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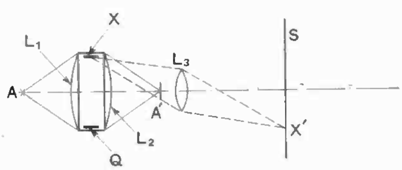
Editorial

The Use of Supersonic Waves as a Light-relay in Television

THE action of a ruled grating in optics is well known. It consists of a succession of narrow transparent strips separated by narrow opaque strips. When light is transmitted through such a grating the adjacent transparent strips may be regarded as sources of light of the same phase, and if the length of the path to the screen is the same the rays will arrive in phase. For points on the screen for which the length of path from adjacent windows differs by a wavelength or exact multiples of a wavelength the waves will also arrive in phase and give a bright line, but for intermediate points the light arriving from one window will be out of phase with that from an adjacent window, and for those points for which the length of path from adjacent windows differs by an odd number of half wavelengths the resultant illumination will be zero. In this way a succession of bright lines is obtained on either side of the central line.

It was in 1932 that Debye & Sears showed that if high-frequency supersonic waves are produced in a liquid, the successive strata of liquid at different pressures acts as a grating due to the dependence of the coefficient of refraction upon the hydrostatic pressure. Suggestions have been made from time to time that this phenomenon should be utilised for the purposes of television and doubtless more would have been heard of it had not attention been so largely confined to the cathode-ray tube. In October, 1937, we published an article by F. Okolicsanyi describing the methods developed by the Scophony Co. along these lines, and in a recent number of the *E.T.Z.* (9th Feb.) G. Otterbein gives a general survey of the subject with special reference to the article referred to.



The basic idea is illustrated in the figure in which the trough containing carbontetrachloride—a liquid which Becker has found to be the most suitable—is flanked on either side by the lenses L_1 and L_2. The source of light A is thus brought to a focus at A' where a small opaque screen prevents it going any further and more particularly prevents it from falling on the screen S. The trough itself and any source of light that it may contain is focussed on the screen S by means of the lens L_3. At one end of the trough is an oscillating quartz crystal Q with a frequency of about 10 million cycles per second, and at the other end an absorbing wall of cork or some such material, so that the waves are absorbed on arrival without appreciable reflection.

Now the brightness of the point X' on the screen S is proportional to the amplitude of the sound wave, i.e., to the pressure variations in the liquid at X, and this depends on the amplitude of the quartz oscillations *a short time before*, viz., when the wave X left the quartz. The oscillations of the quartz are modulated by the received picture signals, and if a line is scanned in the time taken for the sound wave to travel along the trough, the whole line in all its light and shade is represented at the moment by the variation of amplitude of the waves in the trough.

Intermediate System

It is this storage of the picture points in this system that leads Otterbein to maintain that it is a kind of intermediate system between ordinary television and the film system. Each picture point or element is impressed on the wave and lives as long as the wave travels along the trough, being represented on the screen S by a line and not by a point. For the purposes of television, however, this line must be compressed into a point or picture element, and this can be done by interposing a mirror drum in the path of the light and rotating it at such a speed that the above movement of the spot across the screen is exactly counterbalanced. Thus the sound wave travelling along the trough tends to move the spot in one direction and the rotating mirror tends to move it at exactly the same speed in the other direction with the result that the picture element on the screen remains stationary and is illuminated during a time corresponding to a line. This increased illumination is one of the great advantages of the system. The modulation of the oscillations of the quartz causes variations in the amplitude of the supersonic waves emitted, and adjacent variations of amplitude are reproduced on the screen as adjacent variations of illumination. In addition to the rotating mirror drum already referred to, there will be another mirror drum rotating more slowly and at right angles. For 441 lines and 25 pictures per second, Otterbein states that the former, the line scanner, with 21 mirror segments requires to rotate at 31,500 revolutions per minute, while the latter, the frame scanner, with 15 mirror segments need only rotate at 100 revolutions per minute.

Practical Difficulties

This system which is largely due to J. H. Jeffree calls for one's admiration, but mirror drums rotating at 31,500 revolutions per minute are not very attractive. Various ways of avoiding this disadvantage have been devised; some were described in the article referred to. If one gives up the steady illumination of the trough and allows the modulated waves to travel along the trough in darkness until a whole line of the picture occupies the length of trough, one can then reproduce the line by means of a momentary flash triggered off automatically by the synchronising impulse. Very high illumination could be employed during the flash, and a suitable lamp for the purpose is the high-pressure mercury vapour lamp. Unfortunately, the flash cannot be made of short enough duration to give a sharply defined picture; to do this it would have to be reduced to less than a millionth of a second. One is thus forced to use a mirror moving in such a way as to counteract the movement of the image during the flash, but this need not be a rotating mirror but one rocking through a small angle at the necessary speed at the moment of illumination.

Although one cannot but admire the ingenuity displayed in these applications of beautiful scientific phenomena to the problems of television one can readily understand the tendency to look to the cathode-ray tube as the more promising field of development. The cathode-ray tube has its limitations, however, and in the field of large-scale television the principles that we have described may find a successful application.

G. W. O. H.

Noise Reduction by Means of Photo-electric Multipliers*

By F. Preisach, Dr. Ing.

(Tungsram Research Laboratory)

ELECTRON multipliers were introduced for the amplification of weak photo-electric signals, due to the improvement available in signal to noise ratio. In certain applications, background noise could be considerably reduced in comparison with circuits utilising photocells and conventional amplifier valves.[1] No general indication was given however about the gain in sensitivity obtainable by the use of photo-multiplier valves, instead of ordinary photo-cells. In many cases of practice the gain in light sensitivity will be questioned if the same signal to noise ratio is tolerated as in the ordinary arrangement.

Leaving aside problems of design and operating data of multiplier valves, simple computations will be given with the purpose of answering this question in a general manner.

Limit of Sensitivity in Circuits with Ordinary Photocells

Fig. 1 shows the conventional circuit used in amplifying photo-electric signals. The primary electric signal consists of a current fluctuation due to photo-electrons transformed with the aid of the resistance R into voltage fluctuation, which may be amplified with valves in the ordinary way. The limit of sensitivity is determined—apart from the light sensitivity of the photo-electric surface—by the background noise of the arrangement. Three sources of noise may be distinguished:

(1) noise of photocell, due to shot effect of photo-electrons,

(2) Johnson effect of the resistance R,

(3) noise of the first amplifier valve due to shot effect of thermionic electrons.

The third noise source may be taken into account as an "equivalent resistance" in series with the resistor R. This equivalent resistance of modern valves is small enough to be considered in many cases as a correction for the value of R. This noise component will not be treated in detail.

The mean square noise current $\bar{i}^2$ of a vacuum cell is

$$\bar{i}^2 = 2e\,I_a\Delta f \quad \ldots \quad (1)$$

where $e = 1.59 \times 10^{-19}$ Coul. is the charge of the electron, I_a the direct current of the photocell and Δf the width of the frequency band transmitted.[2]

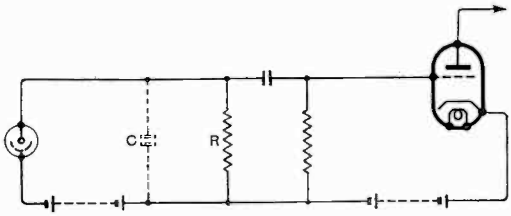


Fig. 1.

The mean square noise voltage $\bar{v}^2$ generated in the resistor R (see Fig. 1) due to Johnson effect is

$$\bar{v}^2 = 4kT\,R\Delta f \quad \ldots \quad (2)$$

$k = 1.37 \times 10^{-23}$ Joule/degree being Boltzmann's constant, T the absolute temperature. Supposing that R represents also the A.C. impedance of the photocell (shunting capacitances being neglected) the square of the ratio of shot noise to Johnson noise in the output of the cell may be easily calculated to

$$\frac{\bar{i}^2R^2}{\bar{v}^2} = \frac{I_aR}{2kT/e} = \frac{I_aR}{2V_T} \quad \ldots \quad (3)$$

We designated kT/e with V_T a "tempera-

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

[1] V. K. Zworykin, G. A. Morton, and L. Malter: *Proc. Inst. Rad. Eng.*, 1936, Vol. 24, p. 351.

[2] Flicker effect, and noise of gas-filled cells are excluded from our considerations.

ture voltage," characterising the thermal energy of electrons in a pure resistance at the absolute temperature T. Formula (3) shows, that the ratio of the two noise components is independent of bandwidths and is given by the ratio of the D.C. voltage drop on the resistor to twice the temperature voltage of the same resistor. At room temperature ($T = 300°$) $V_T = 0.025$ volts, hence the square of the ratio of shot noise to Johnson noise will be

$$\frac{i^2R^2}{\bar{v}^2} = \frac{I_aR}{50} \quad \ldots \quad \ldots \quad \ldots \quad (3a)$$

where I_aR is measured in millivolts.

Noise considerations are of interest in the case of weak signals only, therefore it is likely that the D.C. drop will be small compared with 50 mV, and thus cell noise will be negligible. We wish, however, to discuss this point in detail.

The amount of Johnson noise may be estimated with the aid of formula (2). The resistance R being given, the noise increases with increasing bandwidth of the amplifier. The upper frequency limit of the amplifier cannot be increased, however, indefinitely as the resistance R is shunted by a capacitance C representing the sum of the capacities of photocell, wiring and amplifier valve. For frequencies comparable with $1/2\pi RC$ and higher than this value, formula (2) must be corrected replacing R by the resistive component of the impedance formed by the parallel branches of R and C. Formula (2) must be changed to:

$$\bar{v}^2 = 4kT \int_{f_1}^{f_2} \frac{Rdf}{1 + (2\pi f RC)^2} \quad \ldots \quad \ldots \quad (4)$$

the bandwidth Δf being equal to the difference of the limiting frequencies $f_2 - f_1$. The largest possible noise voltage results from this formula if the bandwidth of the amplifier is assumed to be infinite. Putting $f_1 = 0$, $f_2 = \infty$ and calculating the integral value we get

$$\bar{v}^2_{max} = kT/C \quad \ldots \quad \ldots \quad \ldots \quad (4a)$$

The maximum r.m.s. value of Johnson voltage on the resistor R $V_{R\,max} = \sqrt{\bar{v}^2_{max}}$, obtained for an infinite bandwidth is consequently $V_{R\,max} = \sqrt{kT/C}$. For room temperature putting $k = 1.37 \times 10^{-23}$ and $T = 300°$

$$V_{R\,max} = 10\sqrt{41/C} \quad \ldots \quad \ldots \quad (4b)$$

if the voltage is measured in microvolts and the capacitance in micro-microfarads.

For the amplification of a wide frequency range without distortion, the load of the photocell must be independent of frequency. For a given bandwidth Δf, R must be chosen according to the value of the capacitance C. As the load resistance of the photocell is given by $R/\sqrt{1 + (2\pi f RC)^2}$ if the shunting effect of C is taken into account, it is convenient to choose as "upper frequency limit" of the amplifier the frequency $f_2 = 1/2\pi RC$, giving a load resistance $R/\sqrt{2}$. Thus we have a decrease of signal voltage of 30 per cent. at the frequency f_2, and the choice of the upper frequency limit is justified. Using an amplifier with the bandwidth $f_2 - f_1$, the noise voltage will be reduced by 20-30 per cent. when the exact formula (4) is taken into account instead of formula (4a).

For practical purposes formula (4a) gives indication of the order of magnitude of Johnson noise. It is determined solely by the circuit capacitance C, i.e., the sum of the capacitances of cell, amplifier valve-input and wiring. Assuming $C = 20\,\mu\mu$F we get a *Johnson noise voltage of 15 μV, which is a value not exceeded by conventional valves and cells, and generally approximated to if a good sensitivity is claimed.*

The quantitative interpretation of formula (3) can now be understood more clearly. (For circuits of wide range amplification, the practical rule $f_2 = 1/2\pi RC$ being observed, the shunting effect of the capacity can be neglected and formula (3) remains valid.) According to this formula cell noise exceeds Johnson noise if the light signal is increased until D.C. output is larger than 50 mV, which is the 3,000-fold value of Johnson noise. The ratio of D.C. output to A.C. output is given by the modulation factor M of light, viz., ratio of alternating light to average light. Even if this factor of modulation is only 0.1, the ratio of signal to Johnson noise exceeds 300 for a state of operation in which cell noise exceeds Johnson noise. As in practice much smaller values of signal to noise ratio are tolerated, noise effects begin to be of interest only in dealing with considerably smaller light signals. For the limiting signal strength for which the tolerated amount of signal to noise ratio arises—order of magnitude 3 to 15—cell noise may be neglected.

These considerations serve to establish the general rule that in amplifying photo-electric currents of wide frequency range, the *useful limit of sensitivity is determined by a noise that arises in the load resistance during the process of transformation of signal current into signal voltage.*

Comparison with Electron Multipliers

The preceding remark leads us to the general conclusion that a direct *amplification of photo-electric current* must be advantageous over conventional voltage amplification. By supposing the application of a hypothetical "element of current amplification" between photocell and amplifier, signal strength may be raised above the level of Johnson noise. As in this case Johnson noise (and valve noise too) may be practically suppressed, only cell noise remains to be considered for the determination of the limit of sensitivity. This theoretically deduced need for a current amplifier device is already fulfilled in practice by the invention of the electron multipliers. These valves use the secondary emission of activated surfaces for the amplification of electron currents in vacuo. The electron multiplier device will be dealt with as an ideal element of current amplification, viz., an element that does not introduce noise into the arrangement.

To calculate the gain in sensitivity available with multipliers, we assume a certain value ρ of signal to noise ratio. For this ratio the minimum value of photo-current will be computed (1) for the conventional circuit with a photocell, (2) for a circuit with an electron multiplier. The ratio of these minimum signal currents determines the ratio of useful sensitivity of said arrangements.

In the first case cell noise may be neglected according to computations of the preceding paragraph. According to formula (2) the minimum useful value of signal current I_{sc} for a photocell is:

$$I_{sc} = \rho \sqrt{\frac{4kT\Delta f}{R}} \qquad \ldots \quad \ldots \quad (5)$$

In the second case we assume a noiseless multiplication with a factor γ, which is sufficiently high, so that Johnson noise of the multiplier load may be neglected. To determine the minimum signal current of the photo-cathode of the multiplier I_{sm}, we apply formula (1) for the cathode current I_{a1} of the multiplier. Signal to noise ratio will be:

$$\rho = \frac{I_{sm}}{\sqrt{2eI_{a1}\Delta f}}$$

The relation between r.m.s. signal current I_{sm} and direct current I_a is: $I_{sm} = 1/\sqrt{2}\, MI_a$ (M being the modulation factor), therefore:

$$I_{sm} = \rho^2 \frac{\sqrt{2}}{M} 2e\Delta f \qquad \ldots \quad \ldots \quad (6)$$

Comparing formulae (5) and (6) the ratio of the useful minimum signals is:

$$\frac{I_{sc}}{I_{sm}} = \frac{M}{\rho} \sqrt{\frac{kT}{2e^2R\Delta f}} \qquad \ldots \quad \ldots \quad (7)$$

In practice (transmission of audio and video frequency ranges) the lower frequency limit of the range is small compared with the bandwidth, thus the product $R\Delta f$ is approximatey equal to Rf_2 (f_2 being the upper frequenfy limit). This product is consequently determined alone by the natural capacitance C parallel to the load resistance R. This resistance must be small enough to reduce the decrease of amplification of high frequencies and at the same time large enough for the photocell output to be fully utilised. As pointed out in the previous section it may be considered usual to put $Rf_2 = 1/2\pi C$, the result being:

$$\frac{I_{sc}}{I_{sm}} = \frac{M}{\rho} \sqrt{\frac{\pi kTC}{e^2}} = \frac{M}{\rho} \sqrt{\frac{\pi V_T}{e/C}} \qquad \ldots \quad (8)$$

This formula shows in general terms the gain in useful sensitivity by using an electron multiplier. It may be noted, that besides physical constants our formula contains only the desired value of signal to noise ratio ρ, the modulation factor of light M and the circuit capacitance C. The voltages under the square-root have a simple meaning: V_T is the temperature voltage of the load resistor, e/C is the value of the peak voltage on the terminals of a photocell charged by a single electron (see Fig. 1). At room temperature $V_T = 0.025$ V and, assuming $C = 20\ \mu\mu$F, $e/C = 0.8 \times 10^{-8}$ volt. The ratio of the voltages mentioned is 3.2×10^6. Putting this value into formula (8) we obtain the gain in useful sensitivity:

$$\frac{\text{minimum signal photocell}}{\text{minimum signal multiplier}} \approx \frac{M}{\rho}\,3{,}200 \quad \text{(8a)}$$

a practical formula containing only the two most important factors M and ρ. Supposing 100 per cent. modulated light ($M = 1$), and a signal to noise ratio $\rho = 5$, the gain is 640-fold. With $M = 0.5$ and $\rho = 10$ we still obtain a 160-fold gain using an electron multiplier.

We have now to estimate the importance of two noise sources neglected in deducing formula (8):

(*a*) the noise of the amplifier valve in the ordinary circuit,

(*b*) the additional noise resulting from secondary emission in electron multipliers.

If valve noise is taken into account R in formula (5) must be replaced by $\frac{R}{1 + R_{eq}/R}$ giving the additional factor of $\sqrt{1 + R_{eq}/R}$ in formulae (8) and (8a) if valve noise is measured by means of the equivalent resistance R_{eq}. For the amplification of extremely wide frequency ranges this must be taken into account. For example, putting $\Delta f = 2 \times 10^6$ (television range) and $R = 4{,}000\ \Omega$ and using a modern high slope valve for cell amplification with $R_{eq} = 1{,}000\ \Omega$, the ratio represented by formula (8) is increased by 10 per cent. If a smaller load resistance must be used or noisier valves are inserted the correction factor may however become an important one.

Taking the valve noise in the photocell arrangement into account, the ratio in formula (8a) was increased. On the other hand, an additional noise effect of secondary emission in multipliers tends to decrease the same ratio. The source of this additional noise of multipliers is located in the targets of secondary emission and is caused by fluctuation of the factor of secondary emission. If this factor is large enough, it is sufficient to deal with the fluctuation of the first multiplying target. According to the measurements of Zworykin, Morton, and Malter[1] it is permissible to calculate this additional noise as if the first multiplying electrode would cause a noise according to the amount of its electron emission and use formula (1). This phenomenon results in increased noise output by a factor of $\sqrt{n/n-1}$ if n is the factor of secondary emission of the first target. With $n = 5$ this additional noise is 10 per cent. The theoretical gain in sensitivity in formula (8a) is to be reduced by this amount.

Thus, for application in the television range (to which our examples referred) the effects neglected in formula (8) almost cancel each other.[3]

As a result of discussing formula (8) we may roughly establish a rule, putting average values for M and ρ consistent with practice that *the gain in sensitivity to be attained with photo-electron multipliers is practically 200-fold.*

We must emphasise that the basic assumption of our considerations is that we compare photocells and multipliers having the same light sensitivity of photo-electric surface.

Amount of Current Amplification Necessary

It was assumed above that signal current would be amplified within the electron multiplier to such a degree that the Johnson noise of the load resistance may be neglected. We have to determine now the amount of current amplification necessary for our assumption to be approximately fulfilled. Designating the ratio of shot noise to Johnson noise in the multiplier output with σ, we obtain

$$\sigma^2 = \gamma^2 \frac{I_{a1} R}{2 V_T} \quad \text{(3a)}$$

similarly as in formula (3), if I_{a1} is the direct current of photo-cathode and γ the current amplification of the multiplier valve. The value γ necessary for a ratio σ being in consequence

$$\gamma = \sigma^2 \sqrt{\frac{2 V_T}{I_{a1} R}} \quad \text{(9)}$$

[3] In certain cases a further noise source in multipliers may be detected. This is thermionic electron emission of the photo-cathode at room temperature. It has the same effect as a superimposed constant light and may be formally accounted for by a reduction of the modulation factor M. Thermionic emission of caesium-coated photo-cathodes at room-temperature is approximately 10^{-12} A/cm². Thus it only plays a part if D.C. current of photo-cathode is reduced to a degree making it comparable with the value of thermionic emission.

The maximum value of current amplification γ_{max} is necessary, when we deal with the minimum signal current. Using formula (6) and proceeding in the same way as in deducing (8a) we obtain

$$\gamma_{max} = \sigma^2 \frac{M}{\rho} 3,200 \quad \ldots \quad (9a)$$

Assuming $\sigma = 1$ the result we obtain is the same as given by formula (8a). Supposing an electron multiplier so constructed as to give an amplification equal to the "gain in useful sensitivity" (8a) shot noise of photo-electrons of minimum signal current must be equal to Johnson noise. Consequently $\sigma = 1$, and thus (8a) and (9a) give the same value. An electron multiplier designed in this way gives 70 per cent. of the useful maximum sensitivity available and computed in formula (8a). In order to approximate to the gain in sensitivity given by formula (8a), we have to consider $\sigma > 1$ and thus to build multipliers with greater amplification. Taking $M = 1, \rho = 3$ and $\sigma = 3$ as an example resulting in a great amplification we obtain $\gamma_{max} = 10,000$. In other practical examples the current amplification necessary may often be reduced below 1,000.

If, as is assumed in this paper, current amplification is employed solely for the purpose or reducing background noise, the electron multipliers need not have an amplification factor greater than 10,000.

Electron Optics

By L. M. Myers. Pp. 618 + xviii. Published by Chapman and Hall Ltd., 11, Henrietta Street, London, W.C.2. Price 42s.

The subject of electron optics is one which is rapidly growing in importance, especially as its principles are now finding application in valves. Up to the present the literature on the subject has been very scattered and a large part of it has been in German. A text-book dealing thoroughly with electron optics is thus to be greatly welcomed.

The author begins by discussing analogies between light and electrons and enunciates the fundamental laws of electron optics. He then goes on to consider the path of the electron in electrostatic and in magnetic fields. A chapter on electron lenses follows and then one dealing with aberrations.

The electron multiplier and the electron microscope have chapters to themselves and there is a long discussion of vacuum technique. In his concluding chapter the author deals with a large number of general points which arise in connection with electron optical apparatus.

This brief enumeration of the chief contents of the book gives little idea of the enormous quantity of information contained in it. There are only eight chapters, but some of them are themselves nearly as long as ordinary books. For instance, Chapter III on electron lenses has 142 pages.

The treatment is very complete and mathematics is freely used. There is a bibliography of 23 pages and an index. The book is well illustrated.

In his preface the author says that the book is intended primarily for the graduate student. It is more than a text-book, however, it is a reference book which the vacuum physicist will want to keep by him.

W. T. C.

The Industry

A COMPANY has been formed under the chairmanship of Mr. W. J. Brown, B.Sc., A.M.I.E.E., M.Inst.R.E., to handle American and other products and to investigate problems and give service in connection with their use. The name of the company is Electronic Engineering Services Ltd., Swakeleys Road, Uxbridge, Middlx., and components handled include "Ohmite" resistances, "Gammatron" valves and the Tobe-Deutschman "Mu-switch."

A new range of ceramic-coated power wire-wound resistances is described, with particulars of temperature rating in Bulletin R.339. 15–17, issued by the Dubilier Condenser Co. (1925), Ltd., Victoria Road, North Acton, London, W.3.

We have received from Unitran Electro-Technische Fabriek, Looierslaan, 3, Voorburg, Holland, a catalogue in English giving full technical details of their high-quality audio frequency transformers.

A complete technical specification of the Model 3339 double beam oscillograph is included in a descriptive leaflet recently issued by A. C. Cossor, Ltd., Highbury Grove, London, N.5.

The 13th edition of the descriptive pamphlet DP11 dealing with the principles and applications of the Westinghouse metal rectifier has just been issued and has been completely revised. A leaflet (F) dealing with the "Noregg" and "Westat" constant voltage rectifying systems has been issued as a supplement.

Forthcoming Meetings

April 5th.—I.E.E., Wireless Section, "Radio in Aviation," N.S.S. Hecht.

April 19th.—Television Society (open to visitors), at the I.E.E., "Electron Optics," L. M. Myers.

May 3rd —I.E.E., Wireless Section, "Audio-Frequency Equipment at the London Television Station," I. L. Turnbull and H. A. M. Clark.

High Frequency, Mixing and Detection Stages of Television Receivers*†

By M. J. O. Strutt

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

SUMMARY.—In Section I it is shown that television input signals should be 1 or 2 millivolts at least, in order to be sufficiently above the noise level. This entails a total gain from the aerial up to the second detector of about 5,000. In Section II a receiver diagram used by the Philips Co. in 1936 is described. Two new experimental receiver diagrams are then dealt with. In Section III straight H.F. amplification, using three valve types, of which two are new experimental types, is described, applying three stages between the aerial and the second detector. Section IV deals with the construction of and measurements on an experimental chassis, embodying the features of Section III. The preceding calculations and measurements lead up to a general study of the conditions which valves in television receivers should satisfy (Section V). Section VI deals with a mixer stage and a corresponding superhet television receiver, using the new experimental valves described. In Section VII the conditions to be imposed on a diode, which is used as a second detector in a television receiver, are deduced and a new diode, favourable for this purpose, is described.

I. External and Internal Noise, Input Signal Strength, Necessary Amplification

It has been found, that *external noise*, caused by automobile ignition systems, diathermic short wave apparatus and such like is so high in metropolitan centres, that unimpaired reception of television images is only possible, if the input signal strength of the receiver is more than about 1 millivolt. It is assumed here, that the carrier frequency is about 40 Mc/s and that the band width corresponds to a transmission of about 400 lines.

Referring to the London Alexandra Palace transmitter, the sound carrier has a frequency of 41.5 Mc/s and the picture carrier is at 45 Mc/s (7.23 and 6.67 m wavelength respectively). In many receivers, the first H.F. stage is designed to amplify the sound carrier with its side bands and, moreover, the carrier and one side band of the image. If we take a single LC-circuit between the aerial and the input grid, the necessary band width of this circuit to accommodate these frequencies is about 4 Mc/s. This band width may be taken equal to the resonant width B of a flywheel circuit (Fig. 1), i.e. to the frequency width, for which the impedance of the circuit has fallen to 0.707 of its resonant value. The resonant impedance R of a circuit with a capacitance C is given by the equation: $R = (2\pi CB)^{-1}$, where R is expressed in ohms, C in farads and B in c/s.

Coming to the *internal* noise level of a television receiver, it may be observed that this is generally due to the Brownian electronic motion in the receiver input circuit and in the first valve (shot effect). In some cases the electronic noise of the second receiver circuit and of the second valve may also be perceptible. Considering a resistance R (ohms), a certain effective voltage

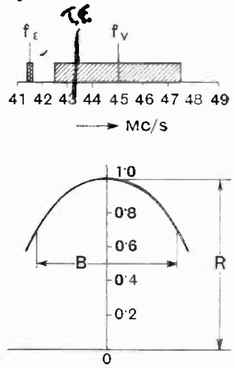


Fig. 1.—*Upper part of figure: The vision- and audio-carrier frequencies f_v and f_a, corresponding to the Alexandra Palace transmitter, together with the modulation side bands. Lower part of figure: Resonance curve of a flywheel circuit (impedance as a function of frequency), tuned so that the audio carrier with its side bands, together with the vision carrier and one side band, are included within the "band width" B of the resonance curve (being the frequency interval corresponding to a drop of the impedance to $1/\sqrt{2}$ of its maximum value).*

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

† Lecture delivered at the International Conference on Television, organised by the Physikalische Gesellschaft Zürich, Switzerland, September 19th–22nd, 1938.

E_{kr} is developed across its ends, due to electronic noise. This voltage is given by:

$$E_{kr}^2 = 4kTRB \text{ (volts)}^2 \quad \ldots \quad \ldots \quad (1)$$

where k is Boltzmann's constant (1.37×10^{-23} Joule degree^{-1}), T the temperature of the resistance R in absolute degrees (273 absolute degrees = 0 degrees Celsius) and B is the frequency interval under consideration, assuming an ideal rectangular filter response curve, in c/s. The values of R and B may approximately be identified with the corresponding values R and B as defined above in connection with a flywheel circuit. Shot noise of amplifying valves may be compared with the electronic noise of a resistance. This equivalent resistance is assumed to be connected between input grid and cathode and is given by:

$$R_{ers} = 2500 \frac{f}{S} \text{ (ohms)} \quad \ldots \quad \ldots \quad (2)$$

where S is the mutual conductance, expressed in mA/V and f a factor, depending upon the construction of the valve. With triodes f is usually about 2 and with multigrid valves f varies between 6 and 10. Special low shot noise valves (e.g. Mullard EF8) have values f of about 3. With the aid of the above equations we may consider the internal noise level of television receivers quantitatively. We assume the input flywheel circuit to have a total capacitance of 30 $\mu\mu$F (including the valve input capacitance), whilst the band width B = 4 Mc/s. Then R is about 1,300 ohms. Eq. (1) gives a circuit noise of about $E_{kr} = 10^{-5}$ volts. The equivalent noise resistance of a normal amplifying valve having a mutual conductance of 4 mA/V is between 3,000 and 6,000 ohms on 7 m wavelength. The electronic noise of this resistance (taking 6,000 ohms) is $\sqrt{6/1,3}$ times the circuit

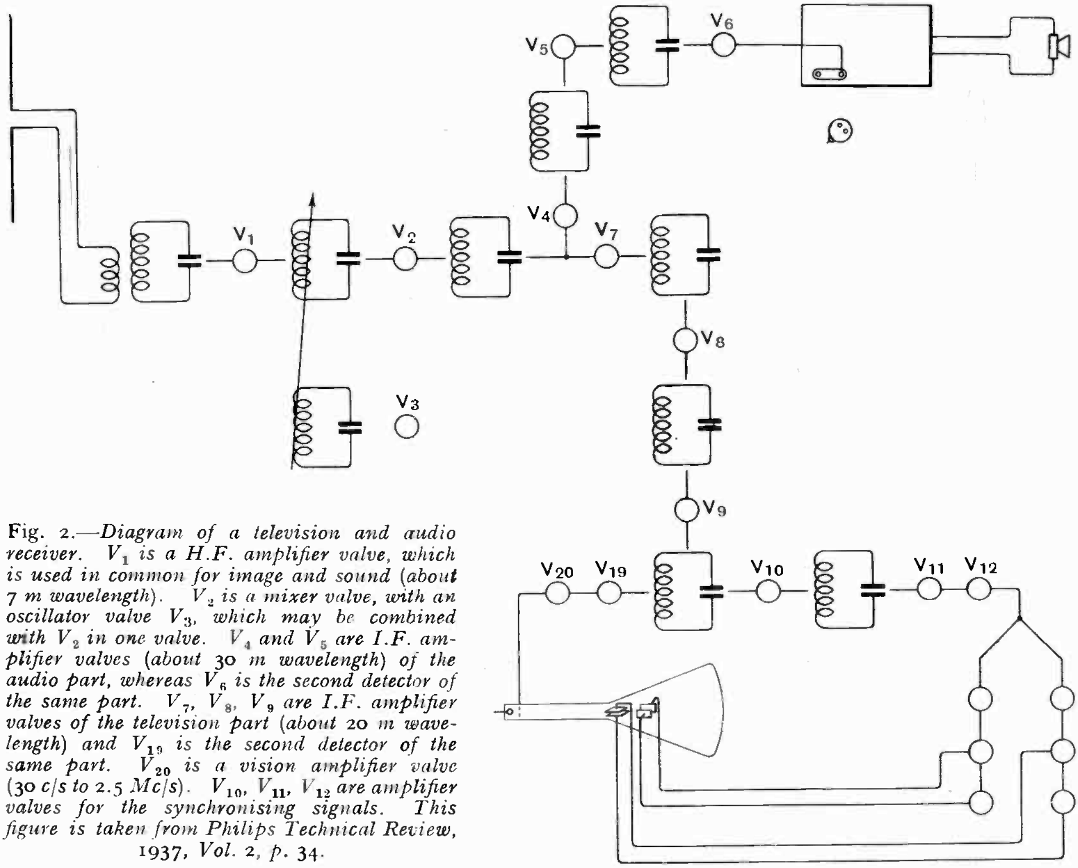


Fig. 2.—*Diagram of a television and audio receiver.* V_1 *is a H.F. amplifier valve, which is used in common for image and sound (about 7 m wavelength).* V_2 *is a mixer valve, with an oscillator valve* V_3*, which may be combined with* V_2 *in one valve.* V_4 *and* V_5 *are I.F. amplifier valves (about 30 m wavelength) of the audio part, whereas* V_6 *is the second detector of the same part.* V_7, V_8, V_9 *are I.F. amplifier valves of the television part (about 20 m wavelength) and* V_{19} *is the second detector of the same part.* V_{20} *is a vision amplifier valve (30 c/s to 2.5 Mc/s).* V_{10}, V_{11}, V_{12} *are amplifier valves for the synchronising signals. This figure is taken from Philips Technical Review,* 1937, *Vol.* 2, *p.* 34.

noise. Hence, in the case considered, valve noise is more important than circuit noise. The effective noise voltages E_{kr} due to the

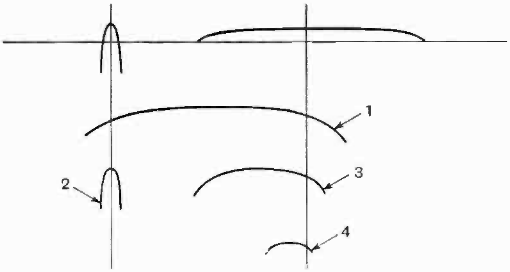


Fig. 3.—*Schematic representation of the various frequency ranges occurring in the receiver, shown in Fig. 2. Upper part: Signals of sound and of vision. 1: Frequency ranges of the stages V_1 and V_2 of Fig. 2. 2: Frequency range of the stages V_4 to V_6 of Fig. 2. This range has been drawn so as to fall inside the figure; its frequency is, of course, much lower than the frequencies of the other parts of this Fig. 3. 3: Ranges of the stages V_7 to V_9 of the vision part (also somewhat displaced as to their absolute frequency values). 4: Range of the stages V_{10} and V_{12}. This figure is taken from Philips Technical Review, 1937, Vol. 2, p. 34.*

circuit and E_v due to the valve have to be added by squares in order to obtain the resultant noise voltage: $E_{res} = (E_{kr}^2 + E_v^2)^{\frac{1}{2}}$. If we have an input signal of 1 millivolt at the input grid of the first valve and a noise voltage of 0.02 millivolts, the modulation depth of the signal by the noise is 4 per cent., which value may be considered as somewhat too high for good reception quality. Hence, in this case, the input signal strength should be more than about 2 millivolts.

The necessary voltages at the cathode-ray tube input are about 50 to 100 volts (modern tubes need less: 20 to 30 volts are required for the Mullard 3962 tube). Taking 2 millivolts at the grid of the first receiver valve, the total amplification is of the order of 50,000. This total amplification may be distributed over the high frequency, mixing and vision-frequency stages.

II. General Arrangement of the Stages in Television Receivers

Whereas a certain uniformity has been reached in the construction of broadcast receivers of late years, leading to a domination of the superhet type, no such uniformity is yet manifest in television receivers. This may be partly ascribed to the development of new valves for television purposes. Each new valve type has some inherent new possibilities, which may be fully taken advantage of only by specially suited receivers' arrangements. It is the chief purpose of this article to bring some such new possibilities forward, which have arisen in connection with new television valves, developed in the Philips' laboratories. No more or less complete treatment of H.F., mixing and detec-

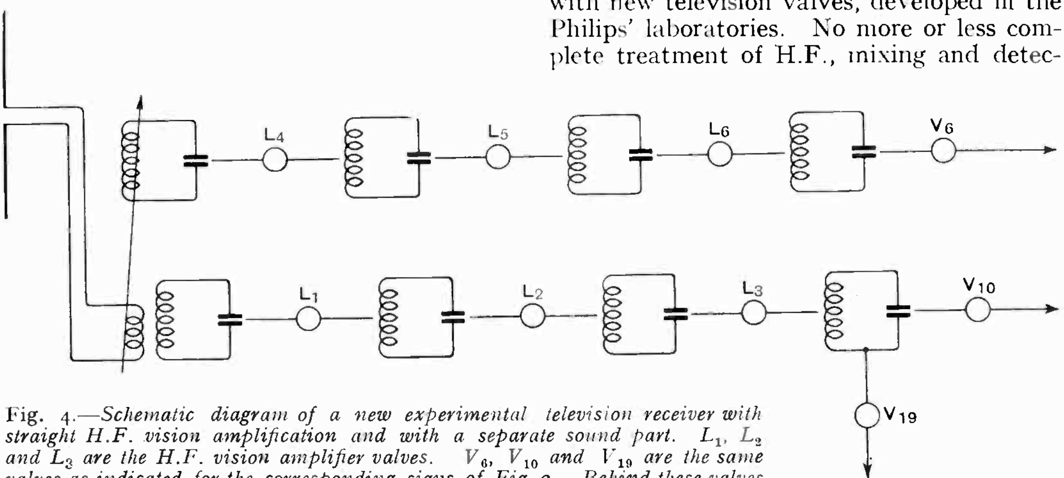


Fig. 4.—*Schematic diagram of a new experimental television receiver with straight H.F. vision amplification and with a separate sound part. L_1, L_2 and L_3 are the H.F. vision amplifier valves. V_6, V_{10} and V_{19} are the same valves as indicated for the corresponding signs of Fig. 2. Behind these valves the same parts as in the receiver of Fig. 2 follow. L_4, L_5 and L_6 are the H.F. valve, mixer valve and I.F. valve of the sound part. It will often be possible to omit L_4. As compared with Fig. 2, 2 or 3 valves less are used in Fig. 4.*

tion stages will be given here, but only some examples of such stages, connected with new valves.

Our discussion starts with a receiver

arrangement (Fig. 2) used by the Philips Co. in commercial television receivers in 1937. As is seen from Fig. 2, image reception is effected by one H.F. stage V_1, a

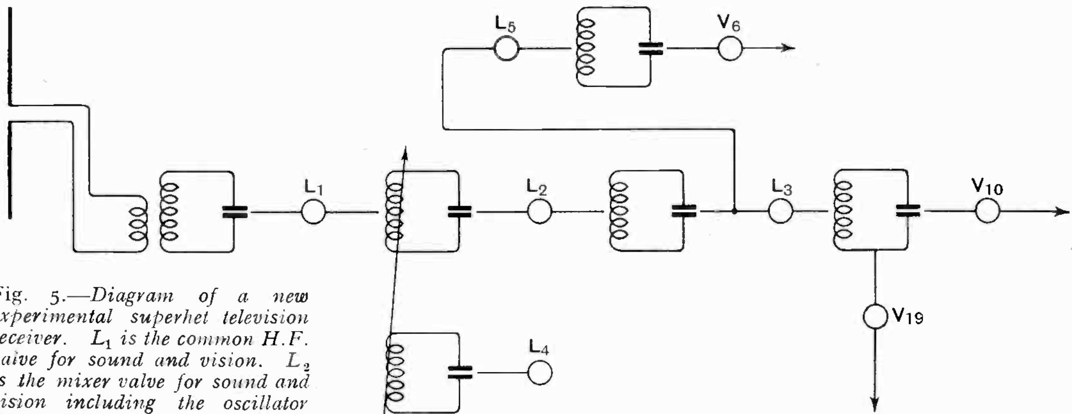


Fig. 5.—*Diagram of a new experimental superhet television receiver.* L_1 *is the common H.F. valve for sound and vision.* L_2 *is the mixer valve for sound and vision including the oscillator* L_4. L_3 *is the I.F. valve (about 20 m wavelength) for the vision part.* L_5 *is the I.F. valve (about 30 m wavelength) for the sound part.* V_6, V_{10}, V_{19} *are the same valves as indicated by these signs in Fig. 2. As compared with Fig. 2, 3 valves less are used in Fig. 5.*

mixing stage V_2, V_3 and three I.F. stages V_7, V_8, V_9. The latter stages might also be called H.F. stages on account of the high I.F. (15 Mc/s). There is furthermore an image detection V_{19} stage and one vision amplifier stage V_{20}. These stages contain 7 valves, if we count the oscillator and mixer as one valve. For sound reception we have 2 I.F. valves behind the mixer stage (mixer and H.F. stage being the same as for image-reception) and a detection stage, followed by the L.F. sound amplifier and loud speaker. The several frequency ranges used in this television receiver are indicated in Fig. 3.

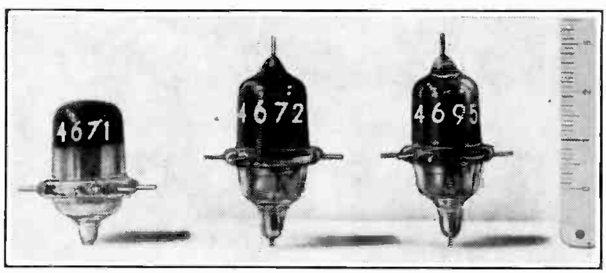


Fig. 6.—*Photograph of three acorn valves, type 4671 (triode), 4672 (H.F. pentode) and 4695 (variable-mu H.F. pentode) of Philips Co.*

In this article, we deal only with stages, corresponding with the valves V_1, V_2, V_3, V_4, V_5, V_7, V_8, V_9, V_{19} of Fig. 2, i.e. with H.F. stages, mixing stages and detection stages. As examples for such stages, using newly developed valves, we shall consider two arrangements, differing from the "classical" arrangement in Fig. 2. These two arrangements might be indicated as straight and as superhet receiver respectively.

With the straight arrangement (see Fig. 4) we assume, that vision-amplification is 10 to 20 times, hence H.F. amplification has to be 2,000 to 5,000. For this amplification three stages are projected, using three valves indicated by L_1, L_2 and L_3 in Fig. 4. The image carrier and one side band will be amplified in these stages. This may be attained by using a band width B (Fig. 1) of 2.5 Mc/s. The sound carrier and its side bands have to be amplified separately by a sound receiver, containing a H.F. valve L_4, a mixing valve L_5, an I.F. valve L_6, a detector V_6 and a L.F. amplifier with loud speaker (see Fig. 4). Hence, 8 valves of Fig. 2 (viz. the valves V_1, V_2, + V_3, V_4, V_5, V_7, V_8, V_9) are replaced by $3 + 3 = 6$ valves (viz. the valves L_1, L_2, L_3, L_4, L_5, L_6 of Fig. 4). Fig. 4 shows the stages under consideration of the simplified television receiver. It might be feasible to eliminate the H.F. valve (L_4) of the sound part in this receiver, which would mean 5 valves instead of 8 in the equivalent stages of Fig. 2. In order to obtain sufficient discrimination between sound and vision reception, the side band, most distant from the sound carrier, will be used for vision amplification.

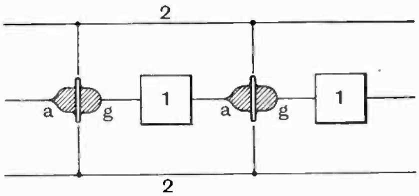


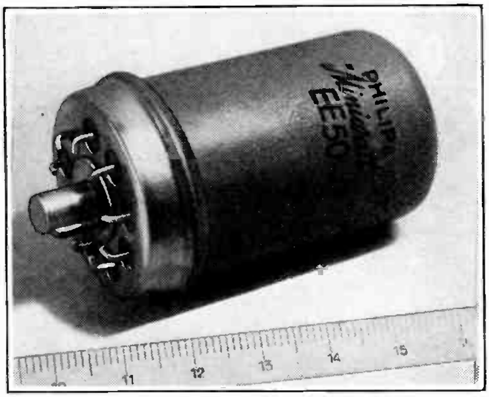
Fig. 7.—*Schematic diagram, illustrating the construction of a H.F. amplifier with acorn valves, a anode connection, g grid connection, 1 flywheel circuits, 2 screens.*

With the superhet receiver, the necessary amplification of the image part is effected by a H.F. stage (1 valve L_1 of Fig. 5), a mixing stage (2 valves L_2 and L_4 of Fig. 5) and an I.F. stage (1 valve L_3 of Fig. 5). As in Fig. 2, the sound part makes use of the same H.F. and mixing stage, as does the image part and moreover uses an I.F. stage (1 valve L_5 of Fig. 5). Hence a total of $4 + 1 = 5$ valves is used. The arrangement of the stages is shown in Fig. 5.

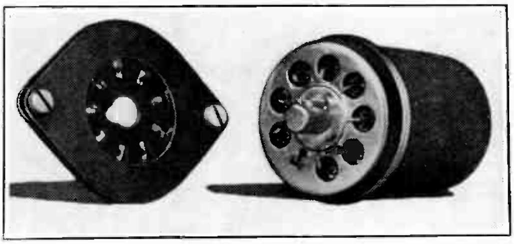
III. Straight High Frequency Amplification

Three valves have been developed (Figs. 8, 9, 10) for this purpose. It must be emphasised, that these are experimental valve types, of which it is not known, when they will be regularly manufactured. Besides these new valves we have made use of acorn type valves (triode type 4671, pentode type 4672, pentode type 4695, see Fig. 6). Short wave figures relating to these valves: input admittance, output admittance and mutual conductance (slope) were measured using specially designed measuring apparatus, which has been fully described elsewhere (see bibliography Nos. 7, 8, 9, 10, 12).

Considering first the acorn type valves (Fig. 6), the triode type 4671 is specially useful as an oscillator and hence will not be used in a straight amplifier. Of the two pentode types, the pentode 4695 shows the highest mutual conductance (about 2 mA/V). Hence this pentode will be dealt with exclusively. The capacitances under working conditions are: input 3.8 $\mu\mu$F. output 2.7 $\mu\mu$F. Input parallel resistance on 7 m wavelength is about 10^5 ohms and output parallel resistance about 4×10^5 ohms. It is possible, using these valves, to use a very low capacitance mounting, as is indicated by Fig. 7. The total capacitance of a circuit mounted in an amplifier between two successive valves is about 12 $\mu\mu$F. Assuming a circuit width B of 2 Mc/s (see Fig. 1) a circuit impedance R (see Fig. 1) of 6,600 ohms is attained and if B is 3 Mc/s we get $R = 4{,}400$ ohms. If a properly adjusted coupling between the aerial and the first receiver circuit is used, about 2 millivolts will represent the minimum signal strength between cathode and grid of the first valve.



(*a*)



(*b*)

Fig. 8.—*Photographs of a new construction of Philips' secondary emission valve, all electrodes being brought out at the bottom end. (a) Shows the whole valve and (b) the bottom side with the valve holder.*

Assuming the three remaining H.F. circuits to be equal we obtain the following amplification figures: with 2 Mc/s band width of the circuits $(2 \times 6.6)^3 = 2{,}300$ and with 3 Mc/s band width about 680. In the former case we would get about 4 or 5 volts on the vision detector and in the latter case about 1.3 volts. Whereas the former value is in agreement with current practice, the latter value might be considered somewhat lower and would call for a greater vision amplification than is usual at present.

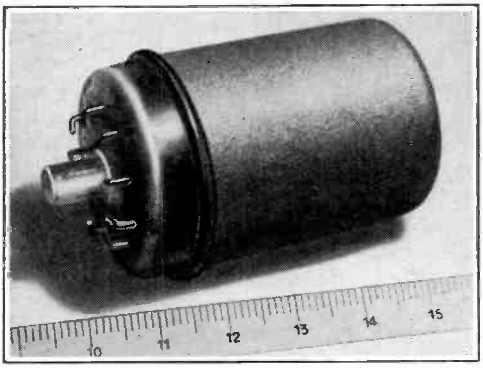


Fig. 9.—*Photograph of a new H.F. amplifier valve (pentode) of similar outer construction to the valve, shown in Fig. 8. Both constructions, Fig. 8 and Fig. 9 are " all-glass " structures.*

In the second place we consider a valve (Fig. 8) which is a new development of the Philips' secondary emission pentode type 4696. This new type shows two outstanding differences from the 4696. All electrode connections, including the input grid connection, are arranged at the bottom of the valve. All leads from the valve electrodes to the prongs are as short as possible. The first feature gives rise to an extremely compact amplifier construction, which incorporates very small capacitances. The second feature materially reduces all damping and loss effects on short waves, due to inductive and capacitive actions of the valve electrodes and of their leads. The most interesting data of this new valve are: mutual conductance 14 mA/V, anode D.C. 10 mA, input capacitance about 9 $\mu\mu$F, output capacitance about 7 $\mu\mu$F (under operating conditions), input parallel resistance about 9,000 ohms, output parallel resistance about 33,000 ohms on 7 m wavelength. The total capacitance of a circuit between two successive valves is about 30 $\mu\mu$F and may be reduced to 23 $\mu\mu$F by extremely careful design. If we stick to the value of 30 $\mu\mu$F and take the circuit band width B (Fig. 1) to be 4 Mc/s, the resonant circuit impedance R (Fig. 1) is 1,300 ohms. For $B = 3$ Mc/s, we obtain $R = 1{,}800$ ohms and for $B = 2$ Mc/s the value of R is 2,700 ohms. Hence amplification of one stage is 18 for $B = 4$ Mc/s, 24 for $B = 3$ Mc/s and 36 for $B = 2$ Mc/s. Using three successive stages it is possible to obtain a total amplification of 5,500, even if B is chosen to be 4 Mc/s.

In the third place we consider a H.F. pentode of high mutual conductance with very favourable short wave admittances, which may be built in two constructions (Figs. 9 and 10). The chief data of this developmental valve are: mutual conductance 4.5 mA/V, anode D.C. 10 mA, input capacitance 7.7 $\mu\mu$F, output capacitance 4.4 $\mu\mu$F (under operating conditions), input parallel resistance 12,000 ohms, output parallel resistance 70,000 ohms on 7 m wavelength. All valve electrode connections are arranged at the bottom of the valve. This feature again gives rise to an extremely compact circuit design with very small capacitances. Total circuit capacitance may be as low as 18 $\mu\mu$F for a circuit between two successive valves. Assuming a band width B of 3 Mc/s, the resonant circuit impedance R is 3,000 ohms and with $B = 2$ Mc/s we get a circuit $R = 4{,}500$ ohms. Hence the stage amplification figures are 13.5 and 20 for $B = 3$ Mc/s and $B = 2$ Mc/s respectively. Using three successive stages, a

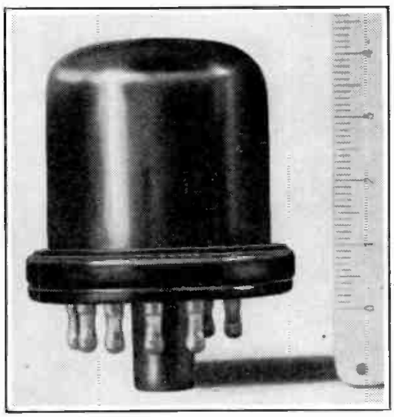


Fig. 10.—*Photograph of a new H.F. pentode, incorporating the same electrode system as the valve in Fig. 9, but in an all-metal construction.*

sufficient H.F. amplification may be attained in television receivers up to the vision detector.

An interesting point arises in connection with the feed-back impedance of valves mounted in a short wave chassis, as shown in Figs. 11, 12(a) and 12(b). This feed-back impedance may be defined by an equivalent capacitance C_{ag}, between anode and grid, which will in general depend on the wavelength under consideration (see bibliography No. 10). We have measured this equivalent capacitance using the chassis of Figs. 11 and 12; with the valve cathodes cold, a voltage was put between cathode and grid and the induced voltage on the anode flywheel circuit measured. Elaborate precautions were taken to prevent induction of voltages in an unforeseen way. With the third valve of this section (H.F. pentode) we found C_{ag} about equal to 0.001 $\mu\mu$F. If g is the stage gain, considering successive equal stages, and $Z^{-1} = \omega C_{ag}$, then a stage will be stable if $gR < Z$, where R is the interstage circuit resonant impedance. Hence, at 7 m wavelength, we have the condition $gR < 3.7 \times 10^6$. As $g = SR$, where S is the transconductance, the interstage circuit resonant impedance R must satisfy the condition $R < 2.8 \times 10^4$ ohm, if $S = 4.5$ mA/V. A stage gain $g = SR$ of 129 is hence possible, if we go up to the limit of stability at 7 m wavelength. Equivalent values were obtained for the other valves considered.

IV. High Frequency Amplifier on 7 m Wavelength, Designed for Measuring Purposes

The figures, given in the preceding section, are derived from measurements on the valves considered, which were carried out using special measuring arrangements. It was thought useful, however, to construct an amplifier chassis, using the valves under consideration, in order to check some of these figures. This experimental chassis is shown in Fig. 12, whilst Fig. 11 shows the connections. The three small variable condensers (max. 6 $\mu\mu$F) of this chassis have been calibrated. A diode voltmeter is connected across each of the three flywheel circuits, using acorn diodes (Philips' type 4674). These small diodes may be clearly seen by inspection of Fig. 12(b).

After completing connections, using the

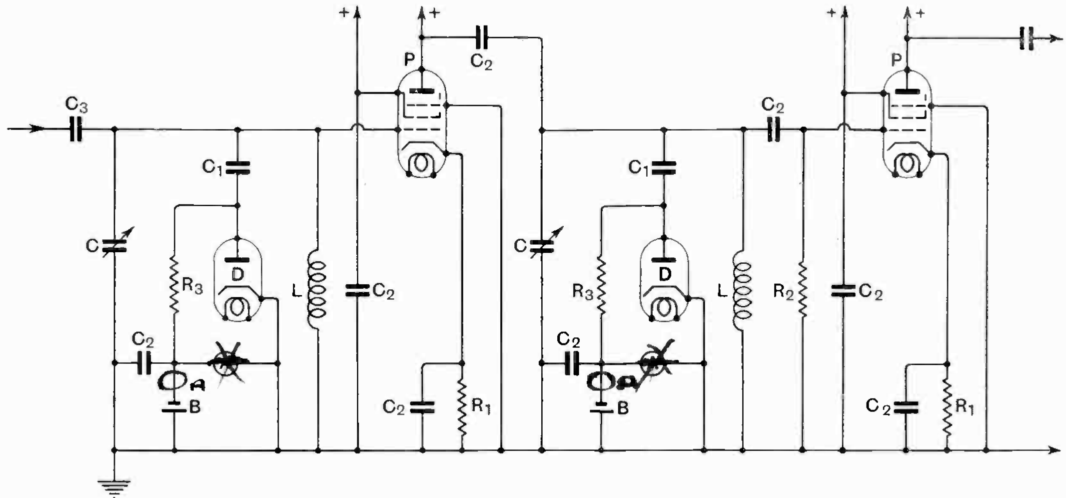


Fig. 11.—*Wiring diagram of an experimental two-stage H.F. amplifier on 7 m wavelength incorporating diode voltmeters before and behind each stage. L are the inductance coils, which are tuned to the desired frequency with the aid of the variable and calibrated condensers C. C_1 and C_2 are block-condensers of about 2,000 $\mu\mu F$, having a small coefficient of inductance. B are variable battery-voltages for the adjustment of the diodes D (acorn diodes). A are microammeters. R_1 are cathode resistances (some 100 ohms) for negative grid bias. R_2 are leakage resistances (about 0.5 Megohm). R_3 are resistances of about 0.2 $M\Omega$. P are the amplifier valves under consideration. C_3 is a small input coupling condenser (about 0.1 $\mu\mu F$) between the transmitter and the input circuit.*

H.F. pentodes dealt with in the preceding section, we have disconnected the coils one-sidedly and have measured the capacitances on 7 m wavelength. The total input circuit capacitance was 16.5 μμF. Taking

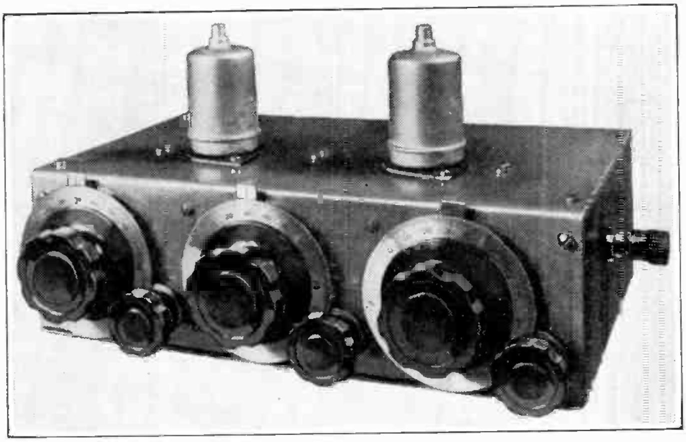
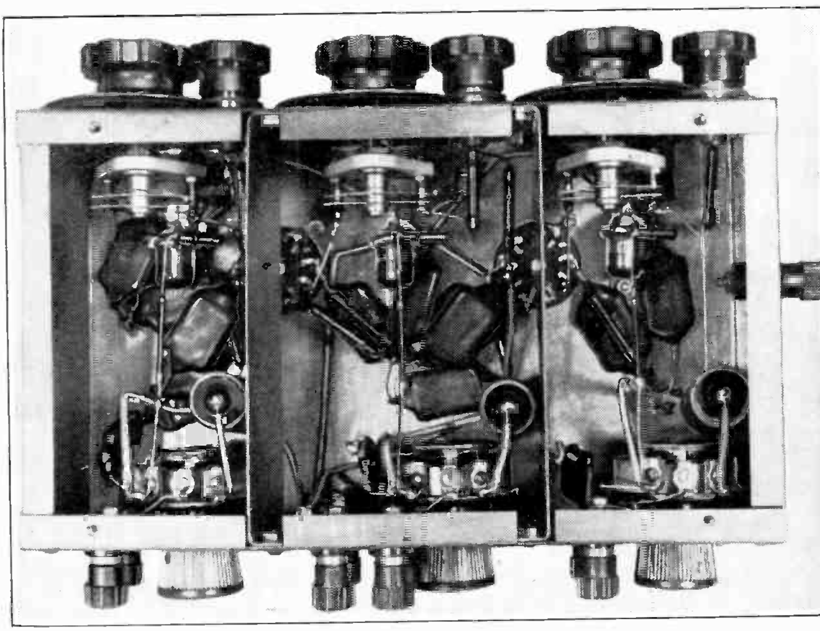


Fig. 12 (a).

Photographs of a two-stage amplifier according to the diagram of Fig. 11. By the arrangement of all valve electrodes at the bottom end of the valves a very compact construction of the amplifier stages is made possible. The acorn diodes of the diode voltmeters are clearly seen in Fig. 12 (b).

(Right) Fig. 12 (b).



0.5 μμF as extra coil capacitance we get the figures 17 μμF, 26 μμF and 17 μμF respectively for the three circuits. It should be mentioned that this chassis has greater capacitances than would be necessary in a normal amplifier chassis. Taking the intermediate circuit as an example, the diode voltmeter and the extra variable condenser have about 10 μμF. As a small trimming condenser of about 2 μμF is necessary for circuit adjustments, we find a total necessary capacitance of $26 - 8 = 18$ μμF for this circuit. This figure confirms the assumption in the preceding section. With 3 Mc/s band width the resonant impedances should be: input circuit 3,100 ohms, intermediate circuit 2,100 ohms, output circuit 3,100 ohms. The amplification figure from the input grid to the output circuit is $(4.5 \times 2.1) \times (4.5 \times 3.1) = 132$. By connecting suitable resistances parallel to the coils the impedances and band widths of the circuits were adjusted to their exact values. As is now well known, commercial leakage resistances show a marked alteration of their admittances in the short wave region, as is seen from Fig. 13. The values of this Fig. 13 were obtained using the same measuring arrangements as for obtaining the short-wave valve admittances quoted above. Some special low-capacitance leakage resistances were constructed. The stage amplification and the total amplification were measured by the aid of the diode voltmeters in the experimental chassis and confirmed the calculated values. The band width of the circuits was separately measured with the aid of the calibrated condensers. The voltage across each circuit was measured with the corresponding diode voltmeter, coupling the circuit very loosely to the transmitter, as a function of the tuning capacitance. If ΔC is the variation of the tuning capacitance, necessary in order to reduce the voltage across the circuit from its maximum (resonant) value to 0.707 of this value, the band width is given by: $B = f\Delta C/C$, where f is the frequency and C the total circuit capacitance at the resonant position. Moreover, the circuit impedance R at the resonant position (Fig. 1) follows from: $R = (2\pi f \Delta C)^{-1}$.

It is, of course, possible to use coupled band filter circuits instead of the simple flywheel circuits considered here. For an equal band width a better discrimination of the sound and image carriers may be obtained by using such circuits.

In the short wave region the mutual conductances at 7 m wavelength have the same absolute values as at longer wavelengths. But a phase angle of transconductances arises, which amounts to 20 to 80 degrees at 7 m for the valves considered. This phase angle is partly due to electronic transit times and partly to inductive and capacitive effects of the valve electrodes and their leads. It is proportional to frequency. Hence, the time lag is the same in the whole frequency region under consideration. No effect of this phase angle on image or sound reproduction occurs.

V. Comparison of Different Valves for Television Receivers

On the basis of the facts mentioned in the preceding sections, a general code may be put forward, enabling us to judge the properties of any valve for use in a television receiver. It is our aim to show that the vision-amplifier valves are, generally speaking, subject to the same conditions as are the H.F. valves, the mixer valve and the I.F. amplifier valves of a television receiver. The stage amplification figure depends on

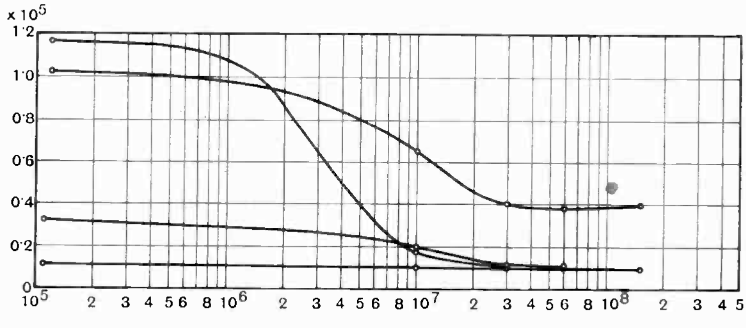


Fig. 13.—*Measured values of resistance at various frequencies for four commercial resistances. The parallel capacitance was about* 0.5 $\mu\mu F$ *in all cases.*

D.C. Resistance Ohms	*Length Inch*	*Diameter Inch*	*Watts*
1.17×10^5	0.33	0.16	¼
1.02×10^5	0.75	0.16	½
0.31×10^5	0.75	0.16	½
0.11×10^5	0.33	0.16	¼

the resonant circuit impedance R and the mutual conductance S. The value of R depends on the total circuit capacitance C and the band width B. Fig. 14 shows the values of R attainable with different values of C and of B. The amplification per stage is:

$$g = SR = \frac{S}{2\pi BC} \quad \ldots \quad \ldots \quad (3)$$

where B is expressed in c/s, S in A/V and C in farads. The total capacitance C is equal to the sum of $C_e + C_0 + C_c$, where C_e is the valve input capacitance, C_0 the valve output capacitance and C_c the circuit mounting capacitance, assuming a circuit between two successive valves. The application of equation (3) is subject to the condition, that the valve input parallel resistance R_e and the valve output parallel resistance R_0, which are both parallel to the circuit resonant resistance R_c, are not too small as compared with R. We have $R^{-1} = R_e^{-1} + R_0^{-1} + R_c^{-1}$. In the short wave region R_0 is always much greater than R_e. Furthermore, $R = (2\pi BC)^{-1}$. If, however, the expression $R_e^{-1} + R_0^{-1}$ yields a value such, that $R_c^{-1} = R^{-1} - R_e^{-1} - R_0^{-1}$ leads to a value R_c, which is too great to be obtained with a normal coil at 7 m wavelength, the full gain g per stage, given by equation (3), cannot be obtained. Hence, in this case, no full advantage can be taken of favourable values of S and of C. A similar reasoning holds for the input of the mixer valve. As an example of these rules, we consider first the H.F. pentode, dealt with in Section III.

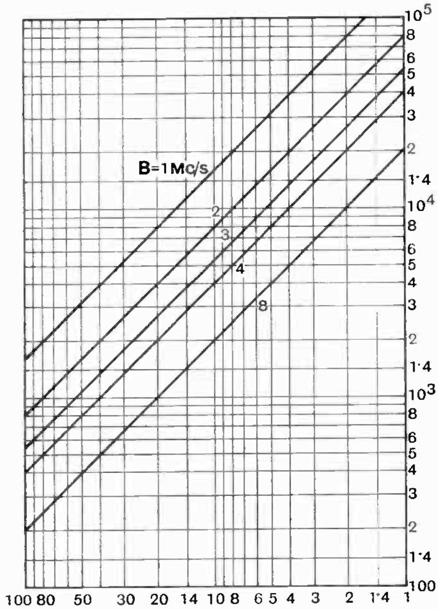


Fig. 14.—*Vertical axis: Circuit resonant impedance (ohms). Horizontal axis: total circuit parallel capacitance C in μμF. Curves for different values of the circuit band width B in Mc/s (see Fig. 1) according to the eq.* $R = (2\pi BC)^{-1}$.

The resonant circuit impedances R are 3,000 and 4,500 ohms for B equal to 3 Mc/s and 2 Mc/s respectively. The value R_e is 12,000 ohms for this valve at 7 m wavelength and $R_0 = 70{,}000$ ohms. Hence we find $R_c = 4{,}200$ ohms at $B = 3$ Mc/s and $R_c = 8{,}000$ ohms for $B = 2$ Mc/s. These values are easily attainable. We have made circuits of 20,000 ohms and more resonant impedance at 7 m. As a second example we consider an experimental television pentode with a mutual conductance of 8 mA/V, an input capacitance of 13.3 μμF, an output capacitance of 5.1 μμF (under working conditions). The resulting value of R at a band width B of 3 Mc/s is 2,200 ohms and at $B = 2$ Mc/s we have $R = 3{,}300$ ohms. The valve input parallel resistance R_e at 7 m was measured to be 2,000 ohms. Hence no full advantage can be taken of the high mutual conductance in combination with the capacitances. This valve shows a lower amplification g per stage at 7 m than the H.F. pentode of the first example, in spite of the fact that the latter valve has only about a half of the transconductance of the former valve.

Applying the valves as I.F. amplifiers, the input and output resistances are usually so high that equation (3) holds without restriction. This is due to the I.F. being 3 or 4 times lower than the H.F., leading to valve resistance values 9 or 16 times greater than at 7 m. wavelength.

We now discuss the vision stages. In these stages, a frequency band is amplified, ranging from very low frequencies up to 2 or 3 Mc/s. Assuming two successive vision valves to be interconnected by a resistance R parallel to a capacitance C, the impedance of the connecting element is $(R^{-1} + j\omega C)^{-1}$. The absolute value of this impedance is equal to R at very low frequencies and drops to 0.707 R at a frequency $\omega = (RC)^{-1}$. This frequency is identified with the band width B of Fig. 1. Hence, in the vision stages, R is again determined by $R = (2\pi BC)^{-1}$, where C is the total interstage capacitance (farads) and B is the cut-off frequency (cycles/sec.). Equation (3) may thus be applied for the vision stages also. The interstage capacitance C consists of three parts: the valve output capacitance, the valve input capacitance and the total mounting capacitance. The values of valve input resistance and valve output resistance are so high for the vision frequency range, that they are of no account as compared with the value of R, mentioned above.

In the H.F. amplification of the sound carrier with its side bands (Fig. 4) valve resistances are still more important than with H.F. image amplification. This is due to the much smaller values of B assigned to the sound H.F. circuits and the resulting high values of R. In the H.F. sound stages the value of R is practically altogether determined by the valve input resistance. This is even true in many cases for the I.F. sound stages (Fig. 5), if the I.F. corresponds to a wavelength of about 30 m. As an example we consider again the H.F. pentode of transconductance 4.5 mA/V, dealt with in Section III. The valve input resistance at 30 m wavelength is $(30/7)^2$. 12,000 = 220,000 ohms. Taking a value $B = 0.1$ Mc/s, the interstage circuit resonant impedance R = 88,000 ohms. Hence the valve input resistance affords no objection to this impedance value. If we consider, however, the television pentode of transconductance 8 mA/V dealt with above, the valve input resistance at 30 m wavelength is $(30/7)^2 \times 2{,}000 = 37{,}000$ ohms. This value is too low as compared with the 88,000 ohms, calculated from band width in combination with valve capacitances.

It is, of course, of material importance that the equivalent valve noise resistance (see equation 2) is sufficiently low with valves used in the first stage of a television receiver. The H.F. pentode of transconductance 4.5 mA/V dealt with in Section III has an equivalent resistance of about 3,000 ohms. The secondary emission pentode of Section III has the same noise resistance of 3,000 ohms.

VI. Superhet Stage for Image and Sound Amplification

According to the diagram in Fig. 5 a common H.F. stage is used for the image and for the sound. If a simple flywheel circuit is used, the band width B (see Fig. 1) should be about 4 Mc/s.

The H.F. stage is followed by the mixing stage. As an example, the application of the secondary emission valve, mentioned in Section III, will be discussed for this stage. The wiring is shown in Fig. 15. The triode oscillator connections are as usual, with the flywheel circuit connected to the anode. No special measures for decreasing frequency drift due to supply tension variations have been indicated in Fig. 15. The oscillator voltage is applied between cathode and grid of the valve S (Fig. 15) by means of a small condenser and a small cathode lead coil (2 or 3 turns of about ½in. diameter). A certain amount of input loss will be caused by this cathode coil as regards the valve S.

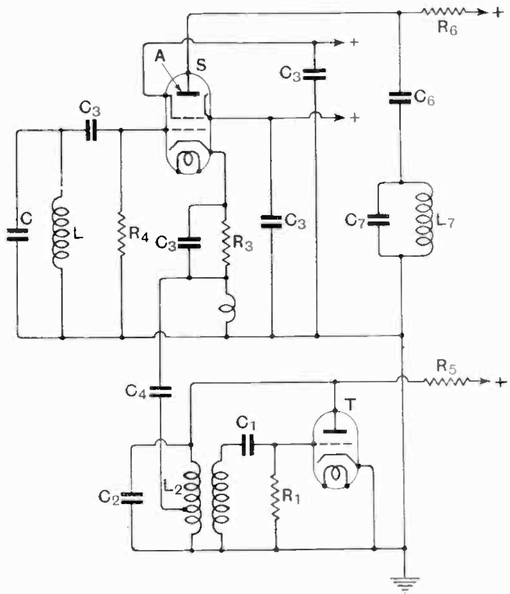


Fig. 15.—*Wiring diagram of a mixer stage, using a secondary emission valve S and an oscillator valve T. CL is the input flywheel circuit (tuned to about 7 m wavelength), the band width of which is sufficient to accommodate the sound, the vision carrier and one vision sideband, adjacent to the sound (see Fig. 1). C_3 and C_6 are block condensers of about 1,000 μμF. R_4 is a leakage resistance of about 0.2 MΩ, R_3 a cathode resistance of some 100 ohms, A the anode of the secondary emission valve S, R_5 and R_6 are series resistances for obtaining the proper electrode tensions, C_4 a small coupling condenser of about 1 μμF, C_2L_2 a flywheel circuit, tuned to about 7 m, R_1 and C_1 resistance (20,000 ohms) and condenser (about 100 μμF) of the oscillator with the triode T. L_7C_7 is an intermediate frequency circuit (about 20 m wavelength).*

In order to avoid this extra loss, the small coupling coil may be designed to form part of the coil L (Fig. 15). We have found, that the valve S shows a conversion conductance of 3 to 4 mA/V for an effective oscillator voltage of 0.5 to 1 volt between cathode and grid. This is about ¼ of the normal transconductance, as might be expected theoretically. Input admittance is about the same as for the valve S used as H.F. amplifier. The I.F. circuit C_7L_7 may be calculated according to Fig. 14, in the same way as the H.F. circuit CL. Hence the resonant impedance of this I.F. circuit is equal to the corresponding value for the H.F. circuit, if the band widths are equal. The gain of the mixing stage will be about $\frac{1}{4}$ of the gain, corresponding to a H.F. stage using the same valve S. It is about 4.5 with 4 Mc/s band width B of the circuit C_7L_7 and about 9 for a band width of 2 Mc/s.

If an I.F. stage, with the same type of valve S, is used behind the mixing stage, the total gain would be about $18 \times 6 \times 25 = 2{,}700$, which represents a sufficient figure from the aerial up to the second detector.

Let us now consider the relative positions of the image and sound carriers as indicated in Fig. 1. The oscillator frequency is assumed to be 30 Mc/s. Then the I.F. for the image carrier is 15 Mc/s (20 m wavelength) and the I.F. for the sound carrier is 11.5 Mc/s (26 m wavelength). The valve data, especially the input admittance and the output admittance, may be calculated from the figures, given in Section III. In order to effect this, we have to consider the rule, according to which the parallel valve

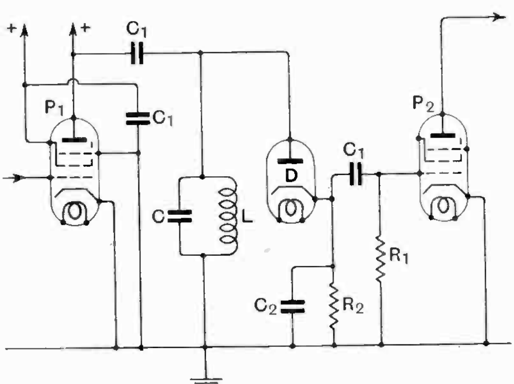


Fig. 16.—*Second detector stage of a television receiver.* P_1 *is the last H.F. or I.F. valve,* C_1 *are block condensers of about* 10,000 $\mu\mu F$, *CL a flywheel circuit, tuned to the H.F.* (7 *m wavelength*) *or to the I.F.* (*about* 20 *m wavelength*). *The condenser* C_2, *the resistance* R_2, *the input parallel capacitance* C_e *of the valve* P_2, *the valve mounting capacitance* C_m *and the band width B are related by the equation ;* $R_2 = (C_2 + C_e + C_m)^{-1}(2\pi B)^{-1}$.

resistances are proportional to the square of the wavelength in this region. Hence, in the I.F. region, these loss resistances are much greater than in the H.F. region and will in general form no limitation of the flywheel-circuit quality. In the vision-frequency part of a receiver the circuit impedance is entirely determined by the transmitted frequency band.

Considering the I.F. sound amplifier stages, band widths of about 0.1 Mc/s are

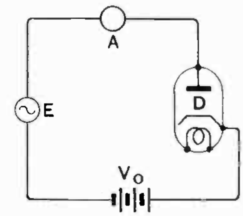


Fig. 17.—*Diagram of a measuring arrangement for comparing the detection efficiency of diode detectors. E is an alternating voltage source, with no internal resistance, A a milliammeter, D the diode under consideration and* V_0 *a variable battery voltage.*

no exception, corresponding to circuit resonant impedances of 50,000 ohms or to even higher values. Whereas the amplification of an image I.F. stage and of a vision stage is about equal to that of a H.F. stage using equal valves of sufficient quality, the amplification of a sound I.F. stage may be considerably higher owing to the smaller band width, e.g. ten times as large. The gain of the mixing stage may equally be considerably higher for the sound than for the image, e.g. ten times as large. Using secondary emission valves and, moreover, a usual I.F. radio valve, the total gain of the sound part from the aerial to the second detector may be $18 \times 60 \times 100 = 108{,}000$, which is a sufficient figure.

VII. Detection Stages

In the second detection stage (the mixing stage is frequently called the first detection stage) the modulation of the I.F. (or H.F.) carrier is separated from the carrier itself. The output of this detection stage is connected to the input of the first vision valve. The input of the detection stage is connected to the anode circuit of the last H.F. (or I.F.) valve. Hence, for a proper construction of the detection stage, it is required to take the last H.F. (or I.F.) stage, as well as the first vision stage into consideration. In Fig. 16 these three stages are shown, where P_1 is the last H.F. (or I.F.) valve, D the detection diode and P_2 the first vision valve. For the frequency, amplified by P_1, the diode capacitance is connected parallel to the circuit CL and to the output of the valve P_1. Hence, it is favourable to make the diode capacitance as small as possible, in order to obtain a high resonant impedance of the circuit CL. The resistance R_2 (Fig. 16) is determined by the band width B which is used and by the total capacitance, which is parallel to R_2 in the vision-frequency range, the product of R_2 and of the capacitance being proportional to the band width B. In order to make R_2 as large as possible, the diode capacitance, and also the input capacitance of P_2 should be as small as possible. For a band width B of 3 Mc/s and for a total capacitance of 20 $\mu\mu$F parallel to R_2 in the vision-frequency range, the value of R_2 is 2,700 ohms.

In order to obtain as much detected voltage as possible across R_2, the alternating voltage across the circuit CL being given, the value of R_2 has to be as large as possible. This detection condition will be elucidated voltages across the diode, this straight line must be intersected with the other curves in Fig. 18 and the differences of the abscissa values corresponding to the points of intersection have to be determined. For 5 volts effective alternating voltage difference, a detected tension of 4.1 volts results from Fig. 18 for the television diode MD4 (see Fig. 19), whereas only about 2.6 volts detected tension is generated by the normal radio diode AB2. From Fig. 18 it may be seen that the detected tension becomes equal to the amplitude value of the alternating voltage, if a very large detection resistance is used, which would correspond to a straight line, nearly coinciding with the horizontal axis. Therefore we could call "efficiency of detection" the value of the detected tension divided by the amplitude of the alternating voltage. This detection

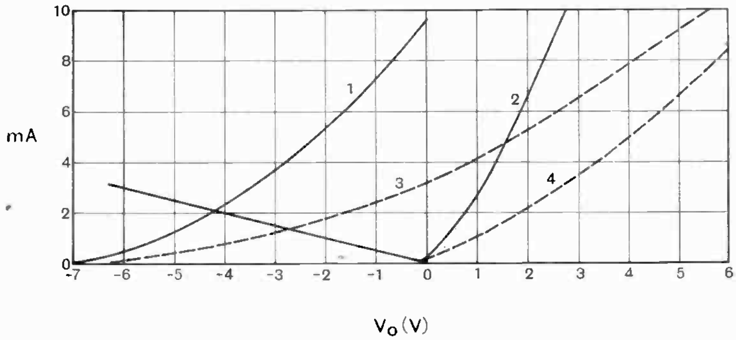


Fig. 18.—*Results of measurements taken with the arrangement of Fig. 17. The curves 1 and 2 relate to the television diodes MD4 and MD6 (see Fig. 19), the curves 3 and 4 relate to the radio diode AB_2. The curves 1 and 3 are taken with an effective alternating voltage E (see Fig. 17) of 5 volts, whereas the curves 2 and 4 are taken without alternating voltage. The diode D.C. in mA is plotted against the battery voltage V_0 (see Fig. 17).*

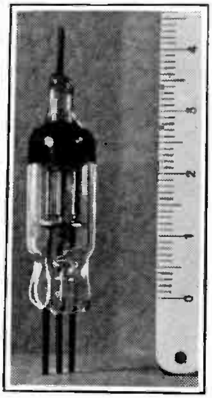


Fig. 19.— *The Philips' television diode MD4.*

in connection with some measurements on diode detectors. Considering Fig. 17, the diode D.C. is measured for different values of the alternating voltage E across the diode terminals as a function of the battery tension V_0. Measured curves for two types of diodes are shown in Fig. 18. If a bypassed resistance R_2 (as in Fig. 16) is connected in series with the diode, this resistance corresponds to a straight line in Fig. 18. The straight line of Fig. 18 corresponds to a resistance of 2,000 ohms. In order to determine the detected tension across this resistance for a given difference of alternating efficiency is about $4.1/7.06 = 58$ per cent. for the television diode MD4 and is only $2.6/7.06 = 37$ per cent. for the radio diode AB2.

A large value of detection efficiency may be obtained by decreasing the cathode-anode distance of a diode, but hereby the capacitance is increased. Hence the two conditions: high detection efficiency and low capacitance are contradictory. It is felt, that the diode MD4 represents a useful compromise.

It should be mentioned that a better separation of I.F. and vision frequency may be obtained by employing special circuits, such as double diode detection, or by the insertion of a band filter between the diode and the first vision-frequency valve.

The author thanks Dr. K. S. Knol and Dr. A. van der Ziel for their able assistance in making most of the measurements, mentioned in this article. The curves of Fig. 18 were measured by Ir. A. J. Heins van der Ven and the equivalent shot effect resistances by Dr. C. J. Bakker. The development of the new valves in question was carried out in collaboration with Ir. H. Alma, Ir. J. L. H. Jonker and Dr. Ir. F. Prakke.

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Correspondence

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

Noise of Frequency-changer Valves

To the Editor, The Wireless Engineer.

SIR,—The original suggestion put forward by Messrs. E. Lukács, F. Preisach and Z. Szepesi, that the shot noise in a frequency-changer is reduced owing to an averaging effect of the anode tuned circuit on a current of varying amplitude, appeared to me to be an *ad hoc* hypothesis unrelated to other phenomena, and I had hoped that they would be willing to accept an alternative explanation. Since they still prefer this hypothesis, however, I must now give more detailed reasons in support of my view; but first I would like to point out a difficulty which appears to me to arise if their hypothesis is applied to a linear amplifying valve.

The reduction of shot noise corresponding to the supposed fluctuation components of the anode current whose frequencies fall within the pass band of the anode circuit is said to occur simply on condition that the anode current is modulated at a frequency which is high compared with the band width (not compared with the mean frequency) of the anode circuit; accordingly, the application of a carrier to a radio-frequency amplifier should equally have this effect of reducing all components of noise within the pass band, and as I am referring to the ideal case of a linear amplifier free from cross-modulation, there will be no introduction of additional noise by beating with other parts of the noise spectrum. The total shot noise should thus be reduced by the application of a carrier. The fact that the modulating frequency is in this case equal to the mid-frequency of the pass band does not appear to be relevant, since it is not fixed in phase with respect to the corresponding component of noise current, and is in any case not equal in frequency to the other noise components falling within the pass band.

I agree that the idea of a fluctuation current, rather than voltage, is a very useful one, and I have myself shown, for example, that the thermal agitation noise in a metallic conductor can be expressed as a fluctuation current calculable from the mechanism of conduction.[1] But this must not be allowed to conceal the fact that a Fourier series for the fluctuation current is merely a means of calculating the response to an impulsive type of current of a circuit whose performance is readily expressible in terms of sinusoidal currents. In support of this view I would quote T. C. Fry[2] who says: "If electrons have been emitted in a statistically steady stream for infinite time past, the probability of the spectrum corresponding to this emission having any pre-assigned ordinate at any given frequency is zero. . . ." In other words, the instantaneous magnitudes of the so-called Fourier components having particular frequencies are indeterminate.

[1] *Journ. I.E.E.*, May, 1938, Vol. 82, p. 522.
[2] *Journ. Franklin Inst.*, 1925, Vol. 199, p. 203.

For the sake of simplicity, let us assume that there is no smoothing of the shot effect at the anode by space charge. (In frequency changers this is not such a bad approximation.) Then we can apply the analysis of Moullin and Ellis[3] for example, and find that each electron transit may be represented by its own Fourier series including components of every frequency. In the absence of any modulation of the anode current, there may be say N electrons arriving in unit time, and we assume that at any chosen frequency the resultant effect of these N electrons will be on the average $N^{\frac{1}{2}}$ times as great as the effect of one electron, so that the mean square current components are proportional to N. If the mean anode current is modulated, e.g. by the oscillator voltage in a frequency changer, we have to replace the constant N by the function $N(1 + k \, . \sin pt)$ where k is the depth of modulation. Now the mean square current components which are proportional to N are not continuous waves but are the resultants of N separate wave trains, where N is very large. It seems inconceivable that the response of a circuit to this current, which is already modulated in every possible way by its inherent nature as the resultant of numerous unrelated components, can be appreciably influenced by superimposing an additional single-frequency modulation, which in the practical case of the frequency-changer is not even a frequency having a special relation to the anode circuit.

It is of course possible that the calculations by which Messrs. Lukács, Preisach and Szepesi have arrived at the conclusion that the reduction in the fundamental components of shot noise is exactly balanced by the increase due to the heterodyning of other frequency bands is actually a means of expressing the facts outlined above, by the superposition of several Fourier series which then suffer a certain amount of mutual cancellation. But I should always regard such a method as a very indirect approach to the problem, for I consider that the idea of "'Fourier components of current' existing steadily" is definitely wrong; all that can be said to exist *steadily* is a mean square value, averaged over an appreciable time, the instantaneous values being quite incapable of prediction.

D. A. Bell.

Chelmsford.

Telephony. Vol. 2 (Automatic Telephony).
By T. E. Herbert, M.I.E.E., and W. S. Procter, A.M.I.E.E. (Pp. 738; Figs. 443). Sir Isaac Pitman and Sons, Ltd., 39, Parker Street, London, W.C.2. Price 20s.

The volume under review meets a long felt want for a single comprehensive work on the subject of automatic telephony, and has the further attribute that together with Volume 1—which deals with manual switching systems and line plant—a valuable work of reference on the telephone system of the British Post Office is made available.

Whilst the authors' main object has been to give an exhaustive account of the step-by-step system of automatic telephony employed in this country, details of other systems are also given to bring out the fundamental differences in design. An early chapter on the elementary principles of the step-by-step system should be of material assistance to the beginner.

In Chapter 3 considerable detail is given of the apparatus employed at subscribers' stations in automatic areas, whilst Chapter 4 describes the various relays and mechanisms utilised at automatic exchanges as components of the switching circuits. The 3,000-type relay is described in detail, and design data are included. A description of the 2,000-type selector is given in Appendix 1.

The facilities and circuit operation of the main switching circuits of the non-director system are given in Chapter 6, followed in Chapter 7 by a description of the circuits employed in satellite areas. The limits of the non-director system for serving large multi-exchange areas are defined at the end of this chapter, and the director system employed at the largest cities in this country is described in principle and in detail in the next chapter. The student will obtain considerable assistance, both in the foregoing and in other chapters where circuit diagrams and descriptions are given, from the inclusion of numerous basic circuit elements, but it is unfortunate that the latest standard graphical symbols, whilst included in an appendix, are not universally employed in the well-executed circuit diagrams. It would also have been advantageous to include, as an appendix or otherwise, 2,000-type selector circuit diagrams, to illustrate the fundamental differences in design necessary as a result of the introduction of the 2,000-type selector.

The various methods employed for providing intercommunication between manual and automatic exchanges are described in Chapters 9 and 10, the latter dealing with coded call indicator working, as employed in London. Chapter 14 gives the facilities provided by the various types of UAX in use in this country, and includes complete circuit descriptions of the UAXs 5 and 12.

To indicate briefly the wide scope of this volume, chapters are also included on miscellaneous circuits, power plant, trunking and grading, maintenance, Siemens No. 16 system, the relay system, revertive impulse systems, and recent developments in switching systems.

The work is well produced, and contains a large number of illustrations and diagrams, and should prove of great value to students of telephony, as well as to communication engineers generally.

H.E.W.

Award of the Duddell Medal

The Council of the Physical Society has awarded the sixteenth Duddell Medal to Mr. Robert W. Paul, M.I.E.E. The Medal is awarded to "persons who have contributed to the advancement of knowledge by the invention or design of scientific instruments, or by the discovery of materials used in their construction." The name of Mr. Robert W. Paul, who is nearly 70, is honoured as a pioneer in two distinct industries, namely the manufacture of electrical measuring instruments and the early development of the cinematograph.

[3] *Journ. I.E.E.*, 1934, Vol. 74, p. 323.

Abstracts and References

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

PROPAGATION OF WAVES

1338. ELECTROMAGNETIC WAVES IN HOLLOW METAL TUBES OF RECTANGULAR CROSS SECTION [Derivation of Complete Theory, without Restrictions, for Perfectly and Imperfectly Conducting Materials: Experiments: Comparison with Pipes of Circular Cross Section as regards Attenuation, Operating Frequencies, etc: Disagreement with Certain Conclusions of Brillouin].—L. J. Chu & W. L. Barrow. (*Proc. Inst. Rad. Eng.*, Dec. 1938, Vol. 26, No. 12, pp. 1520–1555.)

1339. THE SECTORAL ELECTROMAGNETIC HORN, *and* RECTANGULAR HOLLOW-PIPE RADIATORS.—Barrow & others. (*See* 1446 & 1447.)

1340. ELECTRIC RESONANCE CHAMBERS [as Terminations to Wave-Guides, as Directional Radiator (particularly with Parabolic Reflector), and as "Sink" for Wave Power: Space Pattern differs from Barrow's Statement of Effect of Ratio of Free-Space Wavelength to Aperture: etc.].—G. Reber. (*Communications*, Dec. 1938, Vol. 18, No. 12, pp. 5–8 and 25.) This paper deals only with that mode of excitation termed "H_1" by Southworth (2502 of 1936) and "transverse" by Barrow (22 of 1937).

1341. INVESTIGATION OF THE PROPAGATION OF ELECTROMAGNETIC WAVES FOR A FREQUENCY OF 120 MEGACYCLES/SECOND.—E. Bussmann. (*Funktech. Monatshefte*, Dec. 1938, No. 12, pp. 369–384.)

The development of the equipment occupies the first seven pages. The actual tests, over different kinds of terrain, with about 5 watts in the aerial and a receiver of fairly low sensitivity (about 200 μv), led to the following conclusions:—No simple formula for the course of the field strength can give the propagation conditions over open country. Over any country where the absorbing medium contains no, or only few, metallic masses, the radius within which reception is possible in all conditions may be put at 2–3 km. Optical sight is not necessary for such ranges; if it exists, the range is increased to at least 15 km. Within a town district the range falls to 1 km. Over all types of country strong interference is liable to occur between the direct and reflected or diffracted rays: naturally, this may produce, at the maxima, far stronger signals than would be expected from considerations of distance. The influence of the height of the receiver relative to that of the transmitter is of minor importance, unless it produces optical sight. The conduction of the waves by "channels" such as cuttings through woods, or streets, running radially from the transmitter, is demonstrable; the same applies to water and (to a smaller degree) to the masts of a high-tension system. It is not certain whether in the latter case the cause is not a pure aerial effect. At receiving points not enjoying optical sight, a secondary-radiation effect from trees lying in the path may occur. As regards the influence of weather, transitory changes such as thunder showers brought no alteration to the measured values, but great moisture (such as that produced by a thaw) strongly increased the attenuation of a wood compared with that of built-over land. The different moisture content of conifers and deciduous trees showed itself in a difference in the attenuation. Measurements in towns showed no appreciable influence of moisture.

1342. THE ATTENUATION OF ULTRA-SHORT RADIO WAVES ALONG THE EARTH [Equipment for Field-Strength Measurements on 3.64 m Waves up to 50 m from Transmitter: Comparison of Results with Norton's Formula].—S. R. Khastgir & M. K. Chakravarty. (*Indian Journ. of Phys.*, Aug. 1938, Vol. 12, Part 4, pp. 289–297.)

1343. 56-MEGACYCLE RECEPTION *via* SPORADIC-E-LAYER REFLECTIONS [Comparison of Amateur Results over 400–1200 Miles (Summer, 1937) with Hourly Critical-Frequency Measurements by Bureau of Standards, together with Distance/Layer-Height Considerations and 28-Megacycle Comparisons, tends to confirm Suggested Connection : the Question of the Necessary Geographical Separation of Stations on Same Frequency].—E. H. Conklin. (*Proc. Inst. Rad. Eng.*, Jan. 1939, Vol. 27, No. 1, pp. 36–40.)

1344. OBSERVATIONS ON SKY-WAVE TRANSMISSION ON FREQUENCIES ABOVE 40 MEGACYCLES [Field Strengths, at Riverhead (N.Y.), of English, French, & German Television Signals, Oct. 1937–March 1938 : Comparison with " Max. Usable Frequencies " of Weekly Broadcast Data : Better Agreement when Lorentz Polarisation Term is Included : Multi-Path Propagation of English Video Channel, Image Displacement indicating Path-Length Difference of about 3000 Feet]. —D. R. Goddard. (*Proc. Inst. Rad. Eng.*, Jan. 1939, Vol. 27, No. 1, pp. 12–15.) For previous work *see* 218 of 1938.

1345. THE EFFECT OF DIFFRACTION ON THE PROPAGATION OF [Ultra-Short] ELECTROMAGNETIC WAVES IN THE REGION BEYOND THE HORIZON ON THE BASIS OF THE THEORY OF B. VAN DER POL & H. BREMMER.—R. M. Wundt. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 19, 1938, pp. 434–438.)

An account is first given of the theory of van der Pol & Bremmer (*see* 35 & 3102 of 1938). This is compared with the theory of von Handel & Pfister (3971 of 1936 : *see* also 1739 of 1938 and 2441 of 1937) ; curves are given for comparison of the diffraction curves for three different heights of an observing aeroplane (Fig. 3) and for two different wavelengths, 1 m and 10 m (Fig. 4), and of the variation with height (Fig. 5). The chief difference is found to lie in the different form of the exponential function chosen to describe the diffraction. The writer finds that a complete theory must take into account both diffraction and refraction.

1346. A STUDY OF ULTRA-HIGH-FREQUENCY WIDE-BAND PROPAGATION CHARACTERISTICS [Reflection from Buildings, etc., and Consequent Blurred and Multiple Images : etc.].—R. W. George. (*Proc. Inst. Rad. Eng.*, Jan. 1939, Vol. 27, No. 1, pp. 28–35.) A summary was dealt with in 3448 of 1938.

1347. RECEIVING CONDITIONS IN THE ARCTIC [Results obtained by the Wordie (Cambridge) West Greenland Expedition, on 6–21.5 Mc/s Signals from Balloons at Heights up to 20 km and on European, American, Japanese, & Chinese Stations : No Apparent Absorption of Balloon Signals by the " Low-Level " Layers : Aurorae : etc.].—I. M. Hunter. (*Wireless World*, 2nd Feb. 1939, Vol. 44, pp. 111–112.)

1348. STRATIFICATION OF THE IONOSPHERE AND THE ORIGIN OF THE E_1 LAYER [Ionisation Calculations by Modified Pannekoek Method : Reasons for Failure of Hulbert & others to find E_1 Ionisation by This Method : E_1 Layer definitely near 100 km Level of Rapid Transition of O_2 to O, and therefore of Max. Ionisation of O_2].—J. N. Bhar. (*Indian Journ. of Phys.*, Nov. 1938, Vol. 12, Part 5, pp. 363–386.)

1349. DISPERSION, ABSORPTION, AND POLARISATION CURVES FOR RADIO WAVE PROPAGATION IN THE IONOSPHERE [for 0.6, 1.27, & 3.0 Mc/s and Four Collisional Frequencies : based on Appleton-Hartree Formulae applied (neglecting Lorentz Term) to Calcutta Conditions : Discussion of Limiting Polarisation—Polarisation of Split Components emerging from Ionosphere will in general be Elliptical, contrary to Some Writers].—S. P. Ghosh. (*Indian Journ. of Phys.*, Nov. 1938, Vol. 12, Part 5, pp. 341–354.)

1350. CHARACTERISTICS OF THE IONOSPHERE (F_2 REGION) : SUPPLY OF DATA FROM RADIO DEPARTMENT, NATIONAL PHYSICAL LABORATORY [Typescript Copies of Monthly Tables Now Available : also Telephonic Arrangements].—(*Wireless Engineer*, Jan. 1939, Vol. 16, No. 184, pp. 20–21.)

1351. DATA ON THE IONOSPHERE (F_2 REGION) [Availability of Service of Monthly Tables or Early Information by Telephone from Radio Research Station, Slough].—(*Nature*, 14th Jan. 1939, Vol. 143, pp. 70–71.)

1352. SCATTERING OF WIRELESS WAVES IN THE IONOSPHERE [occurs from Irregular Clouds in E Region, encountered by Rays of Frequency above Critical Frequency on Their Oblique Ionospheric Path : No Similar Scattering Clouds in F Region].—T. L. Eckersley. (*Nature*, 7th Jan. 1939, Vol. 143, pp. 33–34.) For previous work *see* 397 of 1938.

1353. RESULTS OF CONTINUOUS IONOSPHERIC RECORDING [Illustrative Records of Ionospheric Reflection on Wavelengths of 80 & 60 m : Record showing Auroral Disturbance].—W. Dieminger & H. Plendl. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 19, 1938, pp. 429–434.)

1354. THE VARIATION OF SOLAR ULTRA-VIOLET RADIATION DURING THE SUNSPOT CYCLE [amounts to 120–150% : Deduction from Critical Frequency Measurements of Ionisation in Regions E and F_1 : Corresponding Variation of Ionisation and Electrical Conductivities by 50–60%].—E. V. Appleton & R. Naismith. (*Phil. Mag.*, Feb. 1939, Series 7, Vol. 27, No. 181, pp. 144–148.)

1355. TRENDS OF CHARACTERISTICS OF THE IONOSPHERE FOR HALF A SUNSPOT CYCLE [E-Layer Ionisation Densities increased by about 1.55/1, F_2-Layer by about 4/1, between 1933 and 1938: Definite Relation between Sunspot Numbers and the Solar Activity responsible for Ionisation (Much Closer for E-Region Ionisation): Possibility of Forecasting for the Descending Half-Cycle, etc.].—N. Smith, T. R. Gilliland, & S. S. Kirby. (*Journ. of Res. of Nat. Bur. of Stds.*, Dec. 1938, Vol. 21, No. 6, pp. 835–845.)

1356. SOLAR ERUPTIONS AND THEIR INFLUENCE ON THE PROPAGATION OF ELECTROMAGNETIC WAVES [Fade-Outs (12–50 m Waves) and Increased Strength of Signals (6000–12 000 m Waves): No Appreciable Interval between Eruption Phenomena and Effects on Ionosphere: Magnitude of Effects independent of Position on Sun's Disc], *and* ON THE STRUCTURE OF SUNSPOTS.—M. Waldmeier. (*Helvetica Phys. Acta*, Fasc. 7, Vol. 11, 1938, pp. 537–538: pp. 538–539: in German.)

1357. THE DELLINGER PHENOMENON [Laboratory Observation of Type of Radiation occurring when Nitrogen Molecule Ions are produced at High Pressure: Phenomenon postulated by Dellinger as Cause of Sudden Ionospheric Disturbance].—J. Kaplan. (*Phys. Review*, 1st Jan. 1939, Series 2, Vol. 55, No. 1, p. 110.)

1358. COMMENT ON A PAPER BY W. E. BOWLS, "SECOND TOWNSEND COEFFICIENT" [Considerations of Energy of Metastable Level of Nitrogen, Energy Transferable in Active Nitrogen: Active Nitrogen can ionise Mercury Vapour, etc.].—J. Kaplan. (*Phys. Review*, 1st Jan. 1939, Series 2, Vol. 55, No. 1, p. 111.) *See* 2126 of 1938.

1359. RED AURORAL LINES ON 14TH/16TH SEPT. [were of Strong Intensity].—C. Störmer: Vegard. (*Nature*, 21st Jan. 1939, Vol. 143, p. 117.) Results differing from those of Vegard referred to in 31 of January.

1360. SPECTRUM OF THE AURORA BOREALIS OF 25TH JAN. 1938 [Observations at Arosa].—F. W. P. Götz. (*Helvetica Phys. Acta*, Fasc. 7, Vol. 11, 1938, pp. 556–557: in German.)

1361. THE COMPONENTS OF THE ANNUAL FLUCTUATION OF HOURS OF SUNSHINE.—Conrad. (*Helvetica Phys. Acta*, Fasc. 1, Vol. 12, 1939, pp. 38–49: in German.)

1362. THE NUMERICAL CALCULATION OF THE BRIGHTNESS OF THE CLEAR SKY FOR 90° ZENITH DISTANCE OF SUN.—Gruner & Klee. (*Helvetica Phys. Acta*, Fasc. 6, Vol. 11, 1938, pp. 513–530: in German.)

1363. RESEARCHES ON ATMOSPHERIC ABSORPTION [by Photographic Photometry: for Light of 8200–2700 AU].—A. & M. E. Vassy. (*Journ. de Phys. et le Radium*, Feb. 1939, Series 7, Vol. 10, No. 2, pp. 75–81.)

1364. THE THEORY OF ABSORPTION [of Electromagnetic Radiation] IN IONISED GAS: I—OPACITY IN STELLAR MATERIAL: II—OPTICAL PROPERTIES OF LIQUID METALS.—B. Majumdar. (*Indian Journ. of Phys.*, Aug. 1938, Vol. 12, Part 4, pp. 233–248.)

1365. DIRECT READING FIELD-STRENGTH MEASURING INSTRUMENTS, *and* THE RELATION OF THE CARRYING CAR TO THE ACCURACY OF PORTABLE FIELD-INTENSITY-MEASURING EQUIPMENT.—Rohde & Spies: Dewitt & Omberg. (*See* 1628 & 1630.)

1366. ON THE ACCURACY OF RADIO FIELD-INTENSITY MEASUREMENT AT BROADCAST FREQUENCIES.—Diamond, Norton, & Lapham. (*See* 1629.)

1367. ON THE PROBLEM OF WAVE-MOTION FOR SUB-INFINITE DOMAINS [General Mathematical Solution employing Laplace Transforms].—A. N. Lowan. (*Phil. Mag.*, Feb. 1939, Series 7, Vol. 27, No. 181, pp. 182–194.) For work on infinite domains *see* 4242 of 1938.

1368. PROPAGATION OF EXPLOSION WAVES IN LIQUIDS AND SOLID BODIES [with a Suggested Application to the Propagation of Short Electromagnetic Waves].—O. von Schmidt. (*Zeitschr. f. tech. Phys.*, No. 12, Vol. 19, 1938, pp. 554–561: *Physik. Zeitschr.*, 15th Dec. 1938, Vol. 39, No. 23/24, pp. 868–875.)

"Schlieren" photographs are given of the propagation of the pressure wave-fronts from a spark and their reflection, refraction, and total reflection at plane surfaces between media of different refractive indices. The writer finds that the Fresnel-Drude energy equations are not satisfied but that there is an additional plane "head" wave (contrasting with the circular or spherical ones). Longitudinal and transverse waves in solid bodies give different "head" waves, which, he suggests, provide a new method of measuring elastic constants. It is also suggested that the long-distance propagation of short radio waves may be explained by such a "head" wave. In the discussion, A. Sommerfeld points out that electromagnetic optics (and thus Fresnel's equations) deals only with stationary conditions, and not with the initial phenomena here described; it is also almost always concerned with plane waves, which is not the case in these photographs.

1369. DIRECT OBSERVATION OF RAYLEIGH WAVES IN CASE OF TOTAL REFLECTION.—Kretschmer & Rschevkin. (*Comptes Rendus (Doklady) de l'Acad. des Sci. de l'URSS*, No. 1, Vol. 20, 1938, pp. 17–20: in English.)

1370. DIFFRACTION OF CAPILLARY RIPPLES: ENVELOPE WAVES [Investigation of Limits of Resemblance between Diffraction Phenomena for Surface Waves on Liquids and Light Waves].—Bouasse. (*Ann. de Physique*, Jan. 1939, Series 11, Vol. 11, pp. 5–128.)

1371. A New Periodic Orbit in the Field of a Magnetic Dipole [Re-entrant Orbit with Two Points of Reversal].—R. A. Hutner. (*Phys. Review*, 1st Jan. 1939, Series 2, Vol. 55, No. 1, p. 109.)

1372. Transmission-Line Calculator [giving Impedance, Current, and Voltage at Any Point along R.F. Lines: with Extension to A.F. Lines].—P. H. Smith. (*Electronics*, Jan. 1939, Vol. 12, No. 1, pp. 29–31.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

1373. The Location of Tropical Disturbances by Means of Associated Static [received on 10 kc/s as Optimum Frequency: Equipment and Technique].—W. B. Bernard. (*Proc. Inst. Rad. Eng.*, Jan. 1939, Vol. 27, No. 1, p. 75: summary only.)

1374. Experiments with Large Surge Currents [of the Order of Lightning-Stroke Currents: with C-R Oscillographic Recording].—R. Foitzik. (*E.T.Z.*, 26th Jan. & 2nd Feb. 1939, Vol. 60, Nos. 4 & 5, pp. 89–92 & 128–133.)

1375. Weather of the Colorado Rockies [including Electrical Effects, Areas "drawing" Lightning, Induced Charges, Coronas, etc: Ball Lightning may be an Optical Illusion].—R. L. Ives. (*Journ. Franklin Inst.*, Dec. 1938, Vol. 226, No. 6, pp. 691–755.) *See* also 48 of January.

1376. Geographical Distribution of Points Struck by Lightning in the Department of Gers [France: Zones similar to those of Upper Garonne].—C. Dauzère. (*Comptes Rendus*, 9th Jan. 1939, Vol. 208, No. 2, pp. 114–116.) For the previous paper *see* 912 of March.

1377. The Electric Strength of Air at High Frequencies [to 900 kc/s: Suggested Modification of Townsend's Theory].—E. W. Seward. (*Journ. I.E.E.*, Feb. 1939, Vol. 84, No. 506, pp. 288–292.)

1378. Meter and Instrument Section: Chairman's Address [Protective Devices for Telecommunication Purposes].—B. S. Cohen. (*Journ. I.E.E.*, Feb. 1939, Vol. 84, No. 506, pp. 237–247.)

1379. Measurements of the Conductivity and Ionisation of Air in the Alps.—J. Moussiegt. (*Comptes Rendus*, 16th Jan. 1939, Vol. 208, No. 3, pp. 216–217.)

1380. The Formation of Large Ions in Gases as a Function of the Magnitude of Particles in Suspension.—O. Te-Tchao. (*Comptes Rendus*, 23rd Jan. 1939, Vol. 208, No. 4, pp. 271–273.)

1381. A Peculiarity of Air Ionised by X-Rays [Production of Large Ions of Feeble Mobility and Slow Recombination].—G. Reboul & F. Perrier. (*Comptes Rendus*, 16th Jan. 1939, Vol. 208, No. 3, pp. 172–173.)

1382. The Influence of Temperature on the Production and Recombination of Carriers in Alpha Ray Columns [Results on Recombination Coefficient in Air, Its Pressure and Temperature Variations, etc.].—W. Seitter. (*Ann. der Physik*, Series 5, No. 2, Vol. 34, 1939, pp. 113–129.)

PROPERTIES OF CIRCUITS

1383. Anode-Bend Rectification with Negative Feedback, with Low Distortion and Attenuation.—H. Köpke. (*Hochf:tech. u. Elek:akus.*, Nov. 1938, Vol. 52, No. 5, pp. 153–161.)

Author's summary:—From the conditions necessary for linear rectification, it is shown that diodes and anode-bend rectifiers can be referred to the same scheme; within quite large ranges, linear rectification can be attained with the anode-bend rectifier on the assumption of a constant and correspondingly large "Durchgriff" [reciprocal of amplification constant] in the valve employed. This condition can be fulfilled, especially with pentodes, by using a negative-feedback coupling [*cf.* Weeden, 953 of 1937]; the chief advantage of the anode-bend rectifier, a small input attenuation with a certain amount of rectifier amplification, is retained. Circuits with varying degrees of negative-feedback coupling can be devised which compensate for the effect of the load circuit in respect of slow carrier variations and rapid ones depending on the modulation . . . Frequency dependence and amplitude distortion of the l.f. voltage obtained do not occur even with high degrees of modulation.

1384. On the Regeneration Characteristics of a Regenerative Detector [and the Writer's Method ("More Practical than Loftin-White Method") of obtaining Uniform Frequency Characteristic by Resistance (alone or with Parallel Variable Condenser) in Regenerative-Coil Circuit].—S. Kanazawa. (*Nippon Elec. Comm. Eng.*, Nov. 1938, No. 13, pp. 422–428.)

1385. Control of Electron Currents with a Three-Electrode Crystal, and a Model of a Barrier Layer.—Hilsch & Pohl. (*See* 1683.)

1386. Television Amplifiers with Negative Feedback.—Pfefferl. (*See* 1592.)

1387. The "Variable Q" Amplifier: a Power Amplifier with Inherent Voltage Compensation for Load Variations [*e.g.* for Voice-Frequency Signalling, Drive Stages for Class C Amplifiers, and Measurement of Coil Power Factors by Reactance-Detuning Method: Extension of Boucherot's Principle (converting Constant-Current Property of Pentode into One of Constant Voltage): etc.].—A. Fairweather & F. C. Williams. (*Wireless Engineer*, Feb. 1939, Vol. 16, No. 185, pp. 57–66.) The paper on the valve generator on the same principle is not to be found where indicated in Footnote 3; presumably it is still in the press.

1388. Corrections to "A Contribution to Tube and Amplifier Theory."—W. E. Benham. (*Proc. Inst. Rad. Eng.*, Dec. 1938, Vol. 26, No. 12, pp. 1429–1430.) *See* 148 of January.

1389. Cascade-Type Duplex Feedback Systems [and Their Superior Stability, "Klirr" Factor, and Noise-Suppression].—Y. Watanabe & S. Okamura. (*Nippon Elec. Comm. Eng.*, Dec. 1938, No. 14, pp. 484–492.)

1390. The Production of Quartz Resonators for the London/Birmingham Coaxial Cable System, *and* Channel Filters employing Crystal Resonators.—C. F. Booth & C. F. Sayers: H. Stanesby & E. R. Broad. (*P.O. Elec. Eng. Journ.*, Jan. 1939, Vol. 31, Part 4, pp. 245–253: pp. 254–264.)

(1) "In this article, which will be continued in subsequent issues of the Journal, the authors describe the nature of quartz crystals, with particular reference to the imperfections affecting their use as resonators in electric wave filters." In this cable system 1280 resonators are required for each supergroup of 40 speech circuits. (2) In the main section, "it is proposed initially to show that the characteristic impedance of the section is identical with the mid-series image impedance of a 'constant *k*' ladder filter. The manner in which the propagation constant varies with frequency will then be studied, with particular reference to the frequencies of infinite attenuation. The results will be related to the insertion-loss characteristic. Finally the design formulae will be developed."

1391. Corrections to "On Single and Coupled Circuits having Constant Response Band Characteristics."—H. S. Loh. (*Proc. Inst. Rad. Eng.*, Dec. 1938, Vol. 26, No. 12, p. 1430.) *See* 937 of March.

1392. Wave Separators [of Constant Input Image Impedance] of the Unsymmetrical Rise-and-Sink Type, and Double Ladder Delay Networks.—A. Matsumoto. (*Nippon Elec. Comm. Eng.*, Nov. 1938, No. 13, pp. 448–450.) For previous work *see* 451 of 1938.

1393. On the Attenuation Characteristics of the All-Pass Type Delay-Network.—T. Osaki & A. Nakasima. (*Nippon Elec. Comm. Eng.*, Dec. 1938, No. 14, pp. 509–510.)

1394. The Theory of Two-Point Impedance of Passive Networks in the Relay Circuit, *and* The Transfer Impedance of Four-Terminal Passive Networks in the Relay Circuit.—A. Nakasima. (*Nippon Elec. Comm. Eng.*, Nov. 1938, No. 13, pp. 405–412: Dec. 1938, No. 14, pp. 459–466.)

1395. On the Fundamental Equations of the Networks.—S. Okada. (*Nippon Elec. Comm. Eng.*, Dec. 1938, No. 14, pp. 504–508.)

1396. On the Resonant Frequency of Closed Concentric Lines.—Hansen. (*See* 1622.)

1397. Exponential Transmission Line, *and* Transmission Lines with Exponential Taper.—Burrows: Wheeler. (*See* 1453 & 1454.)

1398. Definition and Calculation of the Time Constants of Electrical Circuits [Carson's Treatment Not General Enough: New Suggestions].—R. Sartori. (*Alta Frequenza*, Jan. 1939, Vol. 8, No. 1, pp. 33–39.) For Sturley's work, referred to in a footnote, *see* 4315 of 1938.

1399. "Mitnahme" [Pulling into Tune] and Synchronisation of Self-Excited Oscillations.—R. Urtel. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 19, 1938, pp. 460–465.)

Two causes of the deviation of the frequency of an approximately sinusoidal valve generator from the natural frequency of the oscillating circuit are (a) the "swinging" of the damping, through values around zero, during a period, due to the non-linearity of the characteristic; and (b) regeneration which is not phase-pure (*see* Groszkowski, 1933 Abstracts, p. 564). In order to separate out their effects, a model of a "mitnahme" generator is designed (Fig. 1), which analyses the "mitnahme" process into the various factors of "self-excitation, detuning by artificial reactive power, derivation of a quantity regulating the detuning by measuring the phase relation between the impressed and the self-excited voltage, and finally the addition of the two voltages. The model describes the 'mitnahme' process itself, the amplitude dependence of the 'mitnahme' region, and the occurrence, outside the 'mitnahme' region, of beat curves due to frequency modulation of the generator." A discussion of analogous phenomena with a relaxation-oscillation generator leads to the suggestion that the term "mitnahme" should be applied to "the regulation of the frequency of a generator to a desired value by varying a quantity (*e.g.* the reactive power), which is derived from a phase measurement," while "synchronisation" should denote that "an external voltage leads to the earlier effectiveness of some instability of the system than would occur if the generator were left to itself." Examples of synchronisation are given.

1400. On Methods of Tuning to Resonance.—Th. Hegner. (*Funktech. Monatshefte*, Dec. 1938, No. 12, pp. 353–360.)

Advantages and limitations of the phase-comparison method, using c-r oscillograph. Similar treatment of amplitude-tuning methods, using meters or headphones: analysis of series resonance (and comparison between current- and voltage-measurement methods and their errors: the case where the self-capacity of a valve is to be included): analysis of parallel resonance, for cases where the circuit is associated with two, one, or no valves: tuning with a rectifier: effect of retroactive action on the anode-circuit direct current, and its use for indication of resonance: the use of meters with linear, square-law, and convex characteristics.

1401. On Fluctuations in the Neighbourhood of Periodic Motion of an Auto-Oscillating System [with One Degree of Freedom: Derivation and Solution of the Einstein-Fokker Equation: Application to Thermal Agitation and Shot Effect in Dynatron Oscillator].—I. Berstein. (*Comptes Rendus* (*Doklady*) *de l'Acad. des Sci. de l'URSS*, No. 1, Vol. 20, 1938, pp. 11–16: in English.)

1402. Tensor Analysis and Its Application to Equivalent Circuits.—D. W. Epstein. (*RCA Review*, Oct. 1938, Vol. 3, No. 2, pp. 239–254.)

TRANSMISSION

1403. On the Theory of the Barkhausen-Kurz Valve [Investigation of Electron Motion in Potential Fields of "Trough" Form, with the Electrons moving Parallel to Lines of Force (B-K Oscillations) and also Transversely (hitherto Neglected)].—B. Kockel & B. Mrowka. (*Zeitschr. f. tech. Phys.*, No. 2, Vol. 20, 1939, pp. 42–46.)

Theoretical investigation of the motion parallel to the lines of force, giving rise to B-K oscillations in which the "unfavourable" electrons are suppressed by a "sorting-out" process at the electrodes, leads to the following conclusions :—(1) The B-K valve acts regeneratively for oscillations of such frequencies as lie in the neighbourhood of $\omega = \omega_0$ [Barkhausen relation, ω_0 being the "swinging" frequency of the electrons about the grid], $2\omega_0$, $3\omega_0$ . . . etc. [the shorter "dwarf waves" of Potapenko] ; (2) the regeneration for the short-wave oscillations $n\omega_0$ ($n = 2, 3, 4$ . . .) sinks rapidly with increasing n in comparison with that for the fundamental ω_0 ; and (3) with increasing grid absorption (a) the regeneration becomes smaller, (b) each frequency region for which regeneration occurs becomes broader, and (c) in each such frequency region, the point of strongest regeneration becomes displaced towards the higher frequencies.

Similar treatment of motion transverse to the lines of force leads to the following results :—(1) As in the B-K valve, there are zones of value for both the characteristic frequencies ω and ω_0 in which oscillation excitation occurs, and also zones in which damping occurs. In these zones the energy delivery of the electrons to the oscillatory circuit is respectively greater or smaller than the energy absorption. The regions of negative resistance, in which alone the setting-up of oscillations is possible, are represented, as functions of ω and ω_0, as shaded areas in Fig. 3, from which it is possible to see, for given values of ω and ω_0, whether or not oscillations can be set up. (2) It is not in general necessary that the oscillation frequency should agree approximately with the "swinging" frequency or a multiple thereof, for oscillations to be set up. Thus the Barkhausen relation only applies, as a criterion of optimum excitation, to the B-K valve. In the arrangement here considered, for instance, in the case of resonance ($\omega = \omega_0$) there is actually a damping of the oscillations. Similarly the Hollmann condition for ultradynamic excitation has no general significance and applies only to special cases. (3) If, by means of a suitable mechanism (phase screen : *see* Brüche & Recknagel, 2325 of 1938), it is arranged that a part of those electrons which chiefly remove energy from the field is prevented from entering the condenser, the chance of oscillation excitation is improved. In this way it is possible to obtain regeneration even in regions where, without such phase selection, damping out of the oscillations would occur. (4) If the electron beam is deflected so as to impinge on the electrodes, the regeneration or the damping (as the case may be) becomes more powerful, since the power then varies linearly with the a.c. voltage, which must be considered as small, whereas when there is no impinging on the electrodes the power is proportional to the square of that voltage. This corresponds exactly to the relations in the anode and cathode "sorting out" processes in a B-K valve.

1404. Contribution to an Analytical Theory of the Retarding-Field Oscillator [Comparison with Coupled-Circuit Generator].—E. Baumann. (*Helvetica Phys. Acta*, Fasc. 6, Vol. 11, 1938, pp. 461–462 : in German.)

1405. The Influence of the Transit Time of the Electrons in Valves [Analysis for Plane Electrodes on Assumption that Time between Cathode and First Grid is Large compared with Times in Rest of System].—A. G. Clavier. (*Bull. de la Soc. franç. des Élec.*, Jan. 1939, Vol. 9, No. 97, pp. 79–110.)

"The following study is inspired particularly by the works of J. Müller (1934 Abstracts, pp. 493–494) and F. B. Llewellyn (1806 of 1935). The writer has aimed at simplifying the mathematical symbolism and at bringing out the physical significance of the quantities and of the equations. The results are applied to the amplification of high frequencies by pentodes, and it is shown in particular that the amplification of a given band of frequencies, with a maximum of distortion fixed in advance, depends in the last analysis on the value of the time of transit of the electrons between the electrodes to their working point" [so that a decrease in the distance between the electrodes is a step towards higher amplification even though it produces an increase in capacity].

1406. Addition to My Paper on Oscillation Onset in the Plate Condenser.—A. Recknagel : Hollmann & Thoma. (*Zeitschr. f. tech. Phys.*, No. 12, Vol. 19, 1938, pp. 616–617.)

Remarks pointing out that the objections to Hollmann & Thoma's work are still valid (*see* 2257 of 1938). "The objections raised by Gundlach, Brüche, & myself, as well as by Colebrook & Vigoureux, against the violation of the energy law (neglect of the energy effect of the stray field) in the Hollmann-Thoma calculations, still hold good. The agreement, in a special case, between the final formulae is merely produced by a combination, already pointed out elsewhere [1353 of 1938], of the original error mentioned above and of a further error—the employment of a false transit time" [*see* footnote 2].

1407. Spherical-Tank Ultra-High-Frequency Oscillator [with Symmetrically Placed Valves, Internal or External].—H. E. Hollmann. (*Electronics*, Dec. 1938, Vol. 11, No. 12, pp. 26–28.) For previous papers *see* 80 of 1938 and back reference ; *also* 3900 of 1938.

1408. FIRST-ORDER TRANSIT-TIME OSCILLATIONS IN MAGNETRONS.—A. Lerbs & K. Lämmchen. (*Hochf:tech. u. Elek:akus.*, Dec. 1938, Vol. 52, No. 6, pp. 186–192.)

Special valves were designed for this investigation; their principles are shown in Figs. 1, 2 and the valves themselves in Fig. 3: (a) symmetrical push-pull arrangement of an unsplit-anode valve; (b) four-slit valve with two galvanically separate oscillating circuits; (c) anode system for a four-slit valve with four oscillating circuits, galvanically connected to each other, arranged in a "rosette": this type is particularly stable in frequency and, owing to the large radiating surface and the possibility of simple water-cooling, will take more load than Type b. § III describes an investigation of the first-order transit-time oscillation for a skew magnetic field, the different working conditions being varied. It is found that the oscillation can be excited for all emissions with suitable adjustment of the other conditions. The excitation is best in the absence of space-charge phenomena, and not so good when the electric or magnetic field is distorted. This requires a high degree of symmetry in the electrode construction. A skew position of the electric field, by the superposition (by side electrodes) of a cross field, is not so effective as the rotation of the valve in a magnetic field. The bad effect of unequal emission distribution along the filament is also investigated. The character of the oscillations is found to be independent of the number of slits in the anode.

In § IV it is found that, in addition to the oscillation with a skew magnetic field, there is also a first-order oscillation for a strictly coaxial field and high space-charge (Fig. 7, effect of rotating the valve in a magnetic field). The effect on this oscillation of varying the working conditions is investigated (Figs. 10, 11). An explanation of the oscillation mechanism is sought in the different phases of the electrons and the selection of those with the correct phase. Dwarf waves could be obtained for both types of oscillation.

1409. ELECTRON-BEAM MAGNETRONS AND TYPE-B MAGNETRON OSCILLATIONS [Their Mechanism: Useful Output of 100–200 W from Small Radiation-Cooled Magnetron on 50–80 cm: etc.].—K. Okabe. (*Proc. Inst. Rad. Eng.*, Jan. 1939, Vol. 27, No. 1, pp. 24–27.) For previous papers on the electron-beam magnetron *see* 132 of 1938 and back references.

1410. THE WORKING OF IONISED-GAS OSCILLATORS IN A MAGNETIC FIELD [Explanation including Effect of Emission of Secondary Electrons by Impact of Positive Ions].—T. V. Ionescu. (*Comptes Rendus*, 9th Jan. 1939, Vol. 208, No. 2, pp. 85–88.) For previous work *see* 3514 of 1938 and back references.

1411. METHODS OF ULTRA-SHORT WAVE PRODUCTION: SUMMARISING REPORT.—H. E. Hollmann. (*Hochf:tech. u. Elek:akus.*, Nov. & Dec. 1938, Vol. 52, Nos. 5 & 6, pp. 161–172 & 209–215.)

1412. EXPERIMENTAL PROOF OF "PHASE FOCUSING" OF ELECTRONS.—Mayer. (*See* 1657.)

1413. APPLICATION OF THE COMPOSITE MODULATION TO THE PROBLEMS OF SIDEBAND-WIDTH CONTRACTION [Theory and Experiments on Combination of (*e.g.*) Amplitude and Frequency Modulation, involving the Splitting of the Band into 2 Halves, One being Inverted and Displaced into the Other: Methods of Separating Out at Receiving End: etc.].—T. Hayasi & S. Yamagiwa. (*Nippon Elec. Comm. Eng.*, Nov. 1938, No. 13, pp. 436–444.)

1414. CONSTANT-OUTPUT SYNCHRONISED OSCILLATOR INDEPENDENT OF THE INPUT SYNCHRONISING VOLTAGE.—Hayasi, Hukusaki, & Yamagiwa. (Discussed in paper dealt with in 1413, above.)

1415. A NEW LIMITING AMPLIFIER [for Volume Compression: Adaptation of "Little-Known Form of Bridge Circuit" having Many Advantages: Applicable also to Remote-Control Systems and measuring Distortion].—F. M. Davis: Collins Radio. (*Electronics*, Dec. 1938, Vol. 11, No. 12, pp. 56 and 57.)

1416. CALCULATION AND DESIGN OF MODULATION TRANSFORMERS [Laws of Electrical Similitude as a Guide to General Dimensions: Diagram for calculating Core Section: Avoidance of Effects of Stray Magnetic Fields: Importance of Distributed Capacity and Magnetising Losses: etc.].—M. Boella. (*Alta Frequenza*, Jan. 1939, Vol. 8, No. 1, pp. 5–23.)

1417. PAPERS ON THE DISTORTIONS IN CARRIER-FREQUENCY TRANSMISSION SYSTEMS.—Jacoby & Günther: Tischner. (*See* 1546 & 1547.)

1418. THE STABILITY OF A TRIODE-OSCILLATOR WITH GRID-CONDENSER AND LEAK [Analysis of Relaxation (Over-Oscillating) Phenomena occurring particularly on Short Waves and with Strong Retroaction (and constituting a Limit to Design of Oscillators for Short-Wave Superheterodyne Receivers): Condition for Stable Operation].—J. van Slooten. (*Wireless Engineer*, Jan. 1939, Vol. 16, No. 184, pp. 16–20.)

1419. WHAT'S YOUR CRYSTAL FREQUENCY? [Factors making Actual Frequency different from That on Label].—D. L. Lusk. (*QST*, Feb. 1939, Vol. 23, No. 2, pp. 33–35 and 116..122.)

1420. THE DEPENDENCE ON FREQUENCY OF THE TEMPERATURE-COEFFICIENT OF INDUCTANCE OF COILS.—Thomas. (*See* 1636.)

1421. NEW MULTI-FREQUENCY AIRCRAFT EQUIPMENT [with Complete R.F. Unit for Each Frequency, eliminating Elaborate Switching Arrangements and making possible the Simultaneous Use of More than One Channel.]—(*Electronics*, Nov. 1938, Vol. 11, No. 11, p. 70.)

1422. THE INCREASING DANGER OF ELECTRICAL DEATH OR MAIMING IN AMATEUR TRANSMITTERS [Editorial].—(*QST*, Feb. 1939, Vol. 23, No. 2, pp. 7–8.) For De Soto's very detailed and practical article on resuscitation from electrical shock, see *ibid.*, pp. 16–18. *See* also pp. 31 and 96, 98.

RECEPTION

1423. ARTIFICIAL SPHALERITE (ZINC SULPHIDE) AS BEST DETECTOR FOR WAVE-GUIDE MICRO-WAVES.—Reber. (In paper dealt with in 1340, above.)

1424. RECEIVING CONDITIONS IN THE ARCTIC [including Ultra-Short-Wave Signals from Balloon].—Hunter. (*See* 1347.)

1425. SHORT-WAVE OSCILLATOR PROBLEMS [Causes & Cure of Parasitic Oscillation in Frequency-Changers of Short-Wave Superheterodynes].—W. T. Cocking. (*Wireless World*, 9th Feb. 1939, Vol. 44, pp. 127–129.)

1426. THE STABILITY OF A TRIODE-OSCILLATOR WITH GRID-CONDENSER AND LEAK [and a Limit to Design of Oscillators for Short-Wave Superheterodynes].—van Slooten. (*See* 1418.)

1427. DESIGN OF OSCILLATOR CIRCUIT FOR SUPERHETERODYNE RECEIVERS.—(*Electronics*, Jan. 1939, Vol. 12, No. 1, pp. 46 and 48: summary only.)

1428. "DIE EMPFANGSANLAGEN . . ." [Receiving Equipments of the German State Service for Safety in Aviation: Book Review].—O. Koch. (*E.T.Z.*, 5th Jan. 1939, Vol. 60, No. 1, p. 30.)

1429. A SINGLE-SIDEBAND RECEIVER FOR SHORT-WAVE TELEPHONE SERVICE.—A. A. Roetken. (*Proc. Inst. Rad. Eng.*, Dec. 1938, Vol. 26, No. 12, pp. 1455–1465.) A summary was referred to in 3546 of 1938. For Oswald's paper on the whole system *see* 1752, below.

1430. A UNIVERSAL DIVERSITY RECEIVER [Hallicrafters Model DD-1 Dual-Diversity Receiver].—S. G. Taylor. (*Communications*, Dec. 1938, Vol. 18, No. 12, pp. 17–19 and 32, 33.)

1431. THE WQXR RECEIVER [High-Fidelity Receiver for Reception from Stations licensed for Band-Width of 20 kc/s: Special Precautions against Harmonic Distortion and Cabinet Reverberation (Cross Bracing): Wilmotte Baffle Plates in Front of Cone to diffuse High Frequencies: Self-Balancing Phase-Inversion Circuit].—R. Lorenzen. (*Communications*, Dec. 1938, Vol. 18, No. 12, pp. 20–21 and 32.)

1432. RADIO RECEIVERS WITH PUSH-BUTTON TUNING [particularly the Philips Motor-Driven System].—A. Horowitz & J. A. van Lammeren. (*Philips Tech. Review*, Sept. 1938, Vol. 3, No. 9, pp. 253–258.)

1433. EXTERNAL R.F. CONVERTERS [enabling Broadcast-Band Car Receiver to receive Long-Wave Weather Stations and "Emergency Stations" on 2726 kc/s].—M. E. Kennedy. (*Communications*, Nov. 1938, Vol. 18, No. 11, pp. 26, 27, 28.)

1434. MULTI-BAND TUNING INDICATORS: USES OF POLARISED LIGHT [*e.g.* by "Polaroid" Sheet].—(*Wireless World*, 23rd Feb. 1939, Vol. 44, p. 183.)

1435. "MOVIE DIAL" IN WARD RADIO ["Airline" Receivers].—H. Chase. (*Electronics*, Jan. 1939, Vol. 12, No. 1, p. 53.)

1436. MULTIVIBRATOR FOR GANGING [Valuable Aid in Alignment of Receivers].—H. Harris. (*Wireless World*, 23rd Feb. 1939, Vol. 44, pp. 181–183.)

1437. SIMPLIFIED VARIABLE SELECTIVITY [by Short-Circuiting One or Other of Auxiliary Windings inductively coupled to Windings of R.F. Inter-Valve Coupling Transformer].—R. E. Spencer. (*Wireless World*, 16th Feb. 1939, Vol. 44, p. 165.)

1438. FACTORS INFLUENCING THE "Q" OF R.F. COILS IN AMATEUR-BAND RECEIVERS [Wire Size, Length/Diameter Ratio, Dimensions, Winding Forms, and Insulation].—D. Pollack. (*QST*, Feb. 1939, Vol. 23, No. 2, pp. 54–57.)

1439. STUDY AND APPLICATIONS OF A STABLE GENERATOR OF RADIOPHONIC INTERFERENCE-VOLTAGES, "PERTURBATOR" TYPE [Thyratron Relaxation-Oscillation Generator giving Constant-Amplitude Signals resembling Interference, and Its Use in Investigation of Propagation and in Comparison of Interference-Measuring Apparatus].—G. Goffin & G. Marchal. (*L'Onde Élec.*, Dec. 1938, Vol. 17, No. 204, pp. 562–574.)

1440. A SIGNAL-METERING VALVE: A DIFFERENT APPROACH TO THE LIMITATION OF SIGNALS AND NOISE PEAKS IN RECEIVERS [Bridge Circuit using Double Triode, applicable to Other Types besides Superheterodynes].—H. O. Talen. (*QST*, Jan. 1939, Vol. 23, No. 1, pp. 64–66.)

1441. ON THE METHOD OF REDUCING THE IMPULSIVE NOISE BY MEANS OF VOLTAGE LIMITER [in Headphone Reception from High-Gain Amplifier].—Z. Saneyosi. (*Nippon Elec. Comm. Eng.*, Dec. 1938, No. 14, p. 516: summary only.)

1442. USING CONDENSERS FOR ELIMINATING INTERFERENCE FROM ELECTRICAL TRAMWAYS [Swedish Results with Condensers connected to Trolley Wire at Intervals of 200 Feet: Wave-Trap Action, necessitating Choice of Suitable Capacity Value].—S. Lemoine. (*Wireless Engineer*, Jan. 1939, Vol. 16, No. 184, pp. 3–5.)

1443. RADIO INTERFERENCE [from Electrical Apparatus: Production, Propagation, Entrance to Receiving Set].—L. Blok. (*Philips Tech. Review*, Aug. 1938, Vol. 3, No. 8, pp. 235–240.)

1444. RADIO INTERFERENCE—INVESTIGATION, SUPPRESSION, AND CONTROL [Work of the Radio Division of Dept. of Transport, Canada].—H. O. Merriman & F. G. Nixon. (*Proc. Inst. Rad. Eng.*, Jan. 1939, Vol. 27, No. 1, pp. 16–21.)

1445. RÉSUMÉ OF SOME SCHEMES AND SYSTEMS FOR THE SUPPRESSION OF INTERFERENCE [Industrial and Atmospheric] AT THE RECEIVER [Frame Aerials, with Screening: with Compensation by Auxiliary Aerial: Differential Circuits: Limiters].—L. Mouroux. (*L'Onde Élec.*, Dec. 1938, Vol. 17, No. 204, pp. 575–581.)

AERIALS AND AERIAL SYSTEMS

1446. THE SECTORAL ELECTROMAGNETIC HORN [with Two Opposite Sides Flared, Other Two Parallel: Experimental Comparison with Parabolic Reflectors and Broadside Arrays, on 40–100 cm Waves: Unique Possibilities of Horn: Application to Blind-Landing System: etc.], *and* THEORY OF THE ELECTROMAGNETIC HORN.—W. L. Barrow & F. D. Lewis: Barrow & L. J. Chu. (*Proc. Inst. Rad. Eng.*, Jan. 1939, Vol. 27, No. 1, pp. 41–50: pp. 51–64.)

1447. RECTANGULAR HOLLOW-PIPE RADIATORS [Theory for Radiation from Open Hollow Pipes: Verification at Wavelengths 50–100 cm: Justification of Application of Huygens's Principle in conjunction with Hertzian Vector, when Dimensions are Comparable with Wavelength: Advantages over Conventional Aerials].—W. L. Barrow & F. M. Greene. (*Proc. Inst. Rad. Eng.*, Dec. 1938, Vol. 26, No. 12, pp. 1498–1519.)

1448. ELECTRIC RESONANCE CHAMBERS [as Directional Radiators for Micro-Waves].—Reber. (In paper dealt with in 1340, above.)

1449. COAXIAL ANTENNA [for Ultra-Short Waves: claimed to reduce Wasteful High-Angle Radiation].—Western Electric. (*Proc. Inst. Rad. Eng.*, Jan. 1939, Vol. 27, No. 1, Supp. p. ii.)

1450. THE COAXIAL VERTICAL RADIATOR: AN IMPROVED HALF-WAVE ANTENNA SYSTEM FOR LOW-ANGLE RADIATION.—J. J. Long. (*QST*, Jan. 1939, Vol. 23, No. 1, pp. 42–44.)

1451. DISCUSSION ON "THE DISTRIBUTION OF ULTRA-HIGH-FREQUENCY CURRENTS IN LONG TRANSMITTING AND RECEIVING ANTENNAE."—L. S. Palmer & K. G. Gillard. (*Journ. I.E.E.*, Feb. 1939, Vol. 84, No. 506, pp. 293–294.) *See* 4340 of 1938. Denis Taylor describes his own earlier technique and results with 3–5 m waves.

1452. THE "Q" BEAM ANTENNA: A TWO-BAND DIRECTIONAL SYSTEM WITH NON-RESONANT FEEDERS.—L. W. Olander. (*QST*, Feb. 1939, Vol. 23, No. 2, pp. 24–27.)

1453. EXPONENTIAL TRANSMISSION LINE [and Its Use as an Impedance Transformer over Wide-Frequency Range, *e.g.* in connection with Aerial Feeders]: PART II.—C. R. Burrows. (*Communications*, Nov. 1938, Vol. 18, No. 11, pp. 11–13 and 17, 18.) For Part I *see* 458 of February. *Cf.* Neiman, 987 of March.

1454. TRANSMISSION LINES WITH EXPONENTIAL TAPER [Equations: Impedance Matching: Design Formulae].—H. A. Wheeler. (*Proc. Inst. Rad. Eng.*, Jan. 1939, Vol. 27, No. 1, pp. 65–71.) *See* also Burrows, 1453, above.

1455. APPLYING TRANSMISSION-LINE THEORY TO AERIALS.—G.W.O.H: Colebrook. (*Wireless Engineer*, Jan. 1939, Vol. 16, No. 184, pp. 1–2.) Editorial prompted by Colebrook's paper (4345 of 1938).

1456. GENERAL SOLUTION FOR THE INTENSITY OF ELECTROMAGNETIC FIELD PRODUCED BY ANY RADIATING CONDUCTOR [and the Groszkopf-Alford Argument about the "Dipole" and "Retarded-Potentials" Methods].—H. Iwakata. (*Nippon Elec. Comm. Eng.*, Dec. 1938, No. 14, pp. 514–515: summary only.) For Groszkopf's paper *see* 3304 of 1937.

1457. ON THE CRITICAL DIMENSIONS OF TUNED TRANSMITTING CIRCULAR LOOP AERIALS [for Maximum Current: Mathematical Determination by Retarded Induced Potential Method: Experimental Verification].—S. S. Banerjee. (*Phil. Mag.*, Feb. 1939, Series 7, Vol. 27, No. 181, pp. 174–181.)

1458. THE RADIATION RELATIONS FOR ORDINARY HARMONIC DIPOLES AND FOR PARTIALLY SCREENED HARMONIC AERIALS [with Screened Middle Zones and Free Half-Wave or Quarter-Wave Ends: with Opposite-Phase Screening: Mathematical Analysis and Comparison of Radiation Diagrams].—A. Thoma. (*Funktech. Monatshefte*, Dec. 1938, No. 12, pp. 363–368.) From the Berlin-Lichterfelde laboratory for high-frequency engineering and electro-medicine.

1459. CLOSE-SPACING ANTENNA ARRAYS [and the Use of Closely Spaced Dephased Elements to give "Flat-Top" Beams: etc.].—J. D. Kraus. (*Proc. Inst. Rad. Eng.*, Dec. 1938, Vol. 26, No. 10, p. 1424: summary only.) *See* also 1417 & 2316 of 1938.

VALVES AND THERMIONICS

1460. NEWLY CONSTRUCTED WATER-COOLED AND AIR-COOLED MAGNETRONS [Cooling System allows Dissipation of 1 kW, with 120 W Output at 27 cm and 250 W at 65 cm: Air-Cooled Type (4-Split Molybdenum Block) 30–40 W at 30 cm: the Trouble of Back-Heating].—M. Kobayasi & H. Uchida. (*Nippon Elec. Comm. Eng.*, Dec. 1938, No. 14, p. 513: summary only.)

1461. EXPERIMENTAL MULTIPLE WHOLE-ANODE AND FOUR-SPLIT-ANODE MAGNETRONS, *and* ELECTRON-BEAM MAGNETRONS AND TYPE-B MAGNETRON OSCILLATIONS.—Lerbs & Lämmchen: Okabe. (*See* 1408 & 1409.)

1462. THE VLS.381 ULTRA-HIGH-FREQUENCY TRIODE OF "DOOR-KNOB" TYPE OF CONSTRUCTION [Amplifier or Power Oscillator for 100–250 Mc/s, Appreciable Power on 300 Mc/s].—Standard Telephones & Cables. (*Journ. Scient. Instr.*, Jan. 1939, Vol. 16, No. 1, p. 32.) Max. anode dissipation for safe working, 40 watts at 100 Mc/s.

1463. REVIEW OF ULTRA-HIGH-FREQUENCY VACUUM-TUBE PROBLEMS [particularly the High Ratio of Input Conductance to Transconductance, and Its Reduction].—B. J. Thompson. (*RCA Review*, Oct. 1938, Vol. 3, No. 2, pp. 146–155: long summary in *Electronics*, Dec. 1938, Vol. 11, No. 12, pp. 50, 52, 53.)

1464. ON THE THEORY OF THE ACTION OF A PLANE DIODE AT HIGH FREQUENCIES [Linear Effects already Completely Solved: Unsatisfactory Position as regards Non-Linear Effects (Criticism of Benham's Work): Writer's Treatment of Non-Linear Effects of Any Circuit containing Plane Space-Charge-Limited Diode and Lumped or Distributed Constants].—G. Grünberg. (*Tech. Phys. of USSR*, No. 9, Vol. 5, 1938, pp. 696–714: in English.)

1465. THE INFLUENCE OF THE TRANSIT TIME OF THE ELECTRONS IN VALVES.—Clavier. (*See* 1405.)

1466. INITIAL-CURRENT-MODULATED ELECTRON MULTIPLIER AS A "SUPER-STEEP" AMPLIFYING VALVE: I.—G. Weiss & O. Peter. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 19, 1938, pp. 444–451.)

Authors' summary:—The voltage control of the secondary-emission multiplier is discussed. With the control device in front of the multiplier, it is the relative steepness . . . and not the absolute steepness . . . which is important. This relative steepness is greater in the initial current region than in the space-charge region. A cathode temperature as low as possible should be aimed at; this is realised by a Cs-film cathode with a small work function. Slopes of over 100 mA/V have already been attained. The noise level of this initial-current-modulated multiplier is from 2 to 5 times as unfavourable as with normal amplifying valves, according to the input current chosen.

1467. ELECTRONIC VALVES WITH SECONDARY EMISSION [especially the Miniwatt Dario 4696 and Its Uses, and Its "All Glass" Version EE 50 for Ultra-Short Waves, particularly for Television].—L. Chrétien. (*L'Onde Élec.*, Jan. 1939, Vol. 18, No. 205, pp. 38–52.)

1468. AMPLIFICATION BY SECONDARY EMISSION [Considerable Increase in Mutual Conductance without Corresponding Increase in Inter-Electrode Capacities: the EE 50 "All-Glass" Valve, particularly for Wide-Band Amplifiers as in Television].—Mullard Company. (*Wireless World*, 23rd Feb. 1939, Vol. 44, pp. 178–180.)

1469. "ALL-GLASS" VALVES [giving Lower Capacity & Inductance and Elimination of Bakelite Base (with Its Dielectric Constant varying with Temperature): etc.].—Mullard Company. (*Wireless World*, 16th Feb. 1939, Vol. 44, pp. 155–156.)

1470. THE NEW VALVE PROGRAMME ["Steel" and "Red" Series: the Diminution of H.F. Distortion by the "Sliding Screen-Grid Voltage" Method: Improvement of Short-Wave Reception (Low-Noise EF 13 and EF 8, with Extra "Null" Grid shielding Screen Grid): Mixing Valves ECH 11 (Triode-Hexode) and EK 3 (Four-Beam Octode): Diminution of Demodulation Distortion by the "Triple-Diode" Connection (with EAB 1, or ABC 1 specially connected): Valves for "German Small Receiver": etc.].—F. C. Saic. (*E.T.Z.*, 5th Jan. 1939, Vol. 60, No. 1, pp. 1–6.)

1471. EUROPEAN METAL VALVES.—L. Chrétien. (*L'Onde Élec.*, Dec. 1938, Vol. 17, No. 204, pp. 553–561.)

1472. A NEW FREQUENCY-CHANGING VALVE [Objections to Ordinary Octode: the New Four-Beam Octode Type EK3, where Electrons reflected at Signal Grid are prevented from reaching Oscillator Part].—J. L. H. Jonker & A. J. W. M. van Overbeek. (*Philips Tech. Review*, Sept. 1938, Vol. 3, No. 9, pp. 266–271.)

1473. THE IMPORTANCE OF THE H.F. INPUT VALVE [before the Mixing Stage in Superheterodyne Receivers: Shot-Effect Noise and Current-Distribution Noise, and the New Low-Noise H.F. Pentodes based on Two Different Principles].—C. Kerger. (*Electrot. u. Masch:bau*, No. 50, Vol. 56, 1938, pp. 672–675.)

1474. CORRECTIONS TO "A CONTRIBUTION TO TUBE AND AMPLIFIER THEORY."—W. E. Benham. (*Proc. Inst. Rad. Eng.*, Dec. 1938, Vol. 26, No. 12, pp. 1429–1430.) *See* 148 of January.

1475. THE INFLUENCE OF GRID FOCUSING EFFECT ON PLATE-DISSIPATION LIMIT OF A VACUUM TUBE [Analysis of "Hot Spotting" in Valves with Highly Negative Grids: Effect of Various Factors (Wall Thickness, Rate of Water Flow, Heat Conductivity, and Anode Radius) on Non-Uniform Heat Distribution in Anode].—I. E. Mouromtseff. (*Communications*, Dec. 1938, Vol. 18, No. 12, pp. 9–11 and 27.)

1476. THE USE OF THE CATHODE-RAY OSCILLOGRAPH FOR THE DETERMINATION OF TRANSMITTING-VALVE CHARACTERISTICS THAT CANNOT BE MEASURED IN THE ORDINARY WAY [Investigation of I_a/V_a Characteristics to within Saturation-Current Area].—Tj. Douma & P. Zijlstra. (*Philips Transmitting News*, Sept. 1938, Vol. 5, No. 3, pp. 89–96.) Including Posthumus's replacement of mechanical switch by a second c-r tube—the "impulse" tube.

1477. The Fluctuation Theorem (Shot Effect).—N. Campbell: Rowland. (*Proc. Camb. Phil. Soc.*, Jan. 1939, Vol. 35, Part 1, pp. 127–129.) Criticisms of, and comments on procedure in, Rowland's paper referred to in 534 of 1937.

1478. Noise of Frequency-Changer Valves [Absence of Additional Noise from Local-Oscillator Heterodyning of Signal-Frequency Part of Noise Spectrum attributed to Non-Existence of Signal-Frequency Spectrum at Any Point where It can be Heterodyned].—D. A. Bell: Lucáks & others. (*Wireless Engineer*, Jan. 1939, Vol. 16, No. 184, p. 15.) Prompted by the letter dealt with in 537 of February.

1479. The Temperature Response of the Shot Effect of Valves with Oxide-Coated Cathode [Comparison of Theoretical Results (Schottky & Spenke) with Experimental: Reasons for Discrepancies at the Higher and Lower Temperatures: Importance of Previous Treatment of Cathode: etc.].—Z. Szepesi. (*Wireless Engineer*, Feb. 1938, Vol. 16, No. 185, pp. 67–70.) From the Tungsram laboratories.

1480. Some Experiments on Secondary Electron Emission.—R. Kollath. (*Zeitschr. f. tech. Phys.*, No. 12, Vol. 19, 1938, pp. 602–604: *Physik. Zeitschr.*, 15th Dec. 1938, Vol. 39, No. 23/24, pp. 916–918.)

An oscillographic method is described (circuit Fig. 3) for observing the whole yield curve (secondary emission as a function of the incident energy of the primary electrons) as an oscillogram. Three demonstration experiments are described which show the decrease in secondary emission when a beryllium film is vaporised on to the surface, and the effect of temperature on films of compact nickel and vaporised beryllium.

1481. Electron Emission [and the Mechanism of the Activating Process for Dull Emitters: also Field ("Cold") Emission: Malter's Results with Caesium/Aluminium-Oxide/Aluminium Cathodes, and Their Explanation: etc.].—R. Kollath & B. Mrowka. (*Elektrot. u. Masch:bau*, No. 48, Vol. 56, 1938, pp. 650–651.) Summary of a paper in the 1936/37 AEG Research Yearbook.

1482. Thermionic Emission in Transmitting Tubes [with Thoriated Tungsten, Oxide-Coated, & Pure Tungsten Filaments, and Other Electrodes of Various Materials: Relation to Life of Valve].—C. P. Marsden, Jr. (*Electronics*, Dec. 1938, Vol. 11, No. 12, pp. 22–25 and 32.)

1483. Electron-Microscope Studies of Thoriated Tungsten [and the "Eruptions" of Thorium at Randomly Located Points: Preferred Direction of Migration from Eruption Centres: etc.].—A. J. Ahearn & J. A. Becker. (*Phys. Review*, 15th Sept. 1938, Series 2, Vol. 54, pp. 448–458.)

1484. The Variation of Field Electron Emission with Work Function [for Adsorbed Surface Layers, must be measured on Substances which build Uniform Films not consisting of Crystallites: Emission then agrees with Wave-Mechanical Theory].—R. Haefer. (*Naturwiss.*, 13th Jan. 1939, Vol. 27, No. 2, p. 32.) Results differing from those of Müller (135 & 3313 of 1937) whose films probably consisted of crystallites.

1485. Temperature Scale for Rhodium [Results on Emissivity and Thermionic Properties].—Wahlin & Whitney. (*Journ. of Applied Phys.*, Dec. 1938, Vol. 9, No. 12, p. 745.)

1486. The True Temperature Scale of an Oxide-Coated Filament [Determination of Spectral Emissive Power from Measurements of Reflection Coefficient].—C. H. Prescott, Jr., & J. Morrison. (*Review Scient. Instr.*, Jan. 1939, Vol. 10, No. 1, pp. 36–38.)

1487. "Getterstoffe und ihre Anwendung in der Hochvakuumtechnik" [Book Review].—Littmann. (*Elektrot. u. Masch:bau*, No. 47, Vol. 56, 1938, pp. 635–636.)

DIRECTIONAL WIRELESS

1488. A Straight-Line Blind-Landing System using the Electromagnetic Horn.—Barrow & Lewis. (In paper dealt with in 1446, above.)

1489. Aircraft Radio, 1939 [Ultra-Short and Micro-Waves for Course Finding, Blind Landing, Altimetering ("Terrain Clearance" Indication), etc: including the Use of "Horn" Radiators of Wave-Guide Type, giving "Pancake" Beams: the Metcalf "Three-Light" Blind-Landing System: etc.].—D. Fink. (*Electronics*, Jan. 1939, Vol. 12, No. 1, pp. 10–14 and 43.)

1490. The Theory and Experience of Blind Landing.—D. Basim: Bendix Radio. (*Proc. Inst. Rad. Eng.*, Dec. 1938, Vol. 26, No. 12, p. 1429: summary only.)

1491. Wireless Altimeter [Western Electric "Wobbled Ultra-High-Frequency" Apparatus].—Espenschied & Newhouse. (*Wireless World*, 2nd Feb. 1939, Vol. 44, pp. 100–102.)

1492. A Sense-Finding Device for Use with Spaced-Aerial Direction Finders [particularly Suitable for High Frequencies and C-R-Tube Receivers: Sense determined with help of Second Observation with Changed Electrical Connections].—R. A. Fereday. (*Journ. I.E.E.*, Jan. 1939, Vol. 84, No. 505, pp. 96–100.)

1493. Demonstration of the Various Methods of Radio Direction Finding with a Small Short-Wave Emitter.—H. Ristau. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 19, 1938, p. 444.)

1494. Multiple Courses of an Aeronautical Radio Range Beacon, and the Causes of this Phenomenon.—S. Yonezawa & K. Hiraoka. (*Nippon Elec. Comm. Eng.*, Dec. 1938, No. 14, pp. 467–481.) Almost identical with the paper dealt with in 1010 of March.

ACOUSTICS AND AUDIO-FREQUENCIES

1495. PEDRO THE VODER: A MACHINE THAT TALKS [" Voice-Operation Demonstrator " for San Francisco Exposition and New York World's Fair].—(*Bell Lab. Record*, Feb. 1939, Vol. 17, No. 6, pp. 170–171.) Developed from Dudley's speech synthesiser (1038 of 1937). *See* also *Science*, 13th Jan. 1939, Supp. pp. 6–7, and *Electronics*, Feb. 1939, p. 19.

1496. TEMPERATURE REDUCTION IN HIGH-POWERED LOUDSPEAKERS [including Experimental Results on Replacement of Air in Air-Gap by Helium and Hydrogen, making possible Very Light Speech Coils or, alternatively, Increased Operating Efficiency].—F. Massa. (*RCA Review*, Oct. 1938, Vol. 3, No. 2, pp. 196–202.)

1497. OUTPUT STAGE AND LOUDSPEAKER [Permissible Distortion Limits for Varying Degrees of Fidelity (Spurious Combination Tones, Cross Modulation, etc.): Usual Graphical Treatment of Elliptical Load Lines only an Approximation: Comparison of Triodes, Tetrodes, & Pentodes (with & without Negative Feedback) on Various Types of Loading, and the Design of Loudspeaker Transformers].—F. Langford Smith. (*Wireless World*, 9th & 16th Feb. 1939, Vol. 44, pp. 133–136 & 167–170). Based on a Sydney World Radio Convention paper.

1498. DIVERSE TRANSFORMER LOADING [Problems in operating Several Loudspeakers from One Amplifier].—N. Partridge. (*Wireless World*, 23rd Feb. 1939, Vol. 44, pp. 189–191.)

1499. THE ELECTRO-ACOUSTICAL ENGINEER AND THE ARCHITECT [and the Use of the " Flat " Loudspeaker].—(*Elektrot. u. Masch:bau*, No. 46, Vol. 56, 1938, p. 615.)

1500. INDOOR AND OUTDOOR RESPONSE OF AN EXPONENTIAL HORN [Measurements].—Boner, Wayne Jones, & Cunningham. (*Journ. Acous. Soc. Am.*, Jan. 1939, Vol. 10, No. 3, pp. 180–183.)

1501. CONCENTRIC FOLDED-HORN DESIGN [and Its Advantages over " Snail-Shell " and Other Compressed Exponential Horns].—A. J. Sanial. (*Electronics*, Jan. 1939, Vol. 12, No. 1, pp. 16–18.)

1502. WQXR HIGH-FIDELITY RECEIVER WITH BAFFLE PLATES IN FRONT OF CONE, ETC.—Wilmotte. (*See* Lorenzen, 1431, above.)

1503. FUNDAMENTAL VIBRATION OF A RECTANGULAR PLATE [Combination of Graver Tones of Transverse Vibrations].—M. D. Waller. (*Nature*, 7th Jan. 1939, Vol. 143, pp. 27–28.)

1504. MEASUREMENTS ON ACOUSTIC RESONATORS.—H. Gemperlein. (*Hochf:tech. u. Elek:akus.*, Dec. 1938, Vol. 52, No. 6, pp. 193–201.)

Oscillograms are given of the resonance curves and the onset and decay of acoustic oscillations in a one-dimensional resonator (a long thin iron tube; Fig. 1) and in a three-dimensional resonator (Lamé's tetrahedron; Fig. 5). The circuit used is shown in Fig. 1. Absorption measurements are also described (§ IV; circuit Fig. 12) which were made to determine the degree to which a three-dimensional resonator is suitable for measuring the acoustic absorption of materials such as swan's-down.

1505. A BIBLIOGRAPHY ON RECORDING [and Reproduction, of Gramophone Records].—J. G. Sperling. (*Communications*, Dec. 1938, Vol. 18, No. 12, pp. 22 and 27.)

1506. EXPERIMENTAL CONSIDERATION UPON THE A.C. ERASING ON THE MAGNETIC RECORDING, AND PROPOSITION OF THE NEW RECORDING METHOD.—Nagai, Sasaki, & Endo. (*Nippon Elec. Comm. Eng.*, Nov. 1938, No. 13, pp. 445–447.) A summary was dealt with in 4420 of 1938.

1507. ELECTRICAL NETWORKS FOR SOUND RECORDING.—F. L. Hopper. (*Electronics*, Jan. 1939, Vol. 12, No. 1, pp. 44 and 46: summary only.)

1508. " MOTION PICTURE SOUND ENGINEERING " [Book Review].—Acad. of Mot. Pic. Arts & Sciences. (*Journ. Acous. Soc. Am.*, Oct. 1938, Vol. 10, No. 2, p. 150.)

1509. SOUND AMPLIFICATION AND PUBLIC ADDRESS [especially in Buildings with Defective Acoustics, Excessive Reverberation Time: etc.].—J. de Boer. (*Philips Tech. Review*, Aug. 1938, Vol. 3, No. 8, pp. 221–227.)

1510. THE ELECTRO-ACOUSTIC INSTALLATION IN THE LEAGUE OF NATIONS PALACE IN GENEVA.—N. A. J. Voorhoeve & J. P. Bourdrez. (*Philips Tech. Review*, Nov. 1938, Vol. 3, No. 11, pp. 322–330.)

1511. NEW APPLICATIONS FOR HIGH-POWER PUBLIC ADDRESS SYSTEMS [for Beach Patrol (including Location of Lost Children): U.S. Army Signal Corps System, with Sound Radius over 1 Mile, for Crowd of 250 000].—(*Electronics*, Nov. 1938, Vol. 11, No. 11, p. 40.)

1512. LONG-DISTANCE CONFERENCE SYSTEM [with Loss Control and Echo Suppression by Use of " Volcas "].—H. A. Etheridge. (*Bell Lab. Record*, Feb. 1939, Vol. 17, No. 6, pp. 181–184.)

1513. A NEW PHILIPS STUDIO EQUIPMENT [K. R. O. Hilversum].—(*Philips Transmitting News*, Sept. 1938, Vol. 5, No. 3, pp. 79–88.)

1514. LIMITING AMPLIFIERS [for Compressing the Volume Range in Speech-Input Circuit: Gates and Collins Types].—(*Proc. Inst. Rad. Eng.*, Jan. 1939, Vol. 27, No. 1, Supp. p. ii.)

1515. A NEW LIMITING AMPLIFIER [for Volume Compression, Distortion Measurement, etc.].—Davis. (*See* 1415.)

1516. LINE EQUALISATION BY PREDISTORTION.—Creamer. (*See* 1749.)

1517. MUSIC CHANNELS [as rented by B.B.C., Wire-Broadcast and Rediffusion Services, etc: Required Performance and Existing & Contemplated Methods], *and* THE PROVISION OF MUSIC CHANNELS ON 12-CHANNEL CARRIER CABLES [including Test Results on Bristol/Plymouth Route].—F. J. D. Taylor: R. J. Halsey & D. G. Tucker. (*P.O. Elec. Eng. Journ.*, Jan. 1939, Vol. 31, Part 4, pp. 276–279: pp. 280–285.)

1518. A TUBULAR DIRECTIONAL MICROPHONE [Pressure-Type M.C. Microphone coupled to Impedance Element of Fifty 3/8" diam. Aluminium Tubes varying in Length from 3 to 150 cm by Equal Increments].—W. P. Mason & R. N. Marshall. (*Journ. Acous. Soc. Am.*, Jan. 1939, Vol. 10, No. 3, pp. 206–215.) The use of this microphone for broadcasting the 1937 American Legion parade was referred to in 1016 of 1938.

1519. EFFECT OF PHYSICAL SIZE ON THE DIRECTIONAL-RESPONSE CHARACTERISTICS OF UNIDIRECTIONAL AND PRESSURE-GRADIENT MICROPHONES.—F. Massa. (*Journ. Acous. Soc. Am.*, Jan. 1939, Vol. 10, No. 3, pp. 173–179.)

1520. A DIRECTIONAL MICROPHONE WITH CONTROLLED CHARACTERISTICS.—A. J. Ebel. (*Electronics*, Nov. 1938, Vol. 11, No. 11, pp. 40 and 42..48.)

1521. A METHOD OF EQUALISING THE FREQUENCY CHARACTERISTIC OF A TELEPHONE TRANSMITTER [Carbon Microphone].—D. McMillan. (*P.O. Elec. Eng. Journ.*, Jan. 1939, Vol. 31, Part 4, pp. 299–300.)

1522. MICROPHONE WIND SCREENING [Hydrodynamical Principles: Comparison of Bernouilli Screen and Much Larger Ellipsoidal Screen].—W. D. Phelps. (*RCA Review*, Oct. 1938, Vol. 3, No. 2, pp. 203–212.)

1523. EXPLORATION OF PRESSURE FIELD AROUND THE HUMAN HEAD DURING SPEECH.—H. K. Dunn & D. W. Farnsworth. (*Journ. Acous. Soc. Am.*, Jan. 1939, Vol. 10, No. 3, pp. 184–199.) A summary was referred to in 3980 of 1938.

1524. KONTAK [Microphone] UNIT [for clamping on Bridge of Any String Instrument, enabling Latter to be played through Broadcast Receiver].—Amperite Company. (*Electronics*, Jan. 1939, Vol. 12, No. 1, p. 64.)

1525. ACOUSTIC PROPERTIES OF VIOLINS OF OUTSTANDING TONE QUALITY [Frequency Curves: Typical Resonance Regions: Importance of Large Low-Frequency and Small High-Frequency Amplitude: Comparison of Old and New Instruments].—H. Meinel. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 19, 1938, pp. 421–425.) For previous work *see* 213 of January. *Cf.* also Saunders, Koch, 571 of February.

1526. THE DEPARTURE OF THE OVERTONES OF A VIBRATING WIRE FROM A TRUE HARMONIC SERIES.—R. S. Shankland & J. W. Coltman. (*Journ. Acous. Soc. Am.*, Jan. 1939, Vol. 10, No. 3, pp. 161–166.)

1527. DYNAMICS OF THE PIANOFORTE STRING AND THE HAMMER: PART I—HARD HAMMER.—M. Ghosh. (*Indian Journ. of Phys.*, Nov. 1938, Vol. 12, Part 5, pp. 317–330.)

1528. THE FORCE-TIME LAW GOVERNING THE IMPACT OF A HAMMER ON A STRETCHED STRING [Measurement of Instantaneous Force of Impact by Piezoelectric Method: Cathode-Ray Oscillograms equivalent to Force-Time Diagrams].—N. Davy, J. H. Littlewood, & M. McCaig. (*Phil. Mag.*, Feb. 1939, Series 7, Vol. 27, No. 181, pp. 133–143.)

1529. A NEW METHOD FOR TUNING PIANOS [Octaves tuned Free of Beats, Major Tenths Sharp (to give Beat Rates indicated), Fifths Slightly Flat].—J. de Bremaeker: W. B. White. (*Journ. Acous. Soc. Am.*, Oct. 1938, Vol. 10, No. 2, pp. 155–156: long summary.)

Incidentally, the writer designates as "barbarous" the usual practice of not tuning pianos to true octaves at the high and low ends, whereby brilliant music is obtained at the expense of pathetic. This opinion, and his new method of tuning, are roughly treated by White in the issue for Jan. 1939, Vol. 10, No. 3, pp. 246–247.

1530. THE ELECTONE, AN ELECTRONIC PIANO [licensed under Miessner Patents].—G. S. Taylor: Bretzfelder. (*Electronics*, Jan. 1939, Vol. 12, No. 1, pp. 26–28.)

1531. STUDIES OF THE TONE QUALITY OF ORGAN-PIPES: II—REED PIPES [Oscillograms showing Dependence on Blowing Pressure and Relative Phases of Reed and Air Vibrations: Nature of Coupling between Reed and Resonator].—M. Mokhtar. (*Phil. Mag.*, Feb. 1939, Series 7, Vol. 27, No. 181, pp. 195–199.)

1532. RESONANCE IN CERTAIN NON-UNIFORM TUBES [Organ Pipes with Contained Solid Rods: Two Cylinders of Different Diameters joined by Flaring Connector].—A. T. Jones. (*Journ. Acous. Soc. Am.*, Jan. 1939, Vol. 10, No. 3, pp. 167–172.)

1533. SOUNDS—PLEASANT AND UNPLEASANT [Study of the Complex Nature of Musical Sounds].—N. Partridge. (*Wireless World*, 9th Feb. 1939, Vol. 44, pp. 145–147.)

1534. THE FREQUENCY RATIOS OF THE TEMPERED SCALE [Difference between Tempered and Just Scales explained by Use of Common Fractions].—C. Williamson. (*Journ. Acous. Soc. Am.*, Oct. 1938, Vol. 10, No. 2, pp. 135–136.)

1535. THE EFFECT OF THE CONSONANT ON THE VOWEL.—J. W. Black. (*Journ. Acous. Soc. Am.*, Jan. 1939, Vol. 10, No. 3, pp. 203–205.)

1536. THE HARMONIC STRUCTURE OF VOWELS IN SINGING IN RELATION TO PITCH AND INTENSITY.—B. Stout. (*Journ. Acous. Soc. Am.*, Oct. 1938, Vol. 10, No. 2, pp. 137–146.)

1537. SOUND ANALYSIS IN THE HUMAN EAR FROM THE STANDPOINT OF VARIOUS THEORIES OF HEARING.—R. Hildebrandt. (*Funktech. Monatshefte*, Dec. 1938, No. 12, pp. 361–363).

1538. Resonance in the External Auditory Meatus [Method of Measurement by filling the Meatus with Hydrogen and observing Change in Intensity Level of Sound at Different Frequencies : Pressure Magnification due to Meatus Resonance].—T. S. Littler. (*Nature*, 21st Jan. 1939, Vol. 143, p. 118.)

1539. Frequency Distribution of Eigentones in a Three-Dimensional Continuum, *and* Distribution of Eigentones in a Rectangular Chamber at Low Frequency Range.—R. H. Bolt : D. Y. Maa. (*Journ. Acous. Soc Am.*, Jan. 1939, Vol. 10, No. 3, pp. 228–234 : pp. 235–238.) At the meeting at which these papers were read it was suggested that in future the word "eigentone" should be replaced by the more specific terms "normal frequency" and "normal mode."

1540. Investigation of Room Acoustics by Steady-State Transmission Measurements : I [Experiments in Small Model Chamber, using Discrete Normal Frequencies 250–1500 c/s from Special ("Multiple Capillary") Sound Source].—F. V. Hunt. (*Journ. Acous. Soc. Am.*, Jan. 1939, Vol. 10, No. 3, pp. 216–227.)

1541. Auditorium Acoustics and Sound Absorption.—R. Vermeulen. (*Philips Tech. Review*, Dec. 1938, Vol. 3, No. 12, pp. 363–371.)

1542. Measurement of Absorption in Rooms with Sound-Absorbing Ceilings [and Its Difficulties].—J. R. Power. (*Journ. Acous. Soc. Am.*, Oct. 1938, Vol. 10, No. 2, pp. 98–101.) A summary was referred to in 4395 of 1938.

1543. Sound Absorption of Snow [Absorption Coefficients of Freshly-Fallen Snow for Various Frequencies : High Values].—G. W. C. Kaye & E. J. Evans. (*Nature*, 14th Jan. 1939, Vol. 143, p. 80.)

1544. Equivalent Lengths and Corrections of Length in Acoustic Systems.—F. H. van den Dungen. (*Revue d'Acoustique*, [dated] Jan./March 1938, Vol. 7, Fasc. 1/3, pp. 1–19.)

1545. Excitation and Stabilisation of the Singing of Flames.—Z. Carrière. (*Revue d'Acoustique*, [dated] Jan./March 1938, Vol. 7, Fasc. 1/3, pp. 20–38.)

1546. The Probability of the Linear and Non-Linear Voltages occurring in Carrier-Frequency Multiple Systems [Calculations].—H. Jacoby & G. Günther. (*Hochf:tech. u. Elek:akus.*, Dec. 1938, Vol. 52, No. 6, pp. 201–209.)

Authors' summary :—The linear and non-linear voltages arising in a multiple carrier-current system are calculated on a simple assumption as to the amplitude distribution in a speech channel, whose justification is given. For linear voltages, the distribution function is calculated for the resultant voltage, taking into account the effect of cross-talk, the difference in loudness of the various speakers, and the attenuation of their connections to the exchange. The final formula permits the determination of the power which an amplifier must yield in order to transmit n conversations simultaneously, of which each has a definite level at the amplifier output.

The effective value of the "klirr" voltages due to the non-linearity of the common amplifiers on the transmission path is calculated. This increases with the square root of the number of conversations for second-order combination tones and with the number of conversations for third-order combination tones. Finally, the resultant of the combination-tone voltages arising anew at each amplifier is determined. Its r.m.s. value is proportional to the square root of the number of amplifier fields.

1547. Calculation and Measurement of Non-Linear Distortions in Carrier-Frequency Transmission Systems.—H. Tischner. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 19, 1938, pp. 425–429.)

Author's summary :—The non-linear distortions caused by a symmetrical characteristic used over a wide range are calculated by replacing the characteristic by an exponential function. The amplitude of the overtones is obtained by using Bessel functions of the first kind and Weber functions. An arrangement consisting of a buzzer [curve-form and spectrum Fig. 4] and two resonant circuits is suitable for measuring non-linear distortions. The spectrum and the curve-form are very similar to those of the vowel *a* spoken into a carbon microphone [Fig. 5 ; Fig. 7 shows cross-talk attenuation of an amplifier].

1548. A New Microphotometer for the Evaluation of Acoustics Records.—A. Narath & K. Schwarz. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 19, 1938, pp. 465–469.)

1549. The Diffraction of Light by Sound Film [and Its Use for Sound Analysis, for determining the Frequency Characteristic of an Amplifier, etc.].—J. F. Schouten. (*Philips Tech. Review*, Oct. 1938, Vol. 3, No. 10, pp. 298–305.)

1550. Template for Graphing Audio-Amplifier Performance.—H. W. Augustadt. (*Bell Lab. Record*, Jan. 1939, Vol. 17, No. 5, pp. 153–154.)

1551. An Apparatus for Direct-Recording the Pitch and Intensity of Sound [supplemented by Radio Receiver, so that Graphs of Radio Programmes may be obtained].—J. Obata & R. Kobayashi. (*Journ. Acous. Soc. Am.*, Oct. 1938, Vol. 10, No. 2, pp. 147–149.) Embodying an improved version of the "direct-reading pitch recorder" referred to in 1496 of 1938.

1552. Theory of the Chromatic Stroboscope [for Measurement of Musical Note Frequencies : 12-Disc Instrument with Adjustable Drive and Flashing Amplifier].—R. W. Young & A. Loomis. (*Journ. Acous. Soc. Am.*, Oct. 1938, Vol. 10, No. 2, pp. 112–118.)

1553. ANALYSER MEASURING THE RELATIVE PHASES OF THE HARMONICS OF A SOUND.—Z. Carrière. (*Journ. de Phys. et le Radium*, Jan. 1939, Series 7, Vol. 10, No. 1, pp. 14–22.)

1554. APPARATUS FOR ACOUSTIC AND AUDIO-MEASUREMENTS [Automatic Equipment for Reverberation, Response/Frequency, and Other Measurements: A.C. Operated, Portable].—H. A. Chinn & V. N. James. (*Journ. Acous. Soc. Am.*, Jan. 1939, Vol. 10, No. 3, pp. 239–245.)

1555. ABSORPTION EFFECTS IN SOUND-TRANSMISSION MEASUREMENTS [and the Tentative Standards of the American Standards Association].—P. E. Sabine & L. G. Ramer. (*Journ. Acous. Soc. Am.*, Oct. 1938, Vol. 10, No. 2, pp. 102–104.)

1556. NOTE ON THE NEW NOTION OF "ÉCART DIAPHONIQUE" [introduced at CCIF, Oslo Meeting].—L. Simon. (*Ann. des Postes, T. et T.*, Jan. 1939, Vol. 28, No. 1, pp. 28–33.)

1557. ABSOLUTE SOUND MEASUREMENTS IN LIQUIDS [Discussion of Three Methods, particularly the Radiation-Pressure Method and Its Use for Microphone Calibration].—E. Klein. (*Journ. Acous. Soc. Am.*, Oct. 1938, Vol. 10, No. 2, pp. 105–111.) A summary was dealt with in 4410 of 1938: for previous work *see* 2397 of 1938.

1558. A MOVING-COIL PISTONPHONE FOR MEASUREMENT OF SOUND-FIELD PRESSURE.—R. P. Glover & B. Baumzweiger. (*Journ. Acous. Soc. Am.*, Jan. 1939, Vol. 10, No. 3, pp. 200–202.) A summary was dealt with in 4400 of 1938.

1559. AN ADJUSTABLE TUNING-FORK FREQUENCY STANDARD [Weights on Prongs movable while Running: Precise Method of Calibration].—O. H. Schuck. (*Journ. Acous. Soc. Am.*, Oct. 1938, Vol. 10, No. 2, pp. 119–127.) Has been incorporated in the chromatic stroboscope dealt with above (1552).

1560. TELEPHONE TRANSMISSION TESTING BY SUBJECTIVE METHODS.—W. West. (*P.O. Elec. Eng. Journ.*, Jan. 1939, Vol. 31, Part 4, pp. 286–292.)

1561. RECENT ADVANCES IN THE USE OF ACOUSTIC INSTRUMENTS FOR ROUTINE PRODUCTION TESTING [of Motors, Bearings, Motor Horns, Signalling Devices, etc.].—B. Foulds. (*Journ. Acous. Soc. Am.*, Oct. 1938, Vol. 10. No. 2, pp. 128–134.)

1562. THE OPTICAL PHENOMENA OF A SUPERSONIC GRATING IN THE CIRCULAR OPENING OF A QUARTZ RING [in Air and in a Liquid: Stationary Supersonic Fields produced Not Only by Radial Vibrations but by Many Other (chiefly Transverse) Modes: etc.].—J. Ceřovska. (*Journ. de Phys. et le Radium*, Feb. 1939, Series 7, Vol. 10, No. 2, pp. 97–103.)

1563. DISSIPATIVE ACOUSTIC REFLECTION COEFFICIENTS IN GASES BY ULTRASONIC INTERFEROMETRY [Modification of Theory of Acoustic Resonator Interferometer: Experimental Requirements and Adjustments].—R. S. Alleman. (*Phys. Review*, 1st Jan. 1939, Series 2, Vol. 55, No. 1, pp. 87–93.)

1564. ON EXPERIMENTS TO TEST THE OCCURRENCE OF SUPERSONIC-WAVE DISPERSION IN LIQUIDS [Velocities of 53 Mc/s Wave in Water, at Various Temperatures, All Slightly Smaller than Corresponding Values for 7.5 Mc/s Wave].—R. Bär. (*Helvetica Phys. Acta*, Fasc. 6, Vol. 11, 1938, pp. 472–475: in German.)

1565. THE DISPERSION OF SUPERSONIC WAVES IN CASTOR OIL [Value greater than Theory of Viscosity Effects predicts].—L. Zachoval. (*Comptes Rendus*, 23rd Jan. 1939, Vol. 208, No. 4, pp. 265–266.)

1566. PROPERTIES OF DOUBLE REFRACTION OF LIQUIDS, CREATED BY SUPERSONIC WAVES, *and* ON WAVES OF THERMAL AGITATION IN LIQUIDS.—R. Lucas. (*Journ. de Phys. et le Radium*, Jan. 1939, Series 7, Vol. 10, No. 1, pp. 151–152 S: Feb. 1939, No. 2, pp. 60–74.)

1567. THE QUESTION OF COLLISION EXCITATION OF INTRA-MOLECULAR OSCILLATIONS [Theoretical Discussion of Measurements on Supersonic Dispersion].—A. Eucken & L. Küchler. (*Zeitschr. f. tech. Phys.*, No. 12, Vol. 19, 1938, pp. 517–521: *Physik. Zeitschr.*, 15th Dec. 1938, Vol. 39, No. 23/24, pp. 831–835.)

1568. ACOUSTIC RELAXATION PHENOMENA [in Gases and Liquids: Variation with Pressure, Temperature, and Presence of Other Gases: Relation to Molecular Processes: Absorption, Disperson, Relaxation Time in Liquids].—H. O. Kneser. (*Zeitschr. f. tech. Phys.*, No. 12, Vol. 19, 1938, pp. 486–492: *Physik. Zeitschr.*, 15th Dec. 1938, Vol. 39, No. 23/24, pp. 800–806.)

1569. THE NATURE AND EMPLOYMENT OF SUPERSONIC WAVES [Survey].—E. C. Metschl. (*E.T.Z.*, 12th Jan. 1939, Vol. 60, No. 2, pp. 33–40.)

1570. THE PRESENT POSITION OF RESEARCH ON ULTRASONICS.—E. Baumgardt. (*Revue d'Acoustique*, [dated] Jan./March 1938, Vol. 7, Fasc. 1/3, pp. 39–72.)

1571. THE ABSORPTION OF SOUND IN CARBON DIOXIDE AND OTHER GASES [Confirmation of Collision Theory of Anomalous Absorption: Effect of Impurities: etc.].—V. O. Knudsen & E. F. Fricke. (*Journ. Acous. Soc. Am.*, Oct. 1938, Vol. 10, No. 2, pp. 89–97.)

1572. THE VELOCITY OF SOUND IN BINARY MIXTURES OF LIQUIDS, BY A RESONANCE METHOD.—C. Sălceanu. (*Comptes Rendus*, 9th Jan. 1939, Vol. 208, No. 2, pp. 83–85.)

1573. The Internal Friction of Solid Bodies: II—Thermal Damping in Flexural Oscillations.—K. Bennewitz & H. Rötger. (*Zeitschr. f. tech. Phys.*, No. 12, Vol. 19, 1938, pp. 521–526: *Physik. Zeitschr.*, 15th Dec. 1938, Vol. 39, No. 23/24, pp. 835–840.)

1574. Direct Observation of Rayleigh Waves in Case of Total Reflection.—Kretschmer & Rschevkin. (*Comptes Rendus (Doklady) de l'Acad. des Sci. de l'URSS*, No. 1, Vol. 20, 1938, pp. 17–20: in English.)

1575. Propagation of Explosion Waves in Liquids and Solid Bodies.—von Schmidt. (*See* 1368.)

PHOTOTELEGRAPHY AND TELEVISION

1576. Observations on Sky-Wave Transmission on [Television] Frequencies above 40 Megacycles, *and* A Study of Ultra-High-Frequency Wide-Band Propagation Characteristics.—Goddard: George. (*See* 1344 & 1346.)

1577. Deflection Errors of Electric and Magnetic Deflecting Systems [Calculations: Variation with Form of Deflecting Field].—W. Glaser. (*Zeitschr. f. Physik*, No. 5/6, Vol. 111, 1938, pp. 357–372.)

The general theoretical form of the electric and magnetic deflecting fields is derived from their properties of symmetry and the fundamental electromagnetic equations (§§ 1, 2). The "ideal" deflection, in which the deviation is strictly proportional to the deflecting fields and no spot distortion occurs, is calculated (§ 3) from the equations of motion of the electron. The spot distortions are derived (§ 4) by considering terms of higher order in the expressions for the deflecting fields; the effect of finite cross-section of the electron beam is worked out. It is found that there is a "proportionality error," in which the deflection is not strictly proportional to the deflecting fields; this increases as the cube of the angle of deflection but does not affect the focusing of the spot. Of the two kinds of error due to the finite cross-section of the beam, one, the "deflection coma," is proportional to the square of the angle of beam opening and directly proportional to the ideal deflection: the other, the "deflection astigmatism," is directly proportional to the angle of beam opening and to the square of the deflection, and gives rise to elliptical distortion of the spot. Errors due to a skew position of the undeflected beam with respect to the axis of the deflecting system are also considered.

1578. Using Electro-Magnetic Deflection Cathode-Ray Tubes in the Television Receiver: Scanning, Synchronising, and Power-Supply Circuits and Construction for Five- and Nine-Inch Kinescopes.—J. B. Sherman. (*QST*, Feb. 1939, Vol. 23, No. 2, pp. 40–44 and 106.)

1579. Television Deflection Circuits.—E. W. Engstrom & R. S. Holmes. (*Electronics*, Jan. 1939, Vol. 12, No. 1, pp. 19–21 and 32.)

1580. Directive [Electron-Beaming] Action and Control Slope in Cathode-Ray Television Tubes.—E. Schwarz. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 19, 1938, pp. 454–457.)

The concentrating electrode of a cathode-ray tube (Wehnelt cylinder) is frequently also employed to modulate the intensity of the electron beam, in which function the greatest possible steepness of slope of the control characteristic is desirable. The investigations here described were undertaken to find the optimum compromise, for these two rôles, between anode current and concentration in a large projection tube (for 40 kv), and control slope and concentration in a small receiving tube. The electrode system and tube used are shown in Fig. 1; sets of characteristic curves are given, taken under various conditions (Fig. 2, anode current; Fig. 3, angle of beam opening; Fig. 4, current density; Fig. 5, control characteristics and curves of equal beam opening; Fig. 6, maximum angle and average steepness for various output voltages; Fig. 7, quality figure for various output voltages). These are discussed and the optimum slope deduced; further work will refer to the effect of various electrode forms.

1581. Stubby Tele Tube [Short Type 9″ Videotron Cathode-Ray Tube].—M. P. Wilder. (*Communications*, Nov. 1938, Vol. 18, No. 11, p. 18.)

1582. Characteristics of Phosphors for Cathode-Ray Tubes [Table of Data and Spectral Curves].—Headrick. (*Electronics*, Dec. 1938, Vol. 11, No. 12, p. 31.)

1583. The Magnetic Susceptibility of Potassium Bromide Crystals with Colour Centres [Difference Measurements with Very Sensitive Magnetic Balance: Its Theory: Susceptibility Measurements support Assumption that Colour Centres are Free Alkali Atoms].—P. Jensen. (*Ann. der Physik*, Series 5, No. 2, Vol. 34, 1939, pp. 161–177.)

1584. Television Output Circuits [and the Difficulties associated with Many Methods of connecting Receiver, C-R Tube, & "Sync Separator": a Method Free from These].—W. T. Cocking. (*Wireless World*, 23rd Feb. 1939, Vol. 44, pp. 174–177.)

1585. Image Scanning in Colour-Television Transmission [Theoretical Considerations: the Fundamental Necessity for Three Parameters: the Impracticability of the Choice, for These, of Wavelength, Intensity, and Saturation Factor: the Practicability of the Three-Colour System: Two Conditions for the Successive Use of a Single Channel, and Practical Ways of fulfilling These].—H. Pressler. (*Funktech. Monatshefte*, Dec. 1938, No. 12, Supp. pp. 89–93.)

1586. Channel Width and Resolving Power in Television Systems [Relation between Horizontal and Vertical Definition (Equality for $m/rN^2 = 0.41$) and between Horizontal Deflection and Band Width: Effect of Phase Non-Linearity on Wave Forms: Measures of Phase Distortion and Application of Tolerances to Various Modern Systems: etc.].—J. C. Wilson. (*Journ. Television Soc.*, [dated] June 1938, Series 2, Vol. 2, Part 11, pp. 397–420.)

In the subsequent discussion, Bingley (Philco) stresses the importance of single-sideband operation, thus increasing the highest video frequency transmitted, and recommends that the factor 0.41 should be increased if possible to 0.73, to improve picture quality.

1587. H.F. Cables: Construction and Use of Low-Loss Conductors [for Ultra-High Frequencies, in Television Redistribution, Monitoring, etc.].—C. E. Maitland. (*Wireless World*, 23rd Feb. 1939, Vol. 44, pp. 192–194.)

1588. Measurements of High-Frequency Characteristics of Concentric Cables laid at Hiyoshi [with Spiral Wire Supporter and Silk Suspension].—Shinohara, Yoshimura, & Hirayama. (*Nippon Elec. Comm. Eng.*, Nov. 1938, No. 13, pp. 413–421.) A summary was dealt with in 4405 of 1938.

1589. Television Station W2XAX [Chrysler Building, New York City]: Part I—Transmitter.—P. C. Goldmark. (*Communications*, Nov. 1938, Vol. 18, No. 11, pp. 7–10.)

1590. Television Transmitter, 1 kW Type for General Sale.—RCA. (*Communications*, Dec. 1938, Vol. 18, No. 12, p. 31.)

1591. High-Frequency, Frequency-Changing, and Detector Stages of Television Receivers.—M. J. O. Strutt. (*L'Onde Élec.*, Jan. 1939, Vol. 18, No. 205, pp. 14–26: to be contd.)

1592. Television Amplifiers with Negative Feedback [Graphical Treatment assisting the Study of the Processes involved, and agreeing well with Experimental Results].—A. Pfefferl. (*Funktech. Monatshefte*, Dec. 1938, No. 12, Supp. pp. 93–95.)

1593. An Apparatus for Measuring Phase and Group Transit Times at Ultra-High Frequencies [*e.g.* in Television Amplifiers].—Roosenstein. (*See* 1621.)

1594. Type EE 50 Secondary-Emission Valve for Television Wavelengths.—(*See* under "Valves & Thermionics.")

1595. Resistors at Video Frequencies [Investigation of Use of Inductive Wire-Wound Resistances to replace Non-Inductive Resistance plus Capacitance-Compensating Inductance: Circuit for measuring Impedance apart from Effect of Shunt Capacitance].—A. W. Barber. (*Electronics*, Jan. 1939, Vol. 12, No. 1, pp, 38 and 40, 42.)

1596. Television; the Synchronising Signals [with Particular Attention to Interlaced Scanning: English & German (von Oettingen) Methods and the Writer's Half-Line Phase-Retardation System: the Advantage of the Rotating-Disc Generator over Static Generators].—R. Barthélémy. (*L'Onde Élec.*, Jan. 1939, Vol. 18, No. 205, pp. 27–37.)

1597. Television with Nipkow Disc and Interlaced Scanning [and the Special Steps to obtain the Necessary Highly Accurate Synchronisation].—H. Rinia. (*Philips Tech. Review*, Oct. 1938, Vol. 3, No. 10, pp. 285–291.) For the original equipment for sequential scanning *see* 3383 of 1937.

1598. High-Speed Synchronous Motor employed in British Television [for driving Scophony Scanning Mechanism: 30 375 r.p.m.].—J. H. Jupe: Scophony. (*Electronics*, Dec. 1938, Vol. 11, No. 11, p. 38.)

1599. Television Test Equipment.—RCA. (*Communications*, Dec. 1938, Vol. 18, No. 12, pp. 29–31.)

1600. Television Standards: a Discussion of the Proposed R.M.A. Standards for the U.S.A.—A. F. Murray. (*Communications*, Dec. 1938, Vol. 18, No. 12, pp. 14–16 and 28, 33.)

1601. Sarnoff's Statement on Television.—D. Sarnoff. (*Communications*, Nov. 1938, Vol. 18, No. 11, pp. 19 and 20.)

1602. Education of the Television Engineer.—W. H. Date. (*Journ. Television Soc.*, [dated] June 1938, Series 2, Vol. 2, Part 11, pp. 445–449: Discussion pp. 449–453.)

1603. "Der Fernsehdienst der Deutschen Reichspost" [Television Service of German State Post Office: Book Review].—A. Gehrts. (*E.T.Z.*, 5th Jan. 1939, Vol. 60, No. 1, p. 30.)

1604. International Television Conference in Zürich [Notes on Large-Scale Projection, Present State of Television in Germany, New Short-Wave Valves, Mechanical Scanning Device, Permissible Phase Distortion, Errors due to Cable Transmission, Eiffel Tower Emitter, Propagation in Switzerland, Synchronising Impulses, etc.].—(*E.N.T.*, Dec. 1938, Vol. 15, No. 12, pp. 379–382.) The full papers will be published in a special issue of the *Schweizer Archiv für angewandte Wissenschaft und Technik*.

1605. A New Method of Measuring Kerr-Effect Inertia [using Stroboscopically Illuminated Progressive Supersonic Wave as Analyser: Circuit: Some Results for Nitrobenzol and Other Organic Liquids].—O. Maercks & W. Hanle. (*Zeitschr. f. tech. Phys.*, No. 12, Vol. 19, 1938, pp. 538–541: *Physik. Zeitschr.*, 15th Dec. 1938, Vol. 39, No. 23/24, pp. 852–855.)

1606. The Cause of the Disturbing Signal in Television Pick-Up Tubes.—W. Heimann & K. Wemheuer. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 19, 1938, pp. 451–454.)

The resulting disturbance, as seen in the received image, is illustrated by Fig. 2, which shows a darkening of the image towards the side at which the scanning begins. To explain this, the scanning mechanism of the pick-up tube is investigated; Fig. 3 shows the variation with time of the potential of an image element under unilluminated and illuminated conditions (taken with a special tube—1947 of 1938). The sudden rise in potential at the moment of scanning is found to be due to the emergence of secondary electrons (Fig. 4), whose movements are explained in the light of Fig. 3. Fig. 5 shows the potential variation with time of three elements of the scanned mosaic along one line, Fig. 6 a three-dimensional model of the mosaic potential during scanning, Fig. 7 the potential variation with time of the two external elements with scanning symmetrical in time. These show that the disturbance is due to the unsymmetrical rise in potential at the end of the scanning line, which occurs with saw-tooth scanning.

1607. The Structural Characteristics of Certain Silver Films [used as Photocathode Bases in Television Image Analysers, etc: Classification into Mosaics and Translucent Films: Two Types of Mosaic: Process of Agglomeration: Composition of Translucent Film].—S. F. Essig. (*Journ. of Applied Phys.*, Jan. 1939, Vol. 10, No. 1, pp. 61–72.)

1608. The Behaviour of Composite Photocathodes of K, Rb, and Cs in the Ultra-Violet Region.—W. Kluge. (*Zeitschr. f. tech. Phys.*, No. 12, Vol. 19, 1938, pp. 597–600: *Physik. Zeitschr.*, 15th Dec. 1938, Vol. 39, No. 23/24, pp. 911–914.)

From the AEG Valve Factory, Berlin. Measurements of the emission spectra of composite photocathodes of the type Ag-K_2O-K are here given which extend down to 225 mμ. They still show a band structure; the number of bands appears to increase with the atomic weight of the alkali metal. In a discussion of metal and semiconductor surfaces, "it is proposed to consider these bands as an absorption spectrum, measured photo-electrically, of the [alkali] oxides in question, whose lattices are distorted by built-in atoms of the alkali and silver."

1609. The Action of Composite Photocathodes.—H. Teichmann. (*Zeitschr. f. tech. Phys.*, No. 12, Vol. 19, 1938, pp. 600–602: *Physik. Zeitschr.*, 15th Dec. 1938, Vol. 39, No. 23/24, pp. 914–916.)

For previous work *see* 1546 of 1938. It was there indicated that the behaviour of the intermediate layers of composite photocathodes resembles that of electronic semiconductors. New measurements (wavelengths 400–1000 mμ) are here given which support this view and provide information on the position and magnitude of the spectral maximum of the yield of the external photoeffect at these cathodes.

1610. The Photoelectric Properties of Caesium Cathodes when Simultaneously Excited by Light and Electron Bombardment [under Certain Operating Conditions, Summation of Emissions completely Inapplicable: Positive or Negative Effect of Illumination according to Velocity of Exciting Electrons: Possibility of New Photocells with Sensitivity Many Times Larger than Normal: Even Greater Effect of Second Electron Stream instead of Light (involved in Effectiveness of Secondary-Emission Multipliers): etc.].—P. Shmakoff. (*Journ. Television Soc.*, [dated] June 1938, Series 2, Vol. 2, Part 11, pp. 421–424.)

For previous work *see* 4152 of 1936.

1611. On the Behaviour of Some Vacuum Photocells at High Voltages and High Luminous Flux.—H. Krüger & F. Weidert. (*Zeitschr. f. tech. Phys.*, No. 2, Vol. 20, 1939, pp. 50–55.)

Authors' summary:—"With a caesium and a potassium vacuum photocell, for a luminous flux of about 1000 lumens and accelerating potentials from 100 to 1000 volts, the variation of photoelectric current with luminous flux was measured; departures from the proportionality between current and flux were found. Prolonged tests with various values of luminous flux and of potential showed that with both types of cell the combination of high potentials and high luminous fluxes led to a rapid deterioration (loss of sensitivity) of the cell." It is pointed out that several further points ought to be investigated, such as the restoration of damaged cells by months of rest, the effect of the spectral composition of the high luminous flux on the deterioration caused, the influence of the method of preparing the sensitive layer, etc.

1612. Surface and Volume Photoelectric Emission from Barium [Spectral Sensitivity Measurements: Comparison with Theory].—R. J. Cashman & E. Bassoe. (*Phys. Review*, 1st Jan. 1939, Series 2, Vol. 55, No. 1, pp. 63–69.)

1613. A New Type of Photoelectric Cell [Thin Layer of Mercuric Oxide illuminated through Transparent Cellophane Anode: Illumination diminishes Resistance: Effect of Duration of Current Passage, of Illumination Intensity, of Duration of Illumination, of Voltage: Spectral Sensitivity Distribution: Limit of Measurable Flux].—G. Déchêne. (*Comptes Rendus*, 9th Jan. 1939, Vol. 208, No. 2, pp. 95–97.)

1614. Initial Drift in Photocells [Copper-Oxide Photox Cells: Measuring Apparatus and Comparison of Results with Selenium-Cell Measurements].—E. D. Wilson. (*Electronics*, Jan. 1939, Vol. 12, No. 1, pp. 15 and 33.)

1615. Control of Electron Currents with a Three-Electrode Crystal, and a Model of a Barrier Layer.—Hilsch & Pohl. (*See* 1683.)

1616. Selective Sideband *versus* Double Sideband Transmission of Telegraph and Facsimile Signals.—Smith, Trevor, & Carter. (*See* 1751.)

1617. Picture Transmission by the Siemens-Karolus System.—G. M. Jones. (*Journ. Television Soc.*, [dated] June 1938, Series 2, Vol. 2, Part 11, pp. 425–429.) In the subsequent discussion the writer (G.P.O., London) mentions that it is proposed to abandon individual tuning forks at the receivers and to take the synchronising frequency from some standard-frequency source (The Hague, Chelmsford, or Dollis Hill): "we should then have one standard synchronising control throughout Europe."

MEASUREMENTS AND STANDARDS

1618. A Resonance Curve Method for the Absolute Measurement of Impedance at Frequencies of the Order 300 Mc/s.—R. A. Chipman. (*Journ. of Applied Phys.*, Jan. 1939, Vol. 10, No. 1, pp. 27–38.)

"A general theory is developed, together with a simplified experimental procedure, which permits the absolute measurement of the magnitude and phase angle of any value of complex impedance, in terms of the characteristic impedance of a parallel-wire line to which the impedance to be measured is connected as one termination. The observed quantities are the shape of the resonance curve of the current in one of the line's terminations obtained by varying the line length, and the length of line for maximum current. The effects of distributed line resistance and of radiation resistance on the impedance measurements are discussed in detail. Examples are given of the measurement of the impedance of straight resistance wires, and of the resistance of 'metallised' resistors, at a frequency of 377 Mc/sec." The accuracy of the method is discussed and experimental data on the radiation resistance of a parallel-wire line are given.

1619. Parallel-Resonance Methods for Precise Measurements of High Impedances at Radio Frequencies, and a Comparison with the Ordinary Series-Resonance Methods ["Susceptance-" and "Conductance-Variation" Methods and Their Theoretical Advantages for High Impedances: Practical Advantages of the Former except perhaps for Very High Frequencies: Some Results: Long Bibliography].—D. B. Sinclair. (*Proc. Inst. Rad. Eng.*, Dec. 1938, Vol. 26, No. 12, pp. 1466–1497.) A summary was referred to in 1114 of 1938.

1620. A Survey of Ultra-High-Frequency Measurements [Transmission-Line and Skin-Effect Formulae: the Large Errors caused by Neglect of Quadrature Component of Characteristic Impedance: Measurement Methods for Wavelength, Power, Voltage, Reactance, Resistance, and Current].—L. S. Nergaard. (*RCA Review*, Oct. 1938, Vol. 3, No. 2, pp. 156–195.) For an earlier paper *see* 4177 of 1936.

1621. An Apparatus for measuring Phase and Group Transit Times at [Ultra-] High Frequencies.—H. O. Roosenstein. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 19, 1938, pp. 458–460.)

The apparatus is suitable for measuring the phase transit time of passive quadripoles and of amplifiers (*e.g.* for television). A null method of measurement is used (circuit Fig. 2). A signal from an emitter travels to a zero indicator by two paths, on one of which it has known attenuation and transit time, while the quadripole or amplifier under investigation is connected in the other path. The emitter, the method of measurement, and the screening of a long coil (Fig. 3) giving a known transit time are described. It is shown how to determine the group transit time graphically from the phase transit time.

1622. On the Resonant Frequency of Closed Concentric Lines [New, More Exact Method of Calculation: Increased Accuracy for Line of Length Small compared with Quarter Wavelength].—W. W. Hansen. (*Journ. of Applied Phys.*, Jan. 1939, Vol. 10, No. 1, pp. 38–45.)

1623. On the Measurement of Large Loss Angles at Ultra-High Frequencies [primarily in Biological Work: Comparison of Limits of Application, and Accuracy, of Roosenstein-Tatarinov and Drude-Coolidge Methods].—N. Malov. (*Tech. Phys. of USSR*, No. 10, Vol. 5, 1938, pp. 767–777: in German.)

For the writer's work on these methods *see* 3419 of 1937 and 250 of 1938. It is now concluded that for the investigation of strongly absorbing objects the latter method (although with slightly narrower limits of application) is the more accurate; particularly at the higher frequencies, where the self-capacity of the indicator and of the end fixings, in the Roosenstein-Tatarinov method, may exert a considerable influence on the measurements.

1624. Description of the Frequency Meter for Metric Waves, Type MD 61 S.A.D.I.R.—P. Gamet. (*L'Onde Élec.*, Jan. 1939, Vol. 18, No. 205, pp. 53–56.)

1625. Some Recent Continental Advances in the Principles, Construction, and Use of Scientific Instruments [including Electron Microscopes and Straubel's Ultra-High-Frequency Ammeter (Polarised-Light Type) & His Direct-Reading Wavemeter with Variable Condenser rotated at 3000 r.p.m.].—M. Pirani. (*Journ. Scient. Instr.*, Dec. 1938, Vol. 15, No. 12, pp. 389–405.)

1626. Acorn Triode H.F. Valve Voltmeter [Frequencies 20 c/s to 50 Mc/s: with Exploring Head on Flexible Metal Tube].—Salford Elec. Instruments. (*Journ. Scient. Instr.*, Dec. 1938, Vol. 15, No. 12, p. 419.)

1627. On the Theory of the Thermoelectric Couple (General Principles).—V. Kovalenko. (*Tech. Phys. of USSR*, No. 10, Vol. 5, 1938, pp. 789–805: in English.) Influence of vacuum conditions: derivation of fundamental equation: the time lag.

1628. Direct-Reading Field-Strength Measuring Instruments.—L. Rohde & F. Spies. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 19, 1938, pp. 439–444.)

Instruments for measuring the field near the emitter (of strength in general above 10 mv/m; Fig. 3) and the distant field (Fig. 7) are described which are designed for use in very large ranges of field-strength and frequency, while being simple and rapid to manipulate. The instrument for near fields can also radiate a known field of definite polarisation, so that "the field disturbance due to the surroundings and to the presence of the apparatus itself can be determined." Frame aerials are used; the instrument for near fields (circuit Fig. 1) combines a tuned frame and a valve voltmeter. The instrument for distant fields (scheme Fig. 4) also works on a direct voltage measurement; it is built on the heterodyne principle with a logarithmic valve voltmeter and has the advantage of high sensitivity, direct reading, and constancy. The construction, ranges, etc. are described; an example of measurement of a 9 m wave is given and compared with the theoretical curve (Fig. 8).

1629. On the Accuracy of Radio Field-Intensity Measurement at Broadcast Frequencies [for Commercial Equipments, Not Greater than 20% without Special Precautions: 15% Error in Certain Sets due to Assumption that Loop has Same Voltage Step-Up for Distributed Induced Voltage as for Lumped Voltage at Centre: Correction Factor for this Error: Methods for Its Elimination (including Baker & Huxley's): etc.].—H. Diamond, K. A. Norton, & E. G. Lapham. (*Journ. of Res. of Nat. Bur. of Stds.*, Dec. 1938, Vol. 21, No. 6, pp. 795–818.)

1630. The Relation of the Carrying Car to the Accuracy of Portable Field-Intensity-Measuring Equipment [Field Distortion due to Secondary Field from Eddy Currents in Metal Parts: Changes with Position of Car: a Compensation Method: Measurement Errors independent of Frequency in Broadcast Band].—J. H. Dewitt, Jr., & A. C. Omberg. (*Proc. Inst. Rad. Eng.*, Jan. 1939, Vol. 27, No. 1, pp. 1–4.)

1631. Thin Piezoelectrically-Excited Quartz Discs possessing More than One Natural Frequency [in the Neighbourhood of the Fundamental Transverse Oscillation].—R. Schiffermüller. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 19, 1938, pp. 469–475.)

"Experiments are described which show that thin quartz discs exist which possess a series of discrete natural frequencies in the neighbourhood of the frequency of the fundamental transverse oscillation. It appears that these are related to definite parts of the disc. The number and range of these resonance frequencies is increased by using firm sputtered-on metal electrodes, as can be shown optically. The multi-wave property of the quartz disc can also be found in the electrical resonance circuit, but only when the disc has not got such firmly deposited electrodes: multi-peak Cady characteristics have been plotted. With firm sputtered electrodes the effect of the oscillations on the resonance circuit disappears. Explanations of the phenomena are indicated."

1632. Small Temperature Coefficient of Frequency of Quartz Plates [Survey, and Writer's Work leading to Production of Approximately Zero-Coefficient Plates for 300–1100 kc/s by Suitable Choice of Ratio Z′ to X in *AT*-Cut Plates: also Luminous Plates (about 3.4 Mc/s) with Low Coefficient].—P. Modrak. (*Wireless Engineer*, Jan. 1939, Vol. 16, No. 184, pp. 6–15.)

1633. Papers on Quartz Resonators.—Booth & Sayers: Stanesby & Broad. (*See* 1390.)

1634. A Crystal in a Thermos Bottle.—(*Electronics*, Jan. 1939, Vol. 12, No. 1, p. 42: photograph and caption only.)

1635. Frequency Demultipliers for Quartz Clock [maintaining Synchronisation for more than 5000 Hours].—S. Malatesta. (*Alta Frequenza*, Jan. 1939, Vol. 8, No. 1, pp. 24–32.)

1636. The Dependence on Frequency of the Temperature-Coefficient of Inductance of Coils [Coefficient (for Conductor Sections within Defined Range) reaches Max. Value at a Particular Frequency: Theory and Experimental Confirmation, with Explanation of Certain Ceramic-Former Coils: Conclusions as to Best Type of Construction: etc.].—H. A. Thomas. (*Journ. I.E.E.*, Jan. 1939, Vol. 84, No. 505, pp. 101–112.) Arising out of the work dealt with in 82 of 1936.

1637. Multi-Layer Coil Inductance Chart [accurate within 5% except in Exceptional Cases].—J. E. Maynard. (*Electronics*, Jan. 1939, Vol. 12, No. 1, pp. 33–36.)

1638. On Methods of Tuning to Resonance.—Hegner. (*See* 1400.)

1639. Generation of Reference Frequencies [for Laboratory Calibration of Oscillators, for Adjustment of Watches by Jewellers, for Radio Station Carrier Control, for Power Systems, etc: operated by "Long Lines Department" of Bell Laboratories].—L. A. Meacham. (*Bell Lab. Record*, Jan. 1939, Vol. 17, No. 5, pp. 138–140.)

1640. A Wide-Range Beat-Frequency Oscillator [5 kc/s to 1600 kc/s, Max. Output 10 Watts, almost Independent of Frequency: using Electron-Coupled Primary Oscillators].—A. C. Hall. (*Review Scient. Instr.*, Jan. 1939, Vol. 10, No. 1, pp. 38–41.)

1641. A Continuously Variable Radio-Frequency Oscillator [Standard Signal Generator of Purdue University: 195–4440 kc/s in Three Bands: embodying Special Valve Voltmeter using One Diode System of a 6H6 as Grid-Leak Detector and Other as Overload Protector].—C. B. Aiken & I. L. Liu. (*Communications*, Dec. 1938, Vol. 18, No. 12, pp. 12–13 and 27.)

1642. A Special Valve Voltmeter with Overload Protection.—Aiken & Liu. (In paper dealt with in 1641, above.)

1643. High-Voltage Valve Voltmeter for High Frequencies [using Potentiometer].—L. Rohde. (*Hochf:tech. u. Elek:akus.*, Dec. 1938, Vol. 52, No. 6, p. 216: abstract only.)

1644. Instruments for Measuring the Temperature Dependence of H.F. Condensers.—Rohde. (*Hochf:tech. u. Elek:akus.*, Nov. 1938, Vol. 52, No. 5, pp. 178–179: abstract only.)

1645. A New Limiting Amplifier [for Volume Compression, Distortion Measurement, etc.].—Davis. (*See* 1415.)

1646. The "Variable Q" Amplifier: a Power Amplifier with Inherent Voltage Compensation for Load Variations.—Fairweather & Williams. (*See* 1387.)

1647. A Differential Pre-Amplifier for Electrophysiological Purposes and for Bridge Measurements.—König. (*Helvetica Phys. Acta*, Fasc. 6, Vol. 11, 1938, pp. 507–512: in German.)

1648. 10 Megacycle Resistance Attenuator [for Measurements on Coaxial Cables].—K. Kobayashi & T. Ushikubo. (*Nippon Elec. Comm. Eng.*, Nov. 1938, No. 13, pp. 429–430.) A summary was dealt with in 4514 of 1938.

1649. A Direct-Reading Inductance Indicator for Iron-Cored Coil carrying Direct Current [on Filtering-Action Principle, using Double Rectifying System: requiring No Standard Inductance or Resistance: Mains Driven].—T. Hayasi. (*Nippon Elec. Comm. Eng.*, Nov. 1938, No. 13, pp. 451–452.) For the capacity meter on the same principle *see* 2009 of 1938.

1650. A New Method of measuring Intensities of Magnetisation [for Low Constant Fields: Magnetometric Method using Pair of Equal Coils].—Schultz. (*Physica*, Feb. 1939, Vol. 6, No. 2, pp. 137–144: in English.)

1651. On the Question of the Measurement of High-Frequency Voltages, and Impulse Voltages of Very Short Duration, with the Sphere Spark Gap.—P. Jacottet. (*E.T.Z.*, 26th Jan. 1939, Vol. 60, No. 4, pp. 92–97.)

1652. Anti-Vibration Support for Sensitive Portable Galvanometers.—W. S. Gorton. (*Bell Lab. Record*, Feb. 1939, Vol. 17, No. 6, pp. 195–197.)

1653. The Use of Auxiliary Current-Transformers for Extending the Range of Metering Equipment.—G. F. Shotter. (*Journ. I.E.E.*, Jan. 1939, Vol. 84, No. 505, pp. 128–138: Discussion pp. 140–141.)

1654. "American Standards for Electrical Indicating Instruments" [Book Review].—(*Proc. Inst. Rad. Eng.*, Dec. 1938, Vol. 26, No. 12, p. 1561.) Bulletin C-39 of the American Standards Association.

1655. The Physical Society's Exhibition: Recent Developments in Commercial Test Instruments.—(*Wireless Engineer*, Feb. 1939, Vol. 16, No. 185, pp. 71–78.)

1656. Electrical Measuring Instruments [Physical Society's Exhibition, Jan. 1939].—G. A. Whipple. (*Journ. Scient. Instr.*, Feb. 1939, Vol. 16, No. 2, pp. 58–64.)

SUBSIDIARY APPARATUS AND MATERIALS

1657. Experimental Proof of "Phase Focusing" [Electron-Density Modulation of a Cathode Ray by Pure Velocity Modulation (by a "Phase Lens"): only demonstrable at Ultra-High Frequencies].—Mayer. (*Zeitschr. f. tech. Phys.*, No. 2, Vol. 20, 1939, pp. 38–42.)

For Brüche & Recknagel's treatment, from an optical viewpoint, of this phase focusing, by which (for instance) the later-starting electrons are accelerated so that they catch up the earlier ones at a certain point, *see* 2325 of 1938. Owing to the limitation, by the actual length of the tube, of the "striking distance" ("Treffweite," analogous to the "focal distance" in optics) at the end of which all the electrons arrive together, a voltage gradient of the order of 10^{10} v/s is necessary. This means that ultra-high frequencies must be used, although it is impossible to obtain at these frequencies the saw-tooth curve-form of the special shape demanded by Brüche & Recknagel, and a sinusoidal voltage variation must be employed. Author's summary:—"An experimental arrangement is described in which a short u.h.f. accelerating field (phase lens) lies in front of two crossed deflecting fields, namely a constant magnetic field and an u.h.f. electric field. The cathode ray sent through this arrangement traces out on a fluorescent screen a curve from whose ordinate and abscissa values can be found the starting time of the electrons at the u.h.f. accelerating field and the time of arrival at the deflecting plates. The curves show that an originally continuous stream of electrons, whose velocity is modulated by a sinusoidal u.h.f. voltage, varies in space and time in its electron density. In particular, those electrons which have passed through the phase lens during a comparatively large phase-region of increasing sinusoidal voltage are seen, after traversing a definite path length, to reach the deflecting plates simultaneously" [it is shown in section 5 that that part of the spot trace which lies along the ordinate axis is described by these simultaneously arriving electrons: thus Fig. 5a represents an extensive phase focusing, while Fig. 5b corresponds to the simultaneous arrival of only 3 discrete groups of differing velocities].

1658. Deflection Errors of Electric and Magnetic Deflecting Systems.—Glaser. (*See* 1577.)

1659. Dynamical Ballistics in the Cathode-Ray Tube [Ballistic Model in which Metal Balls are shot over Rubber Membrane stretched according to Lines of Force in Tube: Calculation of Paths corresponding to Electron Motion].—Hollmann & Thoma. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 19, 1938, pp. 475–480.) *Cf.* 3941 of 1938 (Kleynen).

1660. ADDITION TO MY PAPER ON OSCILLATION ONSET IN THE PLATE CONDENSER.—Recknagel. (*See* 1406.)

1661. THE PRODUCTION OF VOLTAGES PROPORTIONAL TO TIME [for Cathode-Ray Time Base].—Pieplow. (*Arch. f. Elektrot.*, 17th Dec. 1938, Vol. 32, No. 12, pp. 815–821.)

The departures from linearity in the time deflection of a cathode-ray beam worked by a "kipp" mechanism are summarised for exponential and sinusoidal condenser charging and for saturation valves (pentode Fig. 4); the properties of technical charging pentodes are discussed (§ 3). Measures for the linearisation of the deflection are given (§ 4), including resistances through which the cathode and anode currents pass respectively (Figs. 8, 9), and a circuit for the production of an adjustable negative internal resistance (Fig. 12). Illustrative oscillograms are given (Fig. 14).

1662. A DUAL PURPOSE ELECTRONIC SWITCH [Rate 6–2000 Times per Second: for Simultaneous Observation of Two Processes on a C-R Oscillograph (Patterns displaceable at Will), and as Square-Wave Generator for 60–400 c/s].—Hall. (*Communications*, Nov. 1938, Vol. 18, No. 11, pp. 14–15 and 16, 17.) From the Du Mont laboratories. No description is given.

1663. APPLICATIONS OF CATHODE-RAY TUBES: III—INVESTIGATION OF H.F. PHENOMENA [Modulation Depth, Frequency Modulation, "Blocking" of Oscillators]: IV—RECORDING OF DIAGRAMS [Valve Characteristics, Hysteresis Loops, Frequency Measurement].—van Suchtelen. (*Philips Tech. Review*, Aug. & Nov. 1938, Vol. 3, Nos. 8 & 11, pp. 248–251 & 339–342.) For II *see* 3745 of 1938.

1664. CATHODE-RAY TUBES AND THEIR APPLICATIONS [Physical Society's Exhibition, Jan. 1939].—Beale. (*Journ. Scient. Instr.*, Feb. 1939, Vol. 16, No. 2, pp. 53–58.)

1665. THE USE OF THE CATHODE-RAY OSCILLOGRAPH FOR THE DETERMINATION OF TRANSMITTING-VALVE CHARACTERISTICS.—Douma & Zijlstra. (*See* 1476.)

1666. IMAGE FORMATION IN THE SUPER-[Electron] MICROSCOPE [with Magnetic Lens].—von Borries & Ruska. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 19, 1938, pp. 402–407.)

Authors' summary:—Every point in the object of the super-microscope is struck by an electron beam, emitted from the electron source, whose aperture is in practice of the order of 10^{-3}. At the object, part of the beam is scattered, while part continues unaltered in direction. The thinner the object, the larger is the number of electrons which pass straight through. The deflected beams are deviated through angles large compared with the objective apertures used in practice, which lie between 0.01 and 0.03. The undeflected electrons form a beam, issuing from the object point, which has the same aperture as that of the incident beam. This [object] beam only strikes a small part of the lens opening, since the condenser aperture is small compared with the objective aperture. Only the aperture errors corresponding to this small lens opening need be considered in relation to the focusing of the object beam. The correctness of this view of image formation is proved experimentally.

1667. THE ELECTRON "RASTER" MICROSCOPE: PRACTICAL CONSTRUCTION.—von Ardenne. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 19, 1938, pp. 407–416.)

For the theoretical basis *see* 4076 of 1938 (and 712 of February). Here an account is given of the choice of dimensions of the electron "raster" microscope (shown in cross-section in Fig. 1), the design of the electron probe and of the object "raster" (Fig. 2, circuit for deflecting the electron probe), the apparatus for photographic recording, and the focusing and its maintenance during the recording time. The principle of the whole circuit is shown in Fig. 9, and a view of the apparatus in Fig. 11. Examples of records are given which show that electron probes can be made with a diameter as small as 10^{-5} mm.

1668. ELECTRON-MICROSCOPE STUDIES OF THORIATED TUNGSTEN.—Ahearn & Becker. (*See* 1483.)

1669. INVESTIGATIONS ON THE ONSET AND DECAY OF THE LUMINOUS PROCESS IN PHOSPHORS: I [Oscillograms of Onset and Decay with Short Rectangular Illuminating Pulse].—Schleede & Bartels. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 19, 1938, pp. 364–369: *Physik. Zeitschr.*, 15th Dec. 1938, Vol. 39, No. 23/24, pp. 936–940.)

Authors' summary:—With a special apparatus, phosphors [zinc oxide, zinc sulphide, zinc sulphide activated with copper, calcium tungstate, etc.] were irradiated momentarily by a rectangular pulse of excitation (filtered ultra-violet and cathode rays of various velocities) of length 10^{-5}, 4×10^{-3}, and 0.2 second; the building-up and decay processes, over times of 10^{-4}, 4×10^{-2}, and 1.0 second, respectively, were made visible, the resolving power of the apparatus being 10^{-6}, 4×10^{-4}, and 10^{-2} second in the three cases. It was found that the building-up and decay processes correspond to each other, and that the curve form is strongly dependent on the intensity of the excitation.

1670. MEASUREMENT OF ACTIVATION AND DECAY OF LUMINISCENT ZINC SILICATE [Description of Transmission Phosphoroscope for Measurement of Rates and Indication of Relative Amounts of Fluorescent and Phosphorescent Light].—Beese. (*Journ. Opt. Soc. Am.*, Jan. 1939, Vol. 29, No. 1, pp. 26–28.) *Cf.* von Ardenne, 616 of 1938.

1671. CHARACTERISTICS OF PHOSPHORS FOR CATHODE-RAY TUBES [Table of Data and Spectral Curves].—Headrick. (*Electronics*, Dec. 1938, Vol. 11, No. 12, p. 31.)

1672. Electrical and Luminiscent Properties of Phosphors under Electron Bombardment [studied by Tube with Cathode-Ray Type of Electron Gun: Data for Zinc Orthosilicate, Calcium Tungstate, Zinc Sulphide/Cadmium Sulphide, Zinc Sulphide].—Nottingham. (*Journ. of Applied Phys.*, Jan. 1939, Vol. 10, No. 1, pp. 73–83.) For previous work *see* 617 of 1938.

1673. Fluorescence and Phosphorescence [and the Various Types of Photoluminescence (Distinguishable by Differing Variation of Afterglow Intensity with Time): Zinc Sulphide and other Inorganic "Impurity" Luminophors: etc.].—Gisolf & de Groot. (*Philips Tech. Review*, Aug. 1938, Vol. 3, No. 8, pp. 241–247.) Supplementing the paper referred to in 3758 of 1938.

1674. The Physics of Radiation Transformation by Luminiscent Materials [Model explaining Action of Crystal Phosphors: Influence of Disturbance Centres: Illumination Process connected with Electron Transfer from Conductivity Bond to an Excited Disturbance Centre: etc.].—Schön. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 19, 1938, pp. 361–364: *Physik. Zeitschr.*, 15th Dec. 1938, Vol. 39, No. 23/24, pp. 940–943.)

1675. Influence of Temperature on the Extinction of Phosphors.—Antonov-Romanovsky. (*Comptes Rendus (Doklady) de l'Acad. des Sci. de l'URSS*, No. 5, Vol. 20, 1938, pp. 361–364: in English.)

1676. High-Speed Cinematography [and Some Recent P.O. Work at 2500 Pictures per Second].—Palmer. (*P.O. Elec. Eng. Journ.*, Jan. 1939, Vol. 31, Part 4, pp. 293–298.)

1677. A Simple Variable and Greaseless Leak [for Vacuum Work].—Eltenton. (*Journ. Scient. Instr.*, Jan. 1939, Vol. 16, No. 1, pp. 27–28.)

1678. A Quick Method of checking [Vacuum] Pumping Speeds.—Eltenton. (*Journ. Scient. Instr.*, Dec. 1938, Vol. 15, No. 12, p. 415.)

1679. "Getterstoffe und ihre Anwendung in der Hochvakuumtechnik" [Book Review].—Littmann. (*Elektrot. u. Masch:bau*, No. 47, Vol. 56, 1938, pp. 635–636.)

1680. Zirconium and Its Compounds with a High Melting Point.—Fast. (*Philips Tech. Review*, Dec. 1938, Vol. 3, No. 12, pp. 345–352.)

1681. Measurement of the Thickness of the Walls of Rectifier Bulbs and Other Closed Glass Vessels.—Wagner. (*Elektrot. u. Masch:bau*, No. 43, Vol. 56, 1938, pp. 564–565: summary only.)

1682. Unusual Mercury Rectifier operates at 100 kV [giving 35 kW of Rectified Power].—Dorsey. (*Electronics*, Dec. 1938, Vol. 11, No. 12, p. 40.)

1683. Control of Electron Currents with a Three-Electrode Crystal, and a Model of a Barrier Layer.—Hilsch & Pohl. (*Zeitschr. f. Physik*, No. 5/6, Vol. 111, 1938, pp. 399–408.)

Some experiments are described in which crystals of potassium bromide are used as a model of a barrier-layer rectifier and its control by means of a built-in grid; a "three-electrode crystal" is devised which behaves in a manner analogous to a three-electrode valve. The general nature of electron conduction in KBr crystals is first explained (§ 2). The diffusion of electrons to the anode can be followed by the "colour centres" which are, in the simplest case, neutral metal atoms formed by the combination of electrons with positive ions. The model of a rectifier (§ 2, Figs. 1, 2) consists of a KBr crystal between a platinum plate electrode (the barrier electrode) and a calcium plate or a point electrode covered with a potassium alloy, which permit the passage of electrons. The current/voltage characteristic of this arrangement for stationary currents is shown in Fig. 3; it has the typical rectifier form and the arrangement can be used for rectification of low-frequency currents of period greater than the time of adjustment of the electrons and colour centres. The colour centres have a sharp boundary (Fig. 4) so that the thickness of the barrier layer, *i.e.* the part of the crystal free from colour centres, at any time during its formation can be calculated (eqn. 1). The breakdown of the barrier layer, once formed, follows a different course, without this sharp boundary. A numerical example is given of rectification of a 50-cycle current. A stratified form of the rectifier model is given by a thin layer of pure KBr next to the platinum barrier electrode, backed by a semiconductor such as a mixed crystal of KBr and KH. The thickness and properties of the barrier layer depend on the working conditions, field-strength, etc.

The action of the copper-oxide rectifier is then discussed (§ 4) in the light of the analysis of this model, which corresponds to a diode. The scheme and circuit of a three-electrode crystal is shown in Fig. 6 (§ 5), where a control "grid" in the form of a platinum wire is melted into the crystal. Figs. 7, 8 show the anode & grid current/grid voltage characteristics of this crystal; these are quite similar to those of a three-electrode valve and are discussed on that basis.

1684. On the Rectification of Current at the Boundary between Two Semiconductors, *and* On the Theory of Solid Rectifiers.—Davydov. (*Comptes Rendus (Doklady) de l'Acad. des Sci. de l'URSS*, No. 4, Vol. 20, 1938, pp. 279–282: pp. 283–285: both in English.)

1685. Semiconductor Theory of the Barrier Layer [in Cuprous-Oxide Rectifiers].—Schottky. (*Naturwiss.*, 30th Dec. 1938, Vol. 26, No. 52, p. 843.) Further development of theory referred to in 1930 Abstracts, p. 346, r-h column.

1686. PHYSICS AND TECHNIQUE OF DRY RECTIFIERS [General Construction Scheme of Rectifier: Explanation by Analogy with Indirectly Heated Incandescent Cathode: Equivalent Circuit: Importance of Self-Capacity].—Maier. (*Arch. f. Elektrot.*, 17th Dec. 1938, Vol. 32, No. 12, pp. 799–805.)

1687. THE BEHAVIOUR OF SEMICONDUCTORS IN THE H.F. FIELD.—Henninger. (*Zeitschr. f. tech. Phys.*, No. 12, Vol. 19, 1938, p. 597: *Physik. Zeitschr.*, 15th Dec. 1938, Vol. 39, No. 23/24, p. 911: abstracts only.)

1688. ON THE ELECTRONIC CONDUCTION DUE TO 4*f*-ELECTRONS IN SOME TRIVALENT RARE-EARTH COMPOUNDS [Semiconductors].—Ghosh. (*Indian Journ. of Phys.*, Aug. 1938, Vol. 12, Part 4, pp. 259–270.)

1689. CONSTANT-SLOPE VOLTAGE CONTROL [Variable Output with Uniform Regulation, for Low-Power HT Rectifier Systems: by Variable Resistance in Series with Condenser forming Input to Smoothing Filter].—Tanner & Walker. (*Wireless World*, 16th Feb. 1939, Vol. 44, p. 157.)

1690. THE VOLTAGE REGULATOR APPLIED TO AN AMPLIFIER [Use of Neon-Lamp Regulator to improve Line-Voltage Regulation and eliminate Hum].—Waltz: Bousquet. (*Electronics*, Dec. 1938, Vol. 11, No. 12, p. 34.) For this regulator *see* Bousquet, 4601 of 1938.

1691. ON ELECTRONIC VOLTAGE STABILISERS [Discussion of the Four Main Types: Effect of Source Resistance on Performance: Ten Circuits, including Seven due to Writers: Glow-Discharge Tubes as Bias-Battery Substitutes: Bridge Technique for Determination of Stabiliser Performance].—Hunt & Hickman. (*Review Scient. Instr.*, Jan. 1939, Vol. 10, No. 1, pp. 6–21.)

1692. THE ZINC/ZINC-IODIDE/CARBON ACCUMULATOR [for Hand-Lamps, Audiometers, etc.].—Balbi & Boulding. (*E.T.Z.*, 19th Jan. 1939, Vol. 60, No. 3, p. 82.) From the *Electrical Review.*

1693. IMPULSE VOLTAGE INSTALLATIONS [up to 4 Million Volts, Impulse Energies up to 80 Kilowatt-Seconds].—Boldingh. (*Philips Tech. Review*, Oct. 1938, Vol. 3, No. 10, pp. 306–312.)

1694. CONTROLLED SPARK DISCHARGES AS LIGHT SOURCE FOR SPECTRAL ANALYSIS [Control by Circuit using Synchronous Make-and-Break to separate Spark-Circuit Condenser from Spark-Gap during Charging Pause: Possible Applications].—Kaiser. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 19, 1938, pp. 399–402.)

1695. THE ACTION OF THE SPARK COUNTER.—Greinacher. (*Zeitschr. f. tech. Phys.*, No. 12, Vol. 19, 1938, pp. 592–594: *Physik. Zeitschr.*, 15th Dec. 1938, Vol. 39, No. 23/24, pp. 906–908.) For previous work *see* 2894 of 1938.

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1725. RELATIONS BETWEEN CURIE POINT, ORBITAL MOMENT, AND CRYSTALLINE LATTICE.—Forrer. (*Comptes Rendus*, 16th Jan. 1939, Vol. 208, No. 3, pp. 175–177.)

1726. MAGNETIC AFTER-EFFECT [Magnetic Viscosity] AND CHEMICAL CONSTITUTION.—Snoek. (*Physica*, Feb. 1939, Vol. 6, No. 2, pp. 161–170: in English.)

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1728. THERMOMAGNETIC CHARACTERISTICS OF CUBIC IRON SESQUIOXIDE.—Chaudron & Michel. (*Comptes Rendus*, 9th Jan. 1939, Vol. 208, No. 2, pp. 90–92.)

1729. THE MAGNETIC AND ELECTRIC BEHAVIOUR OF THE MANGANFERRITES [and Their Likeness to Insulating Masses of Conducting Powder whose Particles are surrounded by Insulating Films].—Schulze. (*Elektrot. u. Masch:bau*, No. 44, Vol. 56, 1938, pp. 581–583: long summary.)

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1734. PERMANENT-MAGNET ALLOYS OF COBALT, COPPER, AND NICKEL.—Dannöhl & Neumann. (*E.T.Z.*, 12th Jan. 1939, Vol. 60, No. 2, p. 58: summary only.)

1735. WHAT FIGURES DETERMINE THE "MERIT" OF PERMANENT MAGNETS?—Breitling. (*Elektrot. u. Masch:bau*, No. 47, Vol. 56, 1938, pp. 617–623.)

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1737. MAGNETISABLE SPACING PLATES FOR ELECTROMAGNETS [instead of the Usual Non-Magnetic Plate or Pin between Pole-Piece and Armature].—Gundlfinger. (*Elektrot. u. Masch:bau*, No. 49, Vol. 56, 1938, p. 667: summary only.)

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STATIONS, DESIGN AND OPERATION

1747. ULTRA-HIGH-FREQUENCY EQUIPMENT FOR RELAY BROADCASTING [NBC Equipments developed since 1936].—Brown. (*RCA Review*, Oct. 1938, Vol. 3, No. 2, pp. 133–145.)

1748. A FREQUENCY-MONITORING UNIT FOR RELAY BROADCASTING STATIONS [Portable-Mobile Transmitters working on 1600–3000 kc/s: for Monitoring at the Receiving Location].—Curran. (*Electronics*, Jan. 1939, Vol. 12, No. 1, pp. 22–25 and 33.)

1749. LINE EQUALISATION BY PREDISTORTION [Transmission of Programme Material to Broadcasting Station over 10 Miles of Non-Loaded Cable Greatly Improved by Predistortion (reducing Energy Content of Low-Frequency Components) between Pre-Amplifier & Power Amplifier: Suggested Use also to Reduce Control Points in a Given Channel].—Creamer. (*Proc. Inst. Rad. Eng.*, Jan. 1939, Vol. 27, No. 1, pp. 22–23.)

1750. A SIMPLEX SYSTEM FOR REMOTE PROGRAMS [Buzzer & Headphone System for Communication (without Clicks in Programme Circuit) with Control Room].—Long. (*Communications*, Nov. 1938, Vol. 18, No. 11, pp. 24 and 29, 33.)

1751. SELECTIVE SIDEBAND *versus* DOUBLE SIDEBAND TRANSMISSION OF TELEGRAPH AND FACSIMILE SIGNALS [Theoretical and Experimental Investigation: No Outstanding Advantage for Former System].—Smith, Trevor, & Carter. (*RCA Review*, Oct. 1938, Vol. 3, No. 2, pp. 213–238.)

1752. A SHORT-WAVE SINGLE-SIDEBAND RADIOTELEPHONE SYSTEM [with Reduced Carrier or Pilot Frequency: Reasons for Choice of System: the Use of the Other Sideband as a Second Channel].—Oswald. (*Proc. Inst. Rad. Eng.*, Dec. 1938, Vol. 26, No. 12, pp. 1431–1454.) A summary was referred to in 3791 of 1938. For the receiving end *see* 1429, above (Roetken).

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1754. SOME PRINCIPLES IN AERONAUTICAL GROUND-RADIO-STATION DESIGN [and the Problem of the Avoidance of Interference with Reception, with (*e.g.*) 11 Transmitters in Area of Less than ½ Square Mile: the Importance of the Low-Pass Filter: etc.].—Sandretto. (*Proc. Inst. Rad. Eng.*, Jan. 1939, Vol. 27, No. 1, pp. 5–11.)

1755. BREAK-IN TELEPHONY WITH CARRIER SUPPRESSION: AN ELECTRONIC SYSTEM FOR AUTOMATIC CONTROL OF TRANSMITTER AND RECEIVER.—Kaplan. (*QST*, Feb. 1939, Vol. 23, No. 2, pp. 36–39.) From the Philips laboratories, Eindhoven.

GENERAL PHYSICAL ARTICLES

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1757. THE INFLUENCE OF THE INTERACTION OF MORE THAN TWO MOLECULES ON THE MOLECULAR DISTRIBUTION-FUNCTION IN COMPRESSED GASES.—de Boer & Michels. (*Physica*, Feb. 1939, Vol. 6, No. 2, pp. 97–114: in English.)

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1759. STUDY OF THE COLLISIONS BETWEEN GROUPS OF ELASTIC SPHERES: DERIVATION OF MAXWELL'S LAW OF DISTRIBUTION OF VELOCITIES [and a New Calculation of the Functional Determinant of the Collision Equations].—Peter. (*Helvetica Phys. Acta*, Fasc. 7, Vol. 11, 1938, pp. 587–606: in German.)

1760. ON THE INTRINSIC ENERGY OF THE ELECTRON.—Mercier. (*Helvetica Phys. Acta*, Fasc. 1, Vol. 12, 1939, pp. 55–75: in French.)

1761. COMMENT ON A PAPER BY W. E. BOWLS, "SECOND TOWNSEND COEFFICIENT."—Kaplan. (*See* 1358.)

1762. A CLASSICAL POINT CHARGE [Examination of Modification of Electromagnetic Field, serving as Calculation Model for Point Charge].—Groenewold. (*Physica*, Feb. 1939, Vol. 6, No. 2, pp. 115–128.)

MISCELLANEOUS

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1766. TENSOR ANALYSIS AND ITS APPLICATION TO EQUIVALENT CIRCUITS.—Epstein. (*RCA Review*, Oct. 1938, Vol. 3, No. 2, pp. 239–254.)

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1777. The Transmission of Energy over Long Distances with "Half-Wave" Frequency [*i.e.* Frequency for which the Line Length is a Half Wavelength or a Multiple of This].—Leonhard. (*Electrot. u. Masch:bau*, No. 42, Vol. 56, 1938, pp. 542–547.)

1778. Wireless Section: Chairman's Address [Recent Radio-Engineering Developments carried out by, or in Collaboration with, the P.O. Engineering Department: Ultra-Short-Waves: Quartz Crystals: "Musa" Ray-Diversity System: etc.].—Gill. (*Journ. I.E.E.*, Feb. 1939, Vol. 84, No. 506, pp. 248–260.) A summary was referred to in 865 of February.

1779. A Differential Pre-Amplifier for Electrophysiological Purposes and for Bridge Measurements.—König. (*Helvetica Phys. Acta*, Fasc. 6, Vol. 11, 1938, pp. 507–512: in German.)

1780. Electro-Cardiograph.—A. C. Cossor, Ltd. (*Journ. Scient. Instr.*, Jan. 1939, Vol. 16, No. 1, pp. 28–30.)

1781. Resuscitation from Electrical Shock.—De Soto. (*See* 1422.)

1782. Some Recent Continental Advances in the Principles, Construction, and Use of Scientific Instruments [including Electron Microscopes].—Pirani. (*Journ. Scient. Instr.*, Dec. 1938, Vol. 15, No. 12, pp. 389–405.)

1783. Non-Destructive Testing [Magnetic, Electrical, Acoustical & Other Methods] in the U.S.A.—Lester, Sanford, & Mochel. (*Bull. Am. Soc. for Testing Materials*, Dec. 1938, No. 95, pp. 5–14.) *Cf.* 1049 of March.

1784. Piezoelectric Measurement of Impact of Hammer on Stretched String.—Davy & others. (*See* 1528.)

1785. Pressure, Stress, and Movement Indicator [Variable-Gap Condenser Principle].—Southern Instruments, Ltd. (*Journ. Scient. Instr.*, Jan. 1939, Vol. 16, No. 1, pp. 30–31.)

1786. The Use of the Capacity-Measuring Process for the Testing of the Smoothness of Metallic and Non-Metallic Surfaces.—Sachsenberg & Perthen. (*Elektrot. u. Masch:bau*, No. 51, Vol. 56, 1938, pp. 691–692.)

1787. The Strobotron as an Electron Control Unit [Body-Capacity-Operated Switch and Electron-Control Time-Delay Off-Switch using Two Strobotrons working off Type BH Gaseous Rectifier].—Schulman. (*Communications*, Nov. 1938, Vol. 18, No. 11, pp. 10 and 16.) For the strobotron, originally designed as a stroboscopic light source but with special properties making it useful for many other purposes, *see* 3564 of 1936 and 2351 of 1937.

1788. Electronic Control Circuits for D.C. Motors [using Thyratrons without Intervening Relays].—Ryder. (*Electronics*, Dec. 1938, Vol. 11, No. 12, pp. 20–21.)

1789. Electrical Torsion Meters [for Measurements on Rotating Shafts: Survey].—Merz & Scharwächter. (*E.T.Z.*, 5th Jan. 1939, Vol. 60, No. 1, p. 16: summary only.) Extension of a theoretical work by Nettmann.

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

DIRECTIONAL WIRELESS

495 515.—Direction-finding system depending upon phase-differences set up in a transmission line after mutual modulation.

W. W. Triggs (communicated by Akt. Brown, Boverie & Co.). Application date 1st December, 1937.

495 554.—Direction-finding system in which the signal impulses received from a rotating-beacon transmitter are counted to indicate its bearing.

R. J. Berry (communicated by C. Lorenz Akt.). Application date 20th May, 1938.

495 613.—"Marker" beacons for radiating short-wave beams to indicate distances along an airway route.

R. J. Berry (communicated by C. Lorenz Akt.). Application date 1st March, 1938.

495 624.—Feeding and keying the main and reflector dipoles used for transmitting the wireless beams used in air navigation.

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

496 129.—Direction-finding equipment for giving a continuous indication on the fluorescent screen of a cathode-ray tube of the position of a moving craft relative to two or more fixed beacons.

Marconi's W. T. Co. (assignees of J. Plebanski). Convention date (Poland) 11th January, 1937.

496 217.—Direction finder with means to offset the effect of increasing field-strength on the critical "zero" indication, as the craft under navigation approaches the beacon transmitter.

Marconi's W.T. Co. and W. A. Appleton. Application date 25th May, 1937.

496 239.—Spaced-aerial direction-finder in which the out-of-phase pick-up voltages are fed, after modulation at different frequencies, to a cathode-ray indicator through a common amplifier.

Standard Telephones and Cables and C. F. A. Wagstaffe. Application date 28th May, 1937.

497 147.—Apparatus for indicating the bearing and distance of a distant object, such as an aeroplane, by taking observations on the waves reflected by it from a short-wave transmitter located at the point of observation.

The British Thomson-Houston Co. Convention date (U.S.A.) 9th April, 1936.

497 761.—Arrangement of deflecting-coils for correcting quadrantal error in a wireless direction-finder using a cathode-ray indicator.

Marconi's W.T. Co. and L. E. Q. Walker. Application date 26th June, 1937.

498 344.—Counterpoise system for preventing the radiation of horizontally-polarised waves from a directional transmitter of the overlapping beam type.

R. J. Berry (communicated by C. Lorenz Akt.). Application date 22nd October, 1937.

498 985.—Method of keying the dipole aerials and reflectors used to produce a navigational course of the overlapping-beam type.

C. Lorenz Akt. Convention date (Germany) 12th April, 1937.

RECEIVING CIRCUITS AND APPARATUS

(*See also under Television*)

495 066.—Tuning arrangement in which a cathode-ray indicator is moved bodily with the cursor along the wavelength scale.

C. Metcalfe. Application date 5th May, 1937.

495 313.—Automatic tuning system in which the tendency of the control to "jump" under certain critical conditions is prevented.

Marconi's W.T. Co.; N. M. Rust; and O. E. Keall. Application date 4th May, 1937.

495 339.—Automatic tuning system in which the correcting voltage is derived from the phase-difference between two currents of equal frequency.

The General Electric Co. and G. M. Wells. Application date 13th May, 1937.

495 413.—Application of negative feed-back to stabilise a push-pull arrangement of multi-grid valves.

Baird Television and W. A. Cox. Application date 14th May, 1937.

495 732.—Construction of cathode-ray tuning-indicator for a wireless set.

M-O. Valve Co.; M. Benjamin; and H. S. Smith. Application date 25th August, 1937.

495 879.—Tuning device in which the indicator needle is rotated about its longitudinal axis to present different cursors or markers to different wavelength scales.

L. F. Birdseye. Application date 26th May, 1937.

496 123.—Relay system in which selective reception is ensured by shifting a desired broadcast programme by frequency-conversion from its allotted position in the wavelength scale to a less-congested position.

W. A. Beatty. Application date 19th May, 1937.

496 140.—Device for minimising the effect of interference from the supply mains on a wireless receiver.

W. A. Beatty. Application date 26th May, 1937.

496 145.—Superhet receiver in which wave-band changes are effected both in the preselector and intermediate - frequency circuits, to improve selectivity.

Marconi's W.T. Co. Convention date (U.S.A.) 29th May, 1936.

496 246.—Eliminating static interference from a wireless receiver by interrupting the rectified signal at a comparatively-high frequency.

Marconi's W.T. Co. Convention date (U.S.A.) 28th May, 1936.

496 275.—Press-button system of tuning with flexible means of adjustment.

Murphy Radio. Application date 26th May, 1937.

496 837.—Station and programme indicator in which a list of broadcasting stations is associated with a clock-driven indicator, which shows both the time and the nature of the item being radiated.

J. C. Rogerson. Application date 15th September, 1937.

496 874.—Tuning indicator in which a pointer is moved bodily over a wavelength scale for rough tuning, and simultaneously rotates an associated disc to give fine-tuning.

The General Electric Co.; R. Gosden; S. G. Hunter; and E. L. Mercer. Application dates 7th April and 15th November, 1937.

497 148.—Resistance-capacity back-coupling for a valve amplifier designed to produce no phase-change over a selected range of frequencies.

P. W. Willans and Muirhead & Co. Application date 12th April, 1937.

497 490.—Automatic tuning system in which the control motor is brought to a stop at the selected position by closing instead of opening a circuit.

W. W. Triggs (communicated by Operadio Mfg. Co.). Application date 24th June, 1937.

497 555.—Amplifier with a negative feed-back circuit comprising two transformers with leakage resonance frequencies calculated to prevent self-oscillation.

Philips' Lamp Co. Convention date (Germany) 24th May, 1937.

497 646.—Wireless receiver in which "noise" is reduced by means of a storage circuit which is isolated during static interference.

Marconi's W.T. Co. Convention date (U.S.A.) 21st May, 1936.

497 749.—Slow-motion combined friction and positive driving-gear for the tuning condenser of a wireless set.

Standard Telephones and Cables and R. E. Hall. Application date 25th June, 1937.

497 774.—Automatic tuning system in which the wave-change switch is automatically controlled when a push-button selector is operated for a station outside the wave-band to which the receiver happens to be set.

E. K. Cole; A. W. Martin; and H. G. Jarvis. Application date 13th January, 1938.

497 830.—Multi-band superhet receiver with remote tuning control and an input "mixing" stage structurally separate from the rest of the set.

G. von Schaub. Convention date (Switzerland) 21st March, 1936.

498 811.—Automatic tuning control system applicable to short-wave signals in which both amplitude and frequency modulation is present.

Philip's Lamp Co. Convention date (Switzerland) 10th July, 1937.

498 842.—Noise-suppression circuit for a wireless receiver with means for ensuring a rapid return to normal operation once the suppression point is passed.

Marconi's W.T. Co. and K. R. Sturley. Application date 15th July, 1937.

499 108.—Adjustable mechanical means incorporated in a loud-speaker for cutting-out "hissing" and other noises due to the reduction of the band-width in the I.F. stages of a superhet receiver.

Philip's Lamp Co. Convention date (Germany) 10th May, 1937.

TELEVISION CIRCUITS AND APPARATUS

For Transmission and Reception

495 822.—"Relay" system for distributing television programmes synchronised by a single set of time-base oscillators.

Baird Television and L. R. Merdler.

496 018.—Method of making the "mosaic" photo-sensitive screen used in a television transmitter of the Iconoscope type.

Philip's Lamp Co. Convention date (Germany) 5th March, 1937.

496 119.—Generating and controlling synchronising impulses for television transmission and reception.

E. L. C. White. Application date 23rd April, 1937.

496 213.—Anode-bend rectifier for television signals in which the highest modulation frequencies are of the same order as the lower side-bands of the carrier-wave.

Radio-Akt. D. S. Loewe. Convention dates (Germany) 27th May and 8th July, 1936.

496 662.—Construction of incandescent screen for use with a cathode-ray television receiver.

F. Fischer and M. Lattmann. Convention date (Switzerland) 4th June, 1936.

496 751.—Variable magnetic focusing-arrangement for a cathode-ray tube to enable the size of a televised picture to be altered in the electron stream.

H. Miller. Application date 1st April, 1937.

496 756.—Cathode-ray tube for television in which a reinforced picture-image is obtained on an auxiliary screen by means of secondary emission.

Zeiss Ikon Akt. Convention date (Germany) 6th May, 1936.

496 872.—Single-valve amplifier, particularly for television, in which phase-reversal between input and output is avoided.

E. L. C. White and J. Hardwick. Application date 6th March, 1937.

496 964.—Television scanning system utilising a light cell traversed by supersonic pressure waves.

Scophony and J. H. Jeffree. Application date 10th June, 1937.

497 069.—Light-modulating cell in which a liquid is vibrated at supersonic frequency by a piezo-electric crystal.

Scophony and G. W. Walton. Application date 10th June, 1937.

497 206.—Receiving circuit for handling a pre-determined narrow band of signals supplied from a dipole aerial, such as the carrier-wave and associated side-bands of a sound-and-picture television programme.

Philips' Lamp Co. Convention date (Germany) 5th July, 1937.

497 217.—Transformer coupling, particularly suitable for the intermediate-frequency amplifier of a television receiver handling a wide band of signals.

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

497 371.—Separating synchronising impulses from picture signals in a television system in which synchronising is effected by interrupting the carrier wave.

E. P. Rudkin. Application date 19th June, 1937.

497 404.—Viewing-screen for a television receiver composed of a large number of elementary parts, the transparency or diffusing power of which varies in accordance with the strength of an applied electric or magnetic field.

P. M. G. Toulon. Convention date (France) 9th July, 1936.

497 406.—Electron multiplier for television signals in which the target electrode is curved in such a way as to minimise the so-called "pincushion" type of distortion.

B. M. Crowther. Application date 19th June, 1937.

497 551.—Cathode-ray tube of the Iconoscope type in which the mosaic-cell electrode is constructed to have small capacity with the object of increasing the signal-to-noise ratio.

Marconi's W.T. Co. (assignees of G. A. Morton). Convention date (U.S.A.) 15th May, 1937.

497 566.—Method of making photo-electric surfaces of the mosaic-cell type for use in television.

H. Rupp (assignee of E. P. Rupp). Convention date (Germany) 29th June, 1937.

497 620.—Cathode-ray tube in which the magnetic deflecting coils used for scanning are energised by the higher harmonic frequencies from a relaxation oscillator.

Radio-Akt. D. S. Loewe. Convention date (Germany) 8th October, 1936.

497 626.—Adaptable mounting for a cathode-ray tube in a television cabinet, designed to accommodate different sizes of tube.

The General Electric Co. and F R. Jones. Application date 8th November, 1937.

497 631.—Means for preventing deformation of the electric field around the edges of the deflecting plates of a cathode-ray tube.

V. Zeitline; A. Zeitline; and V. Kliatchko. Convention date (France) 17th November, 1937.

497 760.—Electron-beam type of valve used as a blocking-oscillator for producing synchronising impulses for television scanning.

Marconi's W.T. Co. and R. J. Kemp. Application date 26th June, 1937.

498 037.—Thermionic amplifier with an approximately triangular frequency-response characteristic for handling the side-band frequencies produced in television.

Ferranti and M. K. Taylor. Application date 24th June, 1937.

498 304.—Electron-multiplier for modulating a carrier-wave with television signals.

Fernseh Akt. Convention date (Germany) 10th July, 1936.

498 816.—Method of modulating light by passing it through a piezo-electric crystal in which there is a diffraction-grading effect.

S. Sokoloff. Application date 13th May, 1937.

TRANSMITTING CIRCUITS AND APPARATUS

(See also under Television)

496 710.—High-powered thermionic valves in which certain electrodes are movable and occupy different positions according to whether the valve is in operation or not.

The M-O. Valve Co.; R. Le Russignol; and S. M. Duke. Application date 7th October, 1937.

496 883.—Power amplifying circuit in which the internal impedance of a pentode or tetrode output valve is kept matched to the load, so that excessive voltage surges are avoided.

A. D. Blumlein. Application date 5th June, 1937.

497 198.—"Secret" system of telephony in which noise is deliberately introduced between the natural pauses in speech so as to produce a continous background of confusing noise.

Standard Telephones and Cables (assignees of D. Mitchell). Convention date (U.S.A.) 15th May, 1937.

497 224.—Means for controlling and regulating the frequency of the main and subsidiary transmitters in a common-wave broadcasting system.

C. Lorenz Akt. Convention date (Germany) 18th June, 1936.

497 361.—Means for preventing voltage losses in the operating potentials supplied to the electrodes of a high-powered short-wave amplifier or oscillator valve.

J. M. Dodds and Metropolitan-Vickers Electrical Co. Application date 18th June, 1937.

497 364.—Safety and alarm devices for the cathode-heating circuits of high-powered amplifiers.

Standard Telephones and Cables; R. A. Meers; and F. G. Filby. Application date 18th June, 1937.

498 844.—Preventing "back-lash" in the remote tuning-control of a wireless transmitter designed to operate on a predetermined series of wavelengths.

Marconi's W.T. Co. and J. Stewart. Application date 15th July, 1937.

499 088.—Frequency-multiplying valve generator with a piezo-electric crystal serving as a stabilising control.

Marconi's W.T. Co. (assignees of J. L. Reinartz). Convention date (U.S.A.) 23rd April, 1937.

CONSTRUCTION OF ELECTRONIC-DISCHARGE DEVICES

495 531.—Amplifier, oscillator, or relay device in which a stream of electrons is controlled so that it falls upon one or other of two "split" anodes.

Standard Telephones and Cables (assignees of A. M. Skellett). Convention date (U.S.A.) 31st March, 1937.

496 425.—Cathode-ray type of oscillation-generator in which the electron stream is driven cyclically over a "split" anode.

W. W. Triggs (communicated by Farnsworth Television Inc.). Application date 28th October, 1937.

496 557.—Container for the "gettering" material used in exhausting thermionic valves during manufacture.

Marconi's W.T. Co. Convention date (U.S.A.) 1st June, 1936.

496 564.—Arrangement of accelerating and retarding electrodes in an electron-multiplier designed to increase its effective amplification.

Fernseh Akt. Convention date (Germany) 30th May, 1936.

496 705.—Secondary-emission amplifier designed to prevent a rise in anode-voltage from producing an excessive increase in output current.

Philips' Lamp Co. Convention date (Holland) 1st September, 1936.

496 856.—Method of producing a high vacuum in a discharge tube by combining an alkali "getter" with a gas-producing substance such as a carbonate.

Philips' Lamp Co. Convention date (Germany) 9th March, 1937.

496 904.—Cathode structure for an indirectly-heated power amplifier or rectifier tube.

The British Thomson-Houston Co. Convention date (U.S.A.) 16th October, 1936.

497 160.—Cathode-ray type of electron-multiplier in which a number of "cascaded" electron streams are produced in the same plane from sources arranged in one or more circles.

The British Thomson-Houston Co. Convention date (Germany) 30th July, 1936.

497 563.—Electrode assembly designed to maintain accurate spacing in a valve for handling ultra-high frequencies.

Standard Telephones and Cables (assignees of A. L. Samuel). Convention date (U.S.A.) 16th July, 1937.

497 645.—Electron focusing arrangement with a converging magnetic field to reduce the cross-section of the stream through a cathode-ray tube.

H. G. Lubszynski. Application date 20th May, 1937.

498 347.—Arrangement and mounting of the electrodes in a valve amplifier or generator of the kind in which the electron stream is formed into a beam.

Philips' Lamp Co. Convention date (Germany) 26th November, 1936.

498 843.—Electron-multiplier in which one of the target electrodes is made more highly emissive over a selected part of its surface than elsewhere, in order to control the response of the tube.

Marconi's W.T. Co. and G. B. Banks. Application date 15th July, 1937.

499 487.—Amplifier in which the potential of an electrode emitting secondary electrons is controlled by the bombardment of primary electrons.

G. Krawinkel. Convention dates (Germany) 25th April, 26th May, 10th and 16th June, 1936, and 11th January, 1937.

SUBSIDIARY APPARATUS AND MATERIALS

496 398.—Electron-multiplier used for attenuating or reducing the amplitude of a signal to a desired level, for testing purposes.

Baird Television; V. A. Jones; and T. C. Nuttall. Application date 1st June, 1937.

496 619.—Loud speaker mounted in a box-shaped casing with a perforated end-wall to serve as a baffle-plate.

Philips' Lamp Co. Convention date (Holland) 23rd January, 1937.

496 504.—Preventing undesired resonance in a "cabinet" loud speaker which is deliberately mounted at an angle to the face of the panel.

Murphy Radio and G. S. Brayshaw. Application date 25th June, 1937.

496 841.—Construction of sparking-plug designed to reduce interference with a motor-car radio set.

E. L. W. Byrne (communicated by Titeflex Metal Hose Co.). Application date 30th November, 1937.

497 222.—Method of lining or preparing the walls of a studio used for sound-broadcasting in order to improve its acoustic properties.

A. B. Howe. Application date 19th June, 1937.

497 490.—Ribbon type of microphone in which means are provided for adjusting the axis of minimum response so as to exclude undesired sounds.

Marconi's W.T. Co. (assignees of F. Massa). Convention date (U.S.A.) 1st June, 1936.

497 556.—Relaxation-oscillator which operates under two different stabilised conditions to produce phase-displaced synchronising impulses.

Telefunken Co. Convention date (Germany) 19th July, 1936.

497 672.—Microphone fitted with a damping-member arranged in the gap between the pole-pieces and provided with annular recesses forming air chambers.

A. I. Abrahams. Application date 23rd June, 1937.

497 692.—Loud speaker in which the tubular portion of the diaphragm, taking the speech-coil, is formed with a shoulder-abutment for the spider.

R. Marguerat. Convention date (France) 8th October, 1936.

497 755.—Combination of a silicon-tungsten solid, having a hyperbolic resistance-current characteristic, with a filter circuit, for frequency-changing.

Automatic Telephone and Electric Co. and F. McCabe. Application date 25th June, 1937.

497 950.—Variable condenser of the kind in which one tube slides within another, suitable for use as a "trimmer."

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

498 218.—Loud speaker construction designed to facilitate the centering and alignment of the voice-coil in the air-gap of the magnet.

Cinaudagraph Corp. (assignees of R. Neuschotz). Convention date (U.S.A.) 14th November, 1936.

498 072.—Filter circuit for suppressing high-frequency disturbances produced by electric motors.

The English Electric Co.; H. B. Sedgfield; and H. S. Pound-Corner. Application dates 9th September and 25th October, 1937.

498 963.—Safeguarding the stylus of a radiogram or similar pick-up from mechanical shocks.

Telefunken Co. (assignees of Siemens and Halske Akt.). Convention date (Germany) 25th March, 1937.