1974. Thermal Conditions in Sound Waves [Supersonic Waves in Liquid Helium—Adiabatic or Isothermal ?].—H. J. Groenewold. (*Physica*, March 1939, Vol. 6, No. 3, pp. 303–312: in English.)

1975. Applications of Supersonic Waves [in Metallurgy].—(*Metallurgist* [Supp. to *Engineer*], 30th Dec. 1938, pp. 177–179.)

PHOTOTELEGRAPHY AND TELEVISION

1976. On the Problem of Stereoscopic Television: the Effect of the Decrease in Detail, for Stereoscopic Images transmitted by the Same Frequency Band, as a Function of the Total Number of Elements and of the Character of the Subject [Results suggest Desirability of Actual Short Broadcast Test Programmes].—M. von Ardenne. (*T.F.T.*, Jan. 1939, Vol. 28, No. 1, pp. 26–27.) Application of the theoretical and experimental treatment used in the writer's paper on colour television (4443 of 1938) to the stereoscopic problem. Prints of the experimental results are not reproduced, but specially interested readers can obtain copies from the publisher at cost price.

1977. Stereoscopic Television: a Suggestion.—W. Gartland. (*World-Radio*, 17th March 1939, Vol. 28, p. 8.)

1978. Television Transmission over Lines.—K. Küpfmüller & H. F. Mayer. (*Bull. Assoc. suisse des Élec.*, No. 3, Vol. 30, 1939, pp. 75–76: summary only, in German.) A Zurich Conference paper.

1979. Reviews of Progress: Broadcasting and Television.—N. Ashbridge. (*Journ. I.E.E.*, March 1939, Vol. 84, No. 507, pp. 380–387.)

1980. Present-Day Problems of Television Technique [the German Standards and Their Influence on the Receivers].—A. Gehrts. (*Bull. Assoc. suisse des Élec.*, No. 22, Vol. 29, pp. 622–623: summary only, in German.) A Zurich Conference paper.

1981. The Television Image [Some Problems discussed from Physical, Physiological, & Psychological Viewpoints].—F. Schröter. (*Electronics*, Feb. 1939, Vol. 12, No. 2, pp. 56–57: summary only.)

1982. Television Problems and Their Practical Solution.—F. Schröter. (*A.W.A. Tech. Review*, Oct. 1938, Vol. 3, No. 6, pp. 283–296.) A Sydney World Radio Convention paper.

1983. Development in Large-Screen Television.—L. M. Myers. (*Bull. Assoc. suisse des Élec.*, No. 21, Vol. 29, 1938, p. 596: summary only, in German.) From the Zurich Conference.

1984. The DuMont Television [with Its Actual Transmission of the Entire Scanning Signals].—T. T. Goldsmith, Jr. (*Communications*, Feb. 1939, Vol. 19, No. 2, "Television Engineering" Section, pp. 38–39 and 42..45.)

1985. The Importance of the [Mechau] Picture-Stabilising ["Bildausgleich"] Film Projector as Television Transmitter [for Interlaced Scanning: Two Successive Pictures projected to Same Spot in spite of Continuous Movement of Film].—F. Schröter. (*Bull. Assoc. suisse des Élec.*, No. 21, Vol. 29, 1938, pp. 595–596: summary only, in German.) From the Zurich Conference.

1986. A New Mechanical Scanning System [for Interlaced Scanning of Films, using the Mechau Picture-Stabilising Device: Suitable also for Exploring-Beam Scanning].—W. Amrein. (*Bull. Assoc. suisse des Élec.*, No. 21, Vol. 29, 1938, pp. 596–597: summary only, in German.) From the Zurich Conference.

1987. General Electric Television Licence [10 kW Output 4.5 m Transmitter on 1500 ft Hill at Indian Ladder, Schenectady: 1.4 m Link over 12-Mile Path to Studio].—(*Communications*, Jan. 1939, Vol. 19, No. 1, pp. 21 and 26.)

1988. Television Station W2XAX [Columbia Broadcasting System]: Part II—Studio.—P. C. Goldmark. (*Communications*, Feb. 1939, Vol. 19, No. 2, "Television Engineering" Section, pp. 27 and 30.) For Part I *see* 1589 of April.

1989. Television Economics: Part I.—A. N. Goldsmith. (*Communications*, Feb. 1939, Vol. 19, No. 2, "Television Engineering" Section, pp. 18–20 and 45..47: to be contd.)

1990. National Union Television Laboratory [Free Facilities to Television Receiver Manufacturers].—(*Communications*, Feb. 1939, Vol. 19, No. 2, "Television Engineering" Section, pp. 30 and 42.)

1991. Television Receiver Design Factors.—W. N. Perkins. (*Communications*, Feb. 1939, Vol. 19, No. 2, "Television Engineering" Section, pp. 32 and 34..48.) From the National Union Radio Corporation laboratories.

1992. Construction and Alignment of the Television Receiver.—C. C. Shumard. (*QST*, Jan. 1939, Vol. 23, No. 1, pp. 45–52 and 116, 118.) Continuation of the work referred to in 651 of February.

1993. Television Receivers: R.M.A. Technical Section's Recommendations for Marking of Controls.—(*Electrician*, 23rd Dec. 1938, Vol. 121, p. 749.)

1994. A Television Pick-Up Tube [Combination of Signal Storage by Mosaic, and Signal Amplification by Secondary-Electron Multiplication, by Use of Double-Sided Mosaic to whose One Side the Photoemission from Transparent Photocathode is Accelerated by Oscillating Electric Field: Other Side scanned by Low-Velocity Electron-Beam].—H. A. Finke. (*Proc. Inst. Rad. Eng.*, Feb. 1939, Vol. 27, No. 2, pp. 144–147.)

1995. Storage Television Pick-Up Cameras with Semiconducting Dielectric [to avoid Space-Charge Effects arising with (*e.g.*) Mica-Insulated Mosaics: Use of Glass of Suitable Conductivity: Efficiency 0.5 instead of 0.05: Need for Protection against Over-Illumination: etc.].—H. Salow. (*Funktech. Monatshefte*, Jan. 1939, No. 1, Supp. pp. 1–4.) For previous papers *see* 1065 of March.

1996. A Fixed-Focus Electron Gun for Cathode-Ray Tubes [Focus predetermined by Construction and substantially Independent of Anode Voltage: only One Anode Voltage instead of at least Two: Applicable to Oscillography and Television].—H. Iams. (*Proc. Inst. Rad. Eng.*, Feb. 1939, Vol. 27, No. 2, pp. 103–105.)

1997. Points on the Development of the Television Cathode-Ray Tube.—E. Schwartz. (*Funktech. Monatshefte*, Jan. 1939, No. 1, Supp. pp. 5–6.)

From the Fernseh Company's laboratories. The advantages of magnetic focusing (and its investigation with a special tube containing free fluorescent particles which indicate the course of the beam): completion of the improvement by replacing electrostatic deflection by magnetic: high-power projecting tubes, and the design of fluorescent screens to stand ray energies of 100 w (40 kv), and of 300 w (80 kv) with a conducting base for convection cooling to room temperature and a max. intensity of 540 candles: various suggested substitutes for the fluorescent screen—"relay"-screen principle only advantageous when combined with storage, as in the Scophony supersonic-wave system: etc. For a previous paper *see* 4028 of 1938.

1998. CATHODE-RAY TUBES [History of Development].—O. S. Puckle. (*Wireless World*, 16th & 23rd March 1939, Vol. 44, pp. 242–244 & 275–278.)

1999. AN ELECTROSTATIC-DEFLECTION KINESCOPE UNIT FOR THE TELEVISION RECEIVER [using New 5-Inch Type 1802 Tube].—J. B. Sherman. (*QST*, March 1939, Vol. 23, No. 3, pp. 52–55.)

2000. A NEW HARD-TUBE RELAXATION OSCILLATOR [for Television: using a New Double-Grid Tube: Shorter Retrace Time: Not Critical as to Circuit Constants].—D. H. Black. (*Proc. Inst. Rad. Eng.*, Feb. 1939, Vol. 27, No. 2, p. 156: summary only.)

2001. THE ULTRA-VIOLET DISPERSION FREQUENCIES OF THE ALKALI HYDRIDES [Absorption Spectra for Thin Crystal Films: Agreement with Absorption of Alkali Halides and with Empirical Formula of Hilsch & Pohl].—W. Rauch. (*Zeitschr. f. Phys.*, No. 9/10, Vol. 111, 1939, pp. 650–656.)

2002. THE PRODUCTION OF MICROSTRUCTURAL (FLUORESCENT) SCREENS.—Yu. V. Golbreich. (*Journ. of Tech. Phys.* [in Russian], No. 16, Vol. 8, 1938, pp. 1421–1432.)

A report is presented on the production by the pulverisation method of extremely thin (microstructural) fluorescent screens on cathode-ray tubes. The structure and properties of the screens and methods for testing them are discussed. This is followed by a description of a pulverisator and air-blowing and purifying system developed by the author. The next section deals with suspension of luminiforous particles in various liquids, and a description is given of a sedimentometer developed by the author for determining the distribution function of the particles in the liquid. In the last section the actual spraying of the screen and various factors affecting it are discussed. It is stated that on the basis of this investigation screens were obtained which were approximately 50 times finer than those produced in the U.S.A. for electron televisors (Zworykin system). A number of experimental curves and tables are shown.

2003. THE PRODUCTION OF A THERMALLY STABLE LUSTROUS SILVER LAYER FOR A PHOTO-CATHODE.—Yu. V. Golbreich. (*Journ. of Tech. Phys.* [in Russian], No. 13/14, Vol. 8, 1938, pp. 1229–1234.)

The theory of chemical silvering of glass surfaces is discussed, and various stages of this process are described. The technical requirements for transparent and semi-transparent layers are then considered and a method of silvering (similar to that proposed by Breshir) is described in detail under the following headings: (1) preparation of glass surface; (2) preparation of silvering liquid; (3) silvering, and (4) rinsing of the silver layer, scrubbing and polishing. It is stated that with the method described silver layers can be obtained which will not deteriorate when heated *in vacuo* at temperatures up to 400–450° C.

2004. PHOTO-SENSITIVE TITANIUM DIOXIDE [contaminated with Iron: Preparation].—W. O. Williamson. (*Nature*, 18th Feb. 1939, Vol. 143, p. 279.)

2005. THE PHOTOEFFECT AND SECONDARY EMISSION FROM IODISED POTASSIUM.—N. M. Hopstein & K. S. Puntus. (*Journ. of Tech. Phys.* [in Russian], No. 16, Vol. 8, 1938, pp. 1416–1420.)

An experimental investigation was carried out to determine the effect, on the properties of a potassium layer, of treatment with iodine vapour. A number of experimental curves are shown and a summary is given of the results obtained.

2006. PAPERS ON SECONDARY EMISSION.—Pinciroli & others. (*See* 1924/1927.)

2007. IONISATION AND EXCITATION IN MERCURY VAPOUR PRODUCED BY ELECTRON BOMBARDMENT [Design of Apparatus: Measurement of e/m for Electron: Secondary Emission and Related Effects: Study of Photo-electric Currents produced: Electronic Excitation Function: etc.].—Nottingham. (*Phys. Review*, 15th Jan. 1939, Series 2, Vol. 55, No. 2, pp. 203–219.)

2008. ACTINOELECTRIC EFFECTS IN TARTARIC ACID CRYSTALS.—J. J. Brady & W. H. Moore. (*Phys. Review*, 1st Feb. 1939, Series 2, Vol. 55, No. 3, pp. 308–311.)

2009. "GASEOUS ELECTRICAL CONDUCTORS" [Book Review].—E. L. E. Wheatcroft. (*Engineering*, 3rd March 1939, Vol. 147, p. 257.)

2010. PHOTOCONDUCTIVITY OF METAL FILMS [Effect probably not a Property of Bulk Metal but of Films alone, and related to Their Structure].—T. C. Wilson. (*Phys. Review*, 1st Feb. 1939, Series 2, Vol. 55, No. 3, pp. 316–317.)

2011. BARRIER-LAYER-TYPE PHOTOCELLS [Selenium Layer coated with Extremely Thin Translucent Metal Deposits].—E. M. Wender. (*Journ. Scient. Instr.*, March 1939, Vol. 16, No. 3, pp. 94–95.)

2012. CONVERSION OF VITREOUS AND MONOCLINIC (α) SELENIUM TO THE HEXAGONAL MODIFICATION.—S. R. Das & K. D. Gupta. (*Nature*, 28th Jan. 1939, Vol. 143, p. 165.)

2013. A WAVE RADIATION OCCURRING IN THE TRANSFORMATION OF THE AMORPHOUS METAL MODIFICATION [Wavelength about 2×10^{-6} cm: shown by Photoeffect in Metallic Film or by Point Counter].—J. Kramer. (*Naturwiss.*, 17th Feb. 1939, Vol. 27, No. 7, pp. 108–109.)

2014. THE SUPERSONIC LIGHT-RELAY IN TELEVISION [Survey of the Various Schemes, including the Combination with Two Mirror-Wheels (Becker, Jeffree), the Two-Cell Method (One modulated by Pulses, the Other by Image-Signals: Okolicsanyi) and the Single-Cell, Mirror Wheel, and Oscillating-Mirror Combination ("successfully tried in England"): Cathode-Ray Tubes No Longer the Only Means of High-Quality Reception].—G. Otterbein. (*E.T.Z.*, 9th Feb. 1939, Vol. 60, No. 6, pp. 161–163.) For an editorial by G. W. O. H. see *Wireless Engineer*, April 1939, Vol. 16, No. 187, pp. 167–168.

2015. NOTE ON THE SPECIAL REFLECTIVITY OF RHODIUM.—W. W. Coblentz & R. Stair. (*Journ. of Res. of Nat. Bur. of Stds.*, Jan. 1939, Vol. 22, No. 1, pp. 93–95.)

2016. CARRIER-FREQUENCY WIDE-BAND AMPLIFIER WITH MUTUALLY DETUNED SINGLE CIRCUITS [for Television: Comparison with Resistance-Capacity & Other Amplifiers: Mathematical Analysis].—R. Schienemann. (*T.F.T.*, Jan. 1939, Vol. 28, No. 1, pp. 1–7.)

Among other things, it is shown (eqn. 12) that with such a multi-stage amplifier a suitable detuning and damping of the circuits can allow the same average amplification per stage to be obtained, for the same band width for the whole amplifier, as is obtainable for a single-stage amplifier of the same type; whereas in an amplifier without detuned circuits the amplification per stage decreases with the number of stages, so that for such an amplifier there is an optimum number of stages beyond which it is useless to go either to obtain greater amplification for a given band-width or a wider band-width for a given amplification. For the detuned-circuit amplifier numerical values are given for the design-calculation of amplifiers of up to 10 stages. It is mentioned, finally, that very favourable transit-time conditions can be obtained with these amplifiers for most television purposes.

2017. ANALYSIS AND DESIGN OF VIDEO AMPLIFIERS: PART II [Obtaining the Compromise between Constant Time Delay and Constant Gain over the Wide Frequency Band: Separate Consideration of High-Frequency and Low-Frequency Parts of Band].—S. W. Seeley & C. N. Kimball. (*RCA Review*, Jan. 1939, Vol. 3, No. 3, pp. 290–308.) For Part I *see* 601 of 1938.

2018. A HIGH-GAIN, WIDE-BAND, LABORATORY AMPLIFIER [Flat within 3 db from 25 c/s to 2 Mc/s: for Television Research, etc.].—F. A. Everest. (*Electronics*, Feb. 1939, Vol. 12, No. 2, pp. 16–18.) For gain adjustment, satisfactory voltage division is obtained by using a resistance divider and a capacitance divider in parallel. For previous papers, more theoretical, *see* 2895 of 1938. *See* also 4472 of 1938.

2019. LOW-FREQUENCY DISTORTION INTRODUCED BY AMPLIFIERS IN TELEVISION APPARATUS.—O. B. Lurie [Lurje]. (*Journ. of Tech. Phys.* [in Russian], No. 17, Vol. 8, 1938, pp. 1562–1575.)

The operation is discussed of a multi-stage wide-band amplifier using decoupling resistances and condensers for l.f. compensation, and separate consideration is given to distortion introduced by this amplifier (a) during the transmission of transient images and (b) when conditions have become stabilised. One of the conclusions reached is that if the amplifier does not pass the d.c. component it is not advisable to transmit frequencies lower than the frame frequency.

Methods are also indicated for designing the l.f. part of the amplifier, and it is suggested that to minimise the l.f. distortion the decoupling resistance should be approximately equal to the anode resistance.

2020. HIGH-FREQUENCY, MIXING, AND DETECTING STAGES OF TELEVISION RECEIVERS.—Strutt. (*See* 1909.)

2021. THE APPLICATION OF POLYCASCADE SECONDARY-ELECTRON MULTIPLIERS TO THE MEASUREMENT OF LOW-INTENSITY LIGHT.—A. Dobrolubskij. (*Journ. of Tech. Phys.* [in Russian], No. 12, Vol. 8, 1938, pp. 1130–1136.)

2022. NEW TELEVISION - AMPLIFIER RECEIVING TUBES.—Kauzmann. (*See* 1910.)

2023. AMPLIFIER TESTING BY MEANS OF SQUARE WAVES [Successful Use in Laboratory Adjustment and Production Testing of Oscillograph and Video Amplifiers: Use of Symmetrical and Asymmetrical Square Waves].—G. Swift. (*Communications*, Feb. 1939, Vol. 19, No. 2, "Television Engineering" Section, pp. 22–24 and 26, 52.)

2024. FACSIMILE DEMONSTRATION [Chicago/New York: using Dry Recording Paper (Carbon-Bearing) "as Sensitive to Electricity as Photographic Paper is to Light," giving Positive Prints usable for Reproduction].—Western Union. (*Communications*, Jan. 1939, Vol. 19, No. 1, pp. 18 and 20.)

2025. THE "READO" FACSIMILE PRINTER [for Use with Almost Any Radio Receiver giving 5 Watts].—Crosley Corporation. (*Communications*, Jan. 1939, Vol. 19, No. 1 pp. 26 and 27.)

MEASUREMENTS AND STANDARDS

2026. THERMOCOUPLE METERS [Avoidance of Errors due to Ambient Temperature Variations by Goodwin's Thermal Compensation: Special Ultra-High-Frequency Design with Extremely Thin-Walled Tubular Heater (System will be applied to Nearly All Instruments, eliminating Usual Error Curves): "Expanded Curve" Meters: etc.].—J. B. Epperson. (*Communications*, Jan. 1939, Vol. 19, No. 1, pp. 15–17 and 25.) Based largely on Weston Company material.

2027. THE PRINCIPLES OF THE THEORY OF A THERMOELEMENT.—V. Kovalenko. (*Journ. of Tech. Phys.* [in Russian], No. 15, Vol. 8, 1938, pp. 1311–1325.) For an English version *see* 1627 of April.

2028. MEASUREMENT OF CURRENT AT HIGH [and Ultra-High] FREQUENCIES.—K. Tani & N. Taharakuti. (*Electrot. Journ.*, Tokyo, Dec. 1938, Vol. 2, No. 12, pp. 275–276.) The full paper was dealt with in 4501 of 1938.

2029. THE DESIGN AND CONSTRUCTION OF A SHORT-WAVE FIELD-STRENGTH MEASURING SET [actually for 7–11 m Waves, Field Strengths down to Order of Microvolts/Metre: Thermal Agitation as Standard Signal for setting Amplifier to Known Gain].—F. M. Colebrook & A. C. Gordon-Smith. (*Journ. I.E.E.*, March 1939, Vol. 84, No. 507, pp. 388–398.)

Appendices deal with the transfer vector admittance in loosely-coupled and "over-coupled" systems; the determination of resistances and coupling factors for loosely-coupled tuned circuits; and single-phase & biphase diode frequency-conversion.

2030. A FIELD-STRENGTH MEASURING SET FOR ULTRA-SHORT WAVES: CORRECTION TO ABSTRACT.—V. B. Binshtok.

In Abstract 667 of February the circuit of Binshtok's set was wrongly described: there are two stages of amplification on the first intermediate frequency, followed by a second frequency-changing stage, two stages of amplification on the second intermediate frequency, and an output stage.

2031. A NEW MEASURING SET FOR TRANSIENT PHENOMENA [Phenomena first recorded on Magnetic Sound Recorder, then measured on C-R Oscillograph with Time Axis controlled by Rotation of Sound Recorder].—Okuno, Tsuda, & Kagiwada. (*Electrot. Journ.*, Tokyo, Dec. 1938, Vol. 2, No. 12, p. 292.)

2032. AMPLIFIER TESTING BY MEANS OF SQUARE WAVES.—Swift. (*See* 2023.)

2033. A METHOD OF MEASURING THE TIME CONSTANTS OF OSCILLATING CIRCUITS.—Marique. (*See* 1932.)

2034. AN IMPROVED SUBSTITUTION METHOD FOR MEASURING SMALL ANGLES OF DIELECTRIC LOSS.—K. A. Vodop'yanov & V. F. Ivlev. (*Journ. of Tech. Phys.* [in Russian], No. 17, Vol. 8, 1938, pp. 1521–1526.)

The substitution method proposed in 1910 by Lindemann (Fig. 1) is discussed and an account is given of various improvements effected in this method, resulting in the development of the circuit shown in Fig. 4. This circuit is suitable for measuring loss angles (in solid dielectrics) down to 10^{-5} radian on wavelengths from 5 to 100 m with an accuracy of 30%. The main improvements are: (1) Only one part of the original circuit is used (instead of two symmetrical parts); (2) the tuning condenser C is dispensed with and resonance obtained by varying the frequency of the oscillator; and (3) a special condenser (Fig. 5), in which the distance between the two parallel plates can be varied by means of a micrometric screw, is used for (a) holding the dielectric sample and (b) measuring the capacity of the sample. A table is added showing the results of measurements on a number of crystals.

2035. THE INFLUENCE OF DISTORTIONS DUE TO NON-LINEAR RECTIFICATION ON THE MEASUREMENT OF DIELECTRIC CONSTANTS BY THE BEAT METHOD [Theory].—S. R. Khastgir & K. Sirajuddin. (*Zeitschr. f. Phys.*, No. 7/8, Vol. 111, 1939, pp. 475–476.)

2036. IMPROVED LOW-VOLTAGE A.C. BRIDGES FOR MEASURING PROPERTIES OF INSULATING MATERIALS [Use of Guard Balancing and Completely Guarded Test Cells: etc.].—S. I. Reynolds & H. R. Race. (*Gen. Elec. Review*, Dec. 1938, Vol. 41, No. 12, pp. 529–533.) For frequencies 100 to 2×10^6 c/s.

2037. MUTUAL INDUCTANCE AND FORCE BETWEEN TWO COAXIAL HELICAL WIRES [Derivation of Formula with Three Small Correction Terms, and Application to Current Balance used in the NPL].—C. Snow. (*Journ. of Res. of Nat. Bur. of Stds.*, Feb. 1939, Vol. 22, No. 2, pp. 239–269.)

2038. A METHOD FOR MEASURING THE PHASE DIFFERENCE BETWEEN OSCILLATIONS AT INTEGRALLY RELATED FREQUENCIES.—I. U. Lyubchenko. (*Journ. of Tech. Phys.* [in Russian], No. 17, Vol. 8, 1938, pp. 1548–1556.)

This is a development of a method proposed by Mandelstam & Papalexi. The method is based on the fact that if two frequencies having an integral relationship are applied to a non-linear detector, then the amplitudes of the d.c. component and of harmonics in the anode circuit of the detector will depend on the phase difference between these two frequencies. The theory of the method is discussed and in particular the cases when the frequency ratio is equal to 2 : 3 and 3 : 4. A circuit (Fig. 2) is discussed which was developed for the experimental verification of these two cases and which also contains a device for the automatic counting of phase-difference cycles (up to 10 cycles per second).

2039. REMARK ON THE PAPER BY R. D'E. ATKINSON "ON DISCONTINUITIES IN THE TIME-KEEPING OF CLOCKS IN GREENWICH AND GÖTTINGEN."—H. Gockel & M. Schuler. (*Zeitschr. f. Phys.*, No. 9/10, Vol. 111, 1939, pp. 680–682.) Reply to 268 of January.

2040. COUPLED SELF-EXCITED ELECTRICAL CIRCUITS AND CRYSTAL OSCILLATORS.—Heegner. (*See* 1837.)

2041. A NEW CIRCUIT OF A QUARTZ OSCILLATOR [to avoid Change of Frequency when Output is Changed: Use of Two Tuned Circuits, with Nearly Same Constants, in Parallel or Series, as Plate Load].—K. Sakamoto. (*Electrot. Journ.*, Tokyo, Nov. 1938, Vol. 2, No. 11, p. 267.)

2042. COMMENTS ON "THE NATIONAL PHYSICAL LABORATORY'S NOTATION FOR PIEZOELECTRIC QUARTZ" [Criticism of Two Points—Determination of Co-ordinate Axes in relation to Crystal Form, and Geometric Specification of Orientation of Cutting Plane].—I. Koga. (*Electrot. Journ.*, Tokyo, Dec. 1938, Vol. 2, No. 12, pp. 287–289.)

2043. ELASTIC DEFORMATIONS IN ROCHELLE SALT [Static Determination of Nine Elastic Constants by Surface Pressure on Rectangular Crystal Prisms: Agreement with Dynamic Values: Deformation in Electric Field: Its Temperature Dependence]. —H. Hinz. (*Zeitschr. f. Phys.*, No. 9/10, Vol. 111, 1939, pp. 617–632.)

2044. METHOD OF MEASUREMENT OF THE ELASTIC CONSTANTS AND THE PHASE VELOCITIES OF TRANSVERSE AND LONGITUDINAL WAVES [Dynamic Method: Measurement of Natural Frequencies of Radial and Torsional Oscillations of Circular Plates].—F. Khol. (*Zeitschr. f. Phys.*, No. 7/8, Vol. 111, 1939, pp. 450–453.) For previous work *see* 1996 of 1938.

2045. "A TEXT-BOOK ON CRYSTAL PHYSICS" [Book Review].—W. A. Wooster. (*Science*, 27th Jan. 1939, Vol. 89, pp. 81–82.)

2046. ATTENUATION MEASUREMENT BY THE QUOTIENT METHOD.—G. Opitz. (*Hochf:tech. u. Elek:akus.*, Jan. 1939, Vol. 53, No. 1, pp. 27–33.)

For reference to the principle of this method *see* Zinke, 4176 of 1936. The circuit for direct measurement of attenuation in an oscillating circuit is shown in principle in Fig. 1*a*; those for capacitative and ohmic coupling of the circuit to the generator in Figs. 1*b*, *c* respectively. The theory of their action is described in § II; special attention is given to the design of a capacitative voltage-divider with a large condenser to have frequency-constant divisions for frequencies of the order of 10 Mc/s, and to the construction of a valve voltmeter of minimum loss factor (§ III; Fig. 7). The finished apparatus is described (Fig. 8).

2047. RECENT DEVELOPMENTS IN THE MEASUREMENT OF TELEGRAPH TRANSMISSION.—Shanck, Cowan, & Cory. (*Bell S. Tech. Journ.*, Jan. 1939, Vol. 18, No. 1, pp. 143–189.)

2048. THERMIONIC VALVES AS MEASURING INSTRUMENTS.—James, Polgreen, & Warren. (*See* 1922.)

2049. MEASURING APPARATUS IN RADIO TECHNIQUE.—M. Adam. (*Rev. Gén. de l'Élec.*, 11th Feb. 1939, Vol. 45, No. 6, pp. 163–180.)

2050. SOME ECONOMICAL CONSIDERATIONS OF INSTRUMENT MANUFACTURE.—C. S. Redding: Tinsley. (*Journ. Scient. Instr.*, March 1939, Vol. 16, No. 3, p. 92.) Prompted by Tinsley's article (4535 of 1938).

2051. BRIDGE-TYPE SET FOR MEASURING VACUUM-TUBE PARAMETERS.—J. R. Pernice. (*Communications*, Jan. 1939, Vol. 19, No. 1, pp. 11–13 and 27 . . 35.)

2052. DESIGNING BUCKING-OUT SYSTEMS [Suppression of Steady Plate Current in Valve-Voltmeters, Photocell Instruments, etc: Practical Precautions to obtain Satisfactory Operation].—J. H. Hollister. (*Communications*, Jan. 1939, Vol. 19, No. 1, pp. 19 and 27.)

2053. THE MEASUREMENT OF SMALL POTENTIAL DIFFERENCES BY MEANS OF A DOUBLE-TRIODE VALVE IN A BRIDGE CIRCUIT [with Merits of Tetrode Circuits in eliminating Statistical Fluctuations, while retaining Advantages of Symmetrical Circuits].—J. C. M. Brentano & P. Ingleby. (*Journ. Scient. Instr.*, March 1939, Vol. 16, No. 3, pp. 81–84.)

2054. A NEW IDEA IN V.T. [Valve] VOLTMETER DESIGN [Slide-Back Voltmeter with Automatic Action, giving Direct Readings].—R. E. Pollard. (*QST*, March 1939, Vol. 23, No. 3, pp. 56–58 and 116, 118.)

2055. A STANDARD VOLTMETER WITH ADJUSTABLE SENSITIVITY FOR HIGH VOLTAGES [on Principle of Thomson's Electrodynamometer: Voltages of Order of 50 kV].—M. Nacken. (*Arch. f. Elektrot.*, 16th Jan. 1939, Vol. 33, No. 1, pp. 60–70.)

2056. AN ELECTROSTATIC ANALYSER FOR COMPLEX WAVES OF SMALL AMPLITUDE [using the Selective Properties of the Quadrant Electrometer: R.M.S. Value of 1 Volt gives Good Results].—J. C. Prescott. (*Electrician*, 10th Feb. 1939, Vol. 122, p. 175: short summary only.)

2057. NEW METHOD OF STABILISING AN ELECTROMETER VALVE [with Circuit].—A. Rogozinski. (*Comptes Rendus*, 6th Feb. 1939, Vol. 208, No. 6, pp. 427–429.)

2058. A REVIEW OF THE DESIGN AND USE OF POTENTIOMETERS.—D. C. Gall. (*Electrician*, 10th March 1939, Vol. 122, pp. 307–308.) Summary of I.E.E. paper.

2059. WORKSHOP GALVANOMETERS.—D. C. Gall. (*Journ. Scient. Instr.*, March 1939, Vol. 16, No. 3, pp. 69–73.)

2060. AN AUTOMATIC ARRANGEMENT FOR CORRECTING THE ZERO DISPLACEMENT OF A GALVANOMETER.—J. Tonnelat. (*Comptes Rendus*, 13th Feb. 1939, Vol. 208, No. 7, pp. 501–503.)

2061. THE M P A APPARATUS [for Measuring, Testing, & Balancing All Kinds of Radio Apparatus, Quantities, etc: Combination of H.F. Oscillator with Universal Circuit applicable as Modulator, Tone Generator, Valve Voltmeter, etc.].—H. S. Wilhelmy: Herterich. (*Hochf:tech. u. Elek:akus.*, Jan. 1939, Vol. 53, No. 1, p. 38: Industry Review.)

2062. USE OF BISMUTH-BRIDGE MAGNETIC FLUXMETER FOR A.C. FIELDS.—G. S. Smith. (*Elec. Engineering*, Feb. 1939, Vol. 58, No. 2, Transactions pp. 52–55.)

SUBSIDIARY APPARATUS AND MATERIALS

2063. A Fixed-Focus Electron Gun for Cathode-Ray Tubes.—Iams. (*See* 1996.)

2064. A Simple [Transportable] Cathode-Ray Oscillograph for the Recording of Transient Phenomena [Limiting Speed 500 km/sec.].—Cuilhé & Vogel. (*Rev. Gén. de l'Élec.*, 28th Jan. 1939, Vol. 45, No. 4, pp. 103–106.)

2065. Principles and Construction of Cathode-Ray Oscillographs.—Demontvignier. (*Rev. Gén. de l'Élec.*, 7th & 14th Jan. 1939, Vol. 45, Nos. 1 & 2, pp. 3–14 & 38–43.)

2066. Cathode-Ray Tubes [History of Development].—Puckle. (*Wireless World*, 16th & 23rd March 1939, Vol. 44, pp. 242–244 & 275–278.)

2067. The Use of Cathode-Ray Oscillographs for the Testing of Current Transformers.—Metal. (*Bull. Assoc. suisse des Élec.*, No. 3, Vol. 30, 1939, pp. 71–72.)

2068. A New Measuring Set for Transient Phenomena.—Okuno & others. (*See* 2031.)

2069. Time-Sweep Generator for Cathode-Ray Oscillograph [Multiplication of Effective Size of Screen by shifting Successive Horizontal-Sweep Axes vertically, to give a "Stepped" Time Base].—Oka. (*Electrot. Journ.*, Tokyo, Jan. 1939, Vol. 3, No. 1, p. 22.) Maintaining, unlike other proposals, the correct rectangular-coordinate relation between phenomenon and time.

2070. Dynamic Characteristics of Glow-Discharge [Saw-Tooth Neon-Lamp] Oscillator [Criticism of Mitra & Syam's Work: Stoppage of Discharge Not fully Considered].—S. Mochizuki & K. Iwamoto. (*Electrot. Journ.*, Tokyo, Dec. 1938, Vol. 2, No. 12, pp. 290–291.) For Mitra & Syam's paper *see* 1933 Abstracts, p. 36.

2071. A Multi-Channel Oscillograph Amplifier [Critical Review of Previous (Commutator, Thyratron, etc.) Methods, leading to the "Intermittent Amplifier" Method: Design of Four-Channel Mains-Driven Equipment: Applications].—Williams & Beattie. (*Wireless Engineer*, March 1939, Vol. 16, No. 186, pp. 126–133.)

2072. Corrections to "An Analytical Study of Electrostatic Electron Lenses."—Sugata. (*Electrot. Journ.*, Tokyo, Dec. 1938, Vol 2, No. 12, p. 289.) *See* 1125 of March.

2073. Electrostatic Electron-Optics [General Equations: Thin & Thick Lenses: Aberration & Its Reduction: Apertured Plates: Concentric Tubes].—Gray. (*Bell S. Tech. Journ.*, Jan. 1939, Vol. 18, No. 1, pp. 1–31.)

Approaching the subject in a manner "that appeals to the reader who is more familiar with electrical theory than he is with the concepts of geometrical optics."

2074. A Simplified Derivation of the General Properties of an Electron-Optical Image [Derivation of Aberration Figures, etc., for Axially Symmetric Fields].—Ramberg. (*Journ. Opt. Soc. Am.*, Feb. 1939, Vol. 29, No. 2, pp. 79–83.)

2075. "Electron Optics: Theoretical and Practical" [Book Review]. — Myers. (*Wireless Engineer*, April 1939, Vol. 16, No. 187, p. 173.)

2076. Applied Electron-Optics: I—Principles of the Technique of the Instruments [including Precision Mass Spectrograph and Image Converters]: II—The Electron Microscope and Its Applications.—Brüche: Mahl. (*Rev. Gén. de l'Élec.*, 18th & 25th Feb. 1939, Vol. 45, Nos. 7 & 8, pp. 213–219 & 241–248.)

2077. Mass Spectrographs [Survey of Recent Improvements, etc.].—Cartan. (*Rev. Gén. de l'Élec.*, 28th Jan. 1939, Vol. 45, No. 4, pp. 109–123.)

2078. The Latest Development of the Electron Microscope [Siemens & Halske Apparatus: Specimen Microphotographs: Preparation of Objects: Applications].—Triau. (*Rev. Gén. de l'Élec.*, 31st Dec. 1938, Vol. 44, No. 26, pp. 841–847.)

2079. The Electron Microscope: Latest Position of Development [Short Survey].—(*Funktech. Monatshefte*, Jan. 1939, No. 1, Supp. pp. 6–7.)

2080. Migration of Barium on Molybdenum [studied by Electron Microscope: Varying Behaviour with Temperature].—Benjamin & Jenkins. (*Nature*, 18th Feb. 1939, Vol. 143, pp. 279–280.)

2081. A New Apparatus for the Demonstration of Electron Diffraction [applicable also to Absolute Measurement of High Potential Differences].—Trillat. (*Rev. Gén. de l'Élec.*, 11th Feb. 1939, Vol. 45, No. 6, pp. 183–187.)

2082. The Technique of High-Intensity Bombardment with Fast Particles.—Kurie. (*Phys. Review*, 15th Jan. 1939, Series 2, Vol. 55, No. 2, p. 241: abstract only.)

2083. Integration of the Equations of Motion of an Electrified Particle of Variable Mass, subjected to the Action of Any Electric and Magnetic Fields Whatever [General Theory].—Opatowski. (*Comptes Rendus*, 27th Feb. 1939, Vol. 208, No. 9, pp. 638–640.)

2084. The Production of Large Ionic Currents in Gaseous Discharge Magnetrons ["Gasomagnetrons"].—Vigdorchik [Wigdortschik]. (*Journ. of Tech. Phys.* [in Russian], No. 13/14, Vol. 8, 1938, pp. 1197–1205.)

For previous work on the production of ionic currents by the use of phenomena similar to those in a whole-anode magnetron valve, *see* 92 of 1935. In the present work, special magnetron tubes consisting of a high-vacuum and a soft-vacuum chamber, separated by a water-cooled diaphragm, were developed; with these tubes ionic currents of up to 3 mA were obtained.

2085. THE THEORY OF THE ION CURRENT IN A MAGNETRON USED AS A SOURCE OF IONS.—Sitnikov. (*Journ. of Tech. Phys.* [in Russian], Nos. 16 & 17, Vol. 8, 1938, pp. 1433–1452 & 1527–1547.)

A detailed theoretical discussion of the operation of a magnetron-type tube in which ion current is obtained directly in a vacuum of the order of 10^{-5} mm Hg. In the first part of the paper the liberation of electrons from the filament and the appearance of ions in the filament/anode space is considered, and for given conditions a formula (19) is derived for determining the ion current thus produced. This is followed by an analysis of the various parameters entering into the formula. In the second part the process of extracting the ions from the filament/anode space and directing them along the axis of the tube is discussed, together with the subsequent acceleration of the ions and their concentration into a beam.

2086. A CAPILLARY ION SOURCE FOR THE CYCLOTRON.—Livingston & others. (*Review Scient. Instr.*, Feb. 1939, Vol. 10, No. 2, pp. 63–67.)

2087. NEW ATOM SMASHER USES SHORT-WAVE RADIO GENERATOR ["Linear Resonant Accelerator"].—Smith & Hartman. (*Sci. News Letter*, 4th Feb. 1939, Vol. 35, No. 5, p. 68.)

2088. THE PRODUCTION OF MICROSTRUCTURAL (FLUORESCENT) SCREENS, *and* THE PRODUCTION OF A THERMALLY STABLE LUSTROUS SILVER LAYER FOR A PHOTO-CATHODE.—Golbreich. (*See* 2002 & 2003.)

2089. LUMINESCENCE DECAY AND RELATED PHENOMENA [C-R-Oscillographic Investigation on Zinc-Sulphide Phosphors: Discussion of the Bimolecular Mechanism Theory, and Its Combination with a "Metastable State" Mechanism for the Persistent Phosphorescence: Linear & Non-Linear Luminescence (Experiments with Uranium Glass as Example of Linear Mechanism): etc.].—de Groot. (*Physica*, March 1939, Vol. 6, No. 3, pp. 275–289: in English.)

2090. RECENT VIEWS ON THE LUMINESCENCE OF SOLIDS [based on Faraday Society Conference].—Ewles. (*Sci. Progress*, Jan. 1939, Vol. 33, No. 131, pp. 563–567.)

2091. AN AUTOMATIC RECORDING SPECTRORADIOMETER FOR CATHODOLUMINESCENT MATERIALS [Very Sensitive (Light Emission need be only about 10^{-3} lumen/cm^2) thanks to 10-Stage Electron Multiplier: Highly Stable: Linear Wavelength Scale: etc.].—Zworykin. (*Journ. Opt. Soc. Am.*, Feb. 1939, Vol. 29, No. 2, pp. 84–91.)

2092. THE FLUORESCENCE OF COMPOUNDS CONTAINING MANGANESE.—Randall. (*Proc. Roy. Soc.*, Series A, 7th Feb. 1939, Vol. 169, No. 938, p. S 2: abstract only.)

2093. SPHERICAL GROUND JOINTS [for Semi-Universal Motion] FOR VACUUM SYSTEMS.—Rubens & Henderson. (*Review Scient. Instr.*, Feb. 1939, Vol. 10, No. 2, pp. 49–50.)

2094. APPLICATION OF THE METAL VALVE IN MEASURING VACUUM [All-Metal Rectifier, with Top of Dome cut off for Connection to Vacuum, used as Pirani Gauge].—Rogers & others. (*Gen. Elec. Review*, Dec. 1938, Vol. 41, No. 12, pp. 534–535.)

2095. ELECTRIC SCREENING EFFECT OF THE GRID [against Positive & Negative Ion Currents and Electrostatic Field: Comparison between Calculated & Experimental Results, and between Meshed & Parallel Wires].—Ikeda. (*Electrot. Journ.*, Tokyo, Jan. 1939, Vol. 3, No. 1, pp. 13–15.)

2096. SILVER FILMS ON A MICA CRYSTAL FACE [Microphotographs].—Essig. (*Phys. Review*, 15th Jan. 1939, Series 2, Vol. 55, No. 2, p. 229.)

2097. AN OPTICAL INVESTIGATION OF OXIDE FILMS ON METALS [and a Method for Accurate Measurement of Rate of Formation].—Leberknight & Lustman. (*Journ. Opt. Soc. Am.*, Feb. 1939, Vol. 29, No. 2, pp. 59–66.)

2098. THERMOVOLTAGE AT THE ELEMENT METAL/SEMICONDUCTOR/METAL: II—TEMPERATURE DEPENDENCE (FROM −80° TO +70°C) OF THE THERMOVOLTAGE PER DEGREE FOR CUPROUS OXIDE: III—TEMPERATURE-DIFFERENCE DEPENDENCE OF THE THERMOVOLTAGE PER DEGREE FOR CUPROUS OXIDE: IV—DISCUSSION OF EXPERIMENTAL AND THEORETICAL RESULTS FOR CUPROUS OXIDE.—Schweickert: Rohde: Mönch. (*Ann. der Physik*, Series 5, No. 3, Vol. 34, 1939, pp. 250–258: 259–264: 265–279). For I *see* 3572 of 1936.

2099. COPPER-OXIDE PLATES FOR HIGH-POWER RECTIFIERS.—Levinson & Dunaev. (*Journ. of Tech. Phys.* [in Russian], No. 13/14, Vol. 8, 1938, pp. 1212–1218.) A detailed report on methods developed in the U.S.S.R. for manufacturing large copper-oxide plates for low-voltage heavy-current rectifiers.

2100. CONVERSION OF VITREOUS AND MONOCLINIC (α) SELENIUM TO THE HEXAGONAL MODIFICATION.—Das & Gupta. (*Nature*, 28th Jan. 1939, Vol. 143, p. 165.)

2101. DETERMINATION OF THE CONDITIONS OF FUNCTIONING OF AN A.C. ARC [Solution of Equation giving Current].—Bethenod. (*Comptes Rendus*, 20th Feb. 1939, Vol. 208, No. 8, pp. 562–565.)

2102. POWER SUPPLY FOR THE RADIO RECEIVER [including Thermo-Generators].—Beatt. (*World-Radio*, 24th March 1939, Vol. 28, p. 12.)

2103. Researches on the Direct Production of Electric Current by the Combustion of Gases.—Hirschfeld & Vanduzer. (*Génie Civil*, 28th Jan. 1939, Vol. 114, No. 4, pp. 92–93.)

2104. High-Voltage Smoothing [Use of Valve Bridge Circuit].—(*See* 1865.)

2105. Two Voltage Regulators [Single-Valve Circuit for Very Small Current Drain: Two-Valve Circuit for Any Drain up to 100 mA at Several Thousand Volts, almost Perfect Regulation for Surges or Longer Fluctuations].—Neher & Pickering. (*Review Scient. Instr.*, Feb. 1939, Vol. 10, No. 2, pp. 53–56.)

2106. A Precision Current Control Device [Vacuum Tube Circuit as used for Michigan Cyclotron].—Lawson & Tyler. (*Phys. Review*, 15th Jan. 1939, Series 2, Vol. 55, No. 2, p. 238: abstract only.)

2107. A Speed Regulator for High Requirements [primarily for Control of Tone Generator for Multi-Tone Telecontrol Installation: using Walter's Rectifier-Bridge Circuit as Phase-Sensitive Indicator: Adjustment to 5‰ within 1.1 Sec.].—Huber & Meisterknecht. (*E.T.Z.*, 2nd Feb. 1939, Vol. 60, No. 5, pp. 138–139: summary only.)

2108. Neon Tube as Shunt to Inductive Load in Relay Operation.—Beale: Clement. (*Electronics*, Feb. 1939, Vol. 12, No. 2, p. 52.) Prompted by Clement's article (1698 of April).

2109. Negative Power Factors in Air Capacitors, *and* An Explanation of Negative Power Factors.—Astin: Curtis & Astin. (*Elec. Engineering*, Jan. 1939, Vol. 58, No. 1, p. 42: summaries only.)

2110. "Electrolytic Capacitors" [Book Review].—Deeley. (*Electronics*, Feb. 1939, Vol. 12, No. 2, p. 35.) Published by the Cornell-Dubilier Corporation.

2111. Electrolytic Condensers.—Coursey & Ray. (*Electrician*, 3rd Feb. 1939, Vol. 122, p. 162: summary of I.E.E. paper.)

2112. Dielectrics having High Dielectric Constant [Search for Titanium Compound Formation with Best Compromise between Conflicting Requirements of Large ϵ and Small $\tan\delta$: for $\epsilon = 80$–90, $\tan\delta$ about same as for Silicate Glass: for Lenses & Prisms for Micro-Waves].—K. Morita & S. Suzuki. (*Electrot. Journ.*, Tokyo, Jan. 1939, Vol. 3, No. 1, p. 24.)

2113. Modern Plastic Insulating Materials in Electrical Technique, according to Papers read at the Rochester Congress of the American Electrochemical Society.—Génin. (*Rev. Gén. de l'Élec.*, 18th Feb. 1939, Vol. 45, No. 7, pp. 204–208.)

2114. The Influence of Thermal History on Polyvinyl-Chloride Plastics.—Fuoss. (*Elec. Engineering*, Jan. 1939, Vol. 58, No. 1 p. 40: summary only.)

2115. Properties and Testing of Dielectric Materials [Plastics, Waxes, Ceramics, & Textiles: Survey of Methods and Technique: Some Results: Trend of Modern Investigations of Dielectric Phenomena].—Doust & Sulston. (*Printed Paper of Inst. of P.O. Elec. Eng.*, No. 165, pp. 3–27.)

2116. Studies on the Amorphous State: XVII–Dielectric Losses in "Swelled" Rubbers [Influence of Immersion in Paraffin Oil, Toluene, etc.].—Alexandrov & Dzhian. (*Tech. Phys. of USSR*, No. 11, Vol. 5, 1938, pp. 836–841: in English: *Journ. of Tech. Phys.* [in Russian], No. 17, Vol. 8, 1938, pp. 1515–1520.)

2117. Fibre Glass as an Electrical Insulator.—de Piolenc. (*Rev. Gén. de l'Élec.*, 21st Jan. 1939, Vol. 45, No. 3, pp. 83–85.) For a previous paper *see* 1221 of March.

2118. Manufacture of Electrical Porcelain [by Westinghouse Company].—Whitney. (*Elec. Engineering*, Jan. 1939, Vol. 58, No. 1, pp. 7–11.)

2119. Refractory Materials.—Partridge. (*Journ. Roy. Soc. Arts*, 13th & 20th Jan. 1939, Vol. 87, pp. 227–245 & 254–277.)

2120. National Research Council Conference on Electrical Insulation: Summaries.—(*Elec. Engineering*, Jan. 1939, Vol. 58, No. 1, pp. 40–44.)

2121. Progress in Insulation Research—1938 [with 84 Literature References].—Whitehead. (*Elec. Engineering*, Jan. 1939, Vol. 58, No. 1, pp. 23–31.)

2122. "Elektrische Stossfestigkeit" [Electrical Strength against Surges: Book Review].—Strigel. (*Electrician*, 24th Feb. 1939, Vol. 122, p. 252.)

2123. High-Voltage High-Frequency Phenomena [Studies, at 13 Mc/s, of Breakdown between Needle Sphere Gaps and between Parallel Wires].—Pickles. (*Proc. Inst. Rad. Eng.*, Feb. 1939, Vol. 27, No. 2, p. 155: summary only.)

2124. Dependence on Voltage of the Dispersion of the Dielectric Constants of Strong Electrolytes [Theory based on Debye/Falkenhagen Theory for Weak Fields: Influence of Concentration, Dielectric Constant of Solvent, Temperature, etc.].—Frölich. (*Physik. Zeitschr.*, 15th Feb. 1939, Vol. 40, No. 4, pp. 124–140.)

2125. Chemistry and Communications.—Glover. (*Printed Paper of Inst. of P.O. Elec. Eng.*, No. 166, pp. 3–12.)

2126. Investigations on H.F. Coils with Iron-Ribbon Cores under Variable Superposed D.C. Magnetisation.—Maus. (*See* 1873.)

2127. IRON [Powder] CORES FOR POWER OSCILLATORS.—Mallory Company. (*See* 1867.)

2128. CONTRIBUTION TO THE QUALITATIVE THEORY OF IRON-CORED CHOKE COILS WITH SUPERPOSED MAGNETISATION BY DIRECT CURRENT.—Hauffe. (*See* 1874.)

2129. ALNICO—ITS PROPERTIES AND POSSIBILITIES [with Comparative Data of Other Magnet Materials].—Adams. (*Gen. Elec. Review*, Dec. 1938, Vol. 41, No. 12, pp. 518–522.)

2130. A PHENOMENON OF WAVE PROPAGATION IN A STRING OF MAGNETS: APPLICATION TO FERROMAGNETISM [Magnets form Pass-Band Filter for Oscillations about Their Centres: Expression for Specific Heat of Spontaneous Magnetisation agrees with Experiment].—Parodi. (*Comptes Rendus*, 30th Jan. 1939, Vol. 208, No. 5, pp. 333–336.)

STATIONS, DESIGN AND OPERATION

2131. MICRO-WAVE TELEPHONY: INSTALLATION USING 80 cm AND 1 m WAVELENGTHS AT BORDEAUX [between Shore and Floating Dry-Dock].—Soc. Française Radioélectrique. (*Electrician*, 24th March 1939, Vol. 122, pp. 367–368.)

2132. RADIO FOR POWER COMPANIES [Ultra-Short-Wave Licences granted for Speeding-Up Emergency Service].—(*Gen. Elec. Review*, Dec. 1938, Vol. 41, No. 12, p. 549.)

2133. "POLICE COMMUNICATION SYSTEMS" [Book Review].—Leonard. (*Electronics*, Feb. 1939 Vol. 12, No. 2, p. 35.)

2134. FOREST RADIO SERVICE.—Waltz. (*Electronics*, Feb. 1939, Vol. 12, No. 2, pp. 9–10.)

2135. THE FIRST HIGH-POWERED RADIO STATION WITHOUT STATIC [Plans for Frequency-Modulated Station transmitting Programmes from High-Fidelity New York Station WQXR: Receiver Production begun by General Electric Company].—Armstrong. (*Science*, 27th Jan. 1939, Vol. 89, p. 72.) *See* also *Electronics*, Feb. 1939, Vol. 12, No. 2, p. 36.

2136. NEW BROADCASTING SYSTEM [at Columbia University: Transmission and Reception using Frequency Modulation: Claims of Reduction of Reception Interference and Availability of Larger Number of Broadcasting Channels in Given Wavelength Band].—(*Nature*, 28th Jan. 1939, Vol. 143, p. 152: short note only.)

2137. COMMUNICATIONS BY PHASE MODULATION [Practical Methods of Transmission & Reception (particularly the "Off-Neutralised Crystal-Filter Receiver"): Advantages over Amplitude Modulation (Simpler Modulating Equipment, Power Gain: Benefit of Carrier Exaltation in Receiving): Disadvantages, especially at Receiver: California/New-York Tests].—Crosby. (*Proc. Inst. Rad. Eng.*, Feb. 1939, Vol. 27, No. 2, pp. 126–136.) A preliminary note was referred to in 92 of January.

2138. WAYS OF OVERCOMING THE SCARCITY OF WAVELENGTHS IN BROADCASTING [Single-Sideband Transmission theoretically Desirable but at present Rejected because of Receiver Alterations: Forms of Common-Wave Broadcasting: True (Synchronised) Common-Wave Broadcasting and the Distortion-Zone Difficulty: Wired Broadcasting: the Latest Development—Common-Wave Wired Broadcasting, using Small Transmitters (Radius 1–3 km) with Carrier-Frequency Control over Telephone Cable].—Bender. (*Funktech. Monatshefte*, Jan. 1939, No. 1, pp. 1–4.)

2139. NETWORK BROADCASTING [Statement before FCC, Nov. 1938].—Sarnoff. (*RCA Review*, Jan. 1939, Vol. 3, No. 3, pp. 259–270.)

2140. THE EMPIRE SERVICE BROADCASTING STATION AT DAVENTRY.—Hayes & MacLarty. (*Nature*, 11th Feb. 1939, Vol. 143, p. 234: *Electrician*, 3rd Feb. 1939, Vol. 122, pp. 141–142: Discussion, *ibid.*, 10th Feb., p. 170.) Summaries of an I.E.E. paper.

2141. EMPIRE TELEGRAPH COMMUNICATIONS [Engineering Organisation, etc: Effect of Cosmic Conditions on Wireless Signals: etc.].—Wood. (*Electrician*, 23rd Dec. 1938, Vol. 121, pp. 747–748: summary of I.E.E. paper.)

2142. THE SWISS SHORT-WAVE TRANSMITTER AT SCHWARZENBURG.—(*Bull. Assoc. suisse des Élec.*, No. 1, Vol. 30, 1939, pp. 28–31.)

2143. TRIALS OF THE IMPULSE SYSTEM OF TYPE-PRINTING TELEGRAPHY ON THE LONG-DISTANCE WIRELESS SERVICE BETWEEN BERLIN AND BUENOS AIRES [Performance in Conditions of Doubled-Signals, Strong Echoes, and Atmospheric Disturbances: Average Errors only 0.2‰: etc.].—Hudec. (*T.F.T.*, Jan. 1939, Vol. 28, No. 1, pp. 16–26.) A long paper on this system, including the above trials, appears in *E.N.T.*, Jan. 1939, Vol. 16, No. 1, pp. 1–23.

2144. DESCRIPTION OF THE PRANGINS RADIO-TELEGRAPHIC STATION [the Geneva Transmitting Station].—Anselmi. (*Bull. Assoc. suisse des Élec.*, No. 21, Vol. 29, 1938, pp. 588–592.)

2145. THE BUILDING OF THE BELGIAN NATIONAL BROADCASTING INSTITUTE.—Adam. (*Génie Civil*, 11th Feb. 1939, Vol. 114, No. 6, pp. 132–134.)

2146. "EIAR—ANNO XVII" [Italian Broadcasting in 1939: Book Review].—(*La Ricerca Scient.*, Jan./Feb. 1939, 10th Year, No. 1/2, pp. 72–73.)

2147. THE NEW CENTRE OF TECHNICAL CONTROL OF THE INTERNATIONAL BROADCASTING UNION.—Adam. (*Génie Civil*, 14th Jan. 1939, Vol. 114, No. 2, pp. 39–41.)

2148. VOICE-OPERATED LEVEL CONTROL SYSTEM FOR TELEPHONE NETWORKS.—Reeves. (*Elec. Communication*, Jan. 1939, Vol. 17, No. 3, pp. 291–300.)

GENERAL PHYSICAL ARTICLES

2149. Integration of the Equations of Motion of an Electrified Particle of Variable Mass, subjected to the Action of Any Electric and Magnetic Fields Whatever [General Theory].—Opatowski. (*Comptes Rendus*, 27th Feb. 1939, Vol. 208, No. 9, pp. 638–640.)

2150. Maxwell's Equations and Series of Eddies [Solution of Equations representing Electromagnetic Field connected with Motion of Electrified Particles].—Reulos. (*Comptes Rendus*, 6th Feb. 1939, Vol. 208, No. 6, pp. 423–425.)

2151. On the Equations of the Elementary Particle in the Theory of Relativity.—Caldirola. (*La Ricerca Scient.*, March 1939, 10th Year, No. 3, pp. 172–174.)

2152. The Electronic Charge [Modifications in Measurement by Drop Method give Increased Accuracy].—Laby & Hopper. (*Nature*, 28th Jan. 1939, Vol. 143, pp. 157–158.)

2153. Viscosity of Air and the Electronic Charge [Modification of Oil-Drop Method gives Value of *e* agreeing well with X-Ray Value].—Fortier. (*Comptes Rendus*, 13th Feb. 1939, Vol. 208, No. 7, pp. 506–507.)

2154. Contemporary Advances in Physics: XXXII—Particles of the Cosmic Rays.—Darrow. (*Bell S. Tech. Journ.*, Jan. 1939, Vol. 18, No. 1, pp. 190–217.)

2155. On the Brownian Motion in Electric Resistances.—Bakker & Heller. (*See* 1842.)

2156. Theory of the Electrical Resistance of Good Conductors [Its Calculation for All Temperatures by Method based on Formula from Lorentz-Sommerfeld Electron Theory].—Sauter. (*Naturwiss.*, 17th Feb. 1939, Vol. 27, No. 7, pp. 109–110.)

2157. Magnetism and the Maxwellian Theory [Superfluity of regarding Magnetism as Separate Entity].—Drysdale. (*Nature*, 18th Feb. 1939, Vol. 143, pp. 277–278.)

2158. Townsend Ionisation Coefficients and Glow Potentials in an Argon/Barium Phototube.—Engstrom. (*Phys. Review*, 15th Jan. 1939, Series 2, Vol. 55, No. 2, pp. 239–240: abstract only.)

2159. The Molecular Aspect of the Energies of Adhesion between Various Liquids and Solids: Adsorption as the Result of Electrostatic Forces.—Boyd & Harkins. (*Phys. Review*, 15th Jan. 1939, Series 2, Vol. 55, No. 2, pp. 237–238: abstract only.)

MISCELLANEOUS

2160. Loge X [New Function obeying Laws of Logarithms except that X may assume Negative Values: Basis of Graph Paper with Special Advantages (*e.g.*) for Circuits where Positive & Negative Reactances vary over Wide Range with Frequency, such as Quartz Crystal Circuit].—Lorenzen. (*Communications*, Jan. 1939, Vol. 19, No. 1, pp. 7–9.)

2161. The Correction of Experimental Curves for the Resolving Power of the Apparatus [Theory].—Spencer. (*Phys. Review*, 15th Jan. 1939, Series 2, Vol. 55, No. 2, p. 239: abstract only.)

2162. On the Equivalent Values of Distributed Constants.—Kharkevitch. (*See* 1938.)

2163. Relaxation Methods applied to Engineering Problems: IV—Problems relating to Elastic Stability and Vibrations.—Bradfield & others. (*See* 1940.)

2164. Frequency Interpretation in Inverse Probability.—Deming: Jeffreys. (*Nature*, 4th Feb. 1939, Vol. 143, pp. 202–203: 11th Feb. 1939, p. 242.)

2165. "Frequency Curves and Correlation: Third Edition" [Book Review].—Elderton. (*Sci. Progress*, Jan. 1939, Vol. 33, No. 131, p. 575.)

2166. The Operational Calculus: I [Unified Account of Mathematical Methods: Development based on Laplacian Transform].—Pipes. (*Journ. of Applied Phys.*, March 1939, Vol. 10, No. 3, pp. 172–180.)

2167. Papers on the Co-ordination of Mathematics and Physics with Electrical Engineering.—(*Elec. Engineering*, Feb. 1939, Vol. 58, No. 2, Transactions pp. 35–47.)

2168. Electromagnetic Induction in Non-Uniform Conductors, and the Determination of the Conductivity of the Earth from Terrestrial Magnetic Variations.—Lahiri & Price. (*See* 1832.)

2169. Electrometrical Methods of Measuring the Humidity of Disperse Bodies [*e.g.* Soil].—Alexandrov & Mikhailov. (*Journ. of Tech. Phys.* [in Russian], No. 12, Vol. 8, 1938, pp. 1121–1129.) An English version was dealt with in 1324 of March.

2170. Making Visible of Temperature Fields by the Use of Temperature-Dependent Colour Paints.—Penzig. (*Zeitschr. V.D.I.*, 21st Jan. 1939, Vol. 83, No. 3, pp. 69–74.)

2171. "Piped" Light New Tool for the Operating Room [Use of New Transparent Plastic, "Lucite," as Carrier for Light].—du Pont de Nemours Company. (*Sci. News Letter*, 4th Feb. 1939, Vol. 35, No. 5, pp. 76–77.)

2172. "Plating" with Thin Films makes Glass More Transparent [Reflected Light cancels itself out by Destructive Interference].—Cartwright & Turner: Blodgett. (*Sci. News Letter*, 21st Jan. 1939, Vol. 35, No. 3, p. 35.) With application to lenses, cover-glasses for pictures, etc. *See* also Blodgett, *Science*, 20th Jan. 1939, pp. 60–61.

2173. Transparent and Opaque Screens for the Near Infra-Red.—Pfund. (*Journ. Opt. Soc. Am.*, Feb. 1939, Vol. 29, No. 2, pp. 56–58.)

2174. On Lithium-Fluoride/Quartz Achromatic Lenses.—Stockbarger & Cartwright. (*Journ. Opt. Soc. Am.*, Jan. 1939, Vol. 29, No. 1, pp. 29–31.)

2175. U.S. Steel reports Savings from Photoelectric Furnace Control.—(*Electronics*, Feb. 1939, Vol. 12, No. 2, pp. 38 and 40.)

2176. Industrial Efficiency: Conveyor Control by Photoelectric Cell.—(*Electrician*, 10th Feb. 1939, Vol. 122, p. 169.)

2177. Tube aids Photographic Analysis [*e.g.* of Golf Swing].—(*Electronics*, Feb. 1939, Vol. 12, No. 2, p. 11 and front cover.)

2178. Phototubes save Coating Metals [German Investigations of Optimum Thickness of Protective Coatings in Electroplating: Photoelectric "Lustre" Tester].—Ball: Schlotter & Schmellenmeier. (*Electronics*, Nov. 1938, Vol. 11, No. 11, pp. 48 . . 54.)

2179. Phototubes applied as Traffic Safety Aid [at Trolley-Car Stop in Tunnel].—(*Electronics*, Nov. 1938, Vol. 11, No. 11, p. 40.)

2180. An Apparatus for testing Highway Sign Reflector Units ["Catseyes": using Barrier-Layer Photocell].—Kingslake. (*Journ. Opt. Soc. Am.*, Sept. 1938, Vol. 28, No. 9, pp. 323–326.)

2181. Spectral Absorption used for Mercury-Vapour Detection [Photocell Device].—Woodson. (*Electronics*, Dec. 1938, Vol. 11, No. 12, pp. 34 and 36.) Based on the fact that any vapour will absorb light of the particular colour that it emits when excited.

2182. Phototube scans Rapidly Running Steel Strip for Pin-Hole Flaws.—General Electric. (*Electronics*, Dec. 1938, Vol. 11, No. 12, p. 42: *Gen. Elec. Review*, Dec. 1938, Vol. 41, No. 12, p. 559.)

2183. Phototube guards Ballot Box.—(*Electronics*, Nov. 1938, Vol. 11, No. 11, p. 56: photograph and caption only.)

2184. A Densitometer employing an Alternating-Current Amplifier.—Tabor. (*Journ. Opt. Soc. Am.*, Jan. 1939, Vol. 29, No. 1, pp. 32–34.)

2185. A New Microphotometer for the Evaluation of Acoustic Records.—Narath & Schwarz. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 19, 1938, pp. 465–469.)

2186. A Simple Photox Photometer Head [using Graphite/Graphite Commutator and Single Cell].—Wilson. (*Journn. Opt. Soc. Am.*, Jan. 1939, Vol. 29, No. 1, pp. 35–36.)

2187. Some Tests on Radiation-Mixing Enclosures [used in Photometers of Photoelectric Type].—Moon & Severance. (*Journ. Opt. Soc. Am.*, Jan. 1939, Vol. 29, No. 1, pp. 10–15.)

2188. Present Problems of Light Measurement [in particular of Coloured Light from Gaseous Discharge Tubes].—Dresler. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 19, 1938, pp. 369–372.)

2189. The Application of Polycascade Secondary-Electron Multipliers to the Measurement of Low-Intensity Light.—Dobrolubskij. (*Journ. of Tech. Phys.* [in Russian], No. 12, Vol. 8, 1938, pp. 1130–1136.)

2190. An Automatic Recording Spectroradiometer for Cathodoluminescent Materials.—Zworykin. (*See* 2091.)

2191. Laws and Corollaries of the Black Body [Treatment more suitable than Usual Physicists' Treatment for Some Physical Research and for Engineering Problems], *also* Radiation Laws describing the Emission of Photons by Black Bodies, *and* New λT Relations for Black-Body Radiation.—Benford: Worthing. (*Journ. Opt. Soc. Am.*, Feb. 1939, Vol. 29, No. 2, pp. 92–96: pp. 97–100: pp. 101–102.)

2192. A New Method of Observing Standing [Ultra-Violet] Light Waves [using Photoelectric Action at a Transparent Metallic Film moving to-and-fro in front of a Mirror].—Jäger. (*Ann. der Physik*, Series 5, No. 3, Vol. 34, 1939, pp. 280–295.)

2193. Investigations on Incandescent Lamps using Alternating Current [Their Modulation for Optical Telephony].—Leo. (*Physik. Zeitschr.*, 15th Feb. 1939, Vol. 40, No. 4, pp. 116–124.)

This investigation of the possibilities of modulating incandescent lamps for use in optical telephony deals first with the theory of temperature modulation with pure alternating current (§ 1; *see* also Köhler, 3442 of 1938 [for later work *see* 3828 of 1938]: *also* Leo, *Physik. Zeitschr.*, Vol. 39, 1938, p. 201). Fig. 1 shows temperature variation of tungsten filaments as a function of the specific filament load, Fig. 2 apparatus for its pyrometric determination (§ 2, Table I). § 3 discusses temperature variation with modulated direct current (values, Table II), § 4 the "klirr" factor of the temperature curve (Fig. 3). It is found that only small modulation amplitudes can be used if the frequency reproduction is to be free from harmonics. The modulation of brightness for given temperature variation (§ 5) is discussed on the basis of the radiation law; Fig. 4 shows the relative spectral modulation for various relative temperature fluctuations. The measurement of the depth of modulation along the spectrum is described in § 6 (Fig. 5). It is concluded (§ 7) that "the lamps which can be modulated to the highest degree are those which attain a given mean filament temperature for the highest possible load per milligram of filament weight, that is, lamps with a large radiating surface for given filament cross-section (ribbon lamps); further, lamps with additional heat removal either at the filament ends or by convection in the gaseous filling. The only lamps suitable for modulation purposes are thus ribbon lamps of very small ribbon thickness between powerful supports which are good heat conductors. These are just the lamps with poor efficiency from a technical optical standpoint. The degree of modulation remains very small at high audio frequencies, so that it is only possible to use incandescent lamps for purposes of optical telephony if the frequency band is much cut down and if a considerable amount of amplification is used."

2194. The Cathode-Ray Oscillograph as an Auxiliary in the Measurement of Vibrations, Sound, and Pressure.—Swedenborg. (*Teknisk Tidskrift*, 21st Jan. 1939, Vol. 69, No. 3, Supp. pp. 3–8: in Swedish.)

2195. Electrical Indicator for Pressure, Stress, and Movement [C-R-Tube & Associated Equipment, in One Unit, for use with Capacity-Variation Element (1785 of April)].—Southern Instruments, Ltd. (*Journ. Scient. Instr.*, March 1939, Vol. 16, No. 3, p. 97.)

2196. A Rochelle-Salt Vibration Meter.—Hellmann. (*E.T.Z.*, 16th Feb. 1939, Vol. 60, No. 7, pp. 198–199: summary only.)

2197. Study of the Elastic Relaxation [Modulus of Elasticity and Losses in Ebonite] by a Resonance Method [using a Valve-Generator Drive and Valve Amplifiers].—Mikhailov & Kirilina. (*Tech. Phys. of USSR*, No. 11, Vol. 5, 1938, pp. 842–847: in English.)

2198. A New Electro-Mechanical Effect in Concrete.—Pokrovski. (*Journ. of Tech. Phys.* [in Russian], No. 13/14, Vol. 8, 1938, pp. 1235–1239.)

Experiments were carried out to determine the effect of a dynamic load (blows) on the electrical conductivity of concrete. It appears that electric charges are freed when materials of this type are deformed, and it is suggested that this phenomenon may serve as a basis for estimating deformations in these materials.

2199. A New Arc-Stabiliser for Welding.—Fukuda & Hoh. (*Electrot. Journ.*, Tokyo, Dec. 1938, Vol. 2, No. 12, pp. 291–292.)

2200. Automatic Macroscopic Examination of Materials with X-Rays [by Use of Ionisation Chambers and Associated Equipment], *and* X-Ray Table for the Analysis of Crystal Structure.—de Graaf, van der Tuuk, Oosterkamp. (*Philips Tech. Review*, Aug. 1938, Vol. 3, No. 8, pp. 228–235: Sept. 1938, No. 9, pp. 259–266.)

2201. X-Ray Equipment for Exposures of the Order of 1/100th Second using Condenser-Charging and Discharging Circuit.—(*Electronics*, Feb. 1939, Vol. 12, No. 2, p. 54.)

2202. X-Ray Cinematography with Low-Power Tubes.—Geller. (*Journ. of Tech. Phys.* [in Russian], No. 12, Vol. 8, 1939, pp. 1172–1176.)

2203. Gamma-Ray Defectoscopy.—Gurevich, Zhdanov, & Roschin. (*Journ. of Tech. Phys.* [in Russian], No. 12, Vol. 8, 1938, pp. 1155–1171.)

2204. The Simplest Calculations for the Problems of Magnetic Defectoscopy: I.—Vonsovskij. (*Journ. of Tech. Phys.* [in Russian], No. 16, Vol. 8, 1938, pp. 1453–1467.)

2205. Survey of the Magnetic Powder Methods of Testing Materials and Machine Parts.—Müller. (*Elektrot. u. Masch:bau*, No. 39, Vol. 56, 1938, p. 511: summary only.)

2206. "Der Indikator" [Theory and Mechanical, Optical, and Electrical Types: Book Review].—de Juhasz & Geiger. (*Elektrot. u. Masch:bau*, No. 45, Vol. 56, 1938, p. 599.)

2207. Identifying Cable Wires [New Method with Advantages over the Usual "Test Pick" Method].—Crisfield. (*Bell Lab. Record*, Jan. 1939, Vol. 17, No. 5, pp. 155–157.)

2208. Moisture Meter [for Timber: using Measurement of Electrical Resistance].—Marconi-Ekco. (*Journ. Scient. Instr.*, Jan. 1939, Vol. 16, No. 1, p. 31.)

2209. Measurement of the Thickness of Metal Plates from One Side [without Knowledge of Conductivity or Permeability of Material: Method based on applying Current and picking-off the Potential Difference between Specified Points].—Warren. (*Journ. I.E.E.*, Jan. 1939, Vol. 84, No. 505, pp. 91–95.)

2210. The Surface State of Mechanical Parts: Methods of Measuring the Roughness, including Perthen's Electrical Integration (Capacity) Method.—Nicolau. (*Génie Civil*, 25th Feb. 1939, Vol. 114, No. 8, pp. 173–176.)

2211. The Nunan Yarn Tester [tests and records Strength, and stops Operation when Break occurs].—Nunan. (*Electronics*, Feb. 1939, Vol. 12, No. 2, pp. 12–15.)

2212. Tube Equipment in Industry [Survey, in Tabular Form (with Photographs) of 3 Groups—Measurement, Process Control, Safeguards & Alarms].—(*Electronics*, Feb. 1939, Vol. 12, No. 2, pp. 22–27.)

2213. Electrically-Driven Magnetically-Supported Vacuum-Type Ultracentrifuge [with Piezoelectric Control of Field-Coil Current].—Beams & Black. (*Review Scient. Instr.*, Feb. 1939, Vol. 10, No. 2, pp. 59–63.)

2214. The Magneto-Electric Viscometer.—Martens. (*Journ. of Tech. Phys.* [in Russian], No. 17, Vol. 8, 1938, pp. 1603–1606 [missing in some copies].)

2215. "Admiralty Handbook of Wireless Telegraphy, 1938: Vols I & II" [Book Review].—(*Wireless Engineer*, Dec. 1938, Vol. 15, No. 183, p. 668.)

2216. DIGEST OF TECHNICAL PAPERS AT THE ROCHESTER FALL MEETING, IRE–RMA. (*Electronics*, Dec. 1938, Vol. 11, No. 12, pp. 8–13 and 33.)

2217. "ENCYCLOPÉDIE DE LA RADIOÉLECTRICITÉ" [Book Review: Vol. 2 (H to Z) of Second Edition].—Adam. (*Rev. Gén. de l'Élec.*, 26th Nov. 1938, Vol. 44, No. 21, p. 654.)

2218. "THE RADIO MANUAL: THIRD EDITION" [Book Review].—Sterling. (*QST*, Feb. 1939, Vol. 23, No. 2, pp. 39 and 92.)

2219. "THE AMATEUR RADIO HANDBOOK" [Book Review].—Radio Soc. of Great Britain. (*QST*, Feb. 1939, Vol. 23, No. 2, pp. 92 and 94.)

2220. "THE RADIO AMATEUR'S HANDBOOK": [Book Review].—American Radio Relay League. (*Electronics*, Feb. 1939, Vol. 12, No. 2, p. 35.)

2221. GENERAL DISCUSSION ON "ELECTRICAL ENGINEERING EDUCATION."—(*Journ. I.E.E.*, Feb. 1939, Vol. 84, No. 506, pp. 161–186.)

2222. THE COMMUNICATIONS ENGINEERING INSTITUTE OF THE VIENNA TECHNICAL HIGH SCHOOL.—Petritsch. (*Elektrot. u. Masch:bau*, No. 49, Vol. 56, 1938, pp. 661–665.)

2223. PROCEEDINGS FORMAT [Reasons for Change from "Pocket" Size of *Proc. Inst. Rad. Eng.*].—(*Proc. Inst. Rad. Eng.*, Dec. 1938, Vol. 26, No. 10, pp. 1417–1419.)

2224. THE EVALUATION OF TECHNICAL PERIODICALS.—Lancaster-Jones. (*Engineering*, 16th Dec. 1938, Vol. 146, pp. 707–708.) Editorial on a paper read before a joint meeting of ASLIB and the International Federation for Documentation.

2225. THE PATENT-LAW PROTECTION FOR GERMAN TELEGRAPH, TELEPHONE, AND BROADCASTING EQUIPMENTS AND APPARATUS IN FOREIGN COUNTRIES.—Barth. (*T.F.T.*, Nov. 1938, Vol. 27, No. 11, pp. 419–422.)

2226. POINTS OF PROGRESS IN RADIO TECHNIQUE AT THE SALON DE LA RADIODIFFUSION, PARIS, 1ST/10TH SEPT. 1938.—Adam. (*Rev. Gén. de l'Élec.*, 12th Nov. 1938, Vol. 44, No. 19, pp. 593–602.)

2227. THE "SALON DE LA RADIODIFFUSION" 1938 [Paris Exhibition].—(*L'Onde Élec.*, Dec. 1938, Vol. 17, No. 204, pp. 582–587.)

2228. THE 15TH GREAT GERMAN RADIO EXHIBITION [Notes on New Valves, Broadcast Receivers, Loudspeakers, Television, Measuring Instruments], *and* THE BERLIN RADIO EXHIBITION, 1938.—Fuchs: Anon. (*Hochf:tech. u. Elek:akus.*, Jan. 1939, Vol. 53, No. 1, pp. 1–10: *L'Onde Élec.*, Dec. 1938, Vol. 17, No. 204, pp. 588–594.)

2229. PAPERS ON THE 1938 BERLIN RADIO EXHIBITION, PARTICULARLY THE STATE P.O. HALL.—(*T.F.T.*, Nov. 1938, Supp. Number, Vol. 27, pp. 424–443.)

2230. THE PHYSICAL SOCIETY'S EXHIBITION, 1939.—(*Wireless World*, 12th Jan. 1939, Vol. 44, pp. 41–44.)

2231. PHYSICAL SOCIETY: 29TH ANNUAL EXHIBITION.—(*Electrician*, 6th, 13th, & 20th Jan. 1939, Vol. 122, pp. 9–11, 37–40, & 67–68.)

2232. REVIEWS OF PROGRESS: BROADCASTING AND TELEVISION.—Ashbridge. (*Journ. I.E.E.*, March 1939, Vol. 84, No. 507, pp. 380–387.)

2233. REVIEWS OF PROGRESS: TELEPHONY AND TELEGRAPHY: RADIO TELEGRAPHY AND RADIO-TELEPHONY.—Radley: Rickard. (*Journ. I.E.E.*, March 1939, Vol. 84, No. 507, pp. 359–367: pp. 368–379.)

2234. WIRELESS COMMUNICATIONS [Progress in 1938].—Chetwode Crawley. (*Wireless World*, 29th Dec. 1938, Vol. 43, pp. 576–578.)

2235. ANNUAL REVIEW FEATURES [including Broadcasting, Television, and Radio Research].—(*Electrician*, 27th Jan. 1939, Vol. 122, pp. 87–119.)

2236. ELECTRICAL COMMUNICATION IN 1938.—(*Elec. Communication*, Jan. 1939, Vol. 17, No. 3, pp. 205–229.)

2237. WORLD RADIO CONVENTION PAPERS [Bound Volumes Available from Australia].—(*Electronics*, Feb. 1939, Vol. 12, No. 2, p. 61.)

2238. 14TH GERMAN "PHYSIKERTAG" IN BADEN-BADEN, 11TH–17TH SEPT. 1938.—Lübcke. (*E.T.Z.*, 22nd Dec. 1938, Vol. 59, No. 51, pp. 1377–1380.) *See* also *Funktech. Monatshefte*, Jan. 1939, No. 1, pp. 22–24.

2239. THE SESSION OF THE PHYSICAL SECTION OF THE ACADEMY OF SCIENCES OF THE USSR.—Sominskij. (*Journ.. of Tech. Phys.* [in Russian], No. 16, Vol. 8, 1938, pp. 1495–1499.)

2240. METER AND INSTRUMENT SECTION: CHAIRMAN'S ADDRESS [Protective Devices for Telecommunication Purposes].—Cohen. (*Journ. I.E.E.*, Feb. 1939, Vol. 84, No. 506, pp. 237–247.)

2241. NEW TELEMETERING DEVICES.—Pelpel. (*Bull. de la Soc. franç. des Élec.*, Oct. 1938, Vol. 8, No. 94, pp. 933–947.)

2242. ON THE DISTURBANCES ARISING IN COMMUNICATION LINES FROM THEIR CROSSING OF TRANSMISSION LINES.—Mirolubov. (*Journ. of Tech. Phys.* [in Russian], No. 15, Vol. 8, 1938, pp. 1340–1346.)

2243. TELEPHONY, PRINTING TELEGRAPHY, AND TELEVISION OVER LINES [Frequency Bands and Their Demands on the Nature of the Lines and Cables].—Strecker. (*E.T.Z.*, 23rd Feb. 1939, Vol. 60, No. 8, pp. 214–222.)

Some Recent Patents

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

ACOUSTICS AND AUDIO-FREQUENCY CIRCUITS AND APPARATUS

498 235.—Method of expanding and contracting the volume-range of reproduced sound.

O. Kurt (communicated by K. H. F. Schlegel). Application date 7th July, 1937.

498 468.—Sound-distributing system for a theatre or sports-arena, particularly for assisting deaf people to hear.

J. Poliakoff and O. B. Sneath. Application date 5th July, 1937.

AERIALS AND AERIAL SYSTEMS

500 162.—Non-directional aerial for short-wave working in which two parallel conductors are connected at the "open" ends through a surge impedance.

Soc. Anon. des Industries Radio-Electriques. Convention dates (France) 10th June, 1937 and 8th June, 1938.

DIRECTIONAL WIRELESS

498 417.—Directional system in which three or more pairs of aerials are equally spaced around a circle, each pair being coupled in opposition to a common receiver.

Standard Telephones and Cables and C. F. A. Wagstaffe. Application date 9th July, 1937.

498 940.—Apparatus for teaching the "blind" landing of aircraft along a wireless beam.

C. Lorenz Akt. Convention date (Germany) 15th October, 1936.

498 995.—Arrangement designed to eliminate "night effect" from a direction finder of the kind utilising two spaced aerials coupled to a cathode-ray tube indicator.

Telefunken Co. Convention date (Germany) 12th June, 1937.

499 383.—Automatic direction finder in which the position of a moving craft is "fixed" by the intersection of two separate indicating needles or pointers.

O. G. E. Roberts. Application date 21st July, 1937.

499 708.—Arrangement for simplifying "sense" determination in a direction finder.

C. Lorenz Akt. Convention date (Germany) 14th May, 1937.

499 712.—Means for eliminating the effect of nearby conductors on the field radiated by a directional beacon.

Standard Telephones and Cables (assignees of Le Matériel Téléphonique Soc. Anon.). Convention date (France) 11th June 1937.

499 922.—Frequency control or stabilisation in a carrier-wave signalling system in which a master oscillator supplies a number of different transmitters (or receivers).

Siemens and Halske Akt. Convention date (Germany) 21st October, 1937.

500 006.—Automatic type of direction finder in which the bearing-line is indicated by the interruption of a current as a rotating frame aerial passes through the critical point.

Soc. Anon. des Industries Radio-Electriques. Convention dates (France) 10th March and 19th November, 1937.

500 588.—Method of detecting the presence of invisible aircraft by their reflection of wireless waves.

Marconi's W.T. Co. and D. L. Plaistowe. Application date 13th August, 1937.

RECEIVING CIRCUITS AND APPARATUS

(See also under Television)

497 854.—Multi-scale tuning indicator in which the separate scales are successively illuminated at their edges by totally-reflected internal light.

Marconi's W. T. Co. Convention date (U.S.A.) 30th June, 1936.

497 865.—Valve oscillator in which the tuned circuit is isolated so that the generated frequency is maintained constant in spite of variations in the characteristics of the system as a whole.

International Business Machines Corporation. Convention date (U.S.A.) 10th September, 1936.

497 951.—Multi-scale tuning indicator in which a number of slat-like translucent members are arranged to form a practically-continuous surface, with "edge" lighting.

Marconi's W.T. Co. Convention date (U.S.A.) 30th June, 1936.

498 154.—Push-button tuning system in which the movable member is positively locked in position when it reaches the selected setting.

E. K. Cole and H. C. Rowe. Application date 5th August, 1937.

498 688.—Automatic control of gain and selectivity in a wireless set by phase-stabilised reaction derived from a Lecher-wire coupling.

Marconi's W.T. Co. and N. M. Rust. Application date 15th July, 1937.

498 927.—Push-bottom tuning system in which the various wave-bands as well as individual stations are operated by selector buttons.

Marconi's W.T. Co.; N. M. Rust; and E. F. Hills. Application date 20th July, 1937.

499 028.—Radio receiving system in which an automatic alarm is given on the receipt of a predetermined sequence such as a "distress" signal.

Wallace and Tiernan Products Inc. Convention date (U.S.A.) 20th June, 1936.

499 080.—Dust-proof arrangement for a tuning-control knob of the type capable of two independent movements, each for a different purpose.

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

499 142.—High-frequency receiving system in which radio waves are converted into elastic waves in a fluid medium by a piezo-electric crystal.

Standard Telephones and Cables (assignees of Le Matériel Téléphonique Soc. Anon.). Convention date (France) 18th July, 1936.

499 315.—Multi-stage amplifier with an inverse feed-back circuit which rapidly decreases the "gain" of components outside the working range of frequencies.

Standard Telephones and Cables; B. B. Jacobsen; and A. H. Roche. Application date 21st July, 1937.

499 359.—Means for restoring a set to normal conditions after it has been automatically tuned to a given station by the operation of an electro-magnetic brake.

Philips' Lamp Co. (addition to 481 858). *Convention date (Germany) 14th July* 1937.

499 468.—Receiver or amplifier provided with means for reducing the time taken to heat-up the cathodes of the valves.

Philips' Lamp Co. Convention date (Germany) 16th August 1937.

499 665.—Amplifier in which the primary stream is controlled by a transverse magnetic field which prevents the passage of slow-moving electrons.

Marconi's W.T. Co. Convention date (U.S.A.) 25th July, 1936.

499 774.—Muting circuit for a wireless receiver in which a glow-discharge tube "strikes" at a predetermined voltage to give a silent and clean-cut action.

Marconi's W.T. Co. and O. E. Keall. Application date 28th July, 1937.

499 785.—Parallel assembly of transparent rods used in television for transferring an image formed on a fluorescent screen on to a light-sensitive layer.

Baird Television; V. A. Jones; and K. A. R. Samson. Application date 29th July, 1937.

499 828.—Cathode-ray television transmitter with a mosaic screen designed to prevent the production of space charges likely to give rise to spurious signals.

Baird Television and T. M. C. Lance. Application date 28th July, 1937.

499 860.—Television transmitting tube fitted with a double-sided mosaic structure and a closely-adjacent photo-electric net or grid.

Radio-Akt. D. S. Loewe. Convention date (Germany) 16th June, 1936.

499 877.—Short-wave amplifier or oscillator in which an accelerating grid is interposed between the cathode and the braking electrode of the valve.

Telefunken Co. Convention date (Germany) 27th June, 1936.

499 963.—Multi-band superhet receiver in which the local-oscillator valve is designed to operate uniformly over the whole range of frequencies.

Marconi's W.T. Co. Convention date (U.S.A.) 30th June, 1936.

500 217.—Negative feed-back system for improving the frequency-characteristic of an amplifier.

Baird Television and D. M. Johnstone. Application date 5th August, 1937.

500 314.—Fluorescent screen and mounting, particularly suitable for a cathode-ray tuning-indicator for a wireless set.

The General Electric Co.; M. Benjamin; and R. J. Ballantine. Application date 17th December, 1937.

501 051.—Band-pass coupling between an aerial and a two-wire feeder, suitable for receiving signals over a wide band of frequencies.

Telefunken Co. Convention date (Germany) 17th July, 1936.

TELEVISION CIRCUITS AND APPARATUS

For Transmission and Reception

498 134.—Method of making a mosaic-cell electrode for a cathode-ray tube without the usual heat treatment.

G. S. P. Freeman. Application date 28th May, 1937.

498 470.—Arrangement of the field-magnets of a loud-speaker so that they do not affect the cathode-ray tube in a television receiver cabinet.

Telefunken Co. Convention date (Germany) 3rd July, 1936.

498 475.—Aerial coupling arrangements for separating sound and vision signals received on the same dipole.

A. C. Cossor; L. H. Bedford; and R. Pollock. Application date 6th July, 1937.

498 672.—Process for making the mosaic-cell electrodes used in television from a backing-plate cut from a bundle of very fine wires.

Radio-Akt. D. S. Loewe. Convention date (Germany) 16th June, 1936.

498 824.—Television tube in which an electrostatic image is produced on a control electrode which is capable of secondary emission and is kept at a fixed potential during the fly-back stroke in scanning.

Baird Television and P. W. Willans. Application date 13th July, 1937.

498 841.—Producing synchronising-impulses for television by means of an inclined mirror disposed at one end of the image and reflecting light from it on to a photo-electric cell.

Radio-Akt. D. S. Loewe. Convention date (Germany) 16th July, 1936.

498 867.—Method of generating television signals in a discharge tube containing a translucent "storage" electrode not of the mosaic-cell type.

Farnsworth Television Inc. Convention date (U.S.A.) 2nd November, 1936.

498 945.—Optical system for preventing "brightness" distortion when transmitting television pictures by interlaced scanning.
The General Electric Co. and D. C. Espley. Application date 15th November, 1937.

499 132.—Band-filter or coupling circuits for a wide-band amplifier such as is used in television.
Radio-Akt. D. S. Loewe. Convention date (Germany) 16th April, 1936.

499 425.—Frequency-selective impedances applied to the detector stage of a television receiver for the purpose of preventing the kind of distortion known as "feathering."
The General Electric Co. and D. C. Espley. Application date 4th November, 1937.

499 538.—Resistance-capacitance-coupled television amplifier designed to ensure a constant state of peak potential without "slip."
Radio-Akt. D. S. Loewe. Convention date (Germany) 16th December, 1936.

499 661.—Light-sensitive tube in which substantially all the electrons emitted from a photo-sensitive cathode pass into an electron-multiplier.
Fernseh Akt. Convention date (Germany) 30th July, 1936.

499 744.—Television transmitter of the kind in which the image is projected on to a photo-sensitive surface and the resulting electric image formed on a second screen is scanned by a ray of light.
Radio-Akt. D. S. Loewe. Convention date (Germany) 30th May, 1936.

499 878.—Saw-toothed oscillation generator for the time-base circuit of a cathode-ray television receiver.
Mullard Radio Valve Co.; C. C. Eaglesfield; and J. Archer. Application dates 27th July and 7th December, 1937, and 21st March, 1938.

500 005.—Cathode-ray tube designed to provide a number of separate streams for multiple scanning in television.
Standard Telephones and Cables (assignees of D. A. S. Hale). Convention date (U.S.A.) 29th May, 1937.

500 036.—Circuit for driving the piezo-electric crystal of a light-modulating cell utilising supersonic pressure-waves, and for rectifying the incoming signals.
Scophony; J. Sieger; and S. H. M. Dodington. Application date 30th April, 1937.

500 358.—Band-pass coupling for reducing disturbances in a circuit for separating signals from synchronising impulses in television.
Marconi's W.T. Co. and D. L. Plaistowe. Application date 7th August, 1937.

TRANSMISSION CIRCUITS AND APPARATUS

(See also under Television)

498 186.—Feed-back circuit with quick-acting A.V.C. for stabilising the frequency of a short-wave transmitter.
Standard Telephones and Cables (assignees of J. W. Smith and G. N. Thayer). Convention date (U.S.A.) 17th October, 1936.

498 331.—Neutralising stage for a short-wave transmitter using push-pull amplification.
Marconi's W.T. Co. (assignees of G. L. Usselman). Convention date (U.S.A.) 14th August, 1936.

498 339.—Electrode system for eliminating anode-to-grid capacitance in a transmitting valve for short-wave working.
The British Thomson-Houston Co. Convention date (Germany) 5th September, 1936.

498 627.—Method of grouping the feed-lines in a wired-wireless system in order to match the impedances between consecutive groups.
C. Lorenz Akt. Convention date (Sweden) 27th November, 1936.

499 536.—Electrode system of a valve designed to generate short-wave oscillations at high power.
Marconi's W.T. Co. (assignees of P. D. Zottu; L. S. Nergaard; and A. V. Haeff). Convention date (U.S.A.) 1st December, 1936.

499 546.—Ultra-short-wave generator with means for offsetting the effect of low-frequency fluctuations in the mains supply voltage.
Philips' Lamp Co. Convention date (Germany) 8th March, 1937.

499 604.—Ultra-short-wave valve-oscillator with means for adjusting the inter-electrode spacing.
Standard Telephones and Cables (assignees of C. A. Bieling). Convention date (U.S.A.) 7th November, 1936.

500 831.—Secret system of signalling which cannot be deciphered by identifying characters according to the frequency with which they recur.
H. O. Rugh. Application date 12th January, 1938.

CONSTRUCTION OF ELECTRONIC-DISCHARGE DEVICES

497 763.—Method of mounting and spacing the electrodes of a thermionic valve so that they are resilient though free from microphonic noise.
Marconi's W.T. Co. Convention date (U.S.A.) 27th June, 1936.

497 808.—Arrangement of transverse plates, in a screened cage, for controlling the intensity of the electron stream in a cathode-ray tube.
C. Lorenz Akt. and W. Rogowski. Convention date (Germany) 25th August, 1936.

498 484.—Electrode system of a cathode-ray tube in which the anode nearest the cathode carries the highest applied operating-voltage.
A. C. Cossor; E. E. Shelton; and B. C. Fleming-Williams. Application date 9th July, 1937.

498 511.—Controlling the deflection of an electron stream by varying the inclination of equi-potential surfaces from which the electrons are reflected.
O. Klemperer. Application date 1st May, 1937.

498 566.—Electron-multiplier in which a "cloud" of electrons is constantly moved towards and away from a surface for producing secondary emission.
Farnsworth Television Inc. Convention date (U.S.A.) 22nd March, 1937.

498 703.—Construction and assembly of the electrode system in an amplifier of the kind utilising secondary emission under the control of combined magnetic and electrostatic fields.

The General Electric Co. and A. E. McLeod. Application date 9th October, 1937.

499 218.—Electron discharge tube in which secondary emission is utilised and in which the transit-time of the stream is definitely related to the working wavelength.

Marconi's W.T. Co. and G. B. Banks. Application date 20th July, 1937.

499 532.—Mounting the cathode of a cathode-ray tube so as to prevent the deposition on adjacent surfaces of metal evaporated from it.

The General Electric Co. and J. G. Hobday. Application date 15th November, 1937.

499 649.—Magnetic control system for a discharge tube of the electron-multiplier type.

Marconi's W.T. Co. Convention date (U.S.A.) 22nd July, 1936.

499 815.—Electrode system for a cathode-ray tube in which a series of rings with progressively increasing voltages is used to intensify the electron stream.

Radio-Akt. D. S. Loewe. Convention date (Germany) 28th July, 1936.

499 869.—Method of mounting a photo-sensitive cathode on a supporting surface located within a re-entrant part of the glass stem of the discharge tube.

H. G. Lubszynski; H. Miller; and J. E. I. Gairns. Application date 26th June, 1937.

500 017.—Arrangement and spacing of the electrodes forming the "gun" of a cathode-ray tube.

C. Lorenz Akt. Convention date (Germany) 5th May, 1937.

500 361.—Electrode arrangement for a valve of the so-called "beam" type designed to reduce inter-electrode capacitance.

Marconi's W.T. Co. and G. F. Brett. Application date 7th August, 1937.

500 447.—Electron multiplier in which a series of U-shaped "target" electrodes are arranged between the primary cathode and the output electrode so as to leave an open channel along the main axis.

Electrical Research Products Inc. Convention date (U.S.A.) 20th November, 1936.

SUBSIDIARY APPARATUS AND MATERIALS

497 768.—Wheatstone-bridge arrangement of elements having a non-linear resistance, used as a voltage-regulating device between the supply mains and a load.

Automatic Telephone and Electric Co. and M. O. Williams. Application date 28th June, 1937.

498 340.—Adjustable holder for mounting different sizes of piezo-electric crystals, according to the working frequency required.

Marconi's W.T. Co. (assignees of W. F. Diehl). Convention date (U.S.A.) 31st October, 1936.

498 389.—Design of condenser in which one plate is moved vertically towards or away from a fixed plate to vary the capacitance, particularly for "trimming" purposes.

British Mechanical Productions and K. N. Hawke. Application date 3rd July, 1937.

498 435.—Microphone system in which two condenser or electrostatic instruments of different frequency-characteristics are connected in parallel to a common output transformer.

E. Reisz. Application date 14th February, 1938.

498 116.—Construction of a transmission-line of the so-called dielectric-guide type for carrying high-frequency currents.

Allgemeine Elektricitats Ges. Convention date (Germany) 4th March, 1937.

498 794.—Converting high-frequency electrical oscillations into supersonic mechanical oscillations by a rod of quartz, or a bar having a magneto-strictive action, and shaped to have a progressively-variable cross-section.

Cie. Gen. de Telegraphie Sans Fil. Application date 30th March, 1938.

498 865.—Thermionic amplifier coupled to a photo-electric cell and comprising means for safeguarding the cell against excessive variations on the applied polarising voltage.

Electrical Research Products Inc. and T. Blashill. Application date 10th September, 1937.

499 225.—Method of mounting a piezo-electric crystal so as to reduce "band-width" and "current increment."

Marconi's W.T. Co. (assignees of F. W. Smalts). Convention date (U.S.A.) 30th September, 1936.

499 317.—Transmission line for very high frequencies with distortion means at the input and a correcting network at the output to reduce the normal attenuation losses and phase-changes.

Standard Telephones and Cables; K. G. Hodgson; and W. N. Roseway. Application date 21st July, 1937.

499 590.—Filter circuit comprising a number of half-wave or quarter-wave transmission-line units arranged in series.

Belling and Lee and F. R. W. Strafford. Application date 21st July, 1937.

499 891.—Method of producing a photo-sensitive surface in which any excess of alkali metal is oxidised instead of being removed.

Farnsworth Television Inc. Convention date (U.S.A.) 18th August, 1936.

500 762.—Contrivance for mounting and displaying on a wireless or television receiver a synopsis of the daily programmes.

A. Shawarzwald. Application date 17th January, 1938.