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Editorial

A Band-Pass Filter of Variable Width with Constant Form-Factor and Middle Frequency

IN the ordinary band-pass filter consisting of two coupled circuits, one adjusts the width of the band by varying the coupling. Unfortunately this also changes the shape of the response curve, causing the saddle in the curve to become more or less pronounced, even if the curve remains symmetrical. This can cause non-linear distortion if the set is not accurately tuned to the received waves. This question was discussed in a recent number of *Hochf:tech. u. Elek:akus.*[1] and a band-pass filter designed to overcome the difficulty and give a response curve of constant form-factor and fixed middle frequency for all band-widths.

If two circuits LC with an effective shunt conductance g are coupled by a reactance jX as shown in Fig. 1, the middle angular frequency Ω_0 will be given approximately by the formula

$$\Omega_0 = \frac{1}{2CX} + \omega_0 \text{ where } \omega_0 = \frac{1}{\sqrt{LC}}.$$

The effect of the damping may be represented by putting $g/C = \Delta\Omega$. In an earlier paper Feldtkeller and Tamm[2] introduced a form factor $F = \frac{1}{4} + \frac{1}{4g^2X^2}$ and showed that when this is kept constant the band-width is proportional to $\Delta\Omega$. Hence, if the band-width is varied by varying g, that is, by varying the damping of the circuits, to maintain F constant the coupling reactance must vary inversely as g. The coupling reactance enters, however, into the formula for the middle frequency Ω_0, and to keep this constant it will be necessary to vary C. The effect of this variation of C on the value of $\Delta\Omega$ will be small compared with the effect of the variation of g. With capacitive coupling, with which alone the paper deals $X = -1/\Omega_0 C'$ and $\Omega_0 = -\frac{\Omega_0 C'}{2C} + \frac{1}{\sqrt{LC}}$ where C' is the capacitance of the coupling

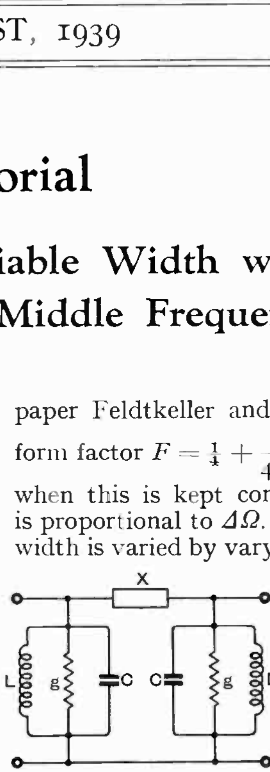

Fig. 1.

[1] Alsleben and Weiler, p. 160, May, 1939.

[2] *Hochf:tech. u. Elek:akus.* 46, p. 133, 1935, and *E.N.T.*, 13, p. 123, 1936.

condenser. Regarding $\sqrt{C}$ as the unknown this gives a quadratic equation the approximate solution of which is

$$C = \frac{1}{\Omega_0^2 L} - C' \text{ from which } \Omega_0^2 = \frac{1}{(C + C')L}.$$

As a matter of fact, this approximate formula for Ω_0^2 might have been written down at once from the fact that the two resonant angular frequencies are obviously $\frac{1}{\sqrt{LC}}$ and $\frac{1}{\sqrt{L(C + 2C')}}$*. Hence to keep the middle frequency of the band constant, the sum of the capacitances of the tuning and coupling condensers must be kept constant.

In the filter described the variation of the damping of the oscillatory circuits was effected by connecting a resistance r in series with a condenser C_d in parallel with the main condenser C. The resistance r was kept constant and its effect varied by varying the series capacitance C_d. Since this varies not only g but also the effective capacitance, another condenser C_a has to be introduced which varies in the opposite direction and thus counteracts the variation of effective capacitance. The resulting circuit is shown in Fig. 2; the condensers C_d C_a and C' are mechanically coupled,

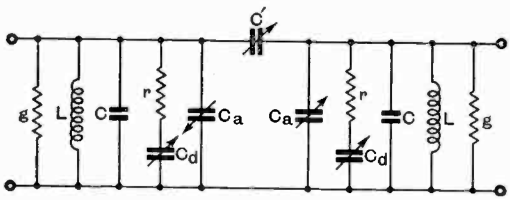

Fig. 2.

C' and C_d varying in the same and C_a in the reverse direction as indicated by the direction of the arrows. The authors point out that it is not essential to vary the damping of both circuits; the symmetry is not upset by varying the damping in one circuit only.

The principle of the method actually employed in the filter constructed and tested is illustrated in Fig. 3, in which for simplicity the movement is represented as linear. The moving plates are connected mechanically and electrically and are earthed as shown. The coupling capacitance C' is increased by withdrawing the earthed middle plate from between the two insulated fixed plates. The capacitance C_d is in-

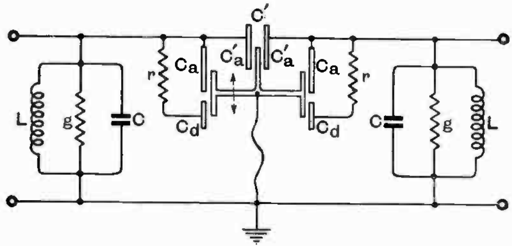

Fig. 3.

creased at the same time, and with it the damping. The plates are so shaped that the total capacitance $C + C' + C_a + C_a' + C_d$ remains constant but it is important to notice that the tuning capacitance C is regarded as constant throughout the paper referred to and the filter appears to be designed to work at one fixed wavelength. Experimental curves are given in the paper showing that the results obtained agree with the calculations. Although the form-factor of the response curves does not vary with the band-width, the sensitivity decreases as the width is increased, as one would expect from the increased damping introduced. This the authors regard as an advantage since a wide band is only employed when receiving relatively powerful transmissions.

G. W. O. H.

* Howe, "Analysis of Frequency in Oscillating Circuits," *Elect. World*, New York, 1916, 68, p. 368, also *The Wireless Engineer*, June and July, 1937, pp. 289 and 347. (See p. 349 for a discussion of the factor F.)

Radiolympia

THE annual wireless exhibition organised by the Radio Manufacturers' Association will be held in Olympia, London, from August 23rd to September 2nd. If present plans materialise, this year's show will have a greater appeal than hitherto to those whose interests lie in the technical rather than the programme side of broadcasting.

A technical survey of the exhibition from a wireless engineer's viewpoint will be included in our October issue. Our sister journal, *The Wireless World*, will devote the issues of August 24th and 31st to a detailed report of the show and a review of technical progress.

Output Stage Distortion*

Some Measurements on Different Types of Output Valves

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SUMMARY.—After an introduction dealing with the disturbing effect of distortion and the installation used for its measurement, details are given of a series of measurements which were carried out on valve combinations comprising a preamplifier in conjunction with different types of output valves. Results show that the modern output pentode is a better safeguard against overload in fortissimo sections than the triode. In the absence of inverse feed-back, distortion is greater in a pentode than in a triode, but, for an output equal to ⅓ of the anode dissipation (maximum efficiency of the output triode), distortion is found to be below the permissible value of 5 per cent. Contrary to what is commonly supposed, this larger distortion is not due to a larger 3rd harmonic but solely to additional 2nd harmonics.

The greater sensitivity of output pentodes enables distortion to be greatly improved by inverse feed-back without lowering the sensitivity to an unserviceable level, as would be the case with output-triodes. Along with push-pull circuits, which have not been dealt with in this treatise, a pentode output valve is therefore appropriate whenever high standards of reproduction quality are demanded.

Tetrode output valves or beam-power valves show great similarity to pentodes, but their output at load resistances above the optimum value is adversely affected by secondary emission phenomena which are still present. The main drawback, however, of this type of output valve is that a phase angle of the load impedance has a pronounced influence upon output.

Introduction

THOUGH the quality of reproduction from output triodes may sometimes be considered to be better than with output pentodes, the latter type of output stage is more commonly used in radio receivers. This is undoubtedly due to the fact that pentodes have a higher efficiency and especially a much greater sensitivity than output triodes. Many receiver designers may, however, ponder the question as to whether the reproduction quality has to some extent been sacrificed to these two characteristics. The following discussion of some of the measurements obtained in practical cases will show that the quality of reproduction with pentodes need by no means be inferior to that given by triodes. Not only have some makes of pentodes been greatly improved during the last two years, but in addition to this the increasing use of inverse feed-back enables certain properties of the triode output stage to be applied also to pentode output stages. In this article we will confine our attention to simple output stages and not enter into the details of push-pull circuits.

The usual quantities in which the performance of output valves can be expressed are: sensitivity (i.e., the A.C. grid voltage required for an output of 50 milliwatts), the maximum output without grid current, and the accompanying distortion. Some valve factories issue in place of (or along with) these two latter values a plotted characteristic showing the distortion (D)† as a function of the output (W_0).

The magnitudes referred to as "output" (W_0) and "sensitivity" [V_i(50 mW)] need no further explanation. The one referred to as "distortion" does, however, call for a few remarks.

The distortion factor D is defined by

$$D = \sqrt{\frac{i_2^2 + i_3^2 + i_4^2 + \ldots}{i_1^2}}$$

where i_1 is the current of the fundamental frequency and i_2, i_3, etc., are the currents of the harmonics. In some cases i_{tot}^2 instead of i_1^2 is placed in the denominator. In practical cases where D is smaller than 10 per cent. this does not make any considerable difference.

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

† A list of symbols used is given at the end of this instalment.

Not in every case is the distortion D a good criterion for the quality of reproduction. The distortion due, for instance, to phenomena of a discontinuous character: the flow of grid current during a part of a cycle of the A.C. grid voltage, or a sudden limitation of the A.C. anode voltage (due to too low an anode voltage), is at once far more disturbing than would be expected from the value of the distortion factor. In an experiment conducted to ascertain the gravity of the distortion which may occur in the diode detector of a radio receiver when the A.C. load of the diode is unequal to the D.C. load, it was found that when these resistances bore a certain ratio to each other a very troublesome distortion occurred although the distortion factor was only 0.2 per cent.

The distortion factor is, however, a very useful value as a criterion if we eliminate such discontinuous phenomena, in which harmonics of a very high order are usually present, and confine ourselves to the forms of distortion caused by more or less continuous curvature irregularities in the characteristics through which operation takes place. In the case of output valves this means eliminating the region in which grid current occurs and the region in which the anode voltage amplitude is sharply demarcated by the course of the $I_a - V_a$ characteristic.

Another important point to be noted when comparing a triode and a pentode is whether the 3rd harmonic is just as disturbing as the 2nd. Distortion in a triode output stage, i.e., without a preamplifier, consists chiefly of 2nd harmonic (quadratic distortion), whereas a pentode output stage sometimes develops, together with 2nd harmonic, considerably more 3rd harmonic (cubic distortion) than is formed in a triode output stage. We would mention in this connection that the distortion in a combination comprising a preamplifier valve and a triode output stage generally contains a large amount of 3rd harmonic (see below), so that the question as to whether the 2nd or the 3rd harmonic is the more disturbing loses some of its importance.

Experiments to determine the degree of audibility and the disturbing effect of quadratic and cubic distortion in speech or music have not as yet been very numerous (W. Janovsky, *ENT*, 1929, Vol. 6, p. 421; F. Massa, *Proc. Inst. Rad. Eng.*, 1933, Vol. 21, p. 682; H. von Braunmühl and W. Weber, *Akust. Zeitschr*, 1937, Vol. 2, p. 135). According to these investigators the greatest amount of distortion is permissible in the case of speech. Thus, according to Massa, in an amplifier whose frequency characteristic extends to 14,000 cycles, a distortion of 5 per cent. 2nd harmonics or of 3 per cent. 3rd harmonics can just be heard when distorted and undistorted reproduction are directly compared with each other. For the form of frequency characteristic which is usual in radio receivers, this limit, according to the same investigator, is the same for both quadratic and cubic distortion, viz., 5 per cent.

For the reproduction of music the critical limit at which a difference between distorted and undistorted reproduction can just be detected by the ear when strained to attention is somewhat lower, its value for both 2nd and 3rd harmonics being equal to 4 per cent. (von Braunmühl and Weber). The results stated here only apply to distortions caused by curvature irregularities of a continuous nature, so that in these cases a distortion factor of 4 per cent. will generally be sufficiently low in practice.

Regarding the disturbing effect of distortion, it may furthermore be stated that the harmonics themselves do not cause troublesome distortion. It is a fact that all natural notes as produced by musical instruments contain harmonics which are present in large numbers and high intensities; in most musical instruments the 2nd to 6th harmonics are even more powerful than the fundamental. However, along with the harmonics themselves there are fresh notes due to the sum and difference frequencies, which are formed as a result of the curves in the valve characteristics.

These fresh notes may bring about a change of "timbre" which does not generally prove disturbing and which remains within the permissible limits in practice. The change of "timbre" is usually due to the sum frequency notes which are masked by the primary notes. The difference frequency notes are in many cases masked by the bass. Really troublesome distortion occurs when the formation of new notes gives rise to hoarseness. This is the case when one of the primary notes is of a very low pitch. In that case the sum and difference frequencies will be little different from some other primary frequency. For instance, two primary notes of 60 and 1,000 c/s will as a result of quadratic distortion not only give rise to frequencies of 120 and 2,000 c/s but also to frequencies of 940 and 1,060 c/s. This means that the 1,000-c/s note appears to be modulated by 60 c/s. When this modulation frequency lies between about 40 and 100 c/s a certain hoarseness occurs which may prove very disturbing. This hoarseness is probably responsible for musical reproduction of a "confused" nature, and is the reason why one is sometimes unable to distinguish the different instruments.

The same limit to the audibility of distortion holds good, according to the above investigators, for both quadratic and cubic distortion, whereas—at the same value of the distortion factor—the compound frequencies generated in the case of cubic distortion have $1\frac{1}{2}$ times as great an amplitude as those generated in the case of quadratic distortion, probably as a result of the fact that with cubic distortion the side bands are twice as far away from the primary note and hence cause less hoarseness, but are more within the range of separate audibility.

When we are not listening to speech or music but to two purely sinusoidal notes the limit of audibility of hoarseness is lower, being located at a distortion factor of from 1 to 1.5 per cent. (H. G. Beljers, *Tijdschrift Nederlandsch Radiogenootschap*, December, 1934).

It may therefore be concluded from the results set forth here, which were found by various experimenters, that for normal radio

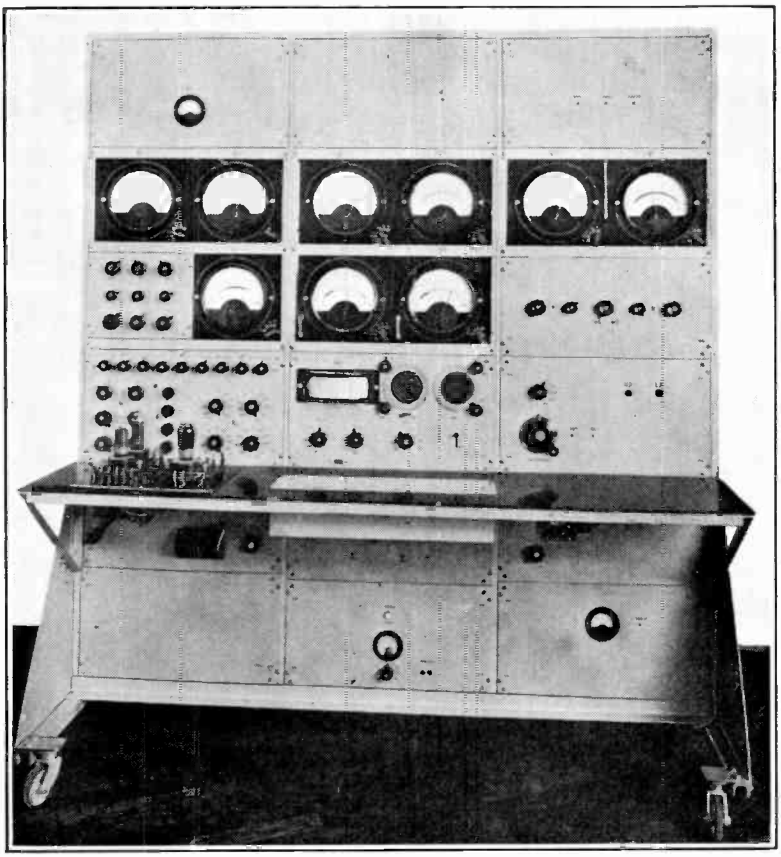


Fig. 1.—*Front view of measuring installation. The functions of the various panels, viewed from left to right, are as follows: 1st row: Stabilised voltage supply for anode and screen-grid voltages of the valves under test. Oscillator 500 c/s. Supply unit and time-base apparatus for the cathode-ray tubes. 2nd row: Meters for heater voltage, anode voltages and grid biases. 3rd row: Switches for heater current circuit, current meters and controls for grid bias. 4th row: Panel with controls for positive potentials, heater current, cathode resistance and load resistance; meter for grid current, cathode-ray tubes; high-pass and low-pass amplifier. On table: Connection panel for valves or valve combinations under test, and in the middle (countersunk): three meters for A.C. grid voltage, output and distortion. 5th row: Choke coil for anode supply to valve under test, and output transformer for push-pull measurements; amplifier for signal; high and low-pass filters. Bottom row: Supply of potentiometers for grid bias; relay which automatically disconnects the positive potentials in the event of failure of the negative grid bias; stabilised supply for the measuring amplifiers.*

C

quality a distortion factor of 4 to 5 per cent. at the maximum occurring amplitude is sufficiently low. In certain cases where very high demands are made upon reproduction quality, the distortion factor at maximum amplitude should not exceed 1 to 1.5 per cent. In both these cases it is essential that no phenomena of a discontinuous nature should occur at the amplitudes corresponding to these distortion factors.

Measuring Installation

The measuring installation (Figs. 1 and 2) used for the following measurements operates on the well-known principle indicated in Fig. 3.‡

The signal from a 500-c/s oscillator is applied, via a filter which effectively suppresses the higher harmonics, to the grid of the valve or valve combination under test.

The anode is fed via a choke coil of such dimensions that it does not introduce any additional distortion. The load impedance is connected via a condenser to the anode. The output may be determined by measuring the current through this impedance. The

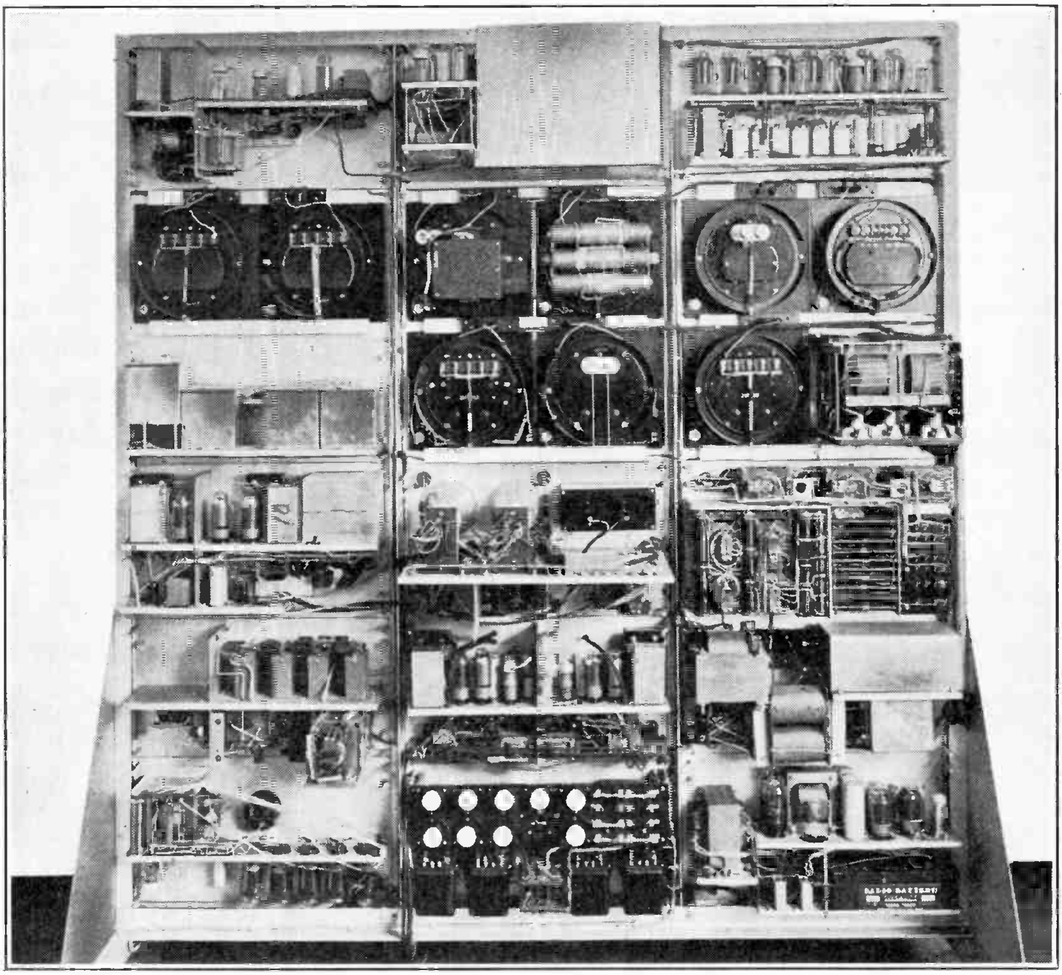


Fig. 2.—*Rear view of measuring installation. For functions of the various components see Fig.* 1.

‡ Ballantine and Cobb, *Proc. Inst. Rad. Eng.*, 1930.

load impedance is connected to two filters each of which is followed by an amplifier. One channel serves for the fundamental, whilst the other only admits the harmonics.

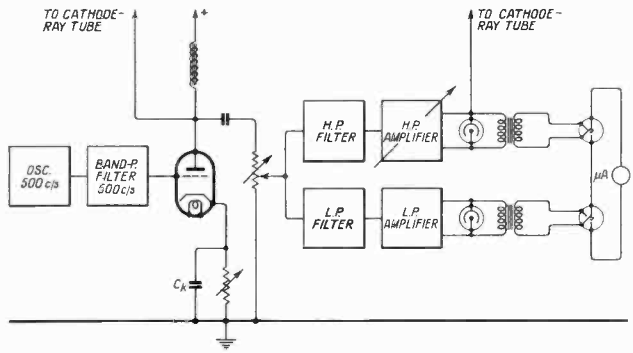


Fig. 3.—*Scheme of measuring installation.*

If desired the high-pass filter in this latter channel may be replaced by other filters which only admit a multiple of the fundamental frequency, so that the distortion may be split up into the various harmonics. Thermocouples are connected via output transformers to the output terminals of the amplifiers. The primary windings of the two output transformers are shunted by neon lamps (Mullard Type 4687) which limit the voltage to 90 volts and thus protect the thermocouples against excessive current surges which might be caused by faulty switching manipulations.

The secondaries of the two thermocouples are coupled in opposition and connected to an instrument with central zero.

The amplification of the high-pass channel is adjustable, so that by adjusting this amplification it is possible to measure the output at a given distortion by increasing the A.C. voltage on the grid of the valve under test to such an extent that the zero instrument passes through the zero point.

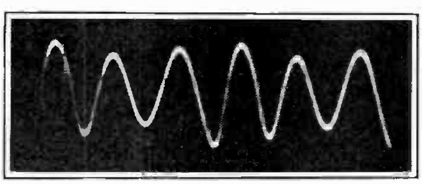


Fig. 4.—*Distortion in a push-pull circuit with two pentodes (without grid current).*

The anode of the valve under test, and the output terminals of the high-pass filter, are each connected to a cathode-ray tube (Mullard 4002), so that the wave form of the A.C. anode voltage can be visually observed on one tube, whilst the other tube shows the harmonics themselves. The shape of this latter figure not only indicates what orders of harmonics are formed in the valve under test, but it also gives a direct picture of any discontinuities, such as grid current, which may occur.

Two photographs of the curve seen on this tube are shown in Figs. 4 and 5. Fig. 4 gives the distortion for a push-pull system of two pentodes operating without grid current, and Fig. 5 the corresponding curve for a push-pull system of two triodes, with a high amplification factor, operating with grid current (Class B amplification). In the latter case, in which the capricious shape of the distortion curve

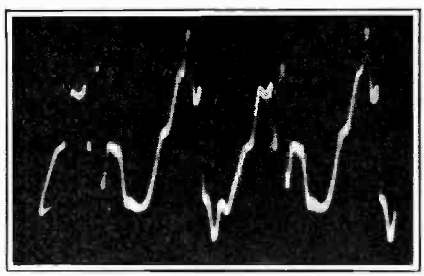


Fig. 5.—*Distortion in a push-pull circuit (Class B) with two triodes (with grid current).*

indicates that there are discontinuities in the characteristics covered, the distortion factor is in no sense a criterion for the quality of reproduction, whereas in the case of Fig. 4 it does lend itself for this purpose.

Preamplifiers

Most of the measurements have been done on the output valve in combination with a preamplifier stage.

In radio receivers this stage generally consists of a triode, which may or may not be combined with diodes, or of a " straight " pentode. In this connection various measurements have been carried out with a TDD4 or an SP4B as preamplifier.

The settings for the two valves were as follows:

TDD4

Cathode resistance.. ..	= 2,000 ohms
Anode resistance	= 60,000 ohms
Supply voltage	= 250
Anode current	= 2 ma

Amplification about 22.

SP4B

Cathode resistance.. ..	= 1,500 ohms
Anode resistance	= 0.1 megohm
Resistance in screen grid supply	= 0.1 megohm
Supply voltage	= 250
Anode current	= 1.3 mA

Amplification about 180.

Triode Output Valve

As the efficiency of a triode output valve as used in radio receivers is generally lower than that of a pentode, the triode measurements were carried out on a valve of Continental make, the AD1, which has a fairly high efficiency and will thus reasonably compare with pentodes in this respect. The AD1 shows considerable similarity with the American 2A3. An oscillogram of the $I_a - V_a$ characteristic is given in Fig. 6.

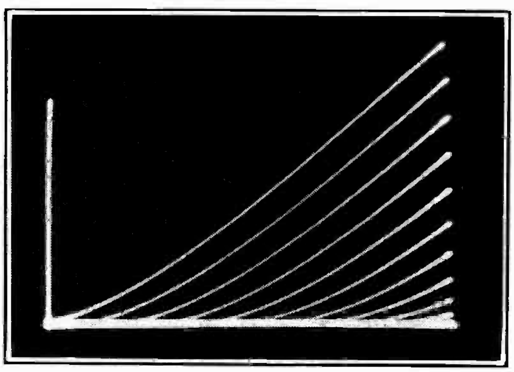


Fig. 6.—*Oscillogram of $I_a - V_a$ curves for the output triode AD1.*

The normal setting of the valve is:

$$V_a = 250 \text{ volts}$$
$$V_{g1} = -45 \text{ volts}$$
$$i_a = 60 \text{ mA}$$

optimum load resistance = 2,300 ohms.

With these settings the internal resistance of the AD1 is about 700 ohms, whilst the required A.C. grid voltage for 50 milliwatts output is equal to 3.3 V_{RMS}.

In view of the low sensitivity of triode output valves a " straight " pentode is often

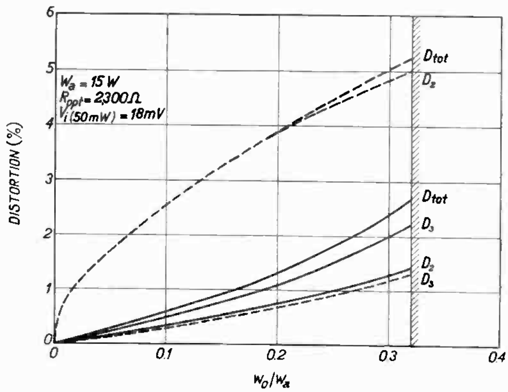


Fig. 7.—*Distortion curves for the combination SP4B + AD1 (full lines) and for AD1 alone (dotted lines).*

used as preamplifier. The distortion curve of the combination SP4B + AD1 is given in Fig. 7. As abscissa we have taken, not the output itself, but the quotient of output and the energy supplied to the anode of the valve (W_a), which in this case amounts to 15 watts. This method renders it easier to compare the performances of different valve types having unequal anode dissipations.

The values plotted are: total distortion (D_{tot}), 2nd harmonic (D_2) and 3rd harmonic (D_3). Harmonics of a higher order are of negligibly small value. The corresponding curves for the triode output valve alone are shown by dotted lines. It will at once be noticed that the total distortion in the combination is far less than in the AD1 alone. This is due to the fact that the 2nd harmonic generated in the output stage is partly neutralised by the 2nd harmonic generated in the preamplifier. The 3rd harmonics which are formed in these two valves are both of the same sign and hence do not neutralise each other, their amount in the combination being actually $1\frac{1}{2}$ times as great as in the output valve alone. As a result of these two causes (neutralisation of 2nd harmonics and summation of the 3rd harmonics), the total distortion consists to a large extent of 3rd harmonics. The sensitivity of the combination amounts to 18 mV for 50 milliwatts output.

If, for the preamplifier, we replace the pentode SP4B by a triode, for instance the TDD4, the sensitivity of the combination will be 150 mV for 50 milliwatts output. The total distortion becomes greater than with the SP4B, but contains fewer 3rd harmonics. By increasing the cathode resistance of the TDD4 from 2,000 to 6,000 ohms, the distortion curves are rendered practically identical with that of the combination SP4B + AD1. Amplification by the TDD4 is in that case about 10 per cent. less than with a cathode resistance of 2,000 ohms.

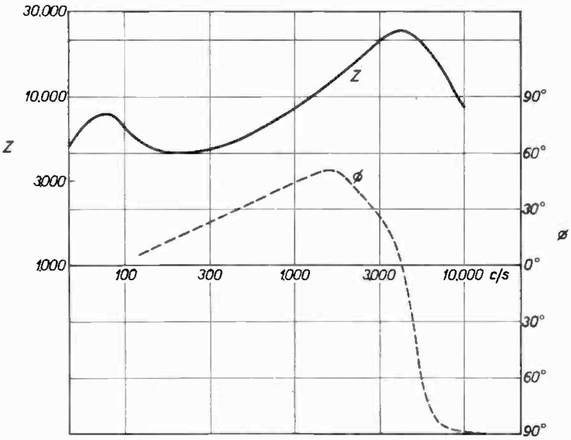


Fig. 8.—*Impedance and phase angle for a combination of an output transformer with a loud speaker, in which the primary winding of the transformer is shunted by a 2,000 μμF condenser.*

If the distortion curve of the combination SP4B + AD1 may be taken as a standard, the limit stated in our Introduction for very good quality (1.5 per cent. distortion), will be reached when $\frac{W_0}{W_a} = 0.22$. The 5 per cent. limit also mentioned in the Introduction will not be reached. The occurrence of grid current in the triode output valve will set a sharp limit to output, at the same time causing very troublesome distortion.

If we are to form an opinion concerning the output stage of a receiver or amplifier, it is not sufficient merely to know the distortion curve at optimum load resistance and the point at which any discontinuities (e.g., the starting of grid current) occur. The impedance of a speaker is constant and purely resistive only over a very small frequency band. Fig. 8 gives the impedance curve for a combination comprising a good loud speaker and an output transformer, as a function of frequency. The primary winding is shunted by a 2,000 μμF condenser. In the same figure we have also plotted the corresponding phase angle. It will be seen that the impedance in the principal frequency band increases by a factor of 2 or 3. The cheaper makes of loud speakers generally show a more pronounced "shift" of the impedance curve as a function of frequency. On this account, when judging the quality of the output stage it is essential to examine what influence is exerted by the value and phase angle of the load impedance upon output and distortion. The qualities of the output stage in this respect can best be studied by plotting output for a given distortion as a function of the load impedance (Z_a).

In the following measurements this has been done for $\cos\phi = 1$ and for $\cos\phi = 0.7$, which latter measurement was carried out on an inductance and resistance in series connection. As the acoustic output of a moving-coil speaker is proportional to the current through the speaker coil, the distortion of the A.C. anode current is thereby measured. To simplify comparison of the different valve types we have again plotted

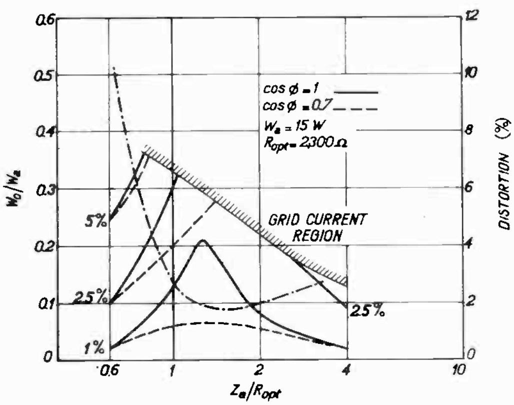


Fig. 9.—*Output at 5 per cent., 2.5 per cent. and 1 per cent. distortion as a function of the load impedance when* $\cos\phi = 1$ *and when* $\cos\phi = 0.7$, *for the combination SP4B + AD1.*

$\frac{W_0}{W_a}$, which is shown as a function of the quotient of the load impedance and optimum load resistance. In the case of $\cos\phi < 1$, not the useful output is plotted, but the apparent output. W_0 is therefore defined as I^2Z_a. This simplifies the comparison with the maximum theoretical output.

Fig. 9 gives these curves for the combination SP4B + AD1 with distortion factors of 5 per cent., 2.5 per cent. and 1 per cent. The values for $\cos\phi = 1$ are shown by a solid line, those for $\cos\phi = 0.7$ by a dotted line. No measurements were carried out in the region where grid current occurs, as these values would be of no practical utility. Furthermore, a chain-dotted line indicates, for $\cos\phi = 1$, the distortion trend when the valve is swung out to the point where grid current starts. It will be seen from this figure that, beginning with low values of the load impedance, output at first increases up to about $\frac{Z_a}{R_{opt}} = 1$; this is chiefly due to the fact that distortion in the triode output valve decreases in general as the value of the load resistance is increased. For $\cos\phi = 1$, the curves for 2.5 per cent. and 5 per cent. distortion reach the point where grid current starts, when the load impedance is approximately at its optimum value, so that for higher values of the load impedance the output will be limited by the condition that no grid current is permissible. In this region the distortion trend is shown by the chain-dotted line. For distortion of 5 per cent. and 2.5 per cent., the figure further shows that the phase angle of the load impedance has comparatively little influence upon the output. At 1 per cent. distortion, however, the output shows a big drop when $\cos\phi$ is less than 1, because at this low distortion factor the extent to which the distortion in the output valve is neutralised by distortion in the preamplifier valve enters largely into account. Owing to the phase angle of the load impedance, the two distortions are no longer exactly in opposite phase and hence the neutralising effect is partly lost.

List of Symbols

- C_k Condenser connected in parallel with the cathode resistance of the output-valve.
- D Distortion factor.
- I_a Direct anode current of the output valve.
- I R.M.S. value of the alternating current through the load impedance.
- R_a Load resistance of the output stage.
- R_i Internal resistance of the output stage.
- R_{opt} Optimum value of the load impedance as recommended by the valve makers.
- V_a Steady anode tension of the output valve.
- V_{am} Amplitude of the alternating anode tension of the output value.
- V_i (50 *mW*) R.M.S. value of the alternating input voltage corresponding with a 50 mW output.
- W_a Maximum anode dissipation of the output valve.
- W_0 Output in volt-amperes (I^2Z_a). In the case of a purely resistive load W_0 is the useful power; in the case of a complex load W_0 is the apparent power.
- Z_a Load impedance of the output stage.

The Wireless World Pre-set Quality Receiver

AN A.C. receiver to be described in the issues of *The Wireless World* for August 17th and 24th is designed primarily for a very high standard of quality of reproduction. It is intended chiefly as a local station receiver, but provision is made for the reception of one or two more distant stations. All tuning is pre-set and switch controlled.

Two push-pull triodes give an output of about 7 watts and are fed with resistance coupling from a penultimate stage containing two triodes. It is preceded by a tone-control stage embodying an R.F. pentode of high mutual conductance. Independent switch-operated bass and treble tone controls are provided. In addition to positions giving a flat response two degrees of rising and two degrees of falling characteristics are obtainable for each switch. No fewer than twenty-five different A.F. response curves are thus obtainable.

The negative feed-back anode-bend detector is preceded by two R.F. stages. A multi-pole switch allows the connections to coils and pre-set condensers to be changed for the reception of any one of six stations. Provision is made for one ultra-short-, three medium- and two long-wave stations; a considerable latitude in the choice of stations is allowed, but in the London area Television Sound, London National and Regional, North Regional, Droitwich, and Radio-Paris are suggested.

A particular feature of the set is the ease with which any desired band-width can be secured from the R.F. circuits. On strong signals which override interference, the band-width can readily be made wide by adopting stagger tuning of the circuits. In this way it is found possible to obtain very high quality from four of the six stations listed above. The two weaker ones, North Regional and Radio-Paris, require resonance tuning of the circuits and there is consequently some sideband cutting. Even this can be alleviated by the tone control.

R.F. and A.F. gain controls are fitted and provision is made for the use of a gramophone pick-up.

Impulse Testing*

Using Cathode-Ray Oscilloscope Equipment

By G. J. Siezen

(Radio Laboratories of the Netherlands Telegraph Administration)

SUMMARY.—A cathode-ray oscilloscope equipment is described, which is provided with a new time base arrangement, being especially suitable as a microscope time base for the recording of transients, as an electronic switch for the simultaneous observation of two different phenomena, and as an impulse generator for impulse testing of electrical transmission systems.

I. Introduction

IT will be known that up to the present practically all commercial oscilloscopes are still equipped with the conventional saw-tooth generators providing a periodic horizontal sweep of the fluorescent spot. There is, without a doubt, a great number of problems in electrotechnical research which, by use of this simple means, may be solved in a really very instructional way.

Yet it appears that in course of time several possibilities of application have arisen entailing additional apparatus and very often too fundamental changes in the mechanism of the time base. The apparatus described below has been developed at the Radio Laboratories of the Netherlands Telegraph Administration with a view to filling some of these gaps.

In particular the following problems were tackled:

(1) The examination of small details of periodic or aperiodic transient phenomena, occurring spontaneously (that is to say without being initiated by the operator himself).

(2) The simultaneous observation of two different phenomena by means of periodical electronic switching.

(3) The oscillographic examination of the distortion of rectangular impulses in electrical transmission systems, and the generation of the impulses used for this purpose.

These at first sight very divergent problems have one point in common, namely, that time has to be divided into intervals of two kinds; there will be two states or periods which will be indicated below by A and B. In problem 1 a distinction has to be made between a period A in which the interesting part of the phenomenon will be observed, and a period B containing only parts of less importance during which for practical reasons the cathode ray has to be rendered invisible, and the time base locked. In problem 2 one has to do with periods A and B during which the phenomena A and B will be alternately rendered visible, whereas in problem 3 two periods have also to be distinguished; these periods in telegraphy are usually called "marking" and "spacing."

Obviously it will be necessary:

(1) to distinguish electrically between two "states" A and B;

(2) to be able to fix arbitrarily their durations T_A and T_B;

(3) to apply an electronic switching device capable of alternately transmitting two different signals A and B to the same output circuit.

These problems have been solved by means of a circuit of which Fig. 1 shows the block diagram.

II. Principles of Action

The central switching element, distinguishing between A and B is a so-called *trigger-relay* (TR). A relay of this type, being a hard valve circuit analogous to the well-known multivibrator of Abraham and Bloch (also called kallirotron of Turner) possesses only two definite stable states of equilibrium A and B. It may be triggered (by the path indicated by EX_A) from A to B and (by the path indicated by EX_B) back from B to A, by so-called *excitation impulses*, and when triggered it will produce by other paths (indicated by SW_A and SW_B) rectan-

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

gular D.C. impulses, so-called *switching impulses*, by means of which other circuits may be switched in or out. The triggering is exceedingly rapid, its duration being less than 1 micro-second.

Besides the *TR*, two octodes OCT_A and OCT_B, and two relaxation circuits RC_1 and RC_2 are used.

The pair of octodes serves as an electronic switching device, the signals *A* and *B* in the octodes OCT_A and OCT_B respectively being so modulated by the *TR* switching impulses, that they will be alternately transmitted to the common anode circuit indicated by *IMP.*

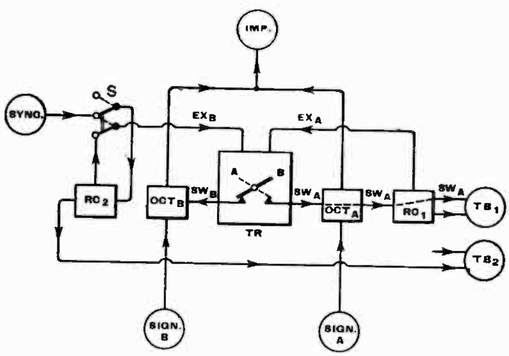


Fig. 1.

The relaxation circuits RC_1 and RC_2, the relaxation time-constants of which, T_1 and T_2, may be arbitrarily varied, serve to fix the times T_A and T_B. To this end they are both coupled to the *TR*, but, for reasons to be mentioned later, in a slightly different way: RC_1 is so controlled by the switching impulses SW_A that it will only be active in the state *A*, whereas RC_2 has the character of a self-supporting relaxation oscillator, not being influenced by switching impulses from the *TR*. Both relaxation circuits however impart, by other paths, viz. EX_A and EX_B, excitation impulses to the *TR* exactly at the end of their respective relaxation phenomena.

Depending on the position of the swi'ch *S*, a periodic and an aperiodic condition of the circuit of Fig. 1 has to be distinguished.

A. Periodic Condition

With *S* in the position indicated the *TR* will be triggered periodically back and forth between the states *A* and *B*.

To avoid needless complication it will be assumed that always T_1 is smaller than T_2. The action will be as follows: suppose that the *TR* has just been triggered from *B* to *A* by an excitation impulse from RC_2. Then the relaxation phenomena in RC_1 and RC_2, lasting T_1 and T_2 seconds respectively, will start simultaneously. As T_1 is smaller than T_2 the next excitation impulse will come from RC_1 exactly T_1 seconds after the beginning. It will trigger the *TR* back from *A* to *B*, RC_1 being then inoperative again. The relaxation phenomenon in RC_2 will now be continued and after a lapse of $T_2 - T_1$ seconds the excitation impulse from RC_2 will trigger the *TR* again from *B* to *A*, thus completing an entire cycle. The same sequence will then be repeated.

It will be clear that the relaxation between T_1 and T_2 on the one hand, and T_A and T_B on the other hand, is given by:

$$\left.\begin{aligned} T_A &= T_1 \\ T_B &= T_2 - T_1 \end{aligned}\right\} \quad \text{or:} \quad \left.\begin{aligned} T_1 &= T_A \\ T_2 &= T_A + T_B \end{aligned}\right\}$$

Consequently in the common anode circuit of the octodes periodic singal impulses will be generated, consisting of the signals *A* and *B*, their *impulse frequency* ν_i and their *impulse ratio* r_i (as defined by: $r_i = \dfrac{T_A}{T_A + T_B}$) depending on T_1 and T_2 as follows:

$$\left.\begin{aligned} \nu_i &= \frac{1}{T_2} \\ r_i &= \frac{T_1}{T_2} \end{aligned}\right\} \quad \text{condition*}: \; T_1 < T_2$$

The relaxation circuits actually used are of the well-known type in which a condenser *C* is charged by the constant plate current *I* of a pentode, and rapidly discharged when the voltage has reached a given value *V*, e.g. by means of a gas-filled triode. The excitation impulses mentioned above are in fact the result of these extremely fast discharges.

* The reader will be able to verify for himself that in general, when $(n - 1)T_2 < T_1 < nT_2$, $(n - 1)$ excitation impulses from RC_2 will per period be lost because of the fact that the *TR* can be triggered via EX_A only when it is in the state *B* (c.f. II, B). The impulse frequency will then be $\dfrac{1}{nT_2}$ and the impulse ratio $\dfrac{T_1}{nT_2}$. Only for the purpose of electronic switching (III, B) a case will be considered where an adjustment with $n = 2$ is used.

The relaxation time-constant T involved in a circuit of this type is given by :

$$T = \frac{C \cdot V}{I}$$

From the above it will be clear that by suitable variation of T_1 and T_2 the impulse frequency and the impulse ratio may easily be adjusted independently of each other. Because ν_i does not depend on T_1 it will be possible to vary r_i independently of ν_i by only changing T_1 (generally in stages by means of C_1 and continuously by means of I_1). Moreover, ν_i may be varied independently of r_i by changing T_1 and T_2 simultaneously, keeping the ratio T_1/T_2 constant (in stages by simultaneous switching of C_1 and C_2 keeping the ratio C_1/C_2 constant, and continuously by varying both I_1 and I_2 keeping I_1/I_2 constant).

An additional advantage of the application of the relaxation circuits in the manner indicated is that they may be applied at the same time as horizontal time bases for the cathode-ray oscilloscope, these time bases being automatically synchronous with the generated impulses. Thus we obtain an intermittent time base TB_1 corresponding to the period A only (for $T_1 = T_A$) and a continuous time base TB_2 on which both periods A and B may simultaneously be rendered visible.* By way of illustration, Fig. 2 shows the voltage curves at the different points indicated in Fig. 1 for the case of periodic action. The curve of TB_1 will have to be more closely considered. As already stated, RC_1 is only active in the period(s) A ; between the saw-teeth generated in this circuit, intervals (the periods B) will thus occur, during which—if no other measures were taken—the cathode ray would remain at the beginning of the time base. For reasons to be mentioned later, this is undesirable. Therefore it will be necessary to render the cathode ray invisible during the period B, for which purpose deflection of the beam to the left side beyond the screen is effected**. The corresponding curve for TB_1 was obtained by subtracting switching impulses of the proper polarity from the saw-tooth voltages generated by RC_1. This may practically be realised by applying the saw-tooth voltages to one of the horizontal deflecting plates, and the switching impulses to the other. By way of illustration the signals A and B have been shown in Fig. 2 as sinusoids with different frequencies and amplitudes ; the Figs. 3 and 4 show the images appearing on the screen when using TB_1 and TB_2 respectively, and applying the signal impulses from IMP directly to the vertical deflecting plates.

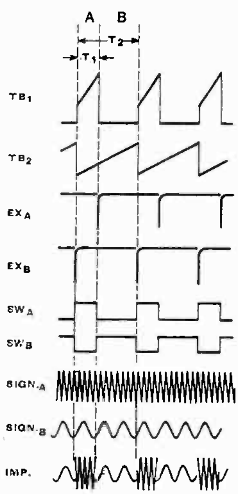


Fig. 2.

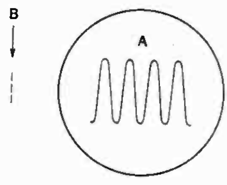


Fig. 3.

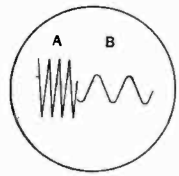


Fig. 4.

The impulses generated may be synchronised with a periodic phenomenon (e.g. one of the signals A and B) by suitable control of the gas-filled triode discharge via $SYNC$ (Fig. 1).

B. Aperiodic Condition.

With a different adjustment of the switch S the circuit of Fig. 1 may be rendered aperiodic. Now the TR is no longer periodically excited by the RC_2 impulses ; consequently the period B becomes a typical waiting period, during which the cathode ray will remain invisible when applying TB_1.

* It will now be clear that, to obtain this advantage, it was necessary to avoid symmetry of the circuit shown in Fig. 1 by removing the connection between RC_2 and the switching impulses SW_B. If this had not been done, the distinction between the indications 1 and A, and 2 and B respectively, would have been quite superfluous. A further disadvantage in this case would have been the difficulty of varying r_i independently of ν_i, the latter depending on both T_1 and T_2.

** A different method has been adopted in the piezo-electrical combustion engine indicator developed by the Netherlands Telegraph Administration on behalf of the Shell Group, the cathode ray being in that case entirely suppressed by means of intensity modulation. A description of this indicator will be published shortly.

It is only by an impulsive excitation via *SYNC*, *S*, and the connection EX_B, that the *TR* can be triggered from *B* to *A*. According to the way of excitation* any change in voltage at *SYNC*, whatever its polarity may be, is to be considered as an excitation impulse, provided :

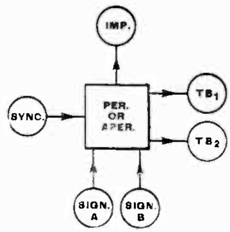


Fig. 5.

(1) it is greater in absolute value than the threshold of sensitivity of the *TR* which, depending on the arrangement, may be of the order of 10 V ;

(2) it is established within a given time, i.e. with a slope that in absolute value lies above a certain limit (also depending on the *TR* arrangement) ;

(3) it is not followed within the triggering time (i.e. about 1 micro-second) by an oppositely directed voltage variation ;

(4) it occurs at a moment where the *TR* is in the state *B*. Excitation impulses occurring in the period(s) *A* remain without result (c.f. note on page 392).

After every successful excitation the fluorescent spot will appear on the screen to produce a single stroke sweep with a duration T_1 that may be arbitrarily chosen, the beam being deflected at the end of each sweep beyond the screen at the left side again. A single signal impulse will then be produced coincidently with each sweep at the *IMP*-output.

Section III will show for which purposes the periodic, and for which the aperiodic condition of the circuit will have to be applied ; by way of simplification the entire circuit of Fig. 1 will, from now on, be represented by a single symbol as shown in Fig. 5, the inscription *PER* or *APER* indicating whether the circuit is in itself periodic or aperiodic.

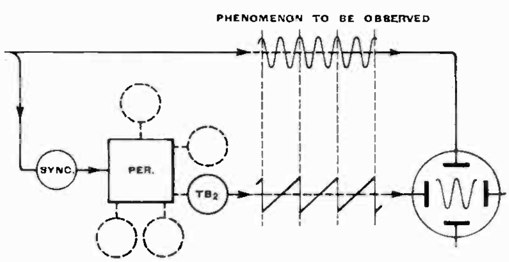


Fig. 6.

* It is, within the scope of the present paper, impossible to consider the *TR* arrangement more closely. For details c.f. : D. Gàbor, diss. Berlin, 1926, and M. Freundlich, diss. Berlin, 1933.

III. Applications

A. Microscope Time Base.

The examination of *periodic phenomena* may be realised by using TB_2 which, in the usual manner, is synchronisable by means of gas-filled triode discharge control (Fig. 6).

However, when it is desirable to observe small parts of a periodic phenomenon on a magnified time-scale, the use of a time base of this type involves the following difficulties :

(1) The greater *n* is, the more unstable the synchronisation to the *n*th harmonic of the fundamental.

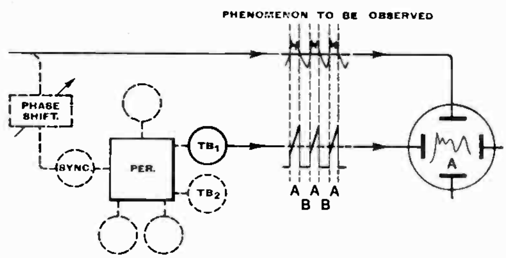


Fig. 7.

(2) The remaining $n - 1$ sweeps per signal period, showing only unimportant parts of the phenomenon, are traced in a disturbing manner zig-zag over the important part instead of disappearing beyond the field of vision—as might be expected from a true microscopic way of viewing.

In this respect, a considerable improvement may be effected by using the time base TB_1 in a periodic condition of the circuit of Fig. 1 (c.f. Section II, A). If TB_2 is now synchronised, preferably by means of a continuously variable phase shifting device, to the fundamental of the phenomenon, it will be possible by adjusting T_1 to the value corresponding to the duration of the interesting part and properly adjusting the phase of synchronisation, to extend the said part on the full length of the time base (Fig. 7). By varying the phase of synchronisation the entire curve may be microscopically examined point by point.

For the examination of *aperiodic phenomena* the circuit of Fig. 1 should preferably be adjusted in the aperiodic condition (c.f. Section II, B). By exciting the *TR* via

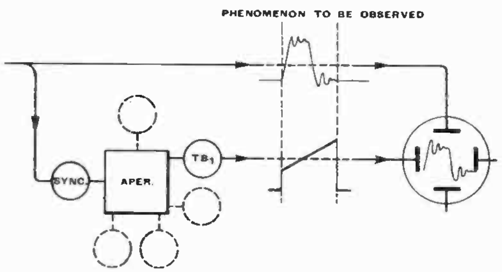


Fig. 8.

SYNC with the phenomenon itself, it will be possible to extend on the full length of the time base portions of any desired duration T_1 following the points where an impulsive voltage change occurs in accordance with the excitation requirements mentioned in Section II, B. The magnification may freely be increased by decreasing T_1. The impulse front, it is true, will always be fixed as the starting point of the sweep, but usually it will also be the relatively high frequency transients immediately following this front which, in order to be viewed accurately, need the greatest horizontal extension.

Fig. 8 illustrates the recording of a non-recurrent transient. It will be clear that the working method discussed will sometimes lead to more than one excitation of the *TR*

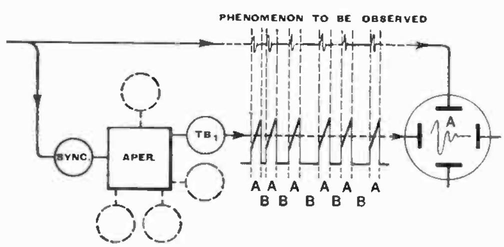


Fig. 9.

per transient. If this is undesirable the excitation impulses still may be selected by utilising the excitation requirements mentioned in Section II, B, viz. with respect to :

(1) Their amplitude (in connection with the *TR* threshold).

(2) Their slope (slope differences may be further exaggerated, for instance with the aid of filters in the synchronisation connections).

(3) Their polarity (the *TR* may be rendered sensitive only to positive, only to negative, or to arbitrarily directed excitation impulses).

(4) The excitation condition No. (4) mentioned in Section II, B.

The phenomenon illustrated in Fig. 8 mainly shows two impulse points, of which only the first plays a part, the second occurring with the given adjustment of T_1, in the period *A*.

It will be clear that the aperiodic time base TB_1 also allows of the detailed study of very short, reproducible phenomena, repeated at unequal intervals. As the

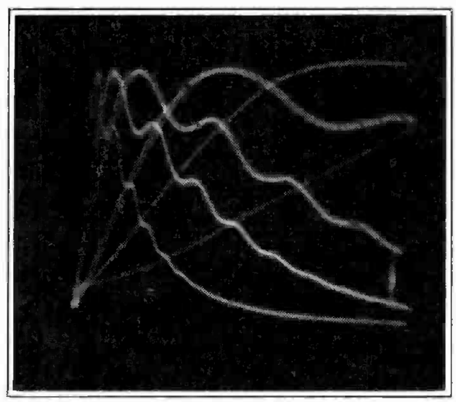


Fig. 10.

sweep is started every time just at the beginning of each phenomenon, a stationary image may be obtained, since the phenomenon will at each repetition be the same from this starting point (Fig. 9). Thus the visual study of transients which are in themselves aperiodic, may be realised if only it is possible to repeat them frequently enough (say 10 to 20 times a second).

If, however, it concerns non-recurrent phenomena, occurring spontaneously (that is to say without being initiated by the operator himself), such as H.T. flash-overs, radio atmospherics, eruptive sounds and the like, a visual examination, especially at high speeds, will be absolutely impossible. In this case a photographic recording is essential, but owing to the impossibility of timing the camera shutter, it will be necessary also to keep the camera opened during the time preceding and following each recording. It was mainly to avoid the danger of over-exposure in these waiting periods that the cathode ray has been rendered invisible in the state B.

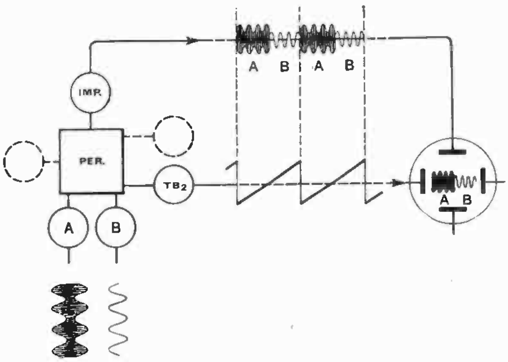


Fig. 11.

A photograph (Fig. 10), showing records of the initial part of a transient with different time base speeds, is given to illustrate the nature of the results which may be obtained. In the most rapid of these recordings, lasting about 100 micro-seconds, a writing speed of more than 1 km/sec. was attained.*

B. The Simultaneous Observation of Two Different Phenomena.

To this end the two phenomena are usually alternately transmitted to the vertical deflecting plates, the frequency of alternation being chosen so high that the eye seems to receive a continuous impression of each of the phenomena. For this purpose an electronic, that is to say practically inertia-less, switching device may be used with advantage. Fig. 11 shows the practical realisation of this principle with the aid of the periodically operated circuit of Fig. 1. The action will need no further explanation after what has been said in Section II, A.

Due to the automatic synchronism of the time base TB_2 and the electronic switching in OCT_A and OCT_B each of the phenomena A and B will appear in a fixed range of the horizontal time base.

If $r_i = \frac{1}{2}$ (as shown in Fig. 11) the phenomenon A will appear on the left-hand half, and B on the right-hand half of the screen. With a different adjustment T_1 may be made slightly greater than T_2; then A will appear during the odd sweeps and the very first part of the even sweeps (c.f. note on page 392). In this case practically the entire time base length may be employed for examining each of the phenomena and, in addition, this method of observation has the advantage that by virtue of the interlacing of the two phenomena, a phase relation—if looked for—may easily be determined.

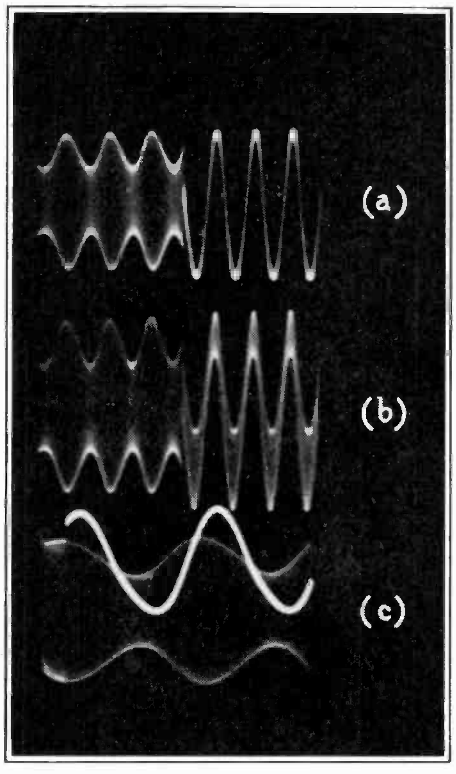


Fig. 12.

The biases of the octodes being equal the two images will appear at the same height. It may be found desirable, however, to be able mutually to shift the images in the vertical sense. This may be accomplished

* Lens $f = 6.3$, reduction 2 : 1, emulsion Perutz Anti Halo Rapid 15/10 DIN. We believe that with better lenses and emulsions it will be possible to attain still higher speeds.

by giving unequal biases, resulting in D.C. impulses superposed on the signal impulses at *IMP* (c.f. Section III, C).

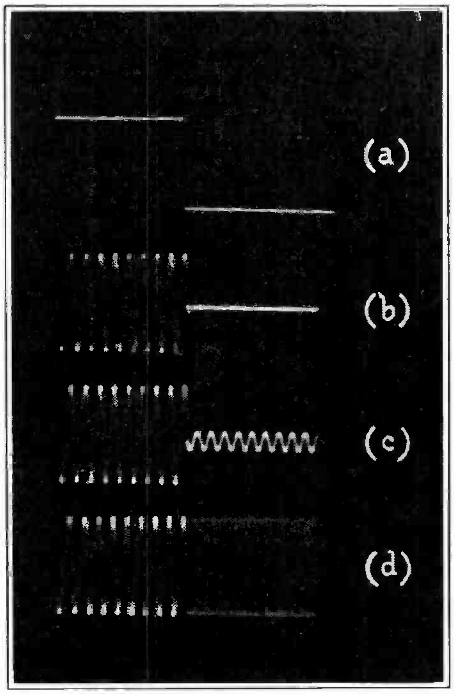


Fig. 13.

The records (a) and (b) of Fig. 12 may serve to illustrate the method with $r_i = \frac{1}{2}$, the first showing a modulated carrier and the pure low frequency signal obtained by detection, the second showing the effect of insufficient carrier filtering. In the bottom record (Fig. 12)(c) the method with $r_i = 1.1$ has been used. The phase relation of the L.F. signal with respect to the carrier envelope has been rendered visible by vertically shifting the L.F. signal.

C. Impulse Testing.

As has been shown in Section II, it is possible to produce very sharp rectangular, both periodic and aperiodic impulses with the aid of the circuit shown in Fig. 1. These impulses will generally be composed of two different signals A and B which, for testing purposes, are generally chosen as sinusoidal voltages :

$$SIGN_A = a_{0A} + a_A \sin 2\pi\nu_A t$$
$$SIGN_B = a_{0B} + a_B \sin 2\pi\nu_B t$$

the constants a_{0A} and a_{0B} referring to the octode biases, one of which may be freely varied.

Fig. 13 shows the most important types of testing impulses, viz. :

(*a*) Direct current impulses

$$a_A = a_B = 0 \qquad a_{0A} \neq a_{0B}$$

(*b*) Ampl. modulated impulses (100 per cent.)

$$a_A = 0 \; a_B \neq 0 \qquad a_{0A} = a_{0B}$$

(*c*) Ampl. modulated impulses (< 100 per cent.)

$$0 \neq a_A \neq a_B \neq 0 \qquad a_{0A} = a_{0B} \; \nu_A = \nu_B$$

(*d*) Freq. modulated impulses

$$a_A = a_B \neq 0 \qquad a_{0A} = a_{0B} \; \nu_A \neq \nu_B$$

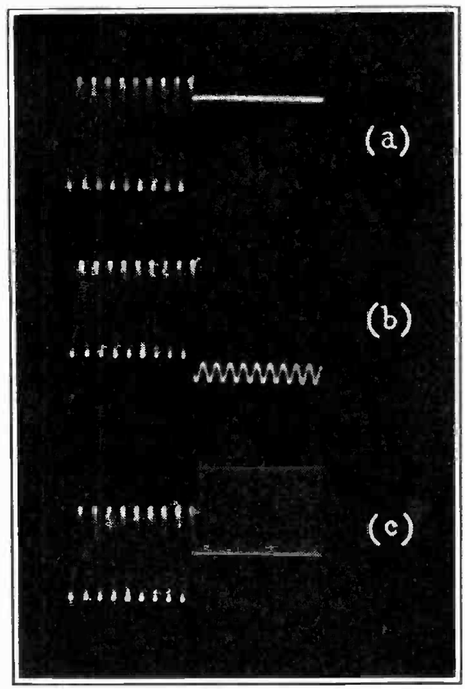


Fig. 14.

Impulses as shown in Fig. 14 (a, b and c) may be obtained from those of Fig. 13 (b, c and d) by superposing D.C. impulses ($a_{0A} = a_{0B}$: asymmetrical adjustment of octode biases).

The impulse frequency ν_i may be varied from about 0.1 c/s to some kc/s (and even considerably higher if hard valves instead of gas-filled triodes are used).

At every impulse frequency the desired impulse ratio r_i may be freely chosen.

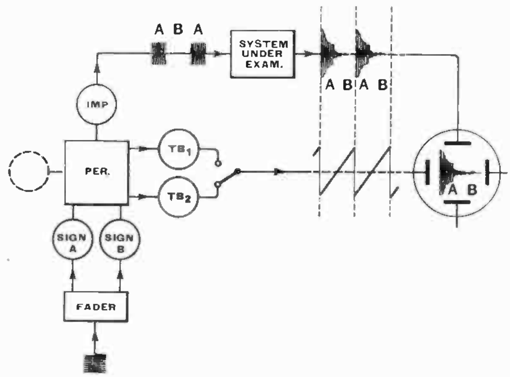


Fig. 15.

The degree of rectangularity of the impulses is only determined by the finite triggering time of the *TR* which, however, is so small (less than 1 micro-second) that even

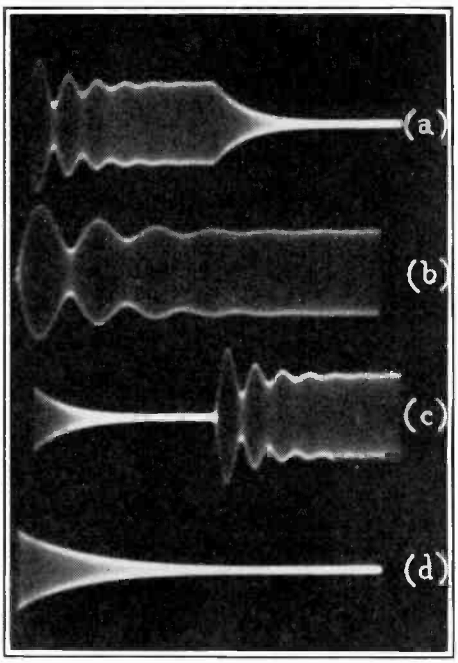


Fig. 16.

at the highest impulse frequencies testing impulses of a considerable rectangularity may be obtained (c.f. Figs. 13 and 14 in which $\nu_i = 1{,}000$ c/s and $r_i = \frac{1}{2}$).

The signal frequencies ν_A and ν_B may be freely chosen in the range for which the octodes are designed, that is to say from 0 to about 30 Mc/s.

With the great variety of impulses that may be generated in the way discussed above, all sorts of electrical transmission systems (such as amplifiers, filters, radio receivers,

Fig. 17.

compressors, expanders, automatic tuning devices, and the like) may be tested. By way of illustration Fig. 15 shows the principle of a test with periodic amplitude-modulated carrier impulses (c.f. Fig. 13 b or c) of which the percentage of modulation may be varied between + 100 per cent. (carrier only during the period *A*) and − 100 per cent. (carrier only during the period *B*) by means of a fader distributing one and the same carrier among the signal inputs *A* and *B* with an arbitrarily adjustable ratio of amplitudes.

The originally rectangular impulses undergo certain distortions when passing through the system under examination, and are finally supplied to the vertical deflecting plates, the horizontal time base being either TB_1 or TB_2. In this manner stationary images of the distorted impulses may be obtained.

Fig. 16 gives an example of the different results which may be obtained when testing with 100 per cent. amplitude-modulated impulses, depending on the choice of time base and the adjustment of the fader. It will be clear that both the switching-in and the switching-out effect may be rendered visible on the full length of the time base, whatever the impulse ratio may be.

The importance of impulse testing as a very fast visual method for the determination of certain transmission properties of electrical systems will be dealt with in a following paper.

The special character of the circuit employed allowed of a constructional realisation of the above mentioned in the form of a single portable apparatus of normal size. The apparatus as it has been constructed at the Radio Laboratories of the Netherlands Post Administration is shown in Fig. 17.

Acknowledgment

The author is greatly indebted to Prof. Dr. Ir. N. Koomans, under whose supervision the apparatus described was developed. He also wishes to express his thanks to Miss E. B. MacFarlane for her gracious help.

Direction Finding*

Improvement in the Quality of Observations by the Use of Non-Linear Amplifiers

By W. Ross, M.A., and R. E. Burgess

(Radio Department, National Physical Laboratory)

THE proposal to use a non-linear amplifier or indicating system in connection with direction-finding aerial systems having a figure-of-eight polar diagram in order to achieve special results has been put forward by several people. For example, Hecht, in British Patent No. 374,182, has suggested such a system in which by the use of a diode valve connected in a special manner the output signal is made to vary more rapidly than the input signal as the latter is varied by rotation of the aerial system or goniometer search coil. More recently, Kaess, in British Patent No. 481,961, has described various types of non-linear amplifier systems or indicating meters which are applied to direction finders with a view to "sharpening" the indicated bearing. In this patent it is claimed for instance, that by using an amplifier in which the amplification decreases with increasing signal (as for example in standard broadcast receivers having automatic volume control) the indication of the signal minimum is made more precise, while by using an amplifier in which the amplification increases with increasing input the indication of the signal maximum is improved. The following discussion of the matter suggests that the first of these two claims would not be borne out in practice, and that it is necessary to increase the amplification with increase in input in each case as will be made clear.

The authors believe that some confusion exists as to the precise concept of the "sharpness" of a bearing. If it is assumed that the aerial system has a perfect figure-of-eight diagram (in the neighbourhood of the signal minimum), then there exists a precise angle at which the signal input to the receiver is zero. With ordinary amplifiers having a more or less fixed noise level this implies that there is an "arc of silence" within which the signal is below noise level. The precision with which the exact minimum position is determined depends to a great extent on the narrowness of this arc of silence, since, with linear amplifiers, the wider the arc of silence, the more gradually will the signal level rise above noise level, as the system is rotated from the minimum position.

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

Under conditions such as these, in which an arc of silence does exist, the only method of improving the sharpness of the indication consists in increasing the sensitivity without at the same time raising the noise level of the amplifier, up to the point at which the arc of silence is determined by the level of the signal in relation to atmospheric noise level. The pick-up of the aerial system is supposed to be prescribed.

It frequently happens, however, particularly in the case of short-wave direction finding, that no position of exactly zero signal exists. That is to say the bearing is flat and signals can be heard even in the minimum position. In such cases observations are made by taking swing bearings and matching intensities on either side of the minimum. The width of the arc over which the system must be "swung" obviously affects the accuracy of the bearing determination. In making such observations the observer swings from the signal minimum position until a definitely perceptible increase in signal level is observed. The width of the arc of swing is thus determined by the displacement of the system from the minimum necessary for the signal level to increase perceptibly *in comparison with the signal level existing at the position of minimum signal.* To put the matter in symbols, suppose that for an angular displacement $\Delta\theta$ from the minimum position, the output signal voltage E increases to $E + \Delta E$. The observer compares the signals E and $E + \Delta E$ and since the ear is a logarithmic indicating device, in effect, he measures or observes the ratio $\frac{E + \Delta E}{E}$. The arc $\Delta\theta$ required for a swing bearing must be such as to make $\frac{\Delta E}{E}$ just perceptible. Clearly then, if for a given $\Delta\theta$ we can find means to increase the ratio $\frac{\Delta E}{E}$ (or, what amounts to the same thing, if we can reduce the angular increment $\Delta\theta$ necessary to produce a given ratio of $\frac{\Delta E}{E}$) we shall reduce the necessary arc of swing and thereby sharpen the bearing.

Thus for the case in which no signal zero exists, a measure of the "sharpness" of the bearing is given by $\frac{\Delta E}{\Delta\theta}\Big/E$ in the neighbourhood of the minimum where E is the output signal voltage. It should be noted that $\frac{\Delta E}{\Delta\theta}$ alone is not a satisfactory measure of the sharpness since the ear observes fractional and not absolute increments in intensity.

Suppose now that e is the signal input voltage. For a linear amplifier we have $E = ge$ when g is a constant (the gain of the amplifier). Hence we also have

$$\frac{\Delta E}{\Delta\theta}\Big/E = \frac{\Delta E}{\Delta\theta}\Big/e$$

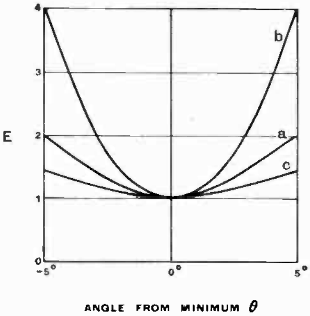
If however we can make

$$E = f(e) \times e$$

where $f(e)$, the gain, is a function which *increases* with e then, $\frac{\Delta E}{\Delta\theta}\Big/E$ will exceed $\frac{\Delta\theta}{\Delta e}\Big/e$ and we shall have succeeded in "sharpening" the indication.

If it is desired to take bearings by observing the signal maximum, then we have a similar state of affairs to that existing when bearings are taken at the signal minimum in conditions of no signal zero. The observer observes the fractional rate at which the signal strength falls as the system is turned from the position of the maximum and, by exactly the same arguments as before we reach the conclusion, that to sharpen the indication we must make $\frac{\Delta E}{\Delta\theta}\Big/E$ exceed $\frac{\Delta e}{\Delta\theta}\Big/e$ where E and e are the output and input signals respectively.

Thus in both cases what is required is a non-linear amplifier, in which the amplification is made to *increase* with increasing input signal. It is not proposed, in this note, to discuss the means by which this result can be achieved since obviously many of the known systems of volume expansion or contrast expansion could be adapted to this end. It should be noted, however, that the necessary "contrast expansion" cannot be achieved by the simple process of taking a standard amplifier using automatic volume control and reversing the polarity of the controlling biasing voltage fed back to the controlled valves, as is suggested by Kaess in the above-mentioned patent. Such an arrangement would clearly be unstable. It is necessary for the network which develops the controlling bias to derive its input from a point in the amplifier chain prior to the stages whose gain is to be controlled by this



Case of non-zero minimum. e = Input voltage; E = Output voltage referred to minimum value. Curve:— a = amplification constant; b = amplification proportional to e (reversed A.V.C.); c = amplification proportional to $\frac{1}{\sqrt{e}}$ (normal A.V.C.). The above curves relate to the case in which the input voltage at the minimum is $\frac{1}{20}$th that at the maximum.

bias, if a stable system of volume expansion is desired.

In conclusion, it should be mentioned that systems employing arrangements to procure an increasing amplification with increasing input have been tested experimentally and a useful improvement in the sharpness of bearings in cases of flat minima has been obtained. To illustrate the degree of improvement which may be procured the curves shown in the figure are given. The curves refer to a special case in which the signal input at the minimum is equal to one-twentieth of the signal input at the maximum. Three cases are illustrated.

(*a*) Corresponding to an amplifier of constant gain.

(*b*) Corresponding to the case of an amplifier whose amplification is proportional to the input, and

(*c*) To the case in which the amplification is inversely proportional to the square root of the input (i.e. the amplification decreases with increasing input).

It is clear that case (*b*) indicates an improvement over case (*a*) while case (*c*) is inferior to case (*a*).

This work was carried out as part of the programme of the Radio Research Board, and the paper is published by permission of the Department of Scientific and Industrial Research.

The Radio and Telecommunications Engineer's Design Manual

By R. E. Blakey, D.Sc. Pp. 142; 84 Figs. Sir Isaac Pitman & Sons, Ltd., 39, Parker Street, London, W.C.2. Price 15s.

In addition to standard textbooks and files of technical journals, every designer or experimenter collects information from many sources—reprints of original papers, manuscript references and abstracts of papers for which he has no reprints, press-cuttings, and notes of his own work. As years go by, these sources of information accumulate and it takes longer and longer to find the information wanted, so that sooner or later the worker begins to collect into one file or notebook those tables, formulae, etc., which he needs for constant reference in the laboratory. Dr. Blakey's "Design Manual" is of the nature of such a collection, edited, rearranged, and more comprehensive than an individual worker is likely to have time or ability to make for himself; it is supplemented by details and diagrams of apparatus which has been found reliable and practical. This book should find a place with Moullin, Terman, and Scroggie, on the laboratory table rather than on the library shelf.

The difficulty confronting the author of any book such as this is to know how much to leave out, but whatever is omitted, space ought always to be found for a comprehensive list of references to sources of more detailed information. Our only serious complaint against this book is that such references are much too infrequent, may we hope that in the next edition they may be subject to an amplification-factor of about ten? For in order to save space, it is often necessary to give results without proof or method of derivation, which is only satisfactory if such reference is given, since many formulae are subject to limitations, either from "neglecting small quantities"—tacitly so assumed, but perhaps by no means "small" in some particular application—or from physical difficulties such as the inevitable residual inductances and capacities of resistors. The reader must be supposed to have some familiarity with high-frequency work, and is not likely to be caught out by such obvious traps as these; but if he is dealing with a problem hitherto unfamiliar to him, the more wary and experienced he is the more he will feel the need of knowing the derivation and limitations of the formulae he proposes to use. There is obviously no space for all this in a notebook or design manual, but the omission ought to be discounted by references. As an example, the first chapter, on Attenuation Networks, contains no references at all; without attempting to be exhaustive one may suggest McElroy's paper (in *Proc. Inst. Rad. Eng.*) with many diagrams and tables, the latter having only one known error; the practical information in Terman's "Measurements in Radio Engineering"; and for theory, Starr's "Electric Circuits and Wave Filters."

In this first chapter, McElroy's "Bridged-T" attenuator deserves a place (it requires but one single-pole switch and is of constant impedance at both ends), and the value of Figs. 5, 6, 7 would be increased if the captions mentioned the characteristic impedance for the resistance values specified.

The second chapter, on Inductance, contains a good selection of the most useful of the many formulae and tables which have been proposed; but the formula for inductance of a shielded coil in terms of L_s the "inductance of the shield," and M the "mutual inductance of shield and coil" cannot be used at all without looking up the reference given to the original paper in *Radio Engineering*, since no indication is given as to how L_s and M are to be determined, or even roughly estimated.

The next section, on Condensers, is excellent; it includes a very full summary of Griffiths' papers in *Experimental Wireless*, 1926 (now *The Wireless Engineer*) dealing with plate-shapes to give prescribed "laws," with proofs and derivations, supplemented by the Author's own solution for the superhet oscillator condenser.

The fourth section summarises the work of Dye and others on the Intervalve Transformer, and gives tables and details for the construction of output and mains transformers.

The remaining chapters, on audio-frequency and high-frequency sources, valve-voltmeters, valve-tests, bridges, factory test gear, etc., contain less formulae and tables than the earlier chapters, and consist largely of diagrams of apparatus and circuits that have proved themselves in use. For these we have nothing but praise; our only criticism, apart from an obvious error in Fig. 35, is that in many diagrams essential component values are omitted, particularly the inductances of coils. The diagrams of two generators of the Author's own design (Figs. 25 and 47) have no component values at all.

Omissions which we should like to see remedied include some reference to H.F. resistance, and optimum wire diameter for coils, summarising Butterworth's work; the very useful Owen Bridge and perhaps one or two other bridges—a summary of transmission-line formulae, which need not take more than a page; and some mention of Filters, at least the prototype or constant-K high-, low- and band-pass and band-stop filters could be summarised diagrammatically on a couple of pages, and a page or two more would suffice for the essential formulae for the m-derived types. And a book of this kind ought certainly to have an index.

We have pointed out some minor imperfections and omissions in the hope that they may be put right in a future edition, but this must not be taken as detracting from the welcome we give to this very useful book. C. R. C.

Principles and Practice of Radio Servicing

By H. J. Hicks. Pp. 305 + x. Published by McGraw-Hill Publishing Co., Ltd., Aldwych House, London, W.C.2. Price 18s.

In its conception this book is unusually good and follows a logical method; it is consequently all the more unfortunate that in its execution it is less satisfactory. The author opens by chapters on the fundamentals of magnetism, electricity and radio; he then goes on to discuss valves and test equipment. The theory of RF and AF amplifiers follows, with a short chapter on detectors and one on power supplies. Volume, tone and frequency control, loud speakers, aerials and noise suppression, and superheterodynes are then dealt with.

The next chapter is entitled "Servicing Radio Receivers," and is followed by others dealing with P.A. apparatus, the business side of servicing, and an appendix.

The idea of prefacing the service material by a discussion of fundamentals and theory is good, for no one can hope to be proficient at servicing without such a grounding. It is, however, questionable whether a single book is large enough to cover both theory and service technique adequately, and when one finds only a single chapter devoted to servicing one is inclined to say that it is not. Chapter headings can be misleading, however, and are in this case, for there is much service material scattered about in the other chapters.

The treatment, especially of fundamentals and theory, is of semi-encyclopedic form, much of it consisting of definitions and explanations of words and expressions commonly used. Several errors unfortunately occur; for instance, the author says that a choke is better than a resistance for A.F. decoupling, whereas in the vast majority of cases a resistance is much more effective. He also recommends the improvement of the voltage regulation of the power supply—by the use of a larger mains transformer, mercury-rectifier, etc.—as a cure for motor-boating. It is very doubtful whether any practical improvement could be obtained by the means he suggests; the use of neon voltage-stabilisers is not mentioned. In referring to Class B output transformers the author repeats an old fallacy—that as the valves pass current alternately the effect of their mean currents on the core is not balanced.

The book is of American origin and is well printed and bound. In spite of its defects, it contains much useful information and should be of assistance to service engineers. W. T. C.

The Industry

A RADIO-FREQUENCY attenuator Type TF360 designed for use below 25 Mc/s and having a range of 0–102 db is described in leaflet Com. A.7 issued by Marconi-Ekco Instruments, Ltd., Electra House, Victoria Embankment, London, W.C.2.

The "Marconitrack" blind approach beacon receiver is described and illustrated in leaflet No. 1310, copies of which may be obtained from Marconi's Wireless Telegraph Co., Ltd., Electra House, Victoria Embankment, London, W.C.2. The equipment weighs only 35 lbs. and is suitable for use with any type of ultra-short-wave beacon conforming to international requirements.

The International Tin Research and Development Council, Fraser Road, Greenford, Middlesex, in its report for 1938 gives a summary of many processes which may be of interest to manufacturers of wireless equipment. A complete list of publications of the Council is included.

Supplement No. 1 to the general catalogue of components sold by F. W. Lechner & Co., Ltd., 5, Fairfax Road, London, N.W.6, gives details of multiple-contact rotary switches, ganged potentiometer units and wire-wound potentiometers for use under tropical conditions.

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

3022. CONTRIBUTION TO THE PROPAGATION OF ELECTROMAGNETIC WAVES ALONG DIELECTRIC WIRES.—A. Klemt. (*Funktech. Monatshefte*, April 1939, No. 4, pp. 122–124.)

The writer's experiments with "dielectric wires" (three-metre glass tubes of various diameters, filled with distilled water) show that with the H_0 wave (and only with this type) a transmission takes place for larger values of λ/r than has previously been thought possible. Thus according to previous ideas, if the dielectric constant is taken as that of distilled water (81) and it is desired to work in the region of least attenuation with a wavelength of 50 cm, then the somewhat deterrent value of about 6 cm ($\lambda/8$) is arrived at for the smallest suitable diameter; whereas the writer's results replace this figure by $\lambda/19.5$, or about 2.5 cm (*see* Fig. 3). Admittedly, if the phase-velocities of a band of frequencies have to be considered, the smaller λ/r ratio must be adhered to because there the curve is flatter and the differences in transmission times are smaller. But if the band is made sufficiently narrow the question of transmission-time distortion need not be considered and the high ratio, giving minimum attenuation, can be worked on.

3023. ELECTROMAGNETIC WAVES IN FREE SPACE, IN METAL PIPES, AND IN DIELECTRIC WIRES [Summary of Demonstration Lecture comprising 25 Experiments].—G. C. Southworth. (*U.R.S.I. Proc. of* 1938 *General Assembly*, Vol. 5, Fasc. 1, 1938, pp. 181–182.)

3024. DISCUSSIONS ON "PROPAGATION OF WAVES ALONG DIELECTRIC CABLES," "THEORY OF CYLINDRICAL DIELECTRIC CABLES, AND RELATIONS WITH THE THEORY OF COAXIAL CABLES," AND "COMPLEMENTARY STUDY ON THE COEFFICIENTS OF ATTENUATION IN CYLINDRICAL DIELECTRIC CABLES AND COAXIAL CABLES."—Brillouin: Clavier: Clavier & Altovsky. (*Bull. de la Soc. franç. des Élec.*, Feb. 1939, Vol. 9, No. 98, pp. 207–210.) *See* 873 of March, 2174 of 1938, & 872 of March.

3025. THE DISPERSION OF WATER FOR ELECTROMAGNETIC WAVES [exists in Wavelength Range One to One-Half Metre: Measurement of Refractive Index, using Standing Waves inside Copper Pipe with Concentric Wire].—L. L. Skolil. (*Phys. Review*, 1st May 1939, Series 2, Vol. 55, No. 9, pp. 880–881.)

3026. ON ELECTRIC WAVES IN SINGLE-WIRE AND PARALLEL-WIRE SYSTEMS: PERMEABILITY OF IRON AND NICKEL.—R. F. Lindman. (*Zeitschr. f. tech. Phys.*, No. 6, Vol. 20, 1939, pp. 185–188.)

In his paper on ferromagnetism at high frequencies (1719 of April) Becker raises objections to the present writer's work on the permeability of iron as deduced from wavelength measurements along thin wires (3095 of 1938: for nickel wires *see* 2 of January), although the results are in excellent agreement with his own theoretical estimates of the short-wave limits in ferromagnetic phenomena. He later informed the writer that these objections are directed against the latter's use, for a parallel-wire system, of a formula derived by Sommerfeld for a single wire; supporting the objections by a quotation of Mie's theoretical work in 1900 on parallel wires, from which it would appear that with the correct formula the difference between the "normal" (velocity of light) wavelength and the wavelength measured along the wires would be greater by a factor 2–4 than that calculated by the Sommerfeld formula. The agreement found by the writer between the measured values and those calculated by that formula is attributed to the presence of harmonics in the waves along the wires.

The present paper refutes Becker's objections, with the help of new measurements on both single and parallel wires of very thin cross-section, made of manganin, iron, and nickel. "Whether the observed agreement of the wavelengths on single wires with those on corresponding parallel-wire systems [contrary to Mie's theory] is due to the special design of the experimental arrangement must remain for the present undecided [it is suggested that the velocity along a single wire remains unchanged if two such wires are stretched parallel to each other at such a distance that no appreciable mutual electrical interaction occurs; such is the case even when the wires are spaced only a few centimetres, provided the wire diameter does not exceed a few millimetres]. With the parallel-wire system harmonics only appeared when the distance between the wires was smaller than about one-fifth of the 'normal' half-wavelength: they did not appreciably affect the fundamental wavelength measured along the wires. With single wires no harmonics were found."

3027. Reflection Waves on Quasi-Homogeneous Lines.—Aguillon. (*See* 3241.)

3028. Paper on Ultra-Short-Wave Links on Mountains, depending on Diffraction, Reflection, and a Combination of Both.—Loeb. (*See* 3359.)

3029. Radio Observations in Puerto Rico [Frequencies between 16 kc/s & 42.5 Mc/s (including London, Berlin, & Paris Television Signals): Frequent Dellinger Effects, with Accompanying Field-Strength Increases on Long Wave (WCI, 18.4 kc/s): Critical Frequencies unexpectedly Lower than at Washington: etc.].—G. W. Kenrick. (*U.R.S.I. Proc. of* 1938 *General Assembly*, Vol. 5, Fasc. 1, 1938, pp. 205–212.) For previous work *see* 4226 of 1938.

3030. Unusual Ranges in Wireless Propagation [of Ultra-Short Waves: Distances 300–2000 km: Survey of American, and Some German, Results].—H. A. Hess. (*Funktech. Monatshefte*, April 1939, No. 4, pp. 125–127.) For the work of Hull and Pierce, on which this survey is chiefly based, *see* 2544 of 1935; 2442 & 3233 of 1937; and 4214 & 4215 of 1938.

3031. Field-Strength Measuring Equipment for Wide-Band Ultra-High Frequency Transmission.—George. (*See* 3262.)

3032. The Measurement of Distances by means of Ultra-Short Waves (Wireless Range-Finding).—Tiberio. (*See* 3175.)

3033. An Interference Method for the Investigation of the Propagation of Electromagnetic Waves, and Associated Papers.—Mandelstam: Papalexi: Schegolev. (*See* 3176/3178.)

3034. Tropospheric Reflections of Radio Waves [with Minimum & Average Heights of C Layer, 1936/1938: Reflection Coefficient about 0.01 (occasionally Much Stronger or Weaker): Test Frequency 2398 kc/s].—R. C. Colwell & A. W. Friend. (*U.R.S.I. Proc. of* 1938 *General Assembly*, Vol. 5, Fasc. 1, 1938, pp. 146–149.) *See* also 3234 of 1937 and 810 of 1938.

3035. The Question of Partial Reflection and the Calculation of the Apparent Height of Ionospheric Regions.—K. Rawer. (*Hochf:tech. u. Elek:akus.*, May 1939, Vol. 53, No. 5, pp. 150–157.)

Calculations are here given for the passage of plane electromagnetic waves through an ionised layer on which they are incident perpendicularly and whose dielectric constant (as shown in Fig. 1) sinks continuously and symmetrically on both sides to a minimum value. An expression (eqn. 4) is chosen for the dielectric constant which enables the wave equation to be integrated exactly in terms of hypergeometric functions; the effect of the earth's magnetic field is neglected but that of collisional friction is included. Expressions for the amplitude and phase of the transmitted and reflected waves are found; Fig. 2 shows curves of the intensity of reflection, Fig. 3 curves of constant reflection, Fig. 4 the effect of the collision frequency on the apparent height and the reflected amplitude, Fig. 5 a comparison of the exact transit-time calculations (deduced from the expressions for phase) with approximate values, Fig. 6 variations of apparent height and reflected amplitude with frequency, Fig. 7 the frequency spectrum of a finite wave-train and those of the train after passage through various ionised regions.

The general conclusions reached are:—"I.–In most cases the ray treatment is permissible. . . . The amplitude of the reflected or transmitted wave falls exponentially with [increasing] collision frequency and with [increasing] ratio layer-thickness/vacuum-wavelength. The apparent height (measured from the centre of the layer) increases in proportion to this ratio and may be calculated from the group velocity. II.–These relations are no longer valid when appreciable partial reflection occurs, *i.e.*, (1) for layers of thickness below a certain value, (2) for thicker layers, in a certain range of frequencies centred round the limiting frequency. . . . In the absence of attenuation, the apparent height has a finite maximum at the limiting frequency. III.–With attenuation, the amplitudes become considerably smaller; the more so, the thicker the layer. The apparent heights near the limiting frequency then diminish. It may occur that the reflection at the true limiting frequency is not observed, since the amplitude has fallen below the observable limit at a lower frequency."

3036. The Propagation and the Total Reflection of Electromagnetic Waves in the Ionosphere [Critical Review of Boses. Paper].—M. N. Saha & K. B. Mathu'r (*Indian Journ. of Phys.*, Feb. 1939, Vol. 13, Part 1, pp. 1–12.)

See 3461 of 1938. "When the collision frequency is taken to be zero, his method gives us the same result for the propagation of wireless waves as that of the earlier workers. The conditions of reflection which he has deduced for the case where collision cannot be neglected appears to require revision."

3037. On Lunar Tides in the Upper Atmosphere [Lunar Tide detected in Region E: Experimentally Determined Expression giving Magnitude & Phase: Semi-Diurnal, of Order of 1 km, in Phase with Lunar Pressure Oscillation at Ground: Difficulties in reconciling New Results with Previous Ideas].—E. V. Appleton & K. Weekes. (*Proc. Roy. Soc.*, Series A, May 1939, Vol. 171, No. 945, pp. 171–187.)

3038. Dissociation, Recombination, and Attachment Processes in the Upper Atmosphere: II—The Rate of Recombination.—D. R. Bates, R. A. Buckingham, H. S. W. Massey, & J. J. Unwin. (*Proc. Roy. Soc.*, Series A, 3rd April 1939, Vol. 170, No. 942, pp. 322–340.)

For previous work *see* 1288 of 1938. The theoretical value of the coefficient of direct electron combination is here deduced by quantal methods, "account being taken of the fact that an electron may recombine into any excited state of the positive ion. It is found that this process is entirely inadequate to account for the observed recombination in both E and F regions . . . reasons are given for supposing that two-body recombination of negative and positive ions . . . is the most likely source of the observed recombination." The theory is compared with observation, and a calculation of the continuous absorption coefficient of atomic oxygen is given.

3039. The Townsend Coefficients for Ionisation by Collision in Pure and Contaminated Hydrogen as a Function of the Cathode Material.—D. H. Hale. (*Phys. Review*, 1st May 1939, Series 2, Vol. 55, No. 9, pp. 815–819.)

3040. Absorption of Electromagnetic Waves in the Earth's Atmosphere [Analytical Treatment of Magneto-Ionic Components for All Magnetic Latitudes: Curves for Different Frequencies].—R. R. Bajpai & K. B. Mathur. (*Proc. Roy. Soc.*, Series A, 3rd April 1939, Vol. 170, No. 942, p. S 21: abstract only.)

3041. Further Studies of F Region at Allahabad [1937/1938: Virtual Height sometimes shows Three Maxima in One Night: Correlation between Hour of Minimum Height & Hour of Maximum Barometric Pressure at Ground: Abnormal High Layers (650 km, etc.) and Their Movements: Complex Echoes: F_1 Region persists till 10 p.m: etc.].—R. R. Bajpai & B. D. Pant. (*Indian Journ. of Phys.*, Feb. 1939, Vol. 13, Part 1, pp. 57–71.)

3042. The Relation of Radio Sky-Wave Transmission to Ionosphere Measurements [Maximum Usable Frequencies & Effective Reflection Heights obtained by Superposition of "Transmission Curves" on Vertical-Incidence Curves: Chart for Calculation of sec ϕ_0 for Transmission-Curve Plotting: Extension of Eckersley & Millington's Skip-Distance Analysis: etc.].—N. Smith. (*Proc. Inst. Rad. Eng.*, May 1939, Vol. 27, No. 5, pp. 332–347.) For the work mentioned *see* Millington, 4220 of 1938.

3043. On Some Effects caused in the Ionosphere by Electric Waves [Mathematical Treatment of Production of Artificial Auroras].—V. A. Bailey. (*A.W.A. Tech. Review*, Jan. 1939, Vol. 4, No. 1, pp. 1–19.)

"Reprinted with adaptations from *Phil. Mag.*, Vol. 26, p. 425, 1939" [this should be 1938: *see* 9 (also 10) of January]. Appendix III (dated Feb. 1939) quotes results of Güntherschulze in 1924 from which the present writer concludes that the values given in Table II may be so reduced that (*e.g.*) with 800 aerials a radiated power of 250 kw would suffice to generate an artificial aurora. It also refers to the work of Townsend & Gill (4157 of 1938). For Bontch-Bruewitch's work (mentioned in the paper) on the use of pulses of 10–20 kw with a consumption of only about 100 w, for ionospheric investigation, *see* 1934 Abstracts, p. 199 (and also p. 608).

3044. Luxembourg Effects [between Medium-Wave Stations, if One is on the Gyro-Wavelength: Calculated Gyro-Wavelengths for European Stations].—"Log-Roller": V. A. Bailey. (*World-Radio*, 26th May 1939, Vol. 28, p. 9, paragraph only.) For work by Bailey *see* also 9/11 of January.

3045. Influences of Limiting Magnitude upon Meteor Frequency.—F. Watson. (*Proc. Nat. Acad. Sci.*, May 1939, Vol. 25, No. 5, pp. 243–245.)

3046. Effect of Cosmic Conditions on Short-Wave Empire Telegraph Circuits.—Wood. (In paper dealt with in 3385, below.)

3047. On the Meteorological Origin of Fading.—D. Nasilov. (*Journ. of Tech. Phys.* [in Russian], No. 1, Vol. 9, 1939, pp. 39–43.)

The author has made a study of weather maps for those days on which the 89 cases of severe fading reported by the Bureau of Standards for 1937 took place. This has led him to the conclusion that (a) fading could, in the cases under consideration, have been produced by the appearance of zones of condensation, and (b) there is not sufficient justification for attributing it to solar activity (Dellinger effect).

The author then replies to the objections that are usually raised against the "meteorological" theory of fading, and in his turn enumerates various facts which cannot satisfactorily be explained by solar activity. It is, however, pointed out in conclusion that it would be wrong to attribute fading to the meteorological factors alone, but that these factors should be taken into account in the study. For previous work *see* 23 of January.

3048. The Times of Appearance of the Dellinger Effect, and Its Intensity Distribution on Different Lines of Wireless Communication.—B. Beckmann, W. Menzel, & F. Vilbig. (*T.F.T.*, Dec. 1938, Vol. 27, No. 12, pp. 555–560.)

No periodicity emerges which agrees with the sun's rotation: processes on the sun, at present unnoticed, are probably involved. Indications are found that E and F regions are themselves affected, the explanation based on an absorbing layer below the E region being inadequate in some cases. Variation of the intensity of the effect with distance, up to 2000 km, is noted; an explanation on the grounds of change of reflecting power with attenuation and angle of incidence is suggested.

3049. CONCERNING THE NATURE OF RADIO FADE-OUT [Joint Report reconciling Apparent Divergence of Views].—D. F. Martyn: L. V. Berkner. (*Phys. Review*, 15th May 1939, Series 2, Vol. 55, No. 10, p. 983.) Quotations from the report show that Berkner's paper (2653 of July) no longer expresses his views, the divergence of which from those of Martyn & co-workers (6 of 1938) is now reconciled.

3050. SOLAR RADIATION CHANGES DURING THE SUNSPOT CYCLE [and the Choice of $f^4/\cos\chi$ as the "Region Character Figure": Values for Regions E, F_1, & F_2].—E. V. Appleton & R. Naismith. (*U.R.S.I. Proc. of* 1938 *General Assembly*, Vol. 5, Fasc. 1, pp. 149–152: in English & French.) *See* also 1354 of April.

3051. A REPRESENTATION OF THE SUNSPOT CYCLE [based on Series of Wolf and Wolfer & Brunner: 22-Year Chief Component as Harmonic of 312-Year Period: etc.].—C. N. Anderson. (*Bell S. Tech. Journ.*, April 1939, Vol. 18, No. 2, pp. 292–299.)

3052. REGULAR CHARACTERISTICS OF THE IONOSPHERE THROUGHOUT HALF A SUNSPOT CIRCLE.—N. Smith, T. R. Gilliland, & S. S. Kirby. (*U.R.S.I. Proc. of* 1938 *General Assembly*, Vol. 5, Fasc. 1, pp. 152–156.) *See* 1355 of April.

3053. THE TIME INTERVAL BETWEEN SOLAR ERUPTIONS AND MAGNETIC STORMS [Hale's Value of 26 Hours is Valid for Storms of Sudden Onset and Not of Exceptional Intensity].—J. Coulomb & G. Dugast. (*Comptes Rendus*, 15th May 1939, Vol. 208, No. 20, pp. 1557–1559.) For previous work *see* 3114 of 1938.

3054. THE AMERICAN MAGNETIC CHARACTER FIGURE C_A IN RELATION TO COMMUNICATION PROBLEMS [Advantages of American Character Figure over International: Correlation Coefficient 0.70 between Transmission-Disturbance Figure and C_A (Linear Relation): the 27-Day Recurrence: etc.].—A. G. McNish & H. F. Johnston. (*U.R.S.I. Proc. of* 1938 *General Assembly*, Vol. 5, Fasc. 1, pp. 157–168.)

3055. THE AURORA POLARIS AND THE LIGHT OF THE NIGHT SKY [Geophysical Discussion at Royal Astronomical Society].—(*Nature*, 27th May 1939, Vol. 143, pp. 884–885.)

3056. THE VARIATIONS OF EFFECTIVE NOCTURNAL RADIATION, DURING CLEAR NIGHTS.—J. Debrach. (*Comptes Rendus*, 8th May 1939, Vol. 208, No. 19, pp. 1524–1525.)

3057. INFLUENCE OF SOLAR RADIATION ON THE MEAN TEMPERATURE OF ATMOSPHERIC OZONE.—A. & É. Vassy. (*Comptes Rendus*, 8th May 1939, Vol. 208, No. 19, pp. 1518–1520.) Remarks on results obtained by Barbier & Chalonge (2673 of July).

3058. NEW EXPERIMENTAL PROOF OF THE INCREASE OF TEMPERATURE IN THE UPPER REGIONS OF THE STRATOSPHERE [Deduction from Absorption of Light by Ozone].—A. & É. Vassy. (*Comptes Rendus*, 22nd May 1939, Vol. 208, No. 21, pp. 1664–1666.)

3059. DISTRIBUTION OF OZONE IN THE STRATOSPHERE [Flagstaff, Arizona, Measurements].—W. W. Coblentz & R. Stair. (*Journ. of Res. of Nat. Bur. of Stds.*, May 1939, Vol. 22, No. 5, pp. 573–606.) A summary was dealt with in 2672 of July.

3060. OPTICAL THICKNESS OF THE TRANSITION LAYER BETWEEN TRANSPARENT MEDIA [Theories of Drude and Maclaurin reduce to Identical Form not permitting Mathematical Separation of Thickness and Refractive Index of Transition Layer: Minimum Thickness of Adsorbed Layer].—H. D. Bruce. (*Proc. Roy. Soc.*, Series A, 6th June 1939, Vol. 171, No. 946, pp. 411–421.)

3061. ERRATA TO PAPER "ON THE PROBLEM OF WAVE-MOTION FOR SUB-INFINITE DOMAINS."—A. N. Lowan. (*Phil. Mag.*, June 1939, Series 2, Vol. 27, No. 185, p. 769.) *See* 1367 of April.

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

3062. THE NATURE OF ATMOSPHERICS: VI [Results obtained by Recording on More Open Time Scale: Destruction of Negative Cloud Moments: Analysis of Oscillatory Wave Trains: High-Frequency Embroidery possibly due to Reflections from Low Ionised Regions].—F. E. Lutkin. (*Proc. Roy. Soc.*, Series A, 6th June 1939, Vol. 171, No. 946, pp. 285–313.) Continuation of work dealt with in 419 of 1938.

3063. REFLECTION OF ATMOSPHERICS FROM THE IONOSPHERE [Evidence that Oscillatory Structure arises from Multiple Reflections from E Region: Effective Height of Reflection decreases to 50 km near and above Thunderstorm producing Atmospheric].—B. F. J. Schonland, J. S. Elder, J. W. van Wyk, & G. A. Cruickshank. (*Nature*, 27th May 1939, Vol. 143, pp. 893–894.)

3064. ON THE WAVE-FORM OF ATMOSPHERICS AT CALCUTTA [Three Main Types—Periodic, with Unequal Positive and Negative Alternations of Different Form: Aperiodic, entirely Positive or Negative (generally Negative): and a Form presenting Several Successive Elements, Positive or Negative (generally Negative) merged into One Another].—S. P. Chakravarti. (*L'Onde Élec.*, April 1939, Vol. 18, No. 208, pp. 181–186.) For previous work *see* 2265 of June.

3065. PRECIPITATION-STATIC INTERFERENCE ON AIRCRAFT AND AT GROUND STATIONS [Historical Review: Meteorological Aspects: Anti-Static Aerials: Generation of Static on Plane: Corona-Discharge Radiation: Practical Discharge System: Ground-Station & Marine Static Reduction].—H. M. Hucke. (*Proc. Inst. Rad. Eng.*, May 1939, Vol. 27, No. 5, pp. 301–316.)

3066. STATIC CHARGES FROM AIRCRAFT ENGINE EXHAUST GASES.—Klumb. (*See* 3122.)

3067. THE MECHANISM OF THE LIGHTNING DISCHARGE [Explanation of Leader-Stroke Mechanism on Basis of Ion Recombination in Discharge Channel].—J. M. Meek. (*Phys. Review*, 15th May 1939, Series 2, Vol. 55, No. 10, pp. 972–977.)

3068. PROGRESSIVE BREAKDOWN IN A CONDUCTING LIQUID [Observations on Luminosity, etc., in Comparatively Slow Type of Liquid Breakdown].—Snoddy & Beams. (*Phys. Review*, 1st May 1939, Series 2, Vol. 55, No. 9, p. 879.)

3069. THE DEVELOPMENT OF THE ELECTRON AVALANCHE IN THE SPARK CHANNEL (FROM CLOUD-CHAMBER OBSERVATIONS).—H. Raether. (*Zeitschr. f. Phys.*, No. 7/8, Vol. 112, 1939, pp. 464–489.)

3070. TRANSPORT OF ELECTRIC CHARGES BY DROPLETS [Conditions for Use in Electrostatic Generators].—Moreau-Hanot. (*See* 3304.)

3071. EARTH CONNECTIONS SUBMITTED TO STEEP-FRONTED WAVES [Oscillographic Comparison of Types including Vertically Driven Tube, Buried Plate, etc.].—J. Cuilhé. (*Bull. de la Soc. franç. des Élec.*, May 1939, Vol. 9, No. 101, pp. 455–464.)

3072. A NEW THEORY OF LAPSE-RATE [" Lapse-Rate for Cumulative Convection "].—D. S. Subrahmanyam. (*Indian Journ. of Phys.*, Feb. 1939, Vol. 13, Part 1, pp. 43–55.)

3073. ON THE RADIATIVE EQUILIBRIUM OF THE EARTH'S ATMOSPHERE [Calculations without Assumption of Independence of Absorption Coefficient on Wavelength].—A. I. Lebedinsky. (*Comptes Rendus (Doklady) de l'Acad. des Sci. de l'URSS*, No. 6, Vol. 22, 1939, pp. 316–317: in English.)

3074. LARGE-ION COUNTER GIVING DIRECTLY THE MOBILITY SPECTRUM.—P. Queney. (*Comptes Rendus*, 8th May 1939, Vol. 208, No. 19, pp. 1521–1523.)

3075. GAMMA-RAY ION CURRENTS IN AIR AT HIGH PRESSURES AND HIGH GRADIENTS AT HIGH AND LOW TEMPERATURES [Measurements: Agreement with Predictions of Initial Recombination Theory and of Columnar Theory].—J. W. Broxon & G. T. Merideth. (*Phys. Review*, 15th May 1939, Series 2, Vol. 55, No. 10, pp. 883–893.)

3076. ON STABILITY IN THE SENSE OF POISSON FOR ORBITS OF COSMIC RAYS, AND MAGNETIC STORMS [Theory: Weak Magnetic Perturbations may cause Relatively Large Changes in Intensity of Cosmic Radiation].—O. Godart. (*Phys. Review*, 1st May 1939, Series 2, Vol. 55, No. 9, p. 875.)

PROPERTIES OF CIRCUITS

3077. ELECTRON-OPTICAL SPECTRUM ANALYSIS OF [Ultra-] HIGH-FREQUENCY OSCILLATIONS.—H. E. Hollmann & A. Thoma. (*Zeitschr. f. Phys.*, No. 7/8, Vol. 112, 1939, pp. 377–394.)

" Harmonic analysis and determination of the variation with time of h.f. oscillations in the metre and decimetre range by the ' inversion spectra ' produced with the aid of a ' white ' electron beam." Fig. 1 shows the scheme of the inversion spectrograph with a connected magnetron emitter (*see* also 274 of January) whose theory is given for an anharmonic transverse field (§ 11); Figs. 2 & 3a,b, give theoretical inversion spectra, Fig. 4 experimental spectra, Fig. 5 the analysis of one of them, Fig. 6 a reconstruction of double spectra, and calibration of the abscissa scale.

3078. TRANSIENT RESPONSE OF MULTI-STAGE VIDEO-FREQUENCY AMPLIFIERS.—Bedford & Fredendall. (*See* 3243.)

3079. TRANSMISSION LINES AS COUPLING ELEMENTS IN TELEVISION EQUIPMENT.—Seeley & Kimball. (*See* 3239.)

3080. ON THE STUDY OF THE DISTORTIONS OF MODULATION DUE TO THE TRANSMISSION CIRCUITS OF MODULATED HIGH FREQUENCIES.—Cafferata: Varaldi-Balaman. (*See* 3231.)

3081. REPORT ON SPONTANEOUS FLUCTUATIONS OF CURRENT AND POTENTIAL [due to Thermal Agitation, Shot Effect, Secondary Emission, Current Distribution, and Combination of Last Three Causes].—C. J. Bakker & B. van der Pol. (*U.R.S.I. Proc. of* 1938 *General Assembly*, Vol. 5, Fasc. 1, 1938, pp. 217–227.) Including "an unpublished result of Bakker's " on the thermal agitation formula, taking into account the frequency of the collisions of the free electrons in the resistance [*cf.* 1842 of May ?].

3082. ON THE GENERAL VALIDITY OF NYQUIST'S THEOREM [Applicability to Any Network with Determinable Temperature and Differential Resistance: Radiation Resistance of Aerial equivalent to Reactance: Link between Shot Noise and Thermal Noise].—D. A. Bell. (*Phil. Mag.*, June 1939, Series 7, Vol. 27, No. 185, pp. 645–660.)

3083. NON-LINEAR DISTORTION DUE TO THE USE OF NON-LINEAR IMPEDANCES IN REGULATING APPARATUS [for Volume Compression, etc.].—B. S. Grigor'ev, V. S. Dulitski, & A. F. Egorov. (*Izvestiya Elektroprom. Slab. Toka*, No. 2, 1939, pp. 38–50.)

The systems used in radio broadcasting for controlling the contrast range of sound intensities include as a rule elements with non-linear impedance characteristics; as a result of this, non-linear distortion is introduced into the transmitted matter. In the present paper systems in which the necessary control is effected by varying (a) the internal impedance of a valve, and (b) the load impedance, are discussed; under each of these headings separate consideration is given to systems utilising (a) the input voltage, and (b) the output voltage, as the controlling factor.

For each of the above cases equations are derived determining the required characteristic of the non-linear element and the ratios of the second and third harmonics to the fundamental frequency. In the light of the theoretical conclusions reached, various practical circuits are discussed.

3084. THE THEORY OF THE STABILITY OF FEEDBACK CIRCUITS WITH LUMPED CONSTANTS.—A. V. Mikhailov. (*Journ. of Tech. Phys.* [in Russian], No. 1, Vol. 9, 1939, pp. 19–31.)

It is pointed out that the Nyquist criterion of the stability of feedback amplifiers (1932 Abstracts, p. 279) is limited by the conditions that (a) the system is stable when it is not closed, and (b) the amplification factor of the system approaches zero when the frequency of the input voltage approaches infinity. In practice, however, in designing systems with lumped constants, cases are met with when the amplification factor approaches not zero but a finite value or even infinity. A more general discussion of the Nyquist criterion is therefore presented in this paper, and new conditions of stability are established for (a) closed systems which are stable when open, and (b) open systems which are stable when closed.

3085. A THEORETICAL AND EXPERIMENTAL INVESTIGATION OF DOW'S [Electron Coupled] CIRCUIT.—E. V. Borisov. (*Izvestiya Elektroprom. Slab. Toka*, No. 2, 1939, pp. 12–24.)

For Dow's work *see* 1932 Abstracts, pp. 164 & 222, and elsewhere. A detailed mathematical analysis of the operation of the circuit is presented and all the formulae necessary for the design of the circuit are derived. The discussion is illustrated by a number of numerical examples, including a complete set of calculations applied to a particular case. This is followed by a report on an experimental investigation in which the theoretical conclusions reached were verified on a circuit operating on a wavelength of 550 m. The stability of the circuit as determined by variation of the supply voltages and by detuning of the anode circuit was also investigated when the circuit was operated on a wavelength of 100 m.

3086. INVESTIGATIONS ON THE CONSTANCY RANGE OF COUNTER TUBES AND THE RESOLVING POWER OF AMPLIFIERS [including Influence of Grid-Leak and Anode Resistances].—K. E. Forsman. (*Zeitschr. f. tech. Phys.*, No. 6, Vol. 20, 1939, pp. 169–180.)

3087. ON THE PROPORTIONING OF THE OSCILLATORY CIRCUIT IN [Transmitter] AMPLIFIERS.—Boella. (*See* 3118.)

3088. REFLEXED AMPLIFIERS. — Watson. (*See* 3128.)

3089. THE TRANSFORMER COUPLING WITH D.C. COMPENSATION [sometimes called "Mixed Coupling": Anode D.C. Component taken through Resistance and kept away from Primary Winding by Condenser, avoiding Reduction of Inductance (prejudicial to Lower Frequencies) and Saturation Effects: Design Calculations].—H. Pitsch. (*Funktech. Monatshefte*, April 1939, No. 4, pp. 100–104.) For previous work *see* 2703 of 1938 and 462/463 of February.

3090. A BAND FILTER OF VARIABLE BAND WIDTH, CONSTANT PLATEAU DIP ["Einsattelung," as measured by Form Factor], AND FIXED BAND CENTRE, FOR THE BROADCAST RANGE.—E. Alsleben & E. Weiler. (*Hochf:tech. u. Elek:akus.*, May 1939, Vol. 53, No. 5, pp. 160–162.)

The conditions for regulating the band width of a filter, while keeping the form factor and band centre constant, are deduced from equations given by Feldtkeller & Tamm (2992 of 1936) for the equivalent filter circuit of Fig. 1. The attenuation of the oscillating circuit must be regulated; this may be done with a variable capacity in series with a fixed resistance (Fig. 2). The circuit diagram of the whole filter is shown in Fig. 3; it contains also a variable coupling condenser and compensating condensers. The arrangement of the whole condenser system is shown in Fig. 4; Fig. 5 gives measured characteristic curves for the filter for different positions of the regulating condenser. It is seen that the form factor remains constant.

3091. CONTRIBUTION TO THE STUDY OF RECIPROCAL NETWORKS [with Special Reference to Negative-Feedback Amplifiers and "Constant k" Filters: Relation between "Reciprocity in Structure" and "Reciprocity in Matrix": etc.].—R. Julia. (*Bull. de la Soc. franç. des Élec.*, March 1939, Vol. 9, No. 99, pp. 281–302.)

3092. THEORY OF MULTIPOLE CONDUCTORS.—S. Koizumi. (*Arch. f. Elektrot.*, 28th March 1939, Vol. 33, No. 3, pp. 171–188.)

A multipole conductor system is defined as a linear passive network of conductors, having two groups of terminals and fulfilling the condition that, corresponding to any employment of the terminals of one group, the terminals of the other group can always be used in such a way that the network is electrically symmetrical with respect to the two groups of terminals. The system may be composed not merely of locally "lumped" constants or uniform lines, but also of combinations of these. The simplest case is the symmetrical quadripole, and the present work consists largely in extending equation 2′, relating to similar quadripoles in cascade and resembling De Moivre's theorem in trigonometry, to deal with multiple-conductor systems.

The treatment is divided into the following sections:—Definition and matrices of a multipole-conductor system. Fundamental transformation of the iteration matrix. Analysis of the multipole system into the system of self-contained quadripoles. Existence conditions of the separation matrix. Determination of the separation matrix and other standard constants. Invariance of certain constants with reference to the exchange of the terminals. Calculation of the standard constants from experimental values. Transformation formulae for the impedance and admittance (*cf.* 3252 of 1937): etc.

3093. THE NUMBER OF IMPEDANCES OF AN *n* TERMINAL NETWORK.—J. Riordan. (*Bell S. Tech. Journ.*, April 1939, Vol. 18, No. 2, pp. 300–314.) Arising out of the paper referred to in 3630 of 1937.

3094. RAPID GRAPHICAL ANALYSIS OF CIRCUIT PERFORMANCE BY THE USE OF LOGARITHMIC CHARTS [with log (|impedance|) and log (frequency) as Axes: Use in Radio Receiver Design].—D. N. Truscott. (*Nature*, 27th May 1939, Vol. 143, pp. 897–898.)

3095. THE APPLICATION OF NEGATIVE FEEDBACK TO FREQUENCY-MODULATION SYSTEMS.—Chaffee. (*See* 3120.)

3096. VALVES WITH WATTLESS RETROACTION AS ADJUSTABLE REACTANCES.—Tüxen. (*See* 3132.)

3097. THE MODULATION RANGE OF THE AUDION ["Leaky-Grid" Detector].—Oertel. (*See* 3127.)

3098. THE BEHAVIOUR OF A DIODE CIRCUIT TO INTERFERING LOW-FREQUENCY AND DIRECT-CURRENT VOLTAGES.—Brück. (*See* 3125.)

3099. QUASI-STABLE FREQUENCY-DIVIDING CIRCUITS [Disadvantages of Self-Oscillatory Frequency Dividers: Early Interlocked Quasi-Stable Circuits & Their Mechanism: Requirements for Correct Working: a Practical Circuit using Frequency-Discriminating Circuits to produce the Necessary Reduction of Direct Feedback without Loss of Intermodulation Feedback: Possible Developments].—R. L. Fortescue. (*Journ. I.E.E.*, June 1939, Vol. 84, No. 510, pp. 693–698.)

3100. ON FREQUENCY MULTIPLICATION [especially Frequency Doubling, with Grid-Controlled Electron Valves].—W. Kleen & H. Ruffler. (*Telefunken-Röhre*, April 1939, No. 15, pp. 64–78.)

Mathematical investigation based on the anode-current/anode-voltage diagram, as used by Rothe for the transmitter amplifier (1918 of May): equivalent diagram of max. useful output, taking practical limiting factors into account: a frequency-doubling stage may be made to have an efficiency of the same order as that of a transmitter amplifier stage.

3101. REMARKS ON THE PAPER "FORCED OSCILLATIONS IN A CONDUCTOR OF FINITE LENGTH AND DIAMETER."—Titov: Suzant. (*See* 3153.)

3102. ON THE METHODS OF CALCULATING THE SUPPLEMENTARY LOSSES [Skin & Proximity Effects] IN NON-MAGNETIC CONDUCTORS CARRYING A SINUSOIDAL ALTERNATING CURRENT, AND THEIR APPLICATION IN THE CURRENT PRACTICE OF THE CONSTRUCTOR OF ELECTRICAL MACHINES.—S. Kohn. (*Bull. de la Soc. franç. des Élec.*, March 1939, Vol. 9, No. 99, pp. 237–256.)

3103. AN "IMAGINARY SHELL" [Coque fictive] VALID AT ALL FREQUENCIES [Modification of Usual Skin-Effect Formula for Equivalent Thickness of Skin] AND ITS APPLICATION TO THE STUDY OF THE INDUCTION FURNACE WITHOUT MAGNETIC CORE.—A. Levasseur. (*Bull. de la Soc. franç. des Élec.*, May 1939, Vol. 9, No. 101, pp. 450–454.)

TRANSMISSION

3104. THE BARKHAUSEN-KURZ OSCILLATIONS IN A "FREE ANODE" CIRCUIT.—N. F. Otpushchennikov. (*Journ. of Tech. Phys.* [in Russian], No. 1, Vol. 9, 1939, pp. 32–38.)

An investigation was carried out of the operation of a retarding-field valve with a "free" (insulated) anode (Fig. 1). As can be seen from Fig. 2, almost continuous wavelength variation between 24 and 70 cm can be obtained with this circuit; also, in addition to normal wavelengths there are two regions (*E* and *D*) of "dwarf" waves. The rôle of the grid circuit in the oscillatory process is discussed, and curves are plotted showing the effect of the grid voltage (Fig. 4) and of the filament current (Fig. 5–7) on the intensity of oscillations.

The main conclusions reached are that this circuit is more easily excited than the Barkhausen-Kurz circuit and that it produces oscillations of greater intensity. It is also pointed out that the operation of this circuit is less dependent on the symmetrical arrangement of the electrodes.

3105. THE ACTION OF A CATHODE CHOKE IN THE RETARDING-FIELD GENERATOR.—W. Schwarz. (*Hochf:tech. u. Elek:akus.*, May 1939, Vol. 53, No. 5, pp. 165–170.)

The cathode choke used customarily in experiments on the nature of retarding-field oscillations here takes the form of a Lecher-wire system, whose effect on the oscillations is the subject of the investigation. The emitter used is shown schematically in Fig. 1, the valve in Fig. 2. The external radiating system is a double Lecher system, the proper oscillating system L_1 and the cathode "choke system" L_2. The tuning curves of L_2 (anode current as a function of length of L_2) are shown in Fig. 3, that of L_1 in Fig. 4. Three different types of L_2 tuning curve are found, corresponding to different positions of the bridge on the system L_1 (Fig. 5). They indicate that the system L_2 has the same effect on the oscillations in L_1 as a secondary Lecher system coupled to L_1. The damping and detuning of L_1 by the presence of L_2 are found to be the chief effect of the presence of L_2, though the effect varies with the mode of coupling of L_1 to the valve (three different arrangements are investigated). The variation of the frequency of the generator with the tuning of the two Lecher systems is shown in Figs. 11, 13. The connection between anode current and oscillating current was found to be linear (§ III; Fig. 15).

3106. THE PRODUCTION OF ULTRA-HIGH-FREQUENCY OSCILLATIONS BY MEANS OF DIODES.—Llewellyn & Bowen. (*See* 3155.)

3107. OUTPUT AND EFFICIENCY OF THE SPLIT-ANODE MAGNETRON OSCILLATING IN THE DYNATRON RÉGIME [where Effects of Transit Time can be Neglected: Performance predicted from Measurements of Valve Resistance at Power Frequencies (Good Agreement with R.F. Measurements): Effects of Tilting the Field & of Anode Modulation: Frequency Stability and the Effects of Operating Conditions: etc.].—A. F. Harvey. (*Journ. I.E.E.*, June 1939, Vol. 84, No. 510, pp. 683–692.)

3108. ON THE EXCITATION OF OSCILLATIONS WITH THE HELP OF A DYNATRON IN A CIRCUIT WITH UNIFORMLY DISTRIBUTED ELECTRICAL CONSTANTS [Analogous Mathematical Treatment would be applicable to Ultra-Short-Wave Production in Magnetrons].—W. Majewski. (*Acta Physica Polonica*, Fasc. 4, Vol. 7, 1939, pp. 340–356: in French.)

Differential equation for a dynatron connected to a system of two parallel wires short-circuited at the far end. The introduction of two parameters, ρ (representing the slope of the straight part of the dynatron characteristic) and η (representing the non-linear part) enables the characteristic to be represented in the simpler form of a third-degree equation (cubic parabola): *see* Groszkowski, 2235 of 1935. The conditions at the limits are established. If the system of differential equations is to have periodic solutions, the leakance of the circuit must be zero ($G = 0$). Among other results, the importance of the parameter g (C_0/Cl, using the notation of Fig. 1) is brought out.

3109. WIDE-BAND VARIABLE-FREQUENCY TESTING TRANSMITTERS [for Ultra-Short Waves: 500–1000 Watts Output: Concentric-Line Frequency Control, in One Type with Metal-Plated Bellows (Cam-Driven) as Part of Inner Conductor, to give Linear Frequency-Sweep: in Other Type with Hand-Operated Crank and Vernier Scale].—G. L. Usselman. (*RCA Review*, April 1939, Vol. 3, No. 4, pp. 466–472.) The first type was used for the Empire State Building investigations (*see* 3262, below).

3110. FREQUENCY MODULATION DEMONSTRATED.—Armstrong. (*See* 3361.)

3111. THE MODULATION OF THE TRANSMITTER AMPLIFIER [Working Conditions for a Limited D.C. Anode-Current Supply (the Usual Case): Useful Power, Anode & Screen-Grid Dissipations, Efficiency, etc., for Varying Values of External Resistance: Class B Working: Grid D.C. Voltage Modulation: Retarding-Grid Modulation: Anode-Voltage Modulation]. — H. Rothe. (*Telefunken-Röhre*, April 1939, No. 15, pp. 79–99.) Further development of the work dealt with in 1918 of May.

3112. DISCUSSION ON "CLASSIFICATION, ACCORDING TO EFFICIENCY, OF THE VARIOUS SYSTEMS OF EMISSION OF MODULATED WAVES."—J. Loeb. (*Bull. de la Soc. franç. des Élec.*, Feb. 1939, Vol. 9, No. 98, pp. 211–213.) *See* 958 of March.

3113. NON-LINEAR DISTORTION DUE TO THE USE OF NON-LINEAR IMPEDANCES IN REGULATING APPARATUS [for Contrast Control].—Grigor'ev, Dulitski, & Egorov. (*See* 3083.)

3114. AMPLIFIERS WITH AUTOMATIC VOLUME COMPRESSION.—Bertolotti. (*See* 3363.)

3115. COPPER-OXIDE MODULATORS IN CARRIER TELEPHONE SYSTEMS [Analytical Studies of Effects arising in Circuits, giving Suppression of Undesired Frequencies].—R. S. Caruthers. (*Bell S. Tech. Journ.*, April 1939, Vol. 18, No. 2, pp. 315–337).

3116. THE MODE OF ACTION OF THE STAR-CONNECTED MODULATOR [Double-Push-Pull Modulator, using Dry-Plate Rectifiers or "Tetradiodes" with 4 Anodes and a Single Cathode].—V. Aschoff. (*AEG-Mitteilungen*, May 1939, No. 5, pp. 281–283.)

3117. ON TUNING RADIO TRANSMITTER CIRCUITS BY SIMULTANEOUS VARIATION OF L AND C IN ACCORDANCE WITH A STRAIGHT-LINE FREQUENCY RELATIONSHIP.—F. E. Evteev & P. G. Panov. (*Izvestiya Elektroprom. Slab. Toka*, No. 2, 1939, pp. 4–11.)

For previous work *see* 953 of March. Formulae are quoted determining the variation of the inductance of a variometer (1) and of the capacity of a condenser (2) when their rotors are turned through an angle ϕ. From these formulae and the condition that the frequency of the circuit should vary in accordance with a straight-line law, a formula (16) is derived for determining the necessary shape of the condenser rotor plates. The variation of the impedance of the circuit when L and C are varied so as to satisfy the straight-line law is also discussed, and a number of practical suggestions are made. The discussion is concluded by two numerical examples in which the shape of the condenser rotor plate is determined for wave-length ranges of 300 to 1500 m and 15 to 30 m.

3118. ON THE PROPORTIONING OF THE OSCILLATORY CIRCUIT IN [Transmitter] AMPLIFIERS [to give the Necessary Requirements of High Efficiency in Transmission of Power and Suitable Selectivity in Its Action: the Question of the L/C Ratio, especially in Transmitters with Several Wave-Ranges].—M. Boella. (*Alta Frequenza*, Feb. 1939, Vol. 8, No. 2, pp. 98–102.)

RECEPTION

3119. THE MECHANISM OF HEARING BY ELECTRICAL STIMULATION [Middle Ear behaves as Condenser Receiver: Great Distortion encountered when Electrical Output of Broadcast Receiver is passed through Head can be reduced by Application of Polarising D.C.: Speech & Music then heard with Great Clarity].—S. S. Stevens & R. C. Jones. (*Journ. Acous. Soc. Am.*, April 1939, Vol. 10, No. 4, pp. 261–269.)

3120. The Application of Negative Feedback to Frequency-Modulation Systems [by causing Portion of Output Voltage to frequency-modulate Local Oscillator in such Phase as to reduce Output Signal: Decrease in Noise & Distortion: Analysis and Experimental Confirmation: Comparison with Frequency-Modulation System using Amplitude Limitation].—J. G. Chaffee. (*Proc. Inst. Rad. Eng.*, May 1939, Vol. 27, No. 5, pp. 317–331.)

3121. Four Types of Interference encountered in Ultra-Short-Wave Link for Television.—Macnamara. (*See* 3236.)

3122. Radio Reception in Aviation [including Measurements on Background Noise Levels, Static Charges (and the Charging Effects of the Exhaust Gases from Otto & Diesel Engines: Use of Tungsten Discharge Points): etc.]. — Esau, Jansky, Kotowski, Klumb. (*Zeitschr. V.D.I.*, 8th April 1939, Vol. 83, No. 14, p. 416: summaries only.) The reports are published in a supplementary volume of the 1938 Yearbook of German Aeronautical Research (3418, below).

3123. AEG Interference-Suppressing Devices. —K. Kegel. (*AEG-Mitteilungen*, March 1939, No. 3, pp. 213–215.)

3124. Electric Shaver Interference Suppression [Correspondence].—(*Wireless World*, 1st & 8th June 1939, Vol. 44, pp. 522 & 547.) *See* also 2753 of July.

3125. The Behaviour of a Diode Circuit to Interfering Low-Frequency and Direct-Current Voltages [Such as may reach the Diode System of a Multiple-System Valve by Imperfect Socket Insulation, Thermal Emission from the Grid of an AVC Valve, Capacitive Couplings inside the Valve, etc.]. —L. Brück. (*Telefunken-Röhre*, April 1939, No. 15, pp. 25–40.)

The occurrence and effects of a constant parasitic direct current reaching the diode gap are considered first: such a current is seen to have the same effect as a constant bias voltage, which leads to the possibility of eliminating its action by applying a negative bias $U = R_a \cdot I_{st}$ (p. 29: I_{st} is the constant parasitic d.c.). Here a comparison is made between the distortion of reproduction which may be caused by such a parasitic current and that occurring in a delayed AVC circuit, where the rectifier system is subjected to a negative bias which is now seen to correspond to a parasitic d.c. in the opposite direction to that just considered. In the final paragraph of p. 32 it is shown how the maximum modulation-percentage that can be rectified without distortion can be found experimentally.

The rest of the paper deals with the behaviour of the diode circuit to l.f. disturbances, usually arriving at point A or B (Fig. 1) by way of lead capacity. The factor determining the value of the voltage appearing in R_a (and proceeding thence to the l.f. stages) is R_D, the resistance which the diode circuit (Fig. 9) displays, to alternating voltage, between the points A & E. The dependence of R_D on the amplitude of the disturbance and on the h.f. voltage on the rectifier is therefore investigated (pp. 33–37). The question of its variation with frequency is also discussed: the l.f. equivalent circuit (Fig. 14) of the basic circuit of Fig. 1 shows how the design of the band filter affects this. This point is investigated at length, and finally it is seen that a disturbing voltage in R_a modulates the h.f. voltage in the oscillatory circuit by varying the damping; also, that the h.f. circuit influences the l.f. resistance.

3126. The Limit of Sensitivity in the Reception of Electric Waves, and Its Attainability.—K. Fränz. (*E.N.T.*, April 1939, Vol. 16, No. 4, pp. 92–96.)

The sensitivity of a receiver is here understood to mean the least field strength required to produce a signal voltage at the receiver output which is equal to the interference voltage due to thermal and shot effects. The present investigation deals with the principles of increasing sensitivity in the parts of the circuit before amplification by means of valves has taken place. Reception with dipole aerials is first discussed; the radiation resistance involves a noise e.m.f., and the minimum observable field strength is found from this (eqn. 3). Fig. 1 shows the theoretical minimum field strength and maximum "input height" (ratio grid-voltage/field-strength) as a function of wavelength. The relation of "input height", "input value" (ratio grid-voltage/aerial-e.m.f.), and sensitivity is discussed; the limits of input height and input value are found not to be simultaneously attainable with the optimum sensitivity given by eqn. 3. Fig. 3 shows the attenuation, input value, resultant grid resistance and sensitivity, as functions of the aerial coupling for loss-free intermediate circuits (eqns. 9–12); it is found that, "so long as no noticeable damping of the grid circuit by the aerial occurs, the sensitivity increases with the input value, while, as the damping increases, the input value reaches its optimum first and the sensitivity attains a flat maximum somewhat later, owing to valve noise." Methods for practical calculation of the sensitivity are described; simplification is attained by omitting consideration of the shot effect. Examples are given which show "how loose the connection between input value and sensitivity really is."

3127. The Modulation Range of the Audion ["Leaky-Grid" Detector].—L. Oertel. (*Telefunken-Röhre*, April 1939, No. 15, pp. 1–24.)

Author's summary:—"In section 1 the modulation limits of an audion are calculated for a linear characteristic field by a simple geometrical representation. Very simple expressions are arrived at for the maximum attainable output alternating voltage, as well as for the input voltage necessary to produce this (eqns. 8, 9, & 21). For a fully modulated triode the output a.c. voltage U_R, as a function of the external resistance, has a maximum in the case where the external resistance has the same value for d.c. and for l.f. (modulation-frequency) a.c. This maximum is at the point $R_a = \sqrt{2} \cdot R_i$. For a pentode no such maximum occurs: U_R is there, to a first approximation, a linear function of the external resistance. The theory is then extended to the case where the d.c. resistance and l.f. resistance are different. The attainable output alternating voltage is larger, as might be expected, if the d.c. resistance R is smaller than the a.c. resistance r (eqns. 18 & 22).

"In section II the theory is extended to any characteristic field which can be represented by a polynomial of the second degree. The anode rectification effect, which works counter to the grid rectification, is now taken into account. Here again, with a fully modulated triode, the alternating voltage appearing in the external resistance has a maximum, lying in this case between $R_a = \sqrt{2} \, . \, R_i$ and $R_a = 1.83 \, R_i$: the value given in eqn. 43 is here to be used for R_i.

"As is shown in section III, there is very good agreement between theory and experiment. This agreement applies not only to the theory developed in section II but also to that for the linear characteristic field. This is very advantageous for practical use, since if the output alternating voltage is required it is only necessary, for its calculation according to the formulae of section I, to know one quantity. For the pentode this is the current J_0 flowing when the h.f. amplitude is zero [*see* pp. 10–11]; for the triode, it is the internal resistance R_i for a grid voltage $U_g = -(1 - 0.325) \, DU_a$ (eqn. 43 [actually the symbol U_B is here used, denoting "battery voltage" instead of "anode voltage"]). Both these quantities can readily be determined by one measurement."

These investigations were undertaken because of the recently increased importance of audion design since its employment in the "German Small Receiver." Previously it was assumed that the counter-action of the anode-bend rectification occurring at large amplitudes reduced and limited the output voltages. "One of the most interesting results of this work has been to show that this effect is not nearly so pronounced, and most certainly not decisive. It is found on the contrary that much larger effects, particularly over-modulation of the grid-circuit working range, determine such limitation." The effect of retroaction is not considered in this paper, as explained in the last paragraph of p. 2, where retroaction is compared to the addition of a h.f. amplifying stage, with special characteristics, in front of the grid circuit.

3128. REFLEXED AMPLIFIERS [Simultaneous Amplification of Intermediate and Audio Frequencies].—S. J. Watson. (*A.W.A. Tech. Review*, Jan. 1939, Vol. 4, No. 1, pp. 35–50.)

Max. gain is found to occur for a special value of resistive audio load, but a lower load is generally desirable to keep the distortion tolerable. Least distortion and least "minimum-volume defect" is obtained by using the lowest feasible grid bias and adjusting the screen voltage so that the valve operates at the peak of the mutual conductance curve.

3129. NON-LINEAR DISTORTION DUE TO THE USE OF NON-LINEAR IMPEDANCES IN REGULATING APPARATUS [for Contrast Control].—Grigor'ev, Dulitski, & Egorov. (*See* 3083.)

3130. AUTOMATIC VOLUME CONTROL [the Dangers of Various Types of Distortion resulting from It, and Their Cure].—F. C. Saic. (*Funktech. Monatshefte*, April 1939, No. 4, pp. 105–112.)

3131. AUTOMATIC FREQUENCY CONTROL: DIRECTLY STABILISED OSCILLATOR [particularly for Short-Wave Telegraphy: Control Potential derived Directly from Oscillator instead of through I.F. Amplifier].—(*Wireless World*, 8th June 1939, Vol. 44, p. 545.)

3132. VALVES WITH WATTLESS RETROACTION AS ADJUSTABLE REACTANCES [in Automatic Tuning Correction].—O. Tüxen. (*Funktech. Monatshefte*, April 1939, No. 4, pp. 113–115.)

An explanation of the use of the anode/cathode space of a valve with wattless back-coupling as a regulable capacity or (more frequently) inductance, instead of the older use of the grid/cathode space of an ordinarily connected valve. For Braude's original paper on wattless retroaction *see* 1932 Abstracts, pp. 337–338; for the present writer's paper on ATC *see* 1875 of May.

3133. TONE-CONTROL SYSTEMS: OBTAINING VARIABLE FREQUENCY RESPONSE [Decision in Favour of Switch-Controlled System].—W. T. Cocking. (*Wireless World*, 8th June 1939, Vol. 44, pp. 532–537.)

3134. RAPID GRAPHICAL ANALYSIS OF CIRCUIT PERFORMANCE BY THE USE OF LOGARITHMIC CHARTS [with log (|impedance|) and log (frequency) as Axes: Use in Radio Receiver Design].—D. N. Truscott. (*Nature*, 27th May 1939, Vol. 143, pp. 897–898.)

3135. STANDARDISATION OF TESTS ON RECEIVERS [Efficiency of AVC: Selectivity of Superheterodyne Receivers].—Société des Radioélectriciens. (*L'Onde Élec.*, May 1939, Vol. 18, No. 209, pp. 234–238) Supplements to Chapters II and III (*see* 972 of March and back reference).

3136. RECEIVING SETS FOR SCHOOLS [and the Requirements of the Central Council for School Broadcasting].—W. H. Whiting. (*World-Radio*, 9th & 16th June 1939, Vol. 28, pp. 16–17 & p. 13.)

3137. AEG BROADCAST RECEIVERS IN THEIR LATEST DEVELOPMENT [Types AEG 18, 28 . . . & the "Big AEG"].—(*AEG-Mitteilungen*, March 1939, No. 3, pp. 211–213.)

3138. PHILCO P 429: SUPERHETERODYNE PORTABLE OPERATED THROUGHOUT BY DRY BATTERIES.—(*Wireless World*, 15th June 1939, Vol. 44, pp. 564–565.)

3139. SINGLE-ADJUSTMENT PUSH-BUTTON TUNER [for Simultaneous Adjustment of Aerial & Oscillator Condensers].—Sprague Specialties. (*Proc. Inst. Rad. Eng.*, May 1939, Vol. 27, No. 5, pp. ii and v.)

3140. LONGER LIFE FOR DIAL LAMPS: NEW RECTIFIER FOR AMERICAN MIDGETS [with Tapped Heater Element].—(*Wireless World*, 8th June 1939, Vol. 44, p. 537.)

3141. The Use of Ferromagnetic Materials in Coils for Radio Frequencies.—R. Koch. (*Alta Frequenza*, April 1939, Vol. 8, No. 4, pp. 251–278.)

Author's summary:—In the first [short] part the properties of ferromagnetic materials for radio frequencies are examined, together with the requirements which such materials should possess in order to give advantageous results; the different types of material now available, and their methods of manufacture, are discussed briefly. In the second part, after outlining the advantages which may be obtained by the use of these materials [instead of air cores], an experimental investigation is described which was made to verify quantitatively these advantages and to investigate their variation with frequency. The research, based on the comparison of coil magnifications, dealt with different types of magnetic materials and various shapes of core, both screened and unscreened types of coil being considered [section 11 deals with variations of inductance with temperature, section 12 with the influence of screening].

The analysis of the results leads to the conclusion that the use of ferromagnetic materials for radio-frequencies is in many cases convenient, but that a tendency to renounce altogether the use of air-cored coils is not justified: the latter are preferable for frequencies above 2–3 Mc/s.

3142. Corrections to "On the Application Possibilities of the 'Universal' Output Transformer."—M. Wünsch. (*Funktech. Monatshefte*, April 1939, No. 4, p. 121.) *See* 2329 of July.

3143. "Radio Troubleshooter's Handbook" [Book Review].—Ghirardi. (*Proc. Inst. Rad. Eng.*, April 1939, Vol. 27, No. 4, p. 297.)

3144. Regimented Listening: Control from the Transmitting End.—(*Wireless World*, 15th June 1939, Vol. 44, p. 553.) Patent No. 498 192.

AERIALS AND AERIAL SYSTEMS

3145. Discussion on "Multiple Reflections between Two Tuned Receiving Antennae" [Brown's Method of Mutual Impedances suggested as Simpler: Authors' Reply].—Palmer, Abson, & Barker: G. H. Brown. (*Journ. I.E.E.*, June 1939, Vol. 84, No. 510, pp. 749–750.) *See* 4341 of 1938.

3146. Resonant Short-Wave [Receiving] Aerials. —(*World-Radio*, 26th May 1939, Vol. 28, pp. 14–15.)

3147. Vertical or Inverted-"L" Aerials: Their Merits for Reception compared. —F. R. W. Strafford. (*Wireless World*, 15th & 22nd June 1939, Vol. 44, pp. 554–555 & 575–577.)

3148 Fashions in Antennas [Various Types of Short-Wave Aerials used for Long-Distance Working by Prominent Amateurs].—B. Goodman. (*QST*, June 1939, Vol. 23, No. 6, pp. 14–18 and 72.) Including Sterba curtains, "lazy H," flat-top beam, and rhombic types.

3149. The Superiority of the Modified Franklin Vertical-Beam Aerial as regards Signal/Noise Ratio: etc.—Wood. (In paper dealt with in 3385, below.)

3150. Short-Wave Transmitting Aerials [at BBC Empire Station, Daventry].—E. W. Hayes. (*World-Radio*, 26th May & 30th June 1939, Vol. 28, pp. 12–13 & 12–13.)

3151. The Radiation Resistance of an Aerial and Nyquist's Theorem.—Bell. (*See* 3082.)

3152. Note on the Calculation of the Radiation from a Cylindrical Antenna of Finite Diameter.—P. Nicolas. (*L'Onde Élec.*, May 1939, Vol. 18, No. 209, pp. 193–211.)

"The calculation of the radiation resistance of an aerial in the form of a thin cylindrical rod has been the subject of numerous publications. For certain applications, however, it is interesting to study the radiation from an aerial whose diameter is *not* infinitely small. Difficulties then arise in the application of the classical formulae." Moreover, most analyses of the radiation from aerials (*see* writer's survey—3684 of 1937) assume a sinusoidal distribution of current—an assumption justified by the simplification it brings, but not acceptable in all cases. Of the various workers who avoid it, the writer concentrates on G. Hara, and in particular on his paper in the *Memoirs of the Ryojun College of Engineering* for Oct. 1936, in which the distribution of current is represented by a Fourier series (this is perhaps the work mentioned in Hara's German paper dealt with fully in 741 of 1935.) "Hara's work furnishes a complete solution of the problem of radiation in an extremely wide range of cases, and the formulae he gives permit, by means of somewhat lengthy calculations, the effective determination of all the important quantities. We, in the first place, will proceed to obtain the formula given by Hara by a way which differs slightly from his and which has the advantage of giving a more general form to the equations. For this purpose we start by establishing a fundamental integral equation which is independent of the type of distribution assumed, and even of the particular fashion in which it is desired to analyse the function $If(x)$." The writer's treatment makes use of the modified Sommerfeld integral as described by Schelkunoff (108 of 1937).

3153. Remarks on the Paper by A. E. Suzant: "Forced Oscillations in a Conductor of Finite Length and Diameter."—N. K. Titov: Suzant. (*Journ. of Tech. Phys.* [in Russian], No. 1, Vol. 9, 1939, pp. 88–92: Reply pp. 92–94.)

See 1874 of 1938. Titov points out that in solving equation ($14C_1$), Suzant has made an arbitrary assumption which leads to contradictory results and vitiates the solution obtained. It is also argued that the method proposed by Suzant does not give a true representation of the phenomenon under investigation. In his reply Suzant disputes Titov's arguments and considers them to be based on a misunderstanding.

3154. ANOTHER INEXPENSIVE SEAL FOR COAXIAL CABLES.—R. L. Morehouse. (*QST*, June 1939, Vol. 23, No. 6, p. 52.)

VALVES AND THERMIONICS

3155. THE PRODUCTION OF ULTRA-HIGH-FREQUENCY OSCILLATIONS BY MEANS OF DIODES [Special Diodes with Critical Transit Times, embodying Concentric Lines & Tuned Cavities (Wave Guides), for Waves around 10 cm: Derivation of Design Formulae and Experimental Results].—F. B. Llewellyn & A. E. Bowen. (*Bell S. Tech. Journ.*, April 1939, Vol. 18, No. 2, pp. 280–291.)

3156. THE 356 A VACUUM TUBE [for Ultra-High Frequencies up to 300 Mc/s: 50 W Anode Dissipation: One Terminal Prong connected to Centre-Tap on Filament].—(*Bell Lab. Record*, April 1939, Vol. 17, No. 8, p. 244: photograph & caption only.)

3157. ULTRA-HIGH-FREQUENCY POWER TUBE [Type 356 A, Stemless Construction: 50 W Rating up to 100 Mc/s, Reduced Ratings up to 300 Mc/s].—Western Electric. (*Proc. Inst. Rad. Eng.*, May 1939, Vol. 27, No. 5, pp. v and vi.)

3158. "GAMMATRON" TRIODES FOR GENERATION OF ULTRA-SHORT WAVES [120 W on 3 m, 15 W on 1 m: "Perfectly Outgassed" Tantalum for Electrodes, "Nonex" Glass Envelopes].—Société "Film et Radio." (*L'Onde Élec.*, May 1939, Vol. 18, No. 209, pp. 239 and 240.)

3159. RECENT DEVELOPMENTS IN RADIO RECEIVING TUBES [Oxide-Coated Straight-Through Filament for Operation from Single Dry Cell: "Loctal"-Type Valves: etc.].—R. M. Wise. (*Proc. Inst. Rad. Eng.*, April 1939, Vol. 27, No. 4, p. 292: summary only.) "Improved loudspeaker design permits satisfactory performance in an ordinary-sized living room with only a 75-milliwatt-output tube." For the "Loctal" valves *see* also *Wireless World*, 1st June 1939, Vol. 44, p. 508.

3160. THE 1852 AS A MIXER: REPLACING THE 6L7 IN THE REGENERATIVE S.S. RECEIVER.—(*QST*, June 1939, Vol. 23, No. 6, pp. 37–38 and 102, 104.)

3161. NEW PENTODE WITH OXIDE CATHODE, WITH A USEFUL OUTPUT OF 500 WATTS [Type P. 500, for 2000 V Anode Voltage], *and* COMPLEMENTARY INFORMATION ON THE P.1000 PENTODE [Improved Form of 1937 Type: Useful Output of 1000 W and over, for 3000 V Anode Voltage].—Deroche, Suart, Warnecke. (*Bull. de la Soc. franç. Radioélec.*, Supp. Number, 1938, Vol. 12, No. 5, pp. 146–152: pp. 153–162.)

3162. VALVE NOISE AT LOW FREQUENCY [Investigation of Frequency Variation and Magnitude of Flicker Effect in Range 40–20 000 c/s for Various Types of Valve: "Normal" and "Abnormal" (Positive-Ion) Effects: etc.].—W. Graffunder. (*Telefunken-Röhre*, April 1939, No. 15, pp. 41–63.)

For the work of Schottky and of Spenke, here referred to as throwing fresh light on the subject, *see* 1362 of 1937 and 3220 of 1938. Author's summary:—(1) In the space-charge region the flicker effect for oxide cathodes varies inversely with the frequency. This variation with frequency is contrary to earlier measurements of J. B. Johnson and to views hitherto held on the occurrence of fluctuations of flicker effect. It forms, however, a support for Schottky's new ideas, according to which the life of a thermally ionised Ba atom in a surface layer (about 10^{-5} cm thick) of the oxide is to be considered as the basic factor. Now and then the flicker effect extends into the region of high frequencies (10^5–10^6 c/s). It is very dependent on the working conditions (under-heating) and varies with time. The important quantity for the use of a valve in an amplifier is the equivalent resistance: from this point of view, indirectly heated valves of steep slope, such as the AC 100/101, RE 074 and RE 084, with their low flicker effect, are to be preferred. The magnitude of the effective grid alternating voltage produced by flicker effect is calculated. With a band width of 40–5000 c/s it is of the order of 0.4–2 μV.

(2) In the saturation region the same frequency law, $\overline{J}^2$ varies as $1/\nu$, holds good. For the variation of the saturation current strength the equation is $\overline{J}^2 = k.s^\alpha$, with an exponent $\alpha < 2$. This result also falls in with the new Schottky ideas. (3) Pure tungsten cathodes have no ["normal"] flicker effect. Occasionally the "abnormal" flicker effect occurs. Cathode-ray oscillograms of this effect are given.

3163. FLUCTUATION NOISE IN PARTIALLY SATURATED DIODES.—D. A. Bell. (*Journ. I.E.E.*, June 1939, Vol. 84, No. 510, pp. 723–725.)

Extension of work dealt with in 2780 of 1938 to the more practically important case of a valve which is mainly space-charge-limited but is not entirely free from temperature-limitation. The theory is applied to two diodes described in some German researches and the results compared with the German values.

3164. LINK BETWEEN SHOT EFFECT AND THERMAL NOISE, BY NYQUIST'S THEOREM.—Bell. (*See* 3082.)

3165. REPORT ON SPONTANEOUS FLUCTUATIONS OF CURRENT AND POTENTIAL [due to Thermal Agitation, Shot Effect, Secondary Emission, Current Distribution, and Combination of Last Three Causes].—Bakker & van der Pol. (*See* 3081.)

3166. CALCULATION OF TRIODE CONSTANTS.—J. H. Fremlin. (*Phil. Mag.*, June 1939, Series 7, Vol. 27, No. 185, pp. 709–741.)

"A new treatment of the equivalent diode is proposed, from which formulae for anode current and mutual conductance in plane or cylindrical triodes are obtained in terms of the penetration factor [" Durchgriff "], the inter-electrode distances, and the voltages applied to grid and anode." The formulae are first developed for the case when the cathode/grid distance is greater than the grid pitch; the apparatus used for testing them is described. It is then shown "how these formulae may be used when the grid is very close to the cathode so long as the reduction of penetration factor is taken into account."

3167. The Determination of the Operating Characteristics of Power Vacuum Tubes [Three Methods—Low-Frequency, Calculation from Static Characteristic Curves, and Calculation from New Empirical Formulae for Static Characteristic Curves, including Division of Space Current between Plate and Grid].—E. L. Chaffee. (*U.R.S.I. Proc. of* 1938 *General Assembly*, Vol. 5, Fasc. 1, 1938, pp. 139–146.) *See* also 3617 & 3618 of 1938.

3168. Predetermination of the Performance of Radio-Frequency Amplifiers [Measurements at Audio-Frequencies with Inter-Electrode Capacitances shunted by External Capacitances].—C. S. Roys. (*Proc. Inst. Rad. Eng.*, May 1939, Vol. 27, No. 5, p. 352: summary only.) The method has been used in the past for testing high-power transmitting valves.

3169. Improvements in the Measurement of the Direct Inter-Electrode Capacitances of Vacuum Tubes [Improved Technique of the "Charging Current Method" (a Substitution Method): Rapid & Accurate Results].—C. H. Williams & K. M. Soukaras. (*U.R.S.I. Proc. of* 1938 *General Assembly*, Vol. 5, Fasc. 1, 1938, pp. 182–186.)

3170. Contribution to the Technique of Measurement of the Secondary Emission of Electrons.—Majewski. (*See* 3248.)

3171. Phenomenon of Secondary-Electron Emission [Possible Influence, on Emission Characteristics, of Positive Charge in Thin Oxydised Films of Ba & Li on Metal Base].—H. Nelson. (*Phys. Review*, 15th May 1939, Series 2, Vol. 55, No. 10, p. 985.)

3172. Comparison of the Secondary Electron Emission due to H_2^+ and D_2^+ Ions [Emission markedly Less for D_2^+ Ions].—M. Healea. (*Phys. Review*, 15th May 1939, Series 2, Vol. 55, No. 10, p. 984.)

3173. Zigzag and Helical Springs [for supporting Current-Carrying Filaments]: Elastic Properties of Molybdenum.—G. L. Tawney. (*Review Scient. Instr.*, May 1939, Vol. 10, No. 5, pp. 152–159.)

DIRECTIONAL WIRELESS

3174. Detection of Obstacles to Navigation without Visibility [with Description of Experimental Apparatus using 16 cm Micro-Waves, installed at Sainte-Adresse: Results in detecting Ships entering Le Havre and Rouen: Useful Range 10 km for Medium-Sized Ships].—Élie, Gutton, Hugon, & Ponte: S.F.R. (*Bull. de la Soc. franç. des Élec.*, April 1939, Vol. 9, No. 100, pp. 345–353.) *See* also 2805 of July.

3175. The Measurement of Distances by means of Ultra-Short Waves (Wireless Range-Finding) [Preliminary Considerations: Comparison of Frequency-Change and Pulse Methods, leading to Choice of the Former (whereas the Latter is More Convenient for Ionospheric Research): etc.].—U. Tiberio. (*Alta Frequenza*, May 1939, Vol. 8, No. 5, pp. 305–323.)

The measurement of reflection and diffraction phenomena produced by the ground and by obstacles "is of great interest for sea and air navigation, for obstacle-detection and range-finding, and for accurate measurements of high speeds." A short outline is given of a transmitter-receiver combination, in which linear frequency variations in the transmitter and in the first conversion oscillator of the receiver are obtained by special tuning condensers driven by constant-speed motors maintained in synchronisation; the presence of echoes is shown by a beat note of audio frequency, and the distance of the reflecting obstacle is given by the measurement of this frequency by a wave analyser. The resolving power which may be expected theoretically is calculated. A paper soon to be published will show how, in practice, difficulties are encountered which prevent the resolving power and sensitivity being pushed to the point which at first sight appears reasonable. "To the useful beat note there is, in fact, inevitably superposed an oscillation of very low fundamental frequency, arising from the periodic frequency variation and possessing numerous and strong harmonics which disturb the reception": *see* Fig. 4 and context. The rest of the paper deals with the theoretical calculation of the intensities of the echoes from flat rectangular obstacles, first placed orthogonally to the direction of propagation (Fig. 5) and then inclined to that direction (Fig. 7). A general relation is found for the resulting field strength, $F = \gamma . E/d^2$, where γ is a coefficient depending on the nature and disposition of the obstacle and having the physical dimension of a length. For an obstacle of effective superficial area of some hundreds of square metres, at a distance of about ten kilometres, for a "cymomotive force" of 100 v (*see* 1354 [and 1704] of 1936) the reflected field strength would work out at about 10 μv/m, "amply sufficient for our type of detection." Most of the treatment deals with 3 m waves, a 1.5 m wavelength being considered occasionally. The sharp beams of (*e.g.*) 15 cm waves, hitherto chiefly used for marine wireless "obstacle detectors" (on the lines of infra-red light-beam devices) are objected to on the grounds that they limit the power to low values as well as the sensitivity of the receiver, and that they have only a narrow angle of exploration. Later articles will deal with some special theoretical points and with the circuits, apparatus, and experimental results of researches carried out in the last three years by the Royal Naval Institute (R.I.E.C.) at Leghorn.

3176. An Interference Method for the Investigation of the Propagation of Electromagnetic Waves [and Some Tests on the Measurement of Velocity over Sea Water and of the Distance between Two Stations].—L. I. Mandelstam. (*Bull. de l'Acad. des Sci. de l'URSS, Série Physique*, No. 4, 1938, pp. 525–538: in Russian.) *See* also 3177 & 3178, below. For previous papers *see* 836/837 of 1938.

3177. On Some Application of Radio-Interference Methods [Theory: 1936/1937 Experiments on 300–700 m Waves over Distances 100–200 km across Sea: Low Precision of Distance Measurement due only to Imperfection of Apparatus: etc.].—N. D. Papalexi. (*Bull. de l'Acad. des Sci. de l'URSS, Série Physique*, No. 4, 1938, pp. 539–550: in Russian.) *See* also 3176 & 3178.

3178. Radio-Interference Distance Meters and Some Results of Distance Measurements obtained under Actual Conditions.—E. J. Schogolev [Schegolev]. (*Bull. de l'Acad. des Sci. de l'URSS, Série Physique*, No. 4, 1938, pp. 551–572: in Russian, with English summary.)

See also 3176 & 3177. The "reflecting" station was equipped with devices for maintaining perfect synchronism between the "direct" and "return" waves. Distance measurements up to 114 km over the sea showed that their accuracy did not depend on the distance. The r.m.s. error (from a series of 4–10 single measurements each taking 5–6 minutes) was 100–300 m; no dependence of the accuracy on meteorological conditions, time of day, or season, was found.

3179. The Possibilities of Ultra-Short Waves for Air Navigation [and the Three-Beam Beacon System avoiding Difficulties of Interlocking System].—F. A. Kolster. (*U.R.S.I. Proc. of* 1938 *General Assembly*, Vol. 5, Fasc. 1, 1938, pp. 136–139.)

3180. The "L.M.T." System of Blind Landing [Full Account of System as already used by Air-France for the Training of 34 Pilots over 300 Flying Hours (550 Landings)].—G. M. Perroux: Le Matériel Téléphonique. (*L'Onde Élec.*, April 1939, Vol. 18, No. 208, pp. 149–180.)

3181. Recent Developments in Aerial Navigation [including the 3-Spot C-R Blind-Landing Indicator for Use with Horn-Radiated Beams: the Stanford University 2-Rhumbatron Oscillator: etc.].—H. H. Willis. (*Proc. Inst. Rad. Eng.*, May 1939, Vol. 27, No. 5, pp. 354–355: summary only.) *Cf.* 1488 & 1489 of April.

ACOUSTICS AND AUDIO-FREQUENCIES

3182. Non-Linear Distortion introduced by the Magnetic System of an Electrodynamic Loudspeaker.—V. V. Furdeev, N. K. Mikheeva, & B. S. Grigor'ev. (*Izvestiya Elektroprom. Slab. Toka*, No. 2, 1939, pp. 25–38.)

It is pointed out that the field intensity in the magnetic gap of an electrodynamic loudspeaker is not uniform and that the usual equation (1) representing the movement of the coil is therefore not accurate. A modified equation (10) is derived and a general solution of it found (14). For the purpose of further discussion, however, a particular solution (13) is used which shows that a third harmonic of the fundamental frequency is present in the oscillations of the radiating system. Since the sound pressure is proportional to the acceleration of the radiating system the distortion introduced is determined as a ratio (15) of the maximum accelerations at the third harmonic and at the fundamental frequency. The results obtained are discussed with practical purposes in view, and a report is given on an investigation in which the distribution of the field intensity in the magnetic gap and the distortion introduced were determined experimentally for loudspeakers of various makes.

3183. Multiple Coil, Multiple Cone Loudspeakers [Double Coil, Single Cone: Single Coil, Triple Cone: Double Coil, Double Cone: and Triple Coil, Triple Cone Types, with Their Characteristics].—H. F. Olson. (*Journ. Acous. Soc. Am.*, April 1939, Vol. 10, No. 4, pp. 305–312.)

3184. The Asymptotic Properties of the Characteristic Functions of Vibrating Plates.—A. Pleijel. (*Comptes Rendus*, 15th May 1939, Vol. 208, No. 20, pp. 1549–1551.)

3185. Sound Propagation in Tubes.—Bürk & Lichte. (*Journ. Acous. Soc. Am.*, April 1939, Vol. 10, No. 4, pp. 333–334.) Long abstract of the German paper dealt with in 4391 of 1938.

3186. The Design and Calibration of Electrostatic Microphones.—E. Paolini. (*Alta Frequenza*, April 1939, Vol. 8, No. 4, pp. 219–250.)

Author's summary: Guiding principles in the design of an electrostatic microphone are described and the effects of various factors on the response curve are dealt with quantitatively. These considerations are illustrated by many practical data derived from experience. Methods of calibration [free-field and pressure-calibration systems, the latter including low and high frequency methods; bridge, thermophone, pistonphone & "membranephone" methods; and compensation, substitution, & resonance methods] are described, together with the necessary precautions to ensure exact results. The various calibration systems are compared and discussed [and it is recommended that every laboratory should have two methods available, for purposes of cross-checking].

3187. Theoretical Treatment of the Piezo-electric Diaphragm Microphone [as opposed to the "Sound Cell" Type: Deductions from Equivalent Circuit (as to Mass of Diaphragm, etc.): the Two Resonance-Curve Maxima: etc.].—P. Beerwald & H. Keller. (*Funktech. Monatshefte*, April 1939, No. 4, pp. 97–100.) For previous work *see* 564 of February.

3188. The AEG Dynamic Sucking-Coil Microphone.—H. Lauffer. (*AEG-Mitteilungen*, May 1939, No. 5, pp. 277–280.)

3189. A Small Pre-Mixing Amplifier [Type 104 A].—E. L. Owens. (*Bell Lab. Record*, April 1939, Vol. 17, No. 8, pp. 260–262.)

3190. Efficient Megaphone [with Rectangular Aperture having Its Long Dimension *Vertical*].—F. R. Watson. (*Scient. American*, May 1939, Vol. 160, No. 5, pp. 320 and 321.)

3191. Wireless Record Player for Radios [Record Player without Connecting Wires to Broadcast Receiver].—General Electric Company. (*Scient. American*, March 1939, Vol. 160, No. 3, p. 164.)

3192. The BBC Sound-Recording Service [Details of the Philips-Miller System].—A. E. Barrett. (*World-Radio*, 2nd June 1939, Vol. 28, pp. 12–13.)

3193. Reversed Speech [throws Light on Habits of Speaking, particularly if One tries Reversing the Order of Original Pronunciation so that Reproduction may give Actual Words].—E. W. Kellogg. (*Journ. Acous. Soc. Am.*, April 1939, Vol. 10, No. 4, pp. 324–326.)

3194. Rooms, Booms, and Decibels: Are "Straight-Line" Amplifiers Worth While?—N. Partridge. (*Wireless World*, 8th June 1939, Vol. 44, pp. 530–532.)

3195. Distortion in Transformer Cores: Part I—Oscillograms and What They Reveal.—N. Partridge. (*Wireless World*, 22nd June 1939, Vol. 44, pp. 572–574.)

3196. The Audibility of Sirens in the Presence of Street Noises [Experimental Observations: Practical Conclusions for Use of Sirens as Warning Signals].—P. Baron. (*Comptes Rendus*, 30th May 1939, Vol. 208, No. 22, pp. 1714–1715.)

3197. International Standard of Concert Pitch [Notes on and Recommendations of Recent International Conference].—G. W. C. Kaye. (*Nature*, 27th May 1939, Vol. 143, pp. 905–906.)

3198. Measurements on the Standard of Concert Pitch [Troubles arising from General Tendency towards Increase, with Variations in Different Countries: Efforts towards International Agreement: Method of Measurement of Pitch of Italian Broadcast Performances, and Some Results].—G. B. Madella. (*Alta Frequenza*, May 1939, Vol. 8, No. 5, pp. 300–304.) *See* also pp. 358–360 (London Meeting) and 2401 of June.

3199. The Sound of Bells: the Secondary Strike Note.—J. Arts. (*Journ. Acous. Soc. Am.*, April 1939, Vol. 10, No. 4, pp. 327–329.)

3200. Distribution of Speech Voltages in the Simultaneous Transmission of a Large Number of Conversations by Carrier Currents.—D. Thierbach & H. Jacoby. (*Ann. des Postes, T. et T.*, Feb. 1939, Vol. 28, No. 2, pp. 118–131.) Translation from the German paper in *Akust. Zeitschr.*, 1936: a shorter version was dealt with in 1430 of 1937.

3201. The AEG Tone-Pitch Recorder, on the Grützmacher-Lottermoser Principle [Upper C-R Tube (without Time Deflection) shows Fundamental Frequency Variations, Lower Tube shows Oscillogram].—E. Sohn. (*AEG-Mitteilungen*, March 1939, No. 3, pp. 222–223.) For this method of recording "melody curves" *see* 4005 of 1938 and back reference.

3202. Sound-Level Distribution Recorder [automatically registering Intensity-Level of Noise or Speech Currents in Successive Short Intervals: for Studies of Room Noise, Static, etc.].—H. Kahl. (*Bell Lab. Record*, April 1939, Vol. 17, No. 8, pp. 254–256.)

3203. A Reverberation-Time Scale for High-Speed Level Recorders.—K. C. Morrical. (*Journ. Acous. Soc. Am.*, April 1939, Vol. 10, No. 4, pp. 300–301.)

3204. The New Sound Measurement Building at Witton, with Special Reference to the Measurement of Noise in Electrical Machinery.—H. Jacoby. (*G.E.C. Journal*, May 1939, Vol. 10, No. 2, pp. 106–111.)

3205. The Absorption of Sound by Vibrating Plates backed with an Air Space [for Large Absorption over Relatively Small Range of Low Frequencies: Rigorous Theory and Approximations].—R. Rogers. (*Journ. Acous. Soc. Am.*, April 1939, Vol. 10, No. 4, pp. 280–287.)

3206. A Theoretical Determination of Sound Absorptivities by the Impedance Method, with Experimental Verification, *and* Comparison of Sound Absorption Coefficients obtained by Different Methods.—H. A. Leedy: F. J. Willig. (*Journ. Acous. Soc. Am.*, April 1939, Vol. 10, No. 4, pp. 288–292: pp. 293–299.)

3207. The Reverberation Characteristic of Large Rooms [Variation of Optimum Reverberation Time with Frequency] and the Properties of Absorbing Materials.—A. Gigli. (*Alta Frequenza*, Feb. 1939, Vol. 8, No. 2, pp. 87–97.) Derivation of the ideal characteristic: comparison with characteristics of Italian porous materials: absorption coefficients compared with those of materials from abroad.

3208. Reverberation-Time Meter [Starting & Stopping of Timing Operation occur within Meter Itself, so that No Connection to Source of Sound is required: Other Advantages].—W. M. Hall. (*Journ. Acous. Soc. Am.*, April 1939, Vol. 10, No. 4, pp. 302–304.)

3209. Contribution to the Electrical Recording of Echoes [for Reverberation-Time Measurements: Zenneck Method, using Pulses (produced by Rotating Contact-Breaker and Loudspeaker) and Oscillograph, improved by Employment of Directional Loudspeakers and Microphones, giving Easier Interpretation of Oscillograms: Desirability of Cross-Checking by replacing Pressure-Type Microphone by Pressure-Gradient Type].—S. Torelli. (*Alta Frequenza*, Feb. 1939, Vol. 8, No. 2, pp. 75–86.)

3210. A Simple Logarithmic Recording Device [Logarithmic Amplifier and Continuously Recording (on Photographic Strip) Galvanometer: for Sound Decay Curves, etc.].—R. Rogers & F. J. Willig. (*Review Scient. Instr.*, May 1939, Vol. 10, No. 5, pp. 150–151.)

3211. Synthetic Reverberation [by 20″-Diam. Rotating Disc, with Fluorescent Material around Periphery, acted on by Light modulated by Signal, and acting on Photocells].—P. C. Goldmark & P. S. Hendricks. (*Proc. Inst. Rad. Eng.*, May 1939, Vol. 27, No. 5, p. 354: summary only.)

3212. Mechanical and Electrical Analogies of the Acoustical Path.—H. L. Saxton. (*Journ. Acous. Soc. Am.*, April 1939, Vol. 10, No. 4, pp. 318–323.)

3213. Equipment for Automatic Measurement of Audio-Frequency Circuits.—Columbia Broadcasting System. (*Proc. Inst. Rad. Eng.*, April 1939, Vol. 27, No. 4, p. ii.)

3214. An Investigation of the Accuracy of König's Formula for the Rayleigh Disc [Discrepancy between Theory and Experiment due to Formation of Vortices in Medium near Disc: Empirical Equation for Low Frequencies].—A. C. Merrington & C. W. Oatley. (*Proc. Roy. Soc.*, Series A, 21st April 1939, Vol. 170, No. 943, p. S 37: abstract only.)

3215. The "Multitone" [giving Eleven Equi-Amplitude Tones spaced equally over Given Frequency Band: using Shock-Excited Oscillators (by Rotating Commutator, without Valves of Any Kind) giving "Surprisingly Pure" Sinusoidal Voltage].—W. L. Barrow. (*Journ. Acous. Soc. Am.*, April 1939, Vol. 10, No. 4, pp. 275–279.)

3216. The 17B Oscillator [Frequencies 1–150 kc/s].—Means. (*See* 3274.)

3217. On Sound Localisation.—H. Wallach. (*Journ. Acous. Soc. Am.*, April 1939, Vol. 10, No. 4, pp. 270–274.)

3218. The Mechanism of Hearing by Electrical Stimulation.—Stevens & Jones. (*See* 3119.)

3219. Microphonic Potentials from the Utricle [are not Absolute Indication of Reception of Acoustic or Vibratory Stimuli: Experiments on Teleost Fish].—R. J. Pumphrey. (*Nature*, 27th May 1939, Vol. 143, pp. 898–899.)

3220. "Frequency Discrimination" in Insects: a New Theory [Evidence for Rectifying Action of Tympanic Organ: High Frequencies emitted by Stridulating Insect probably act as Carrier for L.F. Modulation].—R. J. Pumphrey & A. F. Rawdon-Smith. (*Nature*, 13th May 1939, Vol. 143, pp. 806–807.)

3221. Sound Propagation in the Atmosphere.—Waetzmann, Scholz, & Krüger. (*Journ. Acous. Soc. Am.*, April 1939, Vol. 10, No. 4, pp. 334–335.) Long abstract of the German paper dealt with in 4390 of 1938.

3222. Velocity of Sound in Air [Survey and Conclusions].—W. H. Pielemeier. (*Journ. Acous. Soc. Am.*, April 1939, Vol. 10, No. 4, pp. 313–317.)

3223. Remarks on the Anomalous Damping of Ultrasonic Waves [in Light Gases: Possible Cause may be Fluctuations in Gas].—O. Halpern. (*Phys. Review*, 1st May 1939, Series 2, Vol. 55, No. 9, pp. 881–882.)

3224. Telephony in the United States [Notes on 1938 Report of A.T. & T. Co.].—(*Nature*, 27th May 1939, Vol. 143, p. 906.)

PHOTOTELEGRAPHY AND TELEVISION

3225. On the Image Defects of Magnetic Deflecting Fields.—G. Wendt. (*Telefunken-Röhre*, April 1939, No. 15, pp. 100–132.)

Author's summary:—Starting from the Fermat principle and the corresponding Euler-Lagrange equations of motion, and employing the expression for the refraction exponent given by Glaser and valid for electron-optics, a theory of geometrical electron-optics for magnetic deflecting organs is developed, for which exponential series are set up for the three components of the magnetic vector potential of a symmetrical deflecting system. For paraxial rays and small angles of deflection a distortionless deflection, proportional to the current, is obtained: this, by analogy with the rotation-symmetrical lens in optics, is given the name "Gaussian deflection." The use of further terms of the series developments leads to "deflection errors of the third order," which correspond to the distortion, coma, astigmatism, and field curvature of rotation-symmetrical lenses; naturally a few variations occur as a result of the three-parameter nature of the field (*e.g.* an ellipse in place of a circle as distortion figure, etc.). Spherical aberration and anisotropic coma do not occur. Experimental confirmation on two strongly distorting deflecting systems showed that the theory can usefully be employed for deflecting fields met with in practice.

3226. LINE DEFLECTORS: GENERAL PRINCIPLES OF THE MAGNETIC TYPE.—D. V. Ridgeway. (*Wireless World*, 15th June 1939, Vol. 44, pp. 550–553.) From the Baird laboratories.

3227. RADIAL SCANNING: AVOIDING THE NEED FOR FLY-BACK.—(*Wireless World*, 15th June 1939, Vol. 44, p. 555.) Patent No. 492 302.

3228. NON-LINEAR DISTORTION IN TELEVISION [and the Development of "Contrastor" Circuits].—P. A. Stromberg. (*Izvestiya Elektroprom. Slab. Toka*, No. 2, 1939, pp. 50–58.)

It is shown that non-linear distortion introduced by television apparatus alters the contrast distribution (gamma) of the image but does not affect the shape of the transmitted figures. A report is then presented on the distortion observed in the two RCA television transmitters installed in Moscow, special attention being paid to distortion introduced by the iconoscope and kinescope. Methods used for improving the quality of transmission are discussed, and the paper is concluded by a description of circuits, called "contrastors," developed by the author for controlling the amplitude of the television channel. *Cf.* Maloff, 3229, below.

3229. GAMMA [Contrast] AND RANGE IN TELEVISION [Television, being Monochromatic System, must follow Black-and-White Moving-Picture Technique in making Over-All Object/Image Contrast between 1.4 and 2, to compensate for Lack of Colour: Iconoscope has Low-Gamma Characteristic: the Question of Correction by the Kinescope: etc.].—I. G. Maloff. (*RCA Review*, April 1939, Vol. 3, No. 4, pp. 408–417.) *Cf.* Stromberg, 3228, above.

3230. ANALOGIES IN RADIO AND PHOTOGRAPHY, AND PROBLEMS OF REPRODUCTION OF TELEVISION IMAGES.—B. Dudley. (*Proc. Inst. Rad. Eng.*, May 1939, Vol. 27, No. 5, p. 355: summary only.)

3231. ON THE STUDY OF THE DISTORTIONS OF MODULATION DUE TO THE TRANSMISSION CIRCUITS OF MODULATED HIGH FREQUENCIES [of Special Interest for Television].—H. Cafferata: Varaldi-Balaman. (*L'Onde Élec.*, April 1939, Vol. 18, No. 208, pp. 187–192.) Correspondence on the paper dealt with in 3673 of 1938: Cafferata suggests certain inconsistencies in the treatment of phase distortion which are liable to lead to confusion, and also queries a second point: the author replies.

3232. ON THE "SENSE" OF THE MODULATION IN TELEVISION [Comparative Merits of "Positive" and "Negative" Modulation, as regards Quality, Economy, Behaviour to Parasitic Disturbances, and the Use of AVC in Receivers: the Choice made by Various Countries].—R. Barthélémy. (*Bull. de la Soc. franç. des Élec.*, April 1939, Vol. 9, No. 100, pp. 365–373.)

3233. THE HISTORICAL DEVELOPMENT OF THE INTERLACED SCANNING METHOD [with Patent References, starting with Nipkow (1884), Walton (1923), and Baird (1926)].—F. Raeck. (*Funktech. Monatshefte*, April 1939, No. 4, Supp. pp. 25–29.)

3234. THE PROBLEM OF SYNCHRONISATION OF TELEVISION RECEIVERS.—P. Mandel. (*Bull. de la Soc. franç. des Élec.*, April 1939, Vol. 9, No. 100, pp. 375–385.)

Author's summary:—It may be concluded that any of the three systems here considered [German P.O., Marconi–E.M.I., and the "internal dephasing" system of the Compagnie des Compteurs] will give stability and good interlacing if the synchronising impulses are used judiciously. The transmission of the "mean brightness" which is necessary for the correct reproduction of the primary image is not indispensable for the correct functioning of the interlacing. It is, on the other hand, advantageous to bring the synchronising impulses, before their separation, to a fixed level which is independent of the usual variables of reception. The maintenance of the steep front of the impulses is necessary. Separation by integration, being only an approximate solution, is reserved for less perfect apparatus ["according to our experience, this system is incapable of satisfying the conditions of performance of a television receiver as previously defined"].

3235. NOISE IN TELEVISION RECEIVERS: SOME UNSUSPECTED CAUSES OF INTERFERENCE.—S. West. (*Wireless World*, 15th June 1939, Vol. 44, pp. 563–564.)

3236. THE TELEVISION RADIO LINK [Difficulties in the Operation of 4.5 m Ultra-Short-Wave Link for O.Bs: Four Types of Interference, Their Diagnosis and Cure].—T. C. Macnamara. (*World-Radio*, 16th June 1939, Vol. 28, pp. 12–13.)

3237. A DISCUSSION OF THE RCA TELEVISION EXHIBIT AT THE SAN FRANCISCO WORLD'S FAIR.—C. Davis. (*Proc. Inst. Rad. Eng.*, May 1939, Vol. 27, No. 5, pp. 352–353: summary only.)

3238. THE MARCONI–E.M.I. AUDIO-FREQUENCY EQUIPMENT AT THE LONDON TELEVISION STATION.—I. L. Turnbull & H. A. M. Clark. (*Nature*, 13th May 1939, Vol. 143, p. 817: note on recent I.E.E. paper.)

3239. TRANSMISSION LINES AS COUPLING ELEMENTS IN TELEVISION EQUIPMENT [Simplified Formulae for Transmission-Line Computations: Measurement of Principal T.L. Characteristics: Line-Coupling Stages and Their Requirements].—S. W. Seeley & C. N. Kimball. (*RCA Review*, April 1939, Vol. 3, No. 4, pp. 418–430.)

3240. SOME SPECIAL POINTS RELATING TO THE INSTALLATION OF THE PARIS/VIERZON CABLE [containing Concentric Pair].—P. Desjoyeaux & J. Tardy. (*Ann. des Postes, T. et T.*, March 1939, Vol. 28, No. 3, pp. 175–210.)

3241. Reflection Waves on Quasi-Homogeneous Lines: the Case of Television Transmissions by Coaxial Cable: Part II—Irregularities of the Coaxial Circuit and Their Effects on Television.—L. Aguillon. (*Ann. des Postes, T. et T.*, March 1939, Vol. 28, No. 3, pp. 143–174.) Concluded from 1083 of March. Some corrections to the previous part are given on pp. 173–174.

3242. Non-Stationary Phenomena and Distortion introduced by Television Amplifiers at High Frequencies.—O. B. Lurje. (*Journ. of Tech. Phys.* [in Russian], No. 1, Vol. 9, 1939, pp. 3–18.)

It is pointed out that the distortion introduced by a system can be determined by operational calculus from an examination of the transient curve, *i.e.* of the output-current curve corresponding to the unit impulse applied to the input of the system. A formula (1′) is derived determining the transient curve for a multi-stage television amplifier incorporating compensating circuits for h.f. operation (Fig. 1).

The duration of the building-up period of the curve and the oscillatory nature of this process are discussed separately, from the point of view of distortion due to these factors. Methods are then indicated for desiging amplifiers both with and without compensating circuits, for obtaining a building-up period of definite duration for a given maximum amplitude reached by the transient curve during this period. The paper ends with a discussion on the minimum possible duration of the building-up period, as determined by the amplification factor of the amplifier.

3243. Transient Response of Multi-Stage Video-Frequency Amplifiers [Heaviside Unit Voltage as Best Criterion of Fidelity: Objections to Operational Method and to Fourier Integral Formulation, for Calculation of Response: the Steady-State Square-Wave Formulation and Its Use: Some Results: Practicability of Oscillographic Determination].—A. V. Bedford & G. L. Fredendall. (*Proc. Inst. Rad. Eng.*, April 1939, Vol. 27, No. 4, pp. 277–284.)

3244. Corrections to "Analysis and Design of Video Amplifiers."—Seeley & Kimball. (*RCA Review*, April 1939, Vol. 3, No. 4, p. 504.) *See* 2017 of May.

3245. Measurement of Phase Shift in Television Amplifiers [Expansion of Conventional Oscilloscopic Method: Technique for Measurement of Video Amplifiers, Picture I.F. Amplifiers, etc: Technique for Small Phase Shifts: Some Resulting Values].—A. A. Barco. (*RCA Review*, April 1939, Vol. 3, No. 4, pp. 441–452.)

3246. A Wide-Range Video Amplifier for a Cathode-Ray Oscilloscope [Flat Response from 30 c/s to 7 Mc/s, with Approximately Linear Phase-Shift: for 9-Inch Oscilloscope, for the Testing of High-Definition Television Systems].—A. Preisman. (*RCA Review*, April 1939, Vol. 3, No. 4, pp. 473–485.)

3247. Iconoscopes [New Types 1849 and 1850].—RCA Manufacturing Company. (*Proc. Inst. Rad. Eng.*, April 1939, Vol. 27, No. 4, pp. ii ... vi.)

3248. Contribution to the Technique of Measurement of the Secondary Emission of Electrons.—W. Majewski. (*Acta Physica Polonica*, Fasc. 4, Vol. 7, 1939, pp. 327–339: in French.)

"The phenomenon of secondary emission is poorly understood at present. Such experimental facts as we have on the subject are incomplete and lend themselves badly to a uniform explanation. Nor is the technique of the measurement of this phenomenon either sufficiently elaborated or appropriate to actual needs." The writer describes his investigations on two experimental tubes, to see how suitable they were for the precise measurement of secondary emission. The first is shown in Fig. 1 (circuit Fig. 2): the electrons from the incandescent filament in the bulbous part of the valve are concentrated into a beam which passes into the electric and magnetic fields in the cylindrical part, containing the three targets "1," "2," & "3"; the trajectory of the beam in relation to these can be varied by adjusting the conditions of the fields, so that (for instance) almost all the electrons may be made to reach the target "1" and provoke secondary emission from its surface. This type of tube has the advantage of giving the worker much liberty in varying the conditions, and of having the beams of primary and secondary electrons separated over nearly the whole length of their trajectories.

The second tube (Fig. 8) is of the Farnsworth dynamic multiplier type. The photocathode K which provides the primary electrons is of the silver-caesium type (prepared as described on pp. 337–338): K_1 is the plate whose coefficient of secondary emission, δ_1, is to be measured according to eqn. 9.

3249. A Regenerative Photocell [Primary Photoelectron Stream, amplified by Secondary Emission, acts on Fluorescent Screen which acts back onto Photocathode: Saturation prevented by "Quenching Frequency"].—(*Wireless World*, 1st June 1939, Vol. 44, p. 506.) Patent No. 499 661.

3250. New Composite Photocathodes [especially the Antimony–Caesium Cathode].—N. S. Khlebnikov & N. S. Zaytsev. (*Journ. of Tech. Phys.* [in Russian], No. 1, Vol. 9, 1939, pp. 44–62.)

A report is presented on an experimental investigation of the Sb–Cs, Bi–Cs and Sb–Rb photocathodes. A new method for preparing these cathodes is described, and their properties are discussed. It appears that they possess a very high selectivity; their integral sensitivity greatly exceeds that of any other cathodes and in the case of the Sb–Cs cathode may reach 80 μA/Lm (for voltages around 100 v; for voltages of about 1000–1500 v it may reach 300–400 μA/Lm). The integral sensitivity of these cathodes can be further increased by oxygen treatment.

The volt/ampere characteristics of the Sb–Cs cathodes do not have the shape of a saturation curve but usually fall abruptly at a certain voltage

(Fig. 5). Another important feature of the Sb–Cs cathodes is that they do not show any signs of fatigue even under strong illumination.

The structure of these cathodes and the various processes taking place in them are discussed in detail, and the general conclusion reached by the authors is that cathodes of this type will find very wide application. *Cf.* Gopstein & Khorosh, 2867 of July.

3251. The Spectral Intensity Distributions of Selenium Barrier-Layer Cells [Measurements with Normal Selenium Photo-elements: Maximum of CdSe-Film at Shorter Wavelength than That for Normal Photoelement: Production of Longer-Wave Maximum by Introduction of Cd Disturbing Centres].—P. Görlich. (*Zeitschr. f. Phys.*, No. 7/8, Vol. 112, 1939, pp. 490–500.)

3252. Note on Copper/Cuprous-Oxide Photo-cells [Interpretation of Behaviour in Terms of Theory of Contact between Metal and Semiconductor].—N. F. Mott. (*Proc. Roy. Soc.*, Series A, 6th June 1939, Vol. 171, No. 946, pp. 281–285.)

3253. The Mean Free Path of Electrons in Polar Crystals [Theoretical Calculation: Comparison of Results with Experiments on Semiconductors and Photoconductors].—H. Fröhlich & N. F. Mott. (*Proc. Roy. Soc.*, Series A, 21st April 1939, Vol. 170, No. 943, p. S 36: abstract only.)

3254. The Colour Centres in KCl Crystals with Small Additions of Alkaline-Earth Chlorides [Absorption Bands: Properties: Atomistic Interpretation of Absorption Centres].—H. Pick. (*Ann. der Physik*, Series 5, No. 1, Vol. 35, 1939, pp. 73–83.)

3255. The Reception of Positive Images in Picture-Telegraphy Transmissions.—W. Heintze & H. Schönfeld. (*E.N.T.*, April 1939, Vol. 16, No. 4, pp. 87–91.)

In telegraphic transmissions of pictures it is desirable to be able to receive either a positive or a negative image without any intermediate photographic processes. Hitherto only negative reception with more or less correct tone values has been possible; this paper describes the positive reception recently developed. For positive reception it is necessary for the illumination intensity of the original picture to fall as the received voltage increases. The exact connection between these quantities required for positive reception with correct tone values is investigated in § II; calculations are given which show that a hyperbolic relation must exist between illumination and voltage (eqn. 5; Fig. 1). The experimental curve shows a steeper rise of the vertical branch; reasons for this are given. Fig. 2 shows the curves for the best use of the control range between minimum and maximum light intensities, depending on the degree of contrast in the original picture. The means for attaining the desired illumination/voltage relation are discussed in § III; optical distortion can be used to give the hyperbolic curve (Fig. 3; Fig. 4, stop giving correct tone values). Electric distortion however appears preferable (Fig. 5, distortion curve; Fig. 6, fundamental circuit). Fig. 7 shows the tone-correct image received from a normal object picture, Fig. 8 the image with improved contrast which can be obtained from a flat original.

3256. Automatic Facsimile Telegraph [at Essex House, New York].—Western Union. (*Scient. American*, May 1939, Vol. 160, No. 5, p. 312.)

3257. Improved Methods of Illumination for the Measurement of Accidental [Magnetic, Electric & Mechanical] Double Refraction.—Y. Björnståhl. (*Journ. Opt. Soc. Am.*, May 1939, Vol. 29, No. 5, pp. 201–207.)

3258. Illumination by Luminescence [Survey, leading up to the New "Fluorescent" Lamps].—A. Claude. (*Bull. de la Soc. franç. des Élec.*, April 1939, Vol. 9, No. 100, pp. 307–336: Discussion pp. 337–342.)

MEASUREMENTS AND STANDARDS

3259. A New H.F. Method of Measurement [of Voltages and Frequencies] using the Dielectric Heat Losses.—F. W. Gundlach. (*Hochf:tech. u. Elek:akus.*, May 1939, Vol. 53, No. 5, pp. 162–165.)

The method is based on a dielectric thermal transformer, of which various forms are shown in Fig. 1; it consists essentially of a bead of a dielectric such as glass, into which two h.f. electrodes and a thermoelement are fastened by melting the glass round them. The h.f. current between the electrode heats the glass, which in turn heats the thermoelement, whose rise in temperature can be measured. The theoretical principles are given in § II. Eqn. 5 shows that with constant frequency the thermal transformer acts as a voltmeter with quadratic calibration curve; with constant voltage, it acts as a frequency meter with linear calibration curve. The upper limit of the measuring range is given by the point of heat breakdown of the dielectric (Fig. 3). The practical construction is described in § III; the required properties of the glass are found to be best fulfilled by the glass used for ordinary apparatus. The glass bead and the wires it holds must have the smallest possible dimensions. Possible fields of application of the method are discussed in § IV; the chief is voltage measurement at extremely high frequencies. Its advantages over the valve voltmeter are summarised; its disadvantage lies in the fact that its voltage calibration depends on frequency.

3260. Thermopile for Low Temperature Radiation Measurements [Sensitivity 997 μV/cal/sq.cm/sec.].—I. M. Moriyama. (*Review Scient. Instr.*, May 1939, Vol. 10, No. 5, p. 164.)

3261. Double-Diode Field-Strength Measurements in the Lower Decimetre Wave-Band.—P. Santo Rini. (*Hochf:tech. u. Elek:akus.*, May 1939, Vol. 53, No. 5, pp. 157–159.)

The principle of this aperiodic double-diode circuit for relative field-strength measurements in the lower decimetre wave-band is shown in Fig. 3; a detector is connected to each half of the receiving dipole and an indicating instrument to the centre point. Its advantages and disadvantages are enumerated. The principle is applied in the development of a double-diode circuit for the micro-wave range (Fig. 5; § II); it uses acorn valves as detectors and can be used for wavelengths down to 16 cm. With acorn valves the initial current is high (Figs. 7, 8); in Fig. 5 use is made of the filament heating battery to compensate it, or it may be used to indicate the correct adjustment of the filament voltage to render the measurements reproducible. An example of the use of the circuit is the measurement of the directional characteristic of a paraboloidal mirror on a wavelength of 16 cm (Fig. 10; § III).

3262. FIELD-STRENGTH MEASURING EQUIPMENT FOR WIDE-BAND ULTRA-HIGH-FREQUENCY TRANSMISSION [Transmitter Frequency varied (by 166 kc/s per Second) from 81 to 86 Mc/s and from 140 to 145 Mc/s: Field Strength measured and recorded Automatically at Each 70 kc/s Increment, as Signal Frequency passes through Receiver Pass-Band].—R. W. George. (*RCA Review*, April 1939, Vol. 3, No. 4, pp. 431–440.) 70 measurements were recorded in half a minute. Used for a study of Empire State Buildings transmissions (*see* also 3109, above).

3263. MEASUREMENT OF PHASE SHIFT IN TELEVISION AMPLIFIERS.—Barco. (*See* 3245.)

3264. WIDE-BAND VARIABLE-FREQUENCY TESTING TRANSMITTERS [for Ultra-Short Waves].—Usselman. (*See* 3109.)

3265. MEASUREMENTS OF ADMITTANCES AT ULTRA-HIGH FREQUENCIES [Substitution Method using Resonant Line (Length less than $\lambda/4$) formed by Copper Rod above Brass Bed-Plate: Dielectric Constants and Power Factors of Several Insulators at 60 & 120 Mc/s: Tests at Different Temperatures: Measurement of Input & Output Impedances of Valves].—J. M. Miller & B. Salzberg. (*RCA Review*, April 1939, Vol. 3, No. 4, pp. 486–504.)

3266. RESISTANCE AND PERMEABILITY MEASUREMENTS AT ULTRA-HIGH FREQUENCIES [by Simple, Accurate Method (Test Material forms Inner Conductor of Concentric Resonant Line): Magnetic Permeability rather Lower than with D.C. but apparently Unchanged between 117 and 261 Mc/s: Effects of Oxidising, Roughening, Annealing, Tinning, & Copper-Plating on H.F. Resistance: etc.].—P. D. Zottu. (*U.R.S.I. Proc. of* 1938 *General Assembly*, Vol. 5, Fasc. 1, 1938, pp. 190–204.) An extended version will appear in the *RCA Review*.

3267. THE INNER, INITIAL, MAGNETIC PERMEABILITY OF IRON AND NICKEL AT ULTRA-HIGH RADIO-FREQUENCIES [New Method of Measurement using Coaxial Cable, Fine Central Wire, Correction for Finite Conductivity of Resonance System: Results: Effect of External Magnetic Fields, Tension Changes, Temperature].—J. L. Glathart. (*Phys. Review*, 1st May 1939, Series 2, Vol. 55, No. 9, pp. 833–838.)

3268. ON ELECTRIC WAVES IN SINGLE-WIRE AND PARALLEL-WIRE SYSTEMS: PERMEABILITY OF IRON AND NICKEL.—Lindman. (*See* 3026.)

3269. THE MEASUREMENT OF MAGNETIC SATURATION INTENSITIES AT DIFFERENT TEMPERATURES [New Method applicable to Small Quantities of Substance].—W. Sucksmith. (*Proc. Roy. Soc.*, Series A, 21st April 1939, Vol. 170, No. 943, pp. 551–560.)

3270. THE DETERMINATION OF THE OPERATING CHARACTERISTICS OF POWER VACUUM TUBES, *also* PREDETERMINATION OF THE PERFORMANCE OF R.F. AMPLIFIERS, *and* IMPROVEMENTS IN THE MEASUREMENT OF THE DIRECT INTER-ELECTRODE CAPACITANCES OF VACUUM TUBES.—Chaffee: Roys: Williams & Soukaras. (*See* 3167/3169.)

3271. ATTENUATION MEASUREMENT BY THE QUOTIENT METHOD [Correction to Formula].—G. Opitz. (*Hochf:tech. u. Elek:akus.*, May 1939, Vol. 53, No. 5, p. 171.) *See* 2046 of May (*also* 2906 of July).

3272. STANDARDISATION OF TESTS ON RECEIVERS.—Société des Radioélectriciens. (*See* 3135.)

3273. THE RIDER "VOLTOHMSYST" [Sensitive Meter with High Input Resistance: can be connected to AVC, etc., in Operation without affecting Performance].—(*Wireless World*, 1st June 1939, Vol. 44, p. 512.)

3274. THE 17B OSCILLATOR [for Various Testing Purposes: Range 1–150 kc/s, accurate to 25 c/s: Output (adjustable from 1–1000 Milliwatts) Flat to within 1 db from 3–150 kc/s].—W. J. Means. (*Bell Lab. Record*, May 1939, Vol. 17, No. 9, pp. 291–296.)

Using a condenser having a temperature coefficient of under 3 parts in a million per deg. F. (rotor plates alternately aluminium alloy and invar).

3275. ON AN ARRANGEMENT FOR THE CONTROL OR MEASUREMENT OF VERY SMALL ALTERNATING CURRENTS [without Use of Amplifiers].—E. Gambetta. (*L'Onde Élec.*, May & June 1939, Vol. 18, Nos. 209 & 210, pp. 212–228 & 278–286.)

"The method presented enables one to obtain, in the measurement [or control] of alternating currents and by the use of ordinary apparatus, a high sensitivity, constant even in the neighbourhood of zero current, and of the order of that given by galvanometers in the measurement of direct currents." The principle consists in superposing the current in question on a constant auxiliary alternating current which passes through a sensitive device (preferably of square-law response), which is of such a value as to bring the device to its most sensitive condition, and whose effect on the indicating instrument connected to the device is already compensated. The current under investigation will then produce a new deflection which, for small values of the current, will be practically proportional to it. The two types of sensitive device considered are the thermocouple and the rectifier-type meter.

3276. Measurement of Broadcast Coverage and Antenna Performance: Part III.—Fitch & Duttera. (*See* 3362.)

3277. The Daily Transmission by the Deutschlandsender of the Standard Frequency 1000 c/s and the Tuning Note 440 c/s from the Quartz Clocks of the Phys.-Tech. Reichsanstalt.—A. Scheibe. (*Hochf:tech. u. Elek:akus.*, May 1939, Vol. 53, No. 5, pp. 145–146.)

Notes on the accuracy of the clocks and the emitted frequencies, the availability of the service, the possibility of discovering changes in frequency during passage through the ionosphere by reception of the space wave, etc.

3278. The Control Apparatus for the Emission of Standard Frequencies by the Deutschlandsender.—U. Adelsberger. (*Hochf:tech. u. Elek:akus.*, May 1939, Vol. 53, No. 5, pp. 146–150.)

For the quartz clocks used for these frequency emissions *see* 1934 Abstracts, p. 278, and 3113 (also 3539) of 1936. Here, apparatus is described which is designed to produce the tuning note 440 c/s from the clocks' standard frequency, 1000 c/s. For the apparatus to be trustworthy it is necessary to use the lowest possible current and voltage loads on the amplifier valves, and to provide for inspection when working and for the switching-in of another quartz clock when a replacement is required. The bearing of these requirements on the design of the apparatus, the production of the frequency 440 c/s from the standard 1000 c/s, and the purification of the frequencies, are discussed in §1.2. The construction of the apparatus is described in §II (scheme Fig. 1); its parts are (1) 1000-c/s pre-amplifier with an amplifier for 1000 c/s at the end of the stage, (2) tuning-note generator controlled by the 1000-c/s frequency with an intermediate frequency 11 000 c/s and amplifier at the end of the stage, (3) energy supply with mains connection through a rectifier, a filter, and regulating devices. These are described in detail; the method of inspection is given in §III. The accuracy of the emitted frequencies is found to be from $1–2 \times 10^{-8}$.

3279. Remark on Rohde's Paper on "New Types of Quartz Oscillators . . ." [Quartz Clocks referred to as using the Soldering Type of Holder are Not Those of the Physikalisch-Technische Reichsanstalt].—A. Scheibe & U. Adelsberger: Rohde. (*Zeitschr. f. tech. Phys.*, No. 6, Vol. 20, 1939, p. 188.) *See* 2456 of June.

3280. Torque between Concentric Single-Layer Coils [Small Correction Terms for Formulae for Torque or Mutual Inductance: including Corrections for Imperfect Centering and Effect of Lead-in Wires].—C. Snow. (*Journ. of Res. of Nat. Bur. of Stds.*, May 1939, Vol. 22, No. 5, pp. 607–626.)

3281. An Absolute Determination of the Ampere, using Improved Coils.—Curtis & others. (*Journ. of Res. of Nat. Bur. of Stds.*, May 1939, Vol. 22, No. 5, pp. 485–517.)

3282. "National Physical Laboratory, Collected Researches, Volume 24: Standards" [Book Review].—N. P. L. (*Proc. Inst. Rad. Eng.*, April 1939, Vol. 27, No. 4, p. 295.)

3283. Instruments incorporating Thermionic Valves, and Their Characteristics.—James, Warren, & Polgreen. (*G.E.C. Journal*, May 1939, Vol. 10, No. 2, pp. 112–123.) Part I of the full paper, summaries of which were referred to in 1922 of May.

3284. Remarks on the Damping of Measuring Instruments.—Iliovici. (*Bull. de la Soc. franç. des Élec.*, April 1939, Vol. 9, No. 100, pp. 355–364.)

3285. The Dielectric Constants of the Ammonium Halides.—R. Guillien. (*Comptes Rendus*, 15th May 1939, Vol. 208, No. 20, pp. 1561–1563.)

SUBSIDIARY APPARATUS AND MATERIALS

3286. A Multi-Way Electronic Commutator for the Simultaneous Recording of Several Phenomena by the Cathode-Ray Oscillograph.—Vogel. (*Bull. de la Soc. franç. des Élec.*, Feb. 1939, Vol. 9, No. 98, pp. 151–154.)

This is the arrangement referred to in 2943 of July. It is developed from the more usual two-way commutator circuit in which two amplifier valves are alternately blocked by a common oscillator, the blocking frequency being made high compared with the sweep frequency. The multi-way arrangement consists of a chain of blocking oscillators controlling one another. "Fig. 7 represents, at 'a,' the oscillation of a first oscillator of this type; at 'b' the differentiation (*e.g.* by capacitive coupling) of the preceding curve; after detection, curve 'c' remains which, applied to the second blocking oscillator, gives the phase-displaced impulses 'd,' and so on. By blocking the various amplifiers by the corresponding oscillators, the spot will pass from one curve to another in a definite order and in very constant times, whatever the number of 'ways' chosen may be." This note occurs in the discussion of the paper by Pérès & Malavard (3299, below.).

3287. Discussion on "Considerations on the Recording of Transient Phenomena by the Cathode-Ray Oscillograph" [Question of Screens with Long Persistence].—Vogel. (*Bull. de la Soc. franç. des Élec.*, Feb. 1939, Vol. 9, No. 98, p. 217.) *See* 916 of March. A typographical error in this paper is here corrected in a footnote.

3288. The Problems of the Suppression of Interference in Cathode-Ray Oscillographs [Disturbances due to the Saw-Tooth Time-Base Circuit, arriving by the Mains and by Radiation, or by Action on the Amplifier through Induction between Leads, etc.].—Nentwig. (*Funktech. Monatshefte*, April 1939, No. 4, pp. 124–125).

3289. A WIDE-RANGE VIDEO AMPLIFIER FOR A CATHODE-RAY OSCILLOSCOPE.—Preisman. (*See* 3246.)

3290. ON THE IMAGE DEFECTS OF MAGNETIC DEFLECTING FIELDS.—Wendt. (*See* 3225.)

3291. ELECTRON-OPTICAL SPECTRUM ANALYSIS OF [Ultra-] HIGH-FREQUENCY OSCILLATIONS [by the "Inversion Spectrograph"].—Hollmann & Thoma. (*See* 3077.)

3292. PROPERTIES OF THE SUPER-MICROSCOPIC IMAGE [Image Production in Super-Microscope: Sharpness with Depth: Contrast: Contours: Absorption of Energy and Charge by the Objects].—von Borries & Ruska. (*Naturwiss.*, 5th May 1939, Vol. 27, No. 18, pp. 281–287.) *See* also 1666 of April.

3293. THE TECHNIQUE OF SUPER-MICROSCOPIC INVESTIGATIONS [Preparation and Treatment of Films carrying the Objects: Method of Focusing with Objects which are Weak in Contrast].—Ruska. (*Naturwiss.*, 5th May 1939, Vol. 27, No. 18, pp. 287–292.)

3294. THE METHOD OF RENDERING VEGETABLE VIRUS [Tobacco Mosaic, etc.] VISIBLE IN THE SUPER-MICROSCOPE.—Kausche, Pfankuch, & Ruska. (*Naturwiss.*, 5th May 1939, Vol. 27, No. 18, pp. 292–299.)

3295. THE DISINTEGRATION OF ZINC SULPHIDE BY ALPHA RAYS.—Streck. (*Ann. der Physik*, Series 5, No. 1, Vol. 35, 1939, pp. 58–64.)

3296. DECAY OF WILLEMITE AND ZINC SULPHIDE PHOSPHORS [Measured Values of Decay Rates show Silicates in Different Class from Sulphides, Whose Initial Decay Rate depends on Current Density].—Johnson. (*Phys. Review*, 1st May 1939, Series 2, Vol. 55, No. 9, p. 881.) *Cf.* 2932 (Ramberg & Morton) and 2938 (Nelson & Johnson), both of July.

3297. EFFECT OF THE ELECTRIC FIELD ON THE FORM OF THE EMISSION BANDS IN ELECTROPHOTOLUMINISCENCE [Luminescence excited by Sole Action of Intense Varying Electric Field].—Destriau & Loudette. (*Comptes Rendus*, 15th May 1939, Vol. 208, No. 20, pp. 1569–1571.) Continued from 2500 of June.

3298. OPTICAL LEVERS [for Oscillographs, Galvanometers, etc: Cylindrical-Mirror Arrangement giving Greatly Decreased Loss of Light, and Coincidence Method for Null-Point Measurements].—Mathews. (*Journ. Scient. Instr.*, April 1939, Vol. 16, No. 4, pp. 124–125.)

3299. DISCUSSION ON "THE METHOD OF RHEOGRAPHIC AND RHEOMETRIC ANALOGIES."—Pérès & Malavard. (*Bull. de la Soc. franç. des Élec.*, Feb. 1939, Vol. 9, No. 98, pp. 145–154.) *See* 4545 of 1938.

3300. NEWEST VACUUM PUMPS CREATE LOW PRESSURE [5×10^{-8}mm Hg without Liquid-Air Cooling Traps: the New Oil-Diffusion Pumps].—Hickman & others. (*Scient. American*, May 1939, Vol. 160, No. 5, pp. 316–317.)

3301. ZIGZAG AND HELICAL SPRINGS [for supporting Current-Carrying Filaments]: ELASTIC PROPERTIES OF MOLYBDENUM.—Tawney. (*Review Scient. Instr.*, May 1939, Vol. 10, No. 5, pp. 152–159.)

3302. CONDITIONS FOR PRODUCING INTENSE IONIC BEAMS, *and* FOCUSED BEAM SOURCE OF HYDROGEN AND HELIUM IONS.—Smith & Scott: Scott. (*Phys. Review*, 15th May 1939, Series 2, Vol. 55, No. 10, pp. 946–953: pp. 954–959.)

3303. THE THEORY OF THE ION CURRENT IN THE MAGNETRON AS APPLIED TO THE SOURCE OF IONS.—Sitnikov. (*Bull. de l'Acad. des Sci. de l'URSS, Série Physique*, No. 4, 1938, pp. 515–518: in English.) The original Russian paper was dealt with in 2085 of May: *cf.* also 2084 of May.

3304. TRANSPORT OF ELECTRIC CHARGES BY DROPLETS [Conditions for Use in Electrostatic Generators].—Moreau-Hanot. (*Comptes Rendus*, 8th May 1939, Vol. 208, No. 19, pp. 1492–1494.) A mixture of carbon tetrachloride and vaseline oil was investigated, with a view to the use of liquid particles instead of the solid particles previously employed (3451 of 1937.)

3305. A SIMPLE CYCLOTRON DEE VOLTMETER [and Resonance Indicator].—Whitmer. (*Review Scient. Instr.*, May 1939, Vol. 10, No. 5, p. 165.)

3306. THEORY OF THE GLOW DISCHARGE.—Scherzer. (*Arch. f. Elektrot.*, 14th April 1939, Vol. 33, No. 4, pp. 207–228.)

Approximate integration of potential equation of glow discharge, taking into consideration ionisation by rapid electrons, emission of electrons by ions hitting the cathode, and recombination of electrons and ions in the gas-filled space. Qualitative agreement of potential, stability, and characteristic of discharge with experiment.

3307. DISCUSSION ON "RECENT PROGRESS IN POWER RECTIFIERS AND THEIR APPLICATIONS."—Thompson. (*Journ. I.E.E.*, June 1939, Vol. 84, No. 510, pp. 751–759.) *See* 730 of February.

3308. RECTIFIERS WITH HOT OXIDE-COATED CATHODES, AND DRY-PLATE RECTIFIERS, IN TRANSMITTER INSTALLATIONS.—Kaestner. (*AEG-Mitteilungen*, Feb. 1939, No. 2, pp. 101–106.)

3309. HOT-CATHODE GLASS MERCURY-VAPOUR TUBES, WITH AND WITHOUT GRIDS, *and* AEG LOW-VOLTAGE HOT-CATHODE RECTIFIERS.—Kluge: Germershausen. (*AEG-Mitteilungen*, Feb. 1939, No. 2, pp. 117–124: pp. 125–132.)

3310. A NOTE ON THE OPERATION OF THE PERIODICALLY IGNITED MERCURY-POOL RECTIFIER.—Prinz. (*G.E.C. Journal*, May 1939, Vol. 10, No. 2, pp. 150–152.) Prompted by recent papers (*e.g.* 1164 of March, on the "Sendytron" with special method of starting).

3311. Dry-Plate Rectifiers with Anti-Compound Characteristics [and particularly the Obtaining of Such a Characteristic by the Use of Chokes with Saturation Windings].—Giroz. (*Bull. de la Soc. franç. des Élec.*, March 1939, Vol. 9, No. 99, pp. 257–280.)

3312. The Output Capabilities and Efficiency of the Selenium Dry-Plate Rectifier.—Maier. (*AEG-Mitteilungen*, Feb. 1939, No. 2, pp. 132–139.)

3313. The Mean Free Path of Electrons in Polar Crystals.—Fröhlich & Mott. (*See* 3253.)

3314. On an Arrangement for the Control or Measurement of Very Small Alternating Currents.—Gambetta. (*See* 3275.)

3315. Voltage Stabilisation [Description of Magnetic Stabilisers developed in Russia].—Sazanov. (*Izvestiya Elektroprom. Slab. Toka*, No. 1, 1939, pp. 44–50.)

3316. An Automatic Regulating Transformer for Constant Voltage [primarily for Production of Constant H.T., D.C. Voltages for Counter Tubes, from the Mains: Secondary Constancy within 5 ‰ for Primary Fluctuations of 25%].—Beck. (*Zeitschr. f. tech. Phys.*, No. 6, Vol. 20, 1939, pp. 180–185.)

A symmetrical double-T core carries the primary winding on its centre limb, and is provided with two armatures; the one, carrying the secondary winding, has an air-gap with precision adjustment between itself and the core; the other, carrying no winding and acting merely as a magnetic shunt, is so shaped and mounted (with its motion oil-damped) that under the combined action of the core-attraction and of a spiral-spring restoring force it varies its air-gap with the core in such a relation to the fluctuating primary voltage as to keep the flux in the *first* half of the magnetic circuit (containing the secondary winding) constant. The design shown in Fig. 3 was not completely satisfactory: Fig. 4, with Figs. 5 & 6, shows the successful form of the device.

3317. Investigations on the Constancy Range of Counter Tubes and the Resolving Power of Amplifiers.—Forsman. (*See* 3086.)

3318. A Wilson Cloud-Chamber with Several Expansions per Second.—Brinkman. (*Physica*, June 1939, Vol. 6, No. 6, pp. 519–528: in English.)

3319. On the Working of the [Greinacher] Spark-Counter.—Stuber. (*Helvetica Phys. Acta*, Fasc. 2, Vol. 12, 1939, pp. 109–146: in German.) For Greinacher's papers *see* 1695 of April and back reference.

3320. A Simple Logarithmic Recording Device.—Rogers & Willig. (*See* 3210.)

3321. Dielectric Constants and Power Factors of Some Insulating Materials at Ultra-High Frequencies.—Miller & Salzberg. (*See* 3265.)

3322. The Dependence on Temperature of the Electric Currents in Paraffin.—Scislowski. (*Acta Physica Polonica*, Fasc. 3, Vol. 7, 1939, pp. 214–230: in German.)

3323. Dielectric Loss due to Polar Molecules in Solid Paraffin Wax [Investigation leading to Most Effective Compounds as Components of Practical Low-Loss Dielectrics].—Pelmore. (*Proc. Roy. Soc.*, Series A, 6th June 1939, Vol. 171, No. 946, pp. S 53–S 54.) Extension of work of Jackson (2813 of 1935) and Sillars (1233 of March).

3324. Ceramic Insulators [and the Question of the Affinity for Water: Mechanism Not Yet Explained].—Cochrane: Hartshorn. (*Wireless World*, 8th June 1939, Vol. 44, p. 547.)

3325. Some Ceramic Manufacturing Developments of the Western Electric Company.—Johnson & Shaw. (*Bell S. Tech. Journ.*, April 1939, Vol. 18, No. 2, pp. 255–279.)

3326. Adsorption of Water by Papers at Elevated Temperatures.—Houtz & McLean. (*Bell T. System Tech. Pub.*, Monograph B–1135, 13 pp.)

3327. Extruded Lead Casings for Condensers [replacing Rectangular Tin Can].—Gohn. (*Bell Lab. Record*, May 1939, Vol. 17, No. 9, pp. 277–280.)

3328. Investigations of the Electric Field in the Plate Condenser with Liquid Dielectric by Means of the Electro-Optical Kerr Effect [Field Strength: Space-Charge Phenomena].—Vafiadis. (*Ann. der Physik*, Series 5, No. 1, Vol. 35, 1939, pp. 23–57.)

3329. The Dielectric Constant of Benzene [Measurements], *and* The Dielectric Constant, Dipole Moment, and Molecular Polarisation of 1.4 Dioxane ($C_4H_8O_2$).—Vaughan. (*Phil. Mag.*, June 1939, Series 7, Vol. 27, No. 185, pp. 661–668: pp. 669–676.) For method *see* 250 of January.

3330. Influence of Molecular Form on Dielectric Relaxation [deduced from Measurements of Dielectric Losses of Dilute Solutions of Organic Substances with Ellipsoidal Molecules: Application of Perrin's Theory].—Budó, Fischer, & Miyamoto. (*Physik. Zeitschr.*, 1st May 1939, Vol. 40, No. 9, pp. 337–345.)

3331. Dielectric Relaxation of Molecules with Freely Rotatable Dipole Groups [Improved Calorimetric Measurements of Dielectric Losses of Dilute Solutions: Smaller Relaxation Times of Molecules with Freely Rotatable Groups: Theoretical Discussion].—Fischer & Frank. (*Physik. Zeitschr.*, 1st May 1939, Vol. 40, No. 9, pp. 345–352.)

3332. PROGRESSIVE BREAKDOWN IN A CONDUCTING LIQUID [Observations on Luminosity, etc., in Comparatively Slow Type of Liquid Breakdown].—Snoddy & Beams. (*Phys. Review*, 1st May 1939, Series 2, Vol. 55, No. 9, p. 879.)

3333. THE INFLUENCE OF AN ELECTRIC FIELD ON THE INTERNAL FRICTION OF [Organic Dielectric] LIQUIDS [Measurements with Capillary Viscosimeter: Estimate of Ionic Mobilities].—Menz. (*Ann. der Physik*, Series 5, No. 8, Vol. 34, 1939, pp. 740–760.)

3334. THE DEVELOPMENT OF THE ELECTRON AVALANCHE IN THE SPARK CHANNEL (FROM CLOUD-CHAMBER OBSERVATIONS).—Raether. (*Zeitschr. f. Phys.*, No. 7/8, Vol. 112, 1939, pp. 464–489.)

3335. THE ELECTRIC STRENGTH OF GASES MEASURED BY CORONA DISCHARGE [Groups of Gases in which Energy of Ionisation by Collision starting Spark Discharge is Constant].—Thornton. (*Proc. Roy. Soc.*, Series A, 21st April 1939, Vol. 170, No. 943, p. S 32: abstract only.)

3336. THEORY OF BREAKDOWN [Combined Action of Positive Ionisation, Photoelectric Effect, and Space Charge].—Rogowski. (*Naturwiss.*, 5th May 1939, Vol. 27, No. 18, pp. 302–303.)

3337. SPARKING POTENTIAL OF DEUTERIUM (HEAVY HYDROGEN) [Minimum Value Characteristic of Cathode Material: 3 per cent. Greater than That of Hydrogen: Identical with That of Hydrogen at Higher Pressures].—Jones. (*Nature*, 20th May 1939, Vol. 143, p. 854.)

3338. A NEW METHOD FOR STUDYING THE ADSORPTION OF GASES AT VERY LOW PRESSURES AND THE PROPERTIES OF ADSORBED FILMS OF OXYGEN ON TUNGSTEN, *and* THE KINETICS OF THE FORMATION OF OXYGEN FILMS ON TUNGSTEN.—Morrison & Roberts. (*Proc. Roy. Soc.*, Series A, 6th June 1939, Vol. 171, No. 946, pp. S 55–S 56; p. S 56: abstracts only.)

3339. ADHERENCE OF ORGANIC COATINGS TO METALS [and Causes of Failure].—Schuh. (*Bell T. System Tech. Pub.*, Monograph B-1121, 11 pp.)

3340. FURTHER DATA ON GOLD-CHROMIUM RESISTANCE WIRE.—Godfrey. (*Journ. of Res. of Nat. Bur. of Stds.*, May 1939, Vol. 22, No. 5, pp. 565–571.)

3341. CHOICE OF TRANSFORMER DIMENSIONS [New Method of Calculation giving Cheapest Transformer for Given Load Ratios or Magnetisation & Heat Losses].—Unger. (*Arch. f. Elektrot.*, 28th March 1939, Vol. 33, No. 3, pp. 143–170.)

3342. CONTRIBUTION TO THE CALCULATION OF LEAKAGE FOR ASYMMETRICAL DISC WINDINGS [in Transformers, etc.].—Knaack. (*Arch. f. Elektrot.*, 12th May 1939, Vol. 33, No. 5, pp. 326–341.)

3343. RESISTANCE AND PERMEABILITY MEASUREMENTS AT ULTRA-HIGH FREQUENCIES.—Zottu. (*See* 3266.)

3344. PAPER ON THE MAGNETIC PERMEABILITY OF IRON AND NICKEL AT ULTRA-HIGH FREQUENCIES.—Glathart. (*See* 3267.)

3345. ON ELECTRIC WAVES IN SINGLE-WIRE AND PARALLEL-WIRE SYSTEMS: PERMEABILITY OF IRON AND NICKEL.—Lindman. (*See* 3026.)

3346. AXIAL MAGNETIC PERMEABILITY OF WIRES AND THIN FILMS OF IRON AT HIGH FREQUENCIES [Measurements: Diminution of Permeability towards Short Wavelengths More Pronounced for Wavelength 200 m].—Florescu. (*Comptes Rendus*, 30th May 1939, Vol. 208, No. 22, pp. 1717–1719.)

3347. DISCUSSION ON "STUDY OF THE PROBLEM OF MAGNETIC FILINGS IN SUSPENSION: CONTRIBUTION TO THE THEORY OF MAGNETISM AND HYSTERESIS."—Guilbert. (*Bull. de la Soc. franç. des Élec.*, Feb. 1939, Vol. 9, No. 98, pp. 215–216.) *See* 3393 of 1938.

3348. THE USE OF FERROMAGNETIC MATERIALS IN COILS FOR RADIO FREQUENCIES.—Koch. (*See* 3141.)

3349. THE MEASUREMENT OF MAGNETIC SATURATION INTENSITIES AT DIFFERENT TEMPERATURES.—Sucksmith. (*See* 3269.)

3350. ON THE RATE OF VARIATION OF IRON MAGNETISATION AT DIFFERENT SECTIONS OF THE HYSTERESIS LOOP.—Telesnin. (*Comptes Rendus (Doklady) de l'Acad. des Sci. de l'URSS*, No. 9, Vol. 20, 1938, pp. 647–650: in English.)

3351. A MAGNETIC STUDY OF THE IRON/NICKEL/ALUMINIUM SYSTEM.—Sucksmith. (*Proc. Roy. Soc.*, Series A, 21st April 1939, Vol. 170, No. 943, p. S 39: abstract only.)

3352. THE EVIDENCE FOR A SUPERLATTICE IN THE NICKEL/IRON ALLOY Ni_3Fe [very near Composition of Permalloy].—Leech & Sykes. (*Phil. Mag.*, June 1939, Series 7, Vol. 27, No. 185, pp. 742–753.)

3353. THE PATHS AND RESULTS OF RESEARCH ON FERROMAGNETIC MATERIALS.—Kussmann. (*Zeitschr. V.D.I.*, 22nd April 1939, Vol. 83, No. 16, pp. 445–456.)

3354. MAGNETIC PROPERTIES OF SOME SALTS OF THE IRON GROUP AT LOW TEMPERATURES.—de Haas & Schultz. (*Physica*, June 1939, Vol. 6, No. 6, pp. 481–496: in English.)

3355. ON THE RELAXATION CONNECTED WITH THE TRANSITION FROM THE SUPERCONDUCTIVE INTO THE NORMAL STATE [Caloric Effect Not Intimately Connected with Magnetic Time Effects].—van Laer & Groenewold. (*Physica*, June 1939, Vol. 6, No. 6, pp. 473–480: in English.)

3356. THE MAGNETIC PROPERTIES OF BISMUTH: III—FURTHER MEASUREMENTS ON THE DE HAAS-VAN ALPHEN EFFECT [Field Dependence of Susceptibility: Low Field Values: Comparison with Theory: Estimates of Fundamental Parameters of Electronic Structure].—Shoenberg. (*Proc. Roy. Soc.*, Series A, 3rd April 1939, Vol. 170, No. 942, pp. 341–364.)

3357. INVESTIGATIONS ON MAGNE-CRYSTALLIC ACTION: VI—FURTHER STUDIES ON PARAMAGNETIC CRYSTALS [Cryostat for Measurements of Magnetic Anisotropies of Crystals at Low Temperatures: Results for Various Crystals: Comparison with Theory].—Krishnan, Mookherji, & Bose. (*Phil. Trans. Roy. Soc. Lond.*, Series A, 20th March 1939, Vol. 238, No. 788, pp. 125–148.)

3358. EFFECT OF WEAK PROPORTIONS OF CERTAIN FOREIGN SUBSTANCES ON THE MAGNETIC PROPERTIES OF PLATINUM.—Théron. (*Comptes Rendus*, 22nd May 1939, Vol. 208, No. 21, pp. 1634–1636.)

STATIONS, DESIGN AND OPERATION

3359. RADIOTELEPHONIC COMMUNICATIONS IN HIGH MOUNTAINS BY METRIC WAVES [Problem of linking Refuge Huts with Telephone Network].—Loeb. (*Ann. des Postes, T. et T.*, Feb. 1939, Vol. 28, No. 2, pp. 65–86.)

Reasons for the choice of wavelengths between 1 & 2 metres: propagation in direct visibility: diffraction by a screen: calculation of the diffracted ray, for a screen of any shape: choice of wavelength, so far as diffraction is concerned: reflection: combined effects of diffraction and reflection: example of a wireless link by diffraction alone (Flégère/Refuge d'Argentières): by simple reflection (Flégère/Refuge du Requin): a link involving a diffracted ray and a reflected ray (Flégère/Refuge du Convercle: rapid fading from interference between the two rays, of same order of magnitude, eliminated by suitable orientation of receiving aerial). Apparatus employed: advantages of super-regeneration.

3360. A 112-MC PACK SET: A BATTERY-OPERATED "PERSONAL PORTABLE" FOR EMERGENCY AND FIELD USE.—Chambers. (*QST*, June 1939, Vol. 23, No. 6, pp. 32–36 and 98.)

3361. FREQUENCY MODULATION DEMONSTRATED [over 50-Mile Path: 42.8 & 110 Mc/s Transmissions from Alpine, N.J., & Yonkers, N.Y., respectively: System is "flat" within 1 db from 40 to 15 000 c/s: "Startling" Absence of Noise: Description of Installations].—Armstrong. (*Electronics*, March 1939, Vol. 12, No. 3, pp. 14-17 and 81..85.)

W2XMN (Alpine) was using only 20 kw output; its full output of 40 kw will be available when special air-blowers for cooling the grid seals are working. The effective power at W2XCR (Yonkers) was only 3 kw.

3362. MEASUREMENT OF BROADCAST COVERAGE AND ANTENNA PERFORMANCE: PART III [including Methods of determining One-Mile Signal Intensity, and Steps necessary in Selecting a New Transmitter Site].—Fitch & Duttera. (*RCA Review*, April 1939, Vol. 3, No. 4, pp. 453–465.) For previous parts *see* 2337 of June. Two equations are corrected on p. 465.

3363. AMPLIFIERS WITH AUTOMATIC VOLUME COMPRESSION.—Bertolotti. (*Alta Frequenza*, Feb. 1939, Vol. 8, No. 2, pp. 126–138.)

General characteristics: the increasing-signal control time must be as short as possible (not greater than 1/200th second): the decreasing-signal control time must be variable according to the various characteristics of speech and music; its value may range between 2 and 10 seconds: description of a compresser for a max. compression of 20 db, with control times of 1/10 000th second and 2–10 seconds respectively, making use of the variable-slope characteristic of Type 78 pentodes.

3364. WESTERN UNION TO COLLABORATE WITH AMATEURS [for Emergency Purposes].—(*QST*, June 1939, Vol. 23, No. 6, pp. 45 and 96.)

3365. THE START POINT TRANSMITTING STATION [on Coast of South Devon: to be opened 14th June].—(*World-Radio*, 9th June 1939, Vol. 28, pp. 11–12.)

3366. START POINT: TECHNICAL DETAILS OF THE MAIN TRANSMITTER IN THE B.B.C.'S NEW WEST REGIONAL SCHEME.—(*Wireless World*, 15th June 1939, Vol. 44, pp. 558–559.)

3367. WIRELESS ON THE *Mauretania*.—(*Wireless World*, 22nd June 1939, Vol. 44, pp. 578–580.)

3368. RADIOPHONE SERVICE FOR SMALL SHIPS [Yachts, Tugs, Motor-Boats, etc.].—Dudley. (*Electronics*, March 1939, Vol. 12, No. 3, pp. 11–13.)

GENERAL PHYSICAL ARTICLES

3369. BEHAVIOUR OF AN INTERFEROMETER IN A GRAVITATIONAL FIELD.—Ives. (*Journ. Opt. Soc. Am.*, May 1939, Vol. 29, No. 5, pp. 183–187.)

3370. DISCREPANCIES BETWEEN PHYSICISTS AND ENGINEERS [concerning Electrostatic & Magnetostatic Laws, etc.].—O'Rahilly. (*Electrician*, 5th May 1939, Vol. 122, p. 581.) *See* also Cullwick, *ibid.*, 9th June, p. 739.

3371. SOME REMARKS ON THE INTERNAL FRICTION OF GASES [including the Variation with Temperature]: I & II.—Weber. (*Physica*, June 1939, Vol. 6, No. 6, pp. 551–561 & 562–571: in German.)

3372. THE TOWNSEND COEFFICIENTS FOR IONISATION BY COLLISION IN PURE AND CONTAMINATED HYDROGEN AS A FUNCTION OF THE CATHODE MATERIAL.—Hale. (*Phys. Review*, 1st May 1939, Series 2, Vol. 55, No. 9, pp. 815–819.)

3373. THE DETECTION OF SINGLE POSITIVE IONS, ELECTRONS, AND PHOTONS BY A SECONDARY ELECTRON MULTIPLIER.—Allen. (*Phys. Review*, 15th May 1939, Series 2, Vol. 55, No. 10, pp. 966–971.)

3374. DIAMAGNETISM OF THE RARE ATMOSPHERIC GASES, ARGON, KRYPTON, XENON [Measurement of Susceptibility].—Abonnenc. (*Comptes Rendus*, 27th March 1939, Vol. 208, No. 13, pp. 986–988.)

3375. THE BEHAVIOUR OF ELECTRONS IN IODINE VAPOUR [Behaviour in Halogens, in Spite of Large Electron-Affinities, is Similar to That in Inert Gases, over Considerable Range of Frequencies].—Healey. (*A.W.A. Tech. Review*, Jan. 1939, Vol. 4, No. 1, pp. 21–33.) For previous work *see* 3563 of 1937.

3376. STATISTICAL THEORY OF THE ADSORPTION OF DOUBLE MOLECULES.—Chang. (*Proc. Roy. Soc.*, Series A, 7th March 1939, Vol. 169, No. 939, pp. 512–531.)

MISCELLANEOUS

3377. DISCUSSION ON "REMARKS ON THE USE OF THE FOURIER INTEGRAL."—David. (*Bull. de la Soc. franç. des Élec.*, Feb. 1939, Vol. 9, No. 98, pp. 202–206.) *See* 1312 of March.

3378. SOME FORMULAE FOR THE ASSOCIATED LEGENDRE FUNCTIONS OF THE FIRST KIND.—MacRobert. (*Phil. Mag.*, June 1939, Series 7, Vol. 27, No. 185, pp. 703–705.)

3379. A COMPLETE SET OF ASYMPTOTIC FORMULAS FOR THE WHITTAKER FUNCTION AND THE LAGUERRE POLYNOMIALS.—Taylor. (*Journ. of Math. and Phys.*, March 1939, Vol. 18, No. 1, pp. 34–49.)

3380. A SHORT NOTE ON WHITTAKER'S SOLUTION OF THE EQUATION OF WAVE MOTIONS [Integral Expression of Solution in Spherical Polar Coordinates].—Syono. (*Jap. Journ. of Phys., Transactions & Abstracts*, No. 1, Vol. 13, 1939, Abstracts p. 1.)

3381. THE OPERATIONAL CALCULUS: III [Solution of Linear Partial Differential Equations with Constant Coefficients: General Transmission Line: Evaluation of Integrals: Solution of Integral Equations: Differential Equations with Constant Coefficients: Discontinuous Functions: Bibliography].—Pipes. (*Journ. of Applied Phys.*, May 1939, Vol. 10, No. 5, pp. 301–312.) For I & II *see* 2596 of June.

3382. SIMPLIFIED CALCULATION OF THE ARBITRARY CONSTANTS OF A LINEAR DIFFERENTIAL EQUATION OF THE SECOND ORDER WITH CONSTANT COEFFICIENTS.—Feinberg. (*Journ. of Applied Phys.*, Feb. 1939, Vol. 10, No. 2, p. 140.)

3383. "MATHEMATICS FOR RADIO AND COMMUNICATION: BOOK I" [Book Review].—Maedel. (*Communications*, March 1939, Vol. 19, No. 3, p. 14.)

3384. "L'ISTITUTO NAZIONALE PER LE APPLICAZIONE DEL CALCOLO . . . 1933/1937" [Book Review].—(*Alta Frequenza*, May 1939, Vol. 8, No. 5, pp. 351–352.)

3385. EMPIRE TELEGRAPH COMMUNICATIONS [Cable and Wireless: including Engineering Organisation within Operating Company, Traffic Routes, Signalling Codes, Double-Frequency Keying of Wireless Transmitter, Automatic Frequency Control of Receivers: Effect of Cosmic Conditions: etc.].—Wood. (*Journ. I.E.E.*, June 1939, Vol. 84, No. 510, pp. 638–661: Discussion pp. 662–671.)

3386. BRITISH EMPIRE TELEGRAPH [and Radio] COMMUNICATIONS [from Engineering Aspect].—Wood. (*Nature*, 13th May 1939, Vol. 143, pp. 823–824: note on recent I.E.E. paper.)

3387. THE MEDICAL USE OF THE SHORT [and Ultra-Short] WAVES.—Theile. (*Funktech. Monatshefte*, April 1939, No. 4, pp. 115–118.)

3388. INVESTIGATIONS IN THE NEAR FIELD OF A MIRROR FOR ULTRA-SHORT WAVES [for Medical or Biological Purposes].—Bach. (*See* 2758 of July.)

3389. NERVE CONDUCTION WITH DISTRIBUTED CAPACITANCE [Theoretical Analysis: Expression for Initial Velocity].—Weinberg. (*Journ. of Applied Phys.*, Feb. 1939, Vol. 10, No. 2, pp. 128–134.)

3390. THE METHOD OF RENDERING VEGETABLE VIRUS [Tobacco Mosaic, etc.] VISIBLE IN THE SUPER-MICROSCOPE.—Kausche, Pfankuch, & Ruska. (*Naturwiss.*, 5th May 1939, Vol. 27, No. 18, pp. 292–299.)

3391. THE ELECTRON MICROSCOPE AND MICROBIOLOGY [Results with the Siemens-Ruska Super-Microscope].—Pampana. (*See* 2924 of July.)

3392. OTHER PAPERS ON THE SUPER-MICROSCOPE.—(*See* under "Subsidiary Apparatus & Materials".)

3393. ELECTRO-CULTURE: EXPERIMENTS WITH DISTANT IRON AND THE MAGNETO SPARK [etc: the "Mainpuri Methods"].—Nehru. (*Electrician*, 5th May 1939, Vol. 122, p. 566.)

3394. CONTRIBUTION TO THE STUDY OF AN IONISING RADIATION EMITTED BY ORDINARY METALS.—Reboul. (*Ann. de Physique*, April 1939, Vol. 11, pp. 353–458.)

3395. ABSOLUTE OUTPUT OF RADIATION CAUSED BY ELECTRONS MOVING WITHIN A MEDIUM WITH SUPER-LIGHT VELOCITY, *and* SPATIAL DISTRIBUTION OF VISIBLE RADIATION PRODUCED BY FAST ELECTRONS.—Cherenkov [Cerenkov]. (*Comptes Rendus (Doklady) de l'Acad. des Sci. de l'URSS*, No. 3, Vol. 21, 1938, pp. 116–121: No. 7, Vol. 21, 1938, pp. 319–321: in English.)

3396. ULTRA-VIOLET RADIATION OF CRYSTALS UNDER THE ACTION OF GAMMA RAYS [in Light of Tamm & Frank's Explanation of Cerenkov Radiation].—Zavadovskaya. (*Physik. Zeitschr. der Sowjetunion*, No. 2, Vol. 13, 1938, pp. 244–246 : in English.) For this Cerenkov radiation *see* 375 of January.

3397. EXPERIMENTAL INVESTIGATIONS ON TRIBOLUMINESCENCE AND CRYSTALLOLUMINESCENCE.—Inoue, Tuda, & others. (*Journ. of Sci. of Hirosima Univ.*, March 1939, Vol. 9, No. 2, pp. 129–136 : pp. 137–144 : both in German.)

3398. APPLICATIONS OF COPPER-OXIDE RECTIFIERS.—Morris. (*Elec. Engineering*, March 1939, Vol. 58, No. 3, Transactions pp. 103–106.)

3399. ELECTRICALLY-OPERATED HARDNESS-TESTING INSTRUMENT FOR FOILS AND VERY THIN METALS [using Inductance-Change Principle to measure Impression].—Salford Elec. Instruments. (*Electrician*, 14th April 1939, Vol. 122, p. 488.)

3400. SPARKING EQUIPMENT FOR THE HIGH-FREQUENCY FILMING OF THE CAVITATION REGION.—Ivanov. (*Journ. of Tech. Phys.* [in Russian], No. 19, Vol. 8, 1938, pp. 1761–1769.)

3401. ELECTRIC EAR CONTROLS GRINDING MILL [Flow of Material regulated by Roar of Mill].—(*Sci. News Letter*, 25th Feb. 1939, Vol. 35 [not 36 as printed], p. 120.)

3402. THE QUADRATURE TACHOMETER [Theory and Results with Experimental Model].—Brown. (*Journ. I.E.E.*, April 1939, Vol. 84, No. 508, pp. 499–502.)

3403. AN ELECTRONIC PHASE INDICATOR FOR ELECTRICAL BALANCING MACHINES [for weighing Unbalanced Couples in Rotating Machine Parts : Cathode-Ray Tube with Circular Sweep Circuit].—Marlow. (*Review Scient. Instr.*, April 1939, Vol. 10, No. 4, pp. 128–130.)

3404. ELECTRICAL MEASUREMENT OF SMALL DIFFERENCES IN LENGTH [by Bridge Method : Application to Precision Mechanics].—Froböse & Schönbacher. (*Arch. f. Elektrot.*, 12th May 1939, Vol. 33, No. 5, pp. 341–346.)

3405. DISCUSSION ON "NON-DESTRUCTIVE TESTING," WITH INTRODUCTORY PAPERS [on Electric, Magnetic, Radiographic, & Acoustic Methods, etc.].—Fleming & Churcher : Berthold : Pullin : de Graaf : Dorey : Lester, Sandford, & Mochel. (*Journ. I.E.E.*, May & June 1939, Vol. 84, pp. 519–595 & 709–710.) *Cf.* 1049 of March and 1783 of April.

3406. A SURVEY OF CRYSTAL OPTICS (WITH EMPHASIS ON THE PARTS FINDING APPLICATION IN PHOTOELASTICITY).—Valasek. (*Journ. of Applied Phys.*, April 1939, Vol. 10, No. 4, pp. 209–211.)

3407. REDUCING THE REFLECTION FROM GLASS BY MULTILAYER FILMS.—Cartwright & Turner. (*Phys. Review*, 1st April 1939, Series 2, Vol. 55, No. 7, p. 675 : abstract only.) *See* also 2172 of May.

3408. NEW USES FOR "ELECTRIC EYES" [Photocell Devices : in Counting, Sorting, Controlling Tedious Operations].—(*Journ. of Applied Phys.*, Feb. 1939, Vol. 10, No. 2, p. xii : short note only.)

3409. SPECTROPHOTOMETRY OF REFLECTING MATERIALS [Adaptation of Photoelectric Instrument].—Donaldson. (*Journ. Scient. Instr.*, April 1939, Vol. 16, No. 4, pp. 114–117.)

3410. TERMINOLOGY AND STANDARDS OF ILLUMINATION, *and* BASIC PRINCIPLES IN ILLUMINATION CALCULATIONS.—Crittenden : Moon. (*Journ. Opt. Soc. Am.*, March 1939, Vol. 29, No. 3, pp. 103–107 : pp. 108–116.)

3411. A POCKET SIZE ULTRA-VIOLET METER [reading by Rate of "Clicks" in Headphone].—Taylor. (*Journ. Opt. Soc. Am.*, May 1939, Vol. 29, No. 5, pp. 218–219.)

3412. SPECTROCHEMICAL ANALYSIS.—Ruehle. (*Bell Lab. Record*, March 1939, Vol. 17, No. 7, pp. 202–205.) For an earlier and longer paper *see* 383 of January.

3413. REPRINTS OF ARTICLES ON APPLIED SCIENTIFIC RESEARCH.—(*L'Onde Élec.*, May 1939, Vol. 18, No. 209, p. 240.)

The Director of the National Centre of Applied Scientific Research, Quai d'Orsay, announces his readiness to distribute reprints of such articles, sent to him by the authors, to the appropriate organisations.

3414. A SIMPLE METHOD OF MAKING PHOTOGRAPHIC COPIES [Non-Inverted, by Use of Photographic Paper reversed in Camera].—Distad. (*Review Scient. Instr.*, May 1939, Vol. 10, No. 5, pp. 166–167.)

3415. THE UTILISATION OF MICROFILMS IN SCIENTIFIC RESEARCH, *also* A SIMPLE METHOD FOR FILING MINIATURE NEGATIVES AND MICROFILM RECORDS IN STRIPS, *and* MICROFILM COPYING OF SCIENTIFIC LITERATURE.—Seidell : Dice : Seidell. (*Science*, 13th Jan. 1939, Vol. 89, pp. 32–34 : pp. 39–40 : 10th March 1939, pp. 219–220.)

3416. "REPORT OF THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH FOR THE YEAR 1937–1938" [Book Review].—(*Journ. Scient. Instr.*, March 1939, Vol. 16, No. 3, p. 100.)

3417. "NATIONAL PHYSICAL LABORATORY, ABSTRACTS OF PAPERS, 1937" [Book Review].—N.P.L. (*Proc. Inst. Rad. Eng.*, April 1939, Vol. 27, No. 4, p. 295.)

3418. "JAHRBUCH 1938 DER DEUTSCHEN LUFTFAHRTFORSCHUNG" [Aeronautical Research : Book Review].—(*Génie Civil*, 22nd April 1939, Vol. 114, No. 16, p. 352.)

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

AERIALS AND AERIAL SYSTEMS

504 752.—Two-wire down-lead for an aerial so arranged that inductive interference picked up by it balances out that picked up by the aerial.

Marconi's W.T. Co. (assignees of V. D. Landon). Convention date (U.S.A.) 31st October, 1936.

DIRECTIONAL WIRELESS

503 717.—Method of feeding and supervising the phasing of the currents in a rotating-beam transmitter for navigational work.

Marconi's W.T. Co. (assignees of D. G. C. Luck). Convention date (U.S.A.) 28th July, 1937.

503 892.—Direction finder with means for automatically correcting "quadrantal error" in a ship, whether the latter is fully loaded or in ballast.

Telefunken Co. Convention date (Germany) 3rd July, 1937.

504 060.—Direction finder for "homing" on signal "impulses" which are so short that night-effect is eliminated.

Telefunken Co. Convention date (Germany) 4th February, 1937.

504 163.—Short-wave aerial for transmitting a navigational beam as used to guide an aeroplane in flight.

R. J. Berry (communicated by C. Lorenz Akt.). Application date 24th May, 1938.

504 293.—Directional system depending on the action of two vertical aerials spaced apart by a distance greater than the working wavelength.

H. A. Thomas. Application date 22nd October, 1937.

504 507.—Aerial arrangement for stabilising, or varying at will, the gliding angle in a blind-landing system for aeroplanes.

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

504 733.—Spaced aerial system, for directive working, in which each aerial is fed from the top through a symmetrically-arranged and non-radiating feed-line.

Marconi's W.T. Co.; N. Wells; and A. W. Ladner. Application date 28th October, 1937.

RECEIVING CIRCUITS AND APPARATUS

(*See also under Television*)

503 596.—Tuning indicator in which the station names are printed on a band wound around a pair of rollers.

J. F. Hromadko. Application date 17th November, 1937.

503 698.—Aerial coupling system designed to give greater efficiency and constant tuning, combined with a special method of tuning.

H. Mayr. Application date 25th February, 1938.

503 722.—Preventing positive reaction in an amplifier fitted with a high degree of negative feedback.

Standard Telephones and Cables (communicated by Siemens and Halske Akt.). Application date 5th August, 1938.

503 876.—Superhet receiver with a "mixing" valve in which an electron beam is controlled by different grids located along its length for the purpose of automatic tuning control.

E. K. Cole and G. Bradfield. Application date 19th October, 1937.

503 907.—Receiving circuit for signals transmitted by frequency instead of amplitude modulation.

"Fides" Akt. (assignees of Siemens and Halske Akt). Convention date (Germany) 3rd January, 1938.

504 022.—Push-button tuning system operable over different wave-bands and by remote control.

F. A. Mitchell. Application date 13th September, 1937.

504 091.—Means for developing the bias potentials required in a push-pull amplifier of the Class B type.

C. Lorenz Akt. Convention date (Germany) 22nd July, 1937.

504 190.—Tuning scale which is illuminated by a glow-lamp mounted inside a hollow part of the control knob.

Telefunken Co. Convention date (Germany) 20th October, 1936.

504 230.—Controlling the selectivity of a receiving set so as to discriminate against undesired signals.

Hazeltine Corporation (assignees of H. A. Wheeler). Convention date (U.S.A.) 18th June, 1937.

504 247.—High-fidelity amplifiers of the kind in which parallel-connected channels are coupled at the output by an impedance inverting network.

Marconi's W.T. Co. (assignees of D. Pollack). Convention date (U.S.A.) 30th September, 1937.

504 421.—Accurately tuning by ear a receiver provided with automatic volume control.

Aga-Baltic Radio Akt. Convention date (Sweden) 15th May, 1937.

504 455.—Method of selective reception, without the use of resonance, by periodically varying the internal resistance of a thermionic valve.

L. Gabrilovitch. Convention date (France) 5th September, 1936.

504 560.—Spacing and arrangement of the electrodes of a triode-hexode valve used as a frequency-mixer for a superhet receiver, so as to avoid interaction between the input and local-oscillator circuits.

E. K. Cole and H. A. Brooke. Application date 23rd October, 1937.

504 616.—Multiplex receiving system in which a number of all-wave sets are operated from common antennae and amplifiers, without being subject to "cross-talk" interference.

Marconi's W.T. Co. Convention date (U.S.A.) 24th September, 1936.

504 629.—Amplifier of the electron-multiplier type adapted for use as a relay on a telephone trunk-line.

Farnsworth Television Inc. Convention date (U.S.A.) 31st October, 1936.

504 836.—Circuit for detecting and measuring ultra-high-frequency currents by means of a photo-sensitive cell.

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

504 866.—Plug-and-socket arrangement for connecting a wireless set to the mains supply, either directly, or through a device for converting direct into alternating current.

Philips' Lamp Co. Convention date (Holland) 29th May, 1937.

TELEVISION CIRCUITS AND APPARATUS

For Transmission and Reception

503 455.—Cathode-ray tube with an auxiliary control electrode associated with the usual pair of deflecting plates.

Standard Telephones and Cables, Ltd. (assignees of Le Matériel Téléphonique Soc. Anon.) Convention date (France) 22nd May, 1937.

503 493.—Optical arrangement for preventing distortion in a two-stage mechanical scanning system.

E. Traub. Application date 5th October, 1937.

503 494.—Method of generating synchronising-impulses in a rotating-drum transmitter for television.

E. Traub. Application date 5th October, 1937.

503 502.—Method of controlling the scanning potentials applied to the deflecting plates of a cathode-ray television receiver.

The General Electric Co.; L. C. Jesty; and J. Sharpe. Application date 6th October, 1937.

503 529.—Distorting the wave-form of the synchronising impulses fed to a television receiver in order to prevent irregular frame changes.

Baird Television and A. H. Gilbert. Application date 7th October, 1937.

503 555.—Scanning system for television in which the size of the scanning spot is made less than the width of the line to be scanned, and is given a sinuous movement along its traverse.

A. D. Blumlein. Application date 14th October, 1937.

503 692.—Method of multiplying the frequency of the synchronising signals generated by a rotating-disc scanner for television.

The General Electric Co. and D. C. Espley. Application date 3rd January, 1938.

503 858.—Cathode-ray tube in which the fluorescent screen is replaced by a number of light valves of variable transparency so that the received picture is projected through them on to an external viewing-screen.

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

504 029.—Automatic frequency control for the common local-oscillator of a combined sound and television receiver.

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

503 954.—Arrangement of the "gun" or cathode in a cathode-ray tube operated by intensity-control.

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

504 109.—Electrode arrangement of a cathode-ray tube utilising secondary emission and suitable for receiving television signals.

O. Klemperer. Application date 16th July, 1937.

504 188.—Method of making a photo-electric "mosaic" electrode by directly depositing metal so that it "breaks up" into discrete particles.

Baird Television and E. B. King. Application dates 20th October, 1937, and 29th March, 1938.

504 268.—Television receiver in which each picture element is kept in being for a time sufficient to avoid reliance on the usual persistence-of-vision effect.

E. P. Rudkin and G. M. Hellings. Application dates 15th and 31st July, 1937.

504 460.—Preventing distortion, due to inaccuracies in the timing of the lines in an interlaced scanning system, by suppressing the line impulses a short time before the occurrence of each framing impulse.

Radio-Akt., D. S. Loewe. Convention date (Germany) 26th October, 1936.

504 526.—"Dissector" tube for analysing the "electron image" of a picture into component parts which are then amplified for transmission.

Farnsworth Television Inc. Convention date (U.S.A.) 17th August, 1937.

504 668.—Television transmitter in which a photo-sensitive screen is scanned first by a ray of light and then by a beam of electrons.

Scophony; G. Wikkenhauser; and A. F. H. Thomson. Application date 3rd February, 1938.

504 696.—Suppressing H.F. voltages in the leads used for applying "remote" gain-control to a superhet set, particularly for receiving television signals.

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

504 725.—Preventing the production of degenerative ripples in a saw-toothed oscillation generator, as used for scanning in television.

The British Thomson-Houston Co. and D. J. Mynall. Application date 27th October, 1937.

505 197.—Television system in which an auxiliary photo-electric cell is arranged to compensate for local variations in the brightness of the scanning spot due to uneven thickness of the sensitive screen.

Baird Television; G. Dovaston; and G. E. G. Graham. Application date 5th November, 1937.

505 355.—Focusing arrangement for a cathode-ray tube in which a correcting voltage is applied to prevent any lack of sharpness when the spot is widely deflected.

Radio-Akt. D. S. Loewe. Convention date (Germany) 12th August, 1936.

505 618.—Television transmitter utilising a mosaic-cell screen formed upon a grill or grid which is pervious to the scanning stream.

H. G. Lubszynski and J. D. McGee. Application date 10th November, 1937.

505 653.—Television system in which the amplitude of a transmitted signal conveys an indication of colour, as well as of brightness.

Scophony and F. Okolicsanyi. Application date 11th October, 1937.

TRANSMITTING CIRCUITS AND APPARATUS

(*See also under Television*)

503 677.—Arrangement for preventing cross-talk in two-way carrier-wave signalling over wires.

Standard Telephones and Cables and B. B. Jacobsen. Application date 12th October, 1937.

504 229.—Means for controlling the characteristics of a modulated wave in such a way as to reduce the effects of continuous or intermittent interference.

Hazeltine Corporation (assignees of H. A. Wheeler). Convention date (U.S.A.) 18th June, 1937.

504 196.—Means for increasing the efficiency of the final amplifying-stage in a broadcast or other transmitter using low-power modulation.

R. L. Fortescue. Application date 23rd October, 1937.

504 300.—Transformer coupling arrangement for a balanced modulator for suppressing both the carrier-wave and voice frequency.

Telephone Manufacturing Co.; L. H. Paddle; and J. G. Flint. Application date 27th October, 1937.

504 766.—Frequency or phase modulated signalling system in which slow frequency "drift" is avoided, by means of a time-constant circuit.

Marconi's W.T. Co. (assignees of M. G. Crosby). Convention date (U.S.A.) 13th April, 1937.

504 861.—Secret system of transmission in which the original signal is divided up into a number of sub-frequencies, which are then "jumbled" or transposed.

Standard Telephones and Cables (assignees of A. C. Dickieson). Convention date (U.S.A.) 23rd June, 1937.

CONSTRUCTION OF ELECTRONIC-DISCHARGE DEVICES

503 671.—Constructing and operating an electron multiplier or "multipactor" so as to increase its power output.

Farnsworth Television Inc. Convention date (U.S.A.) 18th August, 1936.

503 738.—Construction and arrangement of the electrodes in a photo-electric cell intended for push-pull operation.

Electrical Research Products Inc. Convention date (U.S.A.) 24th September, 1937.

503 762.—Electron multiplier in which the electrodes are so arranged that a biasing voltage of reasonable magnitude can be used to completely suppress the discharge stream.

Baird Television and V. A. Jones. Application date 7th October, 1937.

504 630.—Electron multiplier in which the degree of amplification is controlled by producing a longitudinal "drift" of electrons along the tube so as to avoid space current limitations.

Farnsworth Television Inc. Convention date (U.S.A.) 9th November, 1936.

505 426.—"Split-anode" magnetron oscillator in which the two anodes are divided by one or more helical slits, the cathode being mounted externally.

Telefunken Co. Convention date (Germany) 26th January, 1938.

505 663.—Arrangement and method of assembling the electrode system of an amplifier of the electron-multiplier type.

Electrical Research Products Inc. Convention date (U.S.A.) 20th November, 1936.

SUBSIDIARY APPARATUS AND MATERIALS

502 743.—Cathode-ray tube and timing-circuit, particularly for recording surges and other transients.

G. J. Scoles and Metropolitan-Vickers Electrical Co. Application date 23rd September, 1937.

503 146.—Method of introducing free alkali into discharge tubes, either for "gettering" purposes, for activating cathodes, or for making certain of the electrodes sensitive to light.

Marconi's W.T. Co. Convention date (U.S.A.) 4th October, 1936.

503 359.—Coupling an electron multiplier to an external circuit in such a way as to minimise the effect of load variations.

Farnsworth Television Inc. Convention date (U.S.A.) 22nd March, 1937.

503 618.—Ball-bearing mounting made of ceramic material for the spindles of variable tuning condensers and inductances to prevent frequency variations due to changes in temperature.

Telefunken Co. Convention date (Germany) 10th October, 1936.

503 893.—Cathode-ray tube indicator for testing the frequency characteristics of electric circuits.

Standard Telephones and Cables (assignees of Le Matériel Téléphonique Soc. Anon.). Convention date (France) 5th July, 1937.

504 015.—Input circuit for a dynatron oscillator operating as a frequency-multiplier.

Standard Telephones and Cables and R. M. Barnard. Application date 15th October, 1937.

504 129.—Cone diaphragm for a loud speaker in which the parts near the apex are made "stiffer" than the rest by applying a suitable coating.

Murphy Radio and A. K. Webb. Application date 22nd October, 1937.

504 141.—Valve amplifier circuit for controlling direct-current relays.

Siemens Bros. and Co. and P. A. Chittenden. Application date 18th January, 1938.

504 238.—Magneto-strictive arrangement for stabilising the frequency of ultra-high-frequency oscillations.

Marconi's W.T. Co. (assignees of W. R. Koch). Convention date (U.S.A.) 28th July, 1937.

504 573.—Condenser, made of a series of comb-like strips, suitable for the aerial lead of a wireless receiving set.

B. W. Gardner. Application date 5th November, 1937.

507 767.—Measuring distances, particularly the height of an aeroplane, by transmitting short-waves from the plane and receiving them back after reflection from the ground.

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