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Editorial

British Standard Glossary of Terms Used in Electrical Engineering*

WE welcome the new edition of this important work. It is over ten years since the first edition was published, and during this period a prodigious development has taken place in many branches of electrical engineering. This development has necessarily been associated with the introduction of new words and terms with which to designate the new apparatus, methods and conceptions. It sometimes happens that the same apparatus is given different names by different workers, especially when development is proceeding along parallel lines in different countries, and, what is much worse, the same name is sometimes applied to two different things. Finality is obviously impossible in the nomenclature of such a subject as electrical engineering, but it is very desirable that there should be a continuous effort to reach agreement and to standardise the usage, especially in countries speaking the same language.

It is not only in the recently developed branches of the subject, however, that a periodical stock-taking of the terms and definitions is necessary, but also in the very foundations of electromagnetic science concerning which international congresses are continually proving the existence of divergent views.

Closely allied to the question of terms and definitions is that of symbols. This is a matter of very great importance and one in which great progress has been made. Everyone appreciates the saving of time and trouble due to the adoption of the now almost universally recognised system of symbols for the principal mechanical and electrical magnitudes and for the multiples and submultiples of the metric system, although one still receives manuscripts in which the author uses *m* indiscriminately for micro, milli, and mega, trusting, apparently, that the reader will guess from the context which is intended. Fortunately, such cases are becoming rare, and writers generally show that they realise the importance of symbols being self-explanatory and in accordance with standard practice.

Only those who have had something to do with the work of revising the Glossary can have any idea of the magnitude and difficulties of the task. It is no easy matter to

*British Standards Institution Publications Dept., 28, Victoria Street, London, S.W.1, price 7s. 6d., 8s. post free.

get a committee of experts to agree on a definition of a term concerning which there may be somewhat divergent views; in fact, the final form adopted may depend on the personnel of the committee. It is generally recognised that the attempt to replace "d.c." by "c.c." died with Professor Silvanus Thompson. When it is remembered that the Glossary contains thousands of terms dealing with widely divergent branches of engineering and, therefore, coming under various committees, and yet in many cases interlinked with terms used in other branches, one is able to appreciate the difficulties involved.

The section on radio-communication now has "and television" added to the title; it contains two entirely new sub-sections, entitled "television" and "cathode-ray tubes," containing 28 and 22 terms respectively. The earlier edition made no reference to television or to cathode-ray tubes.

Another entirely new sub-section in the miscellaneous section is that on electric-welding with 44 terms, instead of being lumped together with electro-farming under "various."

A sign of the times is that whereas in the first edition the electromagnetic waves were propagated through the ether, they are now propagated through space, and the ether, having been ejected from the radio section, now figures among ions and isotopes in the "elemental" terms.

The section dealing with fundamental terms has been almost entirely rewritten. The former somewhat artificial sub-division into fundamental electrostatic, fundamental magnetic, and derived terms has been replaced by a single sub-section for all fundamental electric and magnetic terms. This section is more likely than any other to meet with adverse criticism from those who may not agree with some of the definitions, since it deals with fundamental concepts concerning the magnetic and electric fields about which there is considerable difference of opinion. To judge from the reports of recent international congresses, the definitions given in the Glossary represent fairly closely the average opinion of the expert delegates to these congresses. We have noticed one misprint which has crept in both in the text (p. 11) and in the table of symbols on p. 285, viz., the symbol for electric force or field strength is given as ϵ instead of $\mathcal{E}$. We know from experience how difficult it is to avoid this particular error.

The Glossary will prove invaluable to all who are engaged in electrical engineering.

G. W. O. H.

Routine Testing of Resistances

Visual Measurement of Potential Fluctuations

At the Physical Society's Exhibition a demonstration was given by the Dubilier Condenser Company of an interesting routine method of testing resistances for noisiness. The resistance under test is loaded to the required wattage and any potential fluctuation is applied to the input of a four-stage self-calibrating audio-frequency amplifier of about 100 db gain with a level response from 200 to 10,000 c/s. The output from this amplifier is applied to the vertical plates of a cathode-ray tube, and a 25 c/s time base supplies the horizontal deflection. Noise levels of three to five microvolts are visually detectable.

A New Bridge for the Direct Measurement of Impedance*

By A. Serner, B.Sc., A.C.G.I., A.M.I.E.E.

SUMMARY.—A bridge is described in which a variable non-inductive resistance is balanced against an impedance under test, so that the setting of the resistance at balance gives the ohmic value of the impedance, no calculation being required. A simple formula is given by the use of which the phase angle of the impedance can be obtained from the other condition of balance, should this be required.

A modified form of the bridge is described which can be constructed simply in a permanent form for use where it is frequently required to measure impedances at some standard frequency, e.g., for routine testing.

Both forms of the bridge are suitable for use at audio frequencies, with or without the superimposition of D.C.

1. Introductory Remarks

FOR many purposes it is desirable to know the impedances of various pieces of apparatus. For example, it may be required to match up the impedance of the primary of an output transformer for a radio receiver to that of the final valve. Or, in the case of a piece of apparatus which it is desired to place in parallel with some circuit, say a relay, it may be necessary for its impedance to be more than a certain minimum to avoid undue shunting. In such cases it is useful to have a method of measuring the actual impedance, rather than the inductance, and such a method is afforded by the bridge to be described.

It is common practice to employ some standard frequency for routine measurements and general testing. The bridge has therefore been modified so that it can be made up in a simple permanent form for use with current of a standard frequency, balance being obtained by means of two variable resistance boxes which are connected externally and can be removed when the bridge is not in use.

In the description it has been assumed, for convenience, that the test impedance is inductive; the bridge can, however, be used equally well for measuring capacitive impedances.

2. List of Symbols

R = effective resistance of apparatus to be measured.

L = inductance of apparatus to be measured.

Z = impedance of apparatus to be measured.

θ = phase angle of apparatus to be measured.

P, P', Q, S = non-inductive resistances.

M = mutual inductance.

L_1 = self inductance of primary of M.

C = capacity of condenser.

ω = $2\pi \times$ frequency.

j = $\sqrt{-1}$

3. Bridge Circuits and Method of Use

The circuit of the bridge is shown in Fig. 1. $Z\underline{|\theta}$ is the test impedance, P is a fixed resistance and Q and S are variable resistances, all non-reactive, C is a variable condenser, and M is a variable mutual inductance having a constant primary self inductance L_1.

The bridge is first set up so that $L_1C\omega^2 = 1$ and $Q = P$, where Q includes the effective resistance of L_1 and the equivalent series resistance of C. This is most conveniently done as follows. In the arm YB connect a non-reactive resistance of known value R' in place of $Z\underline{|\theta}$, R' preferably being of the same order as Z. Make S equal to R' and set M at zero. Obtain balance by adjustment of C and Q. The bridge as now connected is an ordinary series resonance bridge and will balance when $L_1C\omega^2 = 1$ and $Q = P$. If

* MS. accepted by the Editor, May, 1936.

measurements are required at a comparatively low frequency that would require an excessive value of C to resonate with L_1, the effective value of L_1 may be increased by the insertion of a fixed inductance in the arm AX.

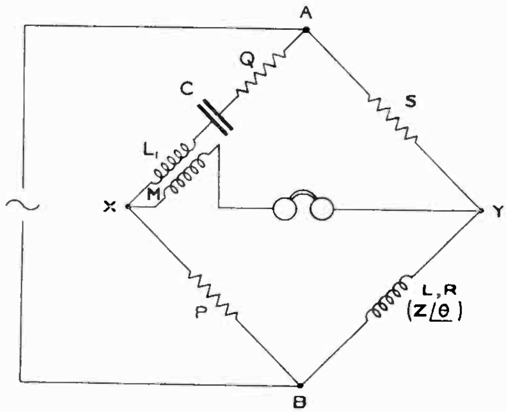


Fig. 1.

The bridge having been set up as described, R' is removed from the arm YB and the test impedance $Z\underline{|\theta}$ connected in its place. Balance is obtained by adjustment of S and M. Fig. 2 shows the vector diagram at balance, I_1 and I_2 being the currents through AXB and AYB respectively. From the initial conditions it follows that the voltage vectors form a bisected isosceles triangle; hence, when the bridge is balanced,

$$Z = S$$

$$\text{and} \quad \theta = 2 \tan^{-1} \frac{\omega M}{P}$$

The calculation involved in the second formula can be simplified by initially making P numerically equal to or an integral fraction of ω.

It is to be noted that if M is continuously variable from zero to a maximum value $\hat{M}$, this range will exactly cover all values of θ from 0° to 90° if P is made equal to $\omega\hat{M}$. It follows that $\hat{M}$ must be high enough to enable P to have sufficient magnitude to afford reasonable bridge sensitivity.

The conditions of balance are substantially independent, as can be seen from Fig. 2. Variation of M varies the length of the vector $j\omega MI_1$, and variation of S produces a movement nearly at right angles to this.

If it is desired to measure $Z\underline{|\theta}$ with a definite value of A.C., this value can be observed by means of a thermal milliammeter placed in series with S. The value of the heater resistance must, of course, then be added to S to obtain the value of Z.

If it is desired to superimpose D.C. it is necessary to place a condenser in series with the headphones to prevent the D.C. from flowing through the latter. Then, in the bridge network, D.C. only passes through S and Z, and can accordingly be measured by means of a moving coil ammeter connected externally in the line feeding the supply to the bridge.

It has been so far assumed that the test impedance is inductive. If, however, it is capacitive, it is only necessary either to reverse the direction of M or to interchange S and Z.

The accuracy of the bridge depends on the precautions taken. By the use of such means as a Wagner earth, and the prevention of interference by suitable screening, considerable accuracy can be obtained. In many cases, such as in measuring the impedances of iron cored coils or transformers, an accuracy of about 0.5 per cent. is ample, and such an accuracy can easily be obtained without taking elaborate precautions.

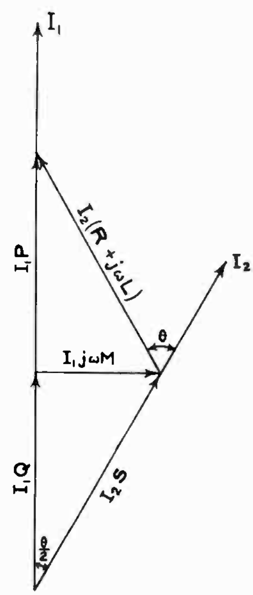


Fig. 2.

4. Simplified Form of Bridge

Consideration of the vector diagram shown in Fig. 2 shows that the preliminary setting up of the bridge, as described in the beginning of section 3, causes two essential conditions to be fulfilled. These are (a) that the end of the secondary of M connected to point X (Fig. 1) be at mid potential between A and B, and (b) that the e.m.f. induced in the secondary of M be in quadrature with the supply voltage across AB, i.e., that the current through the primary of M be in

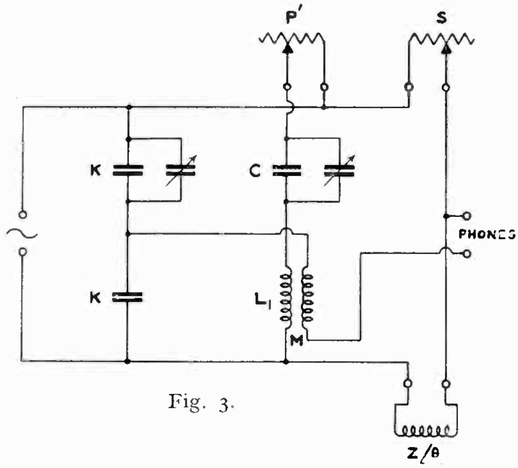


Fig. 3.

phase with the supply voltage across AB. Where a bridge is required to be used at one standard frequency, considerable simplification of apparatus can be effected by separating the circuits fulfilling these two conditions.

Condition (a) can be fulfilled by connecting the secondary of M to a point permanently at mid potential between A and B instead of to X. Such a point may either be the mid point of a transformer secondary feeding the bridge or the junction of two impedances, equal in all respects, connected in series across the line. The latter is recommended, using condensers as the impedances, bearing in mind simplicity of apparatus and convenience in using the bridge with superimposed D.C.

As the secondary of M is not now connected to X, the components of circuit AXB are in simple series and therefore the resistances P and Q may be replaced by a single resistance P'. Also the magnitude of the e.m.f. induced in the secondary of M may be varied by varying the primary current by variation of P' instead of by varying M, and therefore the variable mutual inductance may be replaced by a fixed mutual inductance. Also, as in the case of a fixed frequency bridge condition (b) is satisfied by a fixed value of C, the variable condenser may be replaced by a fixed condenser.

It is to be noted that as P' has replaced $P + Q$, and as P and Q were made equal, the conditions at balance are now

$$Z = S$$

$$\text{and} \quad \theta = 2 \tan^{-1} \frac{2\omega M}{P'}$$

The bridge as now constructed is shown schematically in Fig. 3. The only components which are permanently locked up in the bridge are three fixed condensers, two of which are provided with trimming condensers, and a fixed air-cored mutual inductance. The variable non-reactive resistance boxes forming P' and S, and by means of which balance is obtained, are only connected when the bridge is required to be used.

As an example the construction of a bridge suitable for measuring impedances up to 10,000 ohms at a frequency of 796 c/s ($\omega = 5{,}000$) will be considered. For maximum sensitivity the condensers KK for obtaining the point of mid-potential should each have an impedance of the same order as the test impedance. Condensers of 0.05 μF capacitance, which would have an impedance of 4,000 ohms, would be suitable. Condensers of the same type and of a quality such that their constants are unlikely to change appreciably should be used. Having selected two condensers having capacitances as nearly equal as possible and of approximately the required value, a trimming condenser is placed in parallel with that having the lower capacitance and by adjustment of this trimming condenser they are balanced against each other on a suitable bridge at 796 c/s.

Choice of the value of M is determined by consideration of the range of P'. The lowest value of P', which occurs when $\theta = 90°$, in which case $P' = 2\omega M$, must not be too low as otherwise it would have too great a shunting effect. On the other hand it is desirable to keep this minimum as low as possible so as to obtain as big a range as possible for P' (and hence for θ), the maximum value of which is fixed by the range of the resistance box it is proposed to use, say 10,000 ohms. Bearing these considerations in mind the minimum value of P' can be fixed at 2,000 to 2,500 ohms, which gives a value for M of 0.2 to 0.25 H. An air-cored mutual inductance of this value is accordingly wound. The value of L_1, the self inductance of the primary, is not important, but for constructional reasons it is convenient to make it of the same order as M. M and L_1 are then accurately measured at 796 c/s. It is to be noted that an error in the measurement of M affects the accuracy of values obtained for θ but not of those obtained for Z. Suppose M and L_1 are found to be 0.2 H and 0.25 H respectively, then the value of C required to resonate with L_1 is 0.16 μF. This capacitance is made up with fixed condensers together with a trimming condenser for final adjustment, again using condensers of such a quality that their constants are unlikely to change appreciably. L_1 and C are adjusted to resonance by connecting them in series to form one arm of a bridge fed by a supply of 796 c/s, the other arms of which consist of non-reactive resistances, and balancing the bridge by adjustment of the trimming condenser and of the resistance of one of the adjacent arms. At balance, if the two fixed arms are of equal magnitude, the value of the variable resistance is equal to the magnitude of the sum of the effective resistance of L_1 and the equivalent series resistance of C. It is

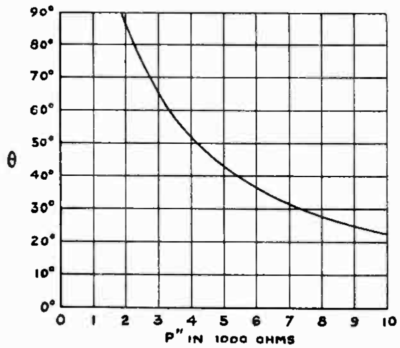


Fig. 4.

necessary to know this magnitude as it forms part of P'. Suppose it is 100 ohms.

Knowing the constants of the bridge it is now possible to draw a calibration curve relating θ to P'', where P'' is the reading of the resistance connected externally in series with L_1 and C, from the equation: $\theta = 2 \tan^{-1} \frac{2\omega M}{P'}$, since P' is equal to the sum of P'', the effective resistance of L_1 and the equivalent series resistance of C, i.e., $P' = P'' + 100$ ohms. The calibration curve for the particular bridge under consideration is shown in Fig. 4.

Having constructed the bridge on the lines indicated, it is advisable to check its accuracy by measuring a few impedances of known magnitudes, which can be made up of inductances and resistances of known values.

While for many purposes it is sufficient to know the ohmic value of an impedance, Z, which is given directly by the reading of S, for some purposes, such as the detection of short-circuited turns, it is useful to know also its angle, θ, and it is therefore convenient to have available a calibration curve such as that shown in Fig. 4.

The Earth's Magnetism

By S. Chapman. pp. 116. Methuen & Co., Ltd., 36, Essex Street, London, W.C.2. 1936. Price 3s. 6d.

Radio workers must not expect to find in this book any direct reference to matters of wireless interest, but they will undoubtedly be intrigued by the author's account of the role which is played by the Heaviside and Appleton ionised layers of the upper atmosphere in giving rise to an important part of the earth's magnetic field. According to the dynamo theory the circulating air currents in the ionised layers as they move across the permanent magnetic field of the earth cause the positive and negative ions to move in opposite directions and so a system of electric currents is produced as by the rotation of a gigantic armature, with corresponding magnetic phenomena at the earth's surface.

Owing to the small size of the book the author has been compelled to give but a cursory treatment of the mathematics of the subject and of such additional phenomena as sunspots and the aurora, but a larger treatise is shortly to be published in which a wider treatment will be possible. The present volume, however, is an excellent summary of the main facts of terrestrial magnetism and the solar and lunar control of the variations of the earth's field. R. T. B.

P.A. Equipment

THE issue of *The Wireless World* for February 5th will be primarily devoted to the subject of Public Address equipment and applications. Recent developments in apparatus will be described and special articles will deal with various aspects of this subject, which is growing in importance so rapidly.

There are to-day uses for P.A. equipment of every category, ranging from domestic requirements to the extensive outfits used in connection with addressing large outdoor audiences.

Amplitude Distortion *

By J. H. Owen Harries

SUMMARY.—The problem is partly physiological and psychological as well as physical. The difficulty in the past has been that the physical measurements, which are the basis of the whole process, have not been correctly performed.

It is shown that the conventional method is not capable of evaluating the distortion. A new method is put forward involving the measurement of the spectrum of component frequencies produced in the output of the apparatus under test when two sine waves are applied simultaneously to the input. It is found that the spread of this spectrum corresponds to the production of audible and objectionable distortion. It is further found that this spread is proportional to the amplitude of the second side tone and to a corresponding fall in the amplitude of the first side tone.

Practical results on valves are shown and it is pointed out that the S-shaped input/output characteristics of pentodes, Class B valves, amplifiers and the like in which saturation effects occur are very objectionable. The failure of the conventional method is exemplified with reference to a typical pentode.

The results of the new measurements are co-related with listening tests, resulting in a quantitative table of the allowable physical distortion levels which correspond to given amounts of audible distortion varying from "high quality" to "objectionable distortion." A Bibliography is included.

Introduction

AMPLITUDE distortion is subject probably to more uncertainty and difference of opinion than any other part of the communication art. An examination of the subject shows that, apparently because of a feeling that it is necessary to take into account physiological and psychological phenomena, the physical side of the question itself has been neglected and shows signs of more confused thinking than one would have believed likely in an art which has received as much attention as that of communication. One authority will state that "2 per cent. harmonic distortion is objectionable"; another will say that "5, 10 or even 15 per cent. is tolerable."

It has been stated that the key to the difficulty lies in the neglect, by conventional methods of measurement, of those "intermodulation products" found if several sine waves are applied to the apparatus simultaneously. This is to some extent true, but the statement lacks generality.

Any method of distortion measurement must include primarily an endeavour to evaluate the shapes of the working input/output characteristics. Physiological and psychological elements of the problem must be taken into account by observing what shapes of characteristic produce objectionable, and what shapes produce unobjectionable, kinds and degrees of audible distortion. The difficulty in the past has been that the physical measurements, which are the basis of the whole process, have not been correctly performed.

The Conventional Method of Measurement

The conventional method of amplitude distortion measurement consists of an endeavour to evaluate the shape of the input/output characteristic in terms of the harmonics it produces when a sine wave input is applied to it. The scalar values, and not the vector values, of the harmonics are measured. Therefore, the shape of the characteristic is not fully determined by this method. It merely gives a comparative basis as regards the shape of the characteristics of the same general algebraic form producing the same phase angles between the harmonics. Figs. 1 and 2 show two totally different wave forms (corresponding to two totally different input/output characteristics) both of which are the resultants of a fundamental and second harmonic of the same scalar amplitude, but having different phase angles.

It is possible to show (Bib. 1 and 2) that the input/output characteristic of an amplifier or a valve can be represented by a power series

$$i = a + bV + cV^2 + \ . \ . \ .$$

* MS. accepted by the Editor, July, 1936.

The values of the coefficients of the series may theoretically be obtained from the static input/output characteristic. If then the equation for a single sine wave $V \sin \omega t$

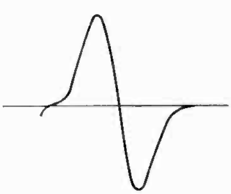


Fig. 1.

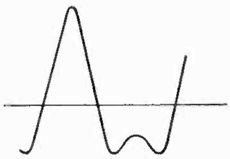


Fig. 2.

Illustrating the wide variations in wave form produced by shifting the phase of the second harmonic without changing its amplitude.

be substituted for V in the series the equations may be solved and the various harmonics found. Similarly two or more sine waves $V_1 \sin \omega_1 t + V_2 \sin \omega_2 t$ may be substituted. The shape of the characteristic is then fully defined in terms of the component waves resulting from solving the equations. This fact appears to have confused certain investigators into thinking that because the input/output characteristic may be represented in this way in terms of harmonics of a single sine wave (or, alternatively, in terms of the spectrum produced by two sine waves) then measurements of the amplitudes of the harmonics of a sine wave will evaluate the shape of the input/output characteristic of the apparatus to which the sine wave is applied. They forget that such measurements do not, unlike the calculations, take into account the phase angles of the harmonics and, therefore, that the results of two such sets of measurements on two different pieces of apparatus are not comparable, unless, by chance or by design, the phase angles are the same in the two cases.

For example, measurements of the scalar values of the harmonics of a sine wave will be satisfactory for evaluating the relative distortion given by two triodes. There is no basis given, however, by such measurements, for the comparison of the distortion of a pentode and a triode, or between a triode and the overall distortion of a transmitter, or a receiver. The input/output characteristics of these four cases may be completely dissimilar, and a mathematical analysis as above will show that the phase angles involved are different.

Extremely small amounts of distortion will naturally approximate to the same result, namely, that the distortion is very small, but it is not the case when dealing with the commonly found amounts of distortion even in good apparatus.

It would be possible to obtain the shape of the static input/output characteristics and to calculate from this the amplitudes of the various output components, but the process is extremely laborious and it would take several days to evaluate a few valves. For the purpose of practical commercial testing such a lengthy process is completely impracticable.

It would also be possible to make a complete analysis of an existing piece of apparatus by measuring not only the amplitudes but the phase angles of harmonics of a sine wave; but the whole method would still be open to the objection of complication in the final result. It would be difficult to rate a piece of apparatus in the form of an easily remembered figure if one had to consider vector values.

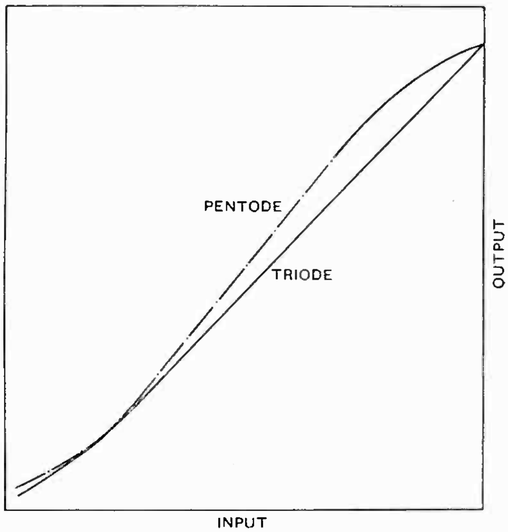


Fig. 3.—*The two general types of input/output characteristic found in communication apparatus. One is typical of the pentode and the other typical of the triode.*

The difficult part about distortion measurements is that, under working conditions, the apparatus under test amplifies over a period of time an indefinitely large number of component waves of an indefinitely large number of different amplitudes and phase angles. Obviously it is impracticable to measure the distortion of an indefinite number of input waves and phase angles. The only practical way of measuring will be to measure the distortion in a definite number of waves. The minimum number which need be used will have to be determined by experiment. The number must be sufficient for the measurements to show changes in

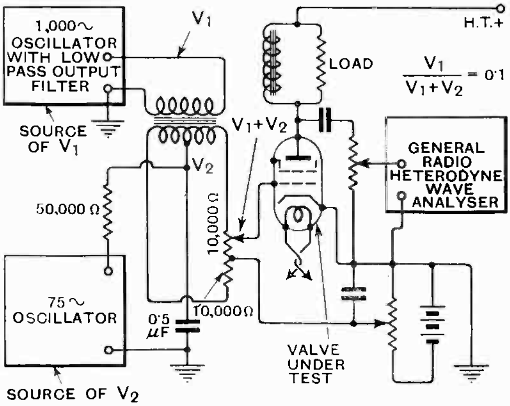


Fig. 4.—*Diagrammatic circuit of a new system of amplitude distortion measurement.*

$$\frac{V_1}{V_1 + V_2} = 0.1$$

the distortion clearly whenever change in the audible result causes the observer to look for alteration in the measured physical distortion.

It is therefore necessary to devise a method of distortion measurement employing, for simplicity's sake, the minimum number of waves, and then to relate this measured distortion, in its various values found in practice, to audible results found by other experiments.

The only way of determining how many component waves it will be necessary to use for measurement is by experiment. A single sine wave input component is found to be insufficient ; but it is found, in practice, that measurements employing two input waves simultaneously are satisfactory in all ordinary circumstances.

The process of measurement is as follows:—

(*a*) Apply two sine waves simultaneously to the apparatus under test. One wave is conveniently made weaker than the other.†

(*b*) Measure the resulting spectrum of output component waves as regards frequency and amplitude.

(*c*) It will be found by inspection* that the (undesirable) spread and number of these output components will be proportional in general to the rise or fall of one or more of the components only.

(*d*) In further measurements, for comparing different pieces of apparatus, it will then only be necessary to measure the amplitude of these special components, the values of which form a convenient and easily remembered numerical rating for amplitude distortion. They may, in general, be expressed as percentages of the weaker of the two fundamental output components.

The practical method of carrying this into effect will now be described, and it is found that this method fulfils the requirements excellently.

Method of Measurement

Fig. 4 diagrammatically shows the circuits employed to measure the distortion produced by a valve. The ratio between two input component waves V_1 and V_2 is shown, together with their frequencies. The frequencies are chosen to suit the analysing characteristics of the wave analyser. (The General Radio analyser is a remarkable piece of apparatus. It is capable of discriminating 1,000 ∓ 75 cycle side tones from a 1,000 cycle main tone.) The phantom mixer circuit is necessary to prevent intermodulation between the two sources of V_1 and V_2.

Two general types of input/output characteristic which are illustrated in Fig. 3 will be found to appear in one form or another almost throughout all communication apparatus. The 3/2 law in valves tends to produce the type of characteristic marked as typical of that of a triode, and saturation effects tend to give the S-shaped characteristic marked as typical of that of a

* Mathematical calculation is too complicated.

† This method is desirable because it has the advantage of actually simulating a common condition in the amplification of signals, namely, the amplification of a weak sound (such as speech or the sound of a violin) when accompanied by a strong sound (such as a piano or orchestra). Conventional sine wave input measurements, however, simulate no practical conditions. It is always better practice to measure under real rather than artificial conditions.

pentode. Pentodes are not the only offenders in this respect. The S shape is found in an even more pronounced form in Class B and positive drive valves in general. In fact it occurs in all circumstances where saturation or overloads (*e.g.*, grid current flow) occurs.

Measurements were performed on a large amount of apparatus of various kinds employing various valves. The broad results of this analysis are shown in Fig. 5. Fig. 5 illustrates three typical partial spectra covering the general types of input/output characteristic.

Complete spectra would, of course, include the ordinary harmonics of the strong wave V_2.

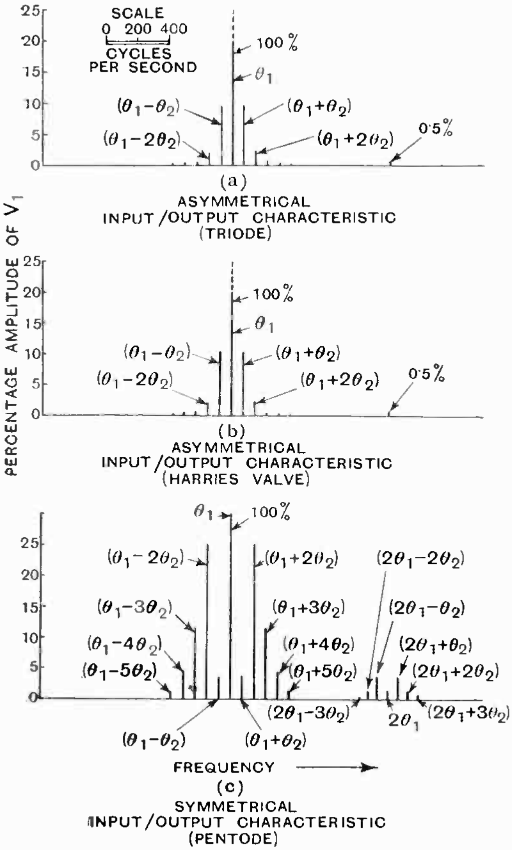


Fig. 5.—*The partial spectra of output component frequencies corresponding to the two general types of input/output characteristic illustrated in Fig.* 3.

These would not, however, give one more information than is already available by ordinary sine wave analysis. They are therefore neglected. In Fig. 5 the spectra of side tones and harmonics of the weak wave V_1 only are shown. These "intermodulation products" due to the modulation of the weak 1,000 cycle wave V_1 of angular frequency θ_1 by the strong 75 cycle wave V_2 of angular frequency θ_2 are found to give the required information. The spectrum given by the triode and the Harries power output valve and other apparatus of the kind having triode-shaped characteristics (Fig. 3) are shown in Fig. 5 (*a*) and (*b*). This type of characteristic will be referred to as producing "asymmetrical" distortion, because of its effect on the wave form of a sine wave. The spectrum of the S-shaped characteristic (which will be referred to as giving "symmetrical" distortion) is given in Fig. 5 (*c*). Comparing these two cases it will be seen that only the first side tones $[\theta_1 \pm \theta_2]$ (corresponding to modulation of V_1 by V_2 at the frequency of V_2 itself) are at all appreciable with "asymmetrical" or "triode distortion." (The experiments were supplemented by arranging that the actual output itself could be made audible. As was rather to be expected, there was a negligible deterioration in the tonal quality in the case of the triode and Harries valve due to this rise of first side tone.*) "Symmetrical" or "pentode" distortion produced a most pronounced spectrum of strong side tones extending over a very wide band (Fig. 5 (*c*)). The second harmonic of the 1,000 cycle wave is over-modulated and reduced to a scratchy noise. The first side tones $[\theta_1 \pm \theta_2]$ are quite small, but the second side tones $[\theta_1 \pm 2\theta_2]$ have risen, and correspond to modulation of the 1,000 cycle wave V_1 at twice the frequency of the stronger wave V_2, *i.e.*, a kind of "frequency doubling" distortion. On listening to the output during this test, the pure 1,000 cycle note had disappeared and was substituted by a very distorted tone. One would therefore expect the reproduction of telephony to be harsh and scratchy on complex sounds. The weaker of the sounds would be most distorted, and this would correspond to severe distortion of, for instance, a voice or violin when accompanied by stronger piano or orchestral tones.

In accordance with item (*d*) above, it is found by inspection that the objectionable

* This test was, of course, only a rough one and must not be taken as a definite statement that the first side tone is audibly negligible.

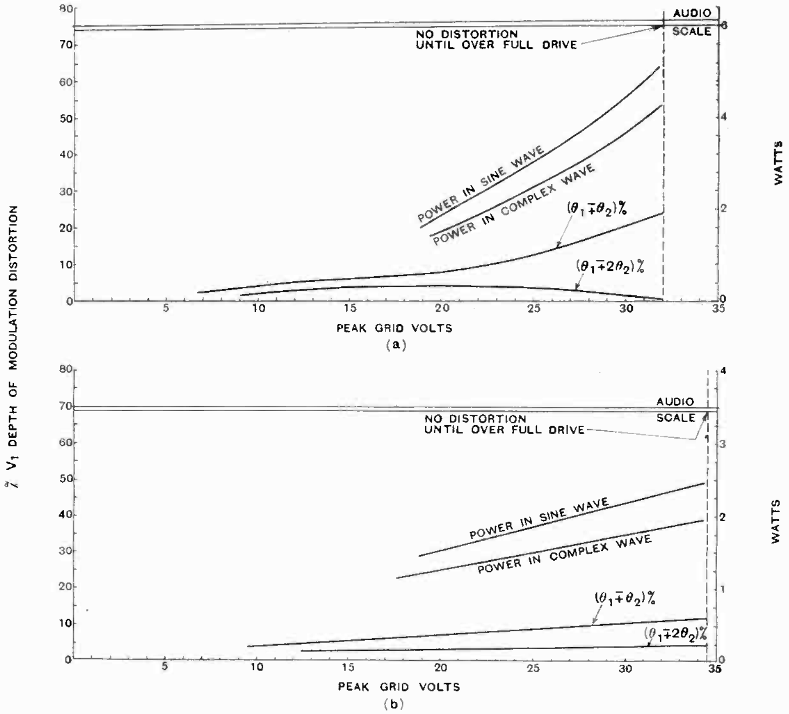
spread of the output spectra, and the very great increase of total side tones in the case of symmetrical distortion, is coincident with the rise of the second side tone $[\theta_1 \mp 2\theta_2]$ and the fall of the first side tone $[\theta_1 \pm \theta_2]$; and therefore that only these two need be used for rating the valves. This is found to apply to other apparatus as well as to valves. Conveniently the amplitudes of these two side tones may be expressed in terms of the percentage modulation depth they produce of the 1,000 cycle wave. If the amplitude of a side tone is a per cent. of that of the 1,000 cycle tone, then the corresponding percentage modulation depth will be $2a$ per cent.

Practical Results on Valves

It is now possible to set out a number of measurements and to show the comparative performance of the new method of measurement of amplitude distortion compared with that of the old. The results of three typical triodes are shown in Fig. 6. The first side tone rises evenly with drive and the second side tone remains constant at a very small value around 5 per cent. modulation depth, or falls slightly. The distortion audible by listening to the output wave on a loud speaker through an amplifier the input of which is connected to an attenuator across the load is also indicated on the graphs. No observable distortion was noted until grid current set in.

Similar results were found in the case of the Hivac Harries valve (Bib. Nos. 4 and 5) illustrated in Fig. 7. (The claim made for these valves by the makers is that the distortion level measured with a resistive load is of the same kind and degree as that of triodes).

The results on two pentodes are shown in Fig. 8, and the remarkable rise of second side tone, corresponding to a very great spread and rise of the spectra of distortion (Fig. 5 (c)), will be observed.



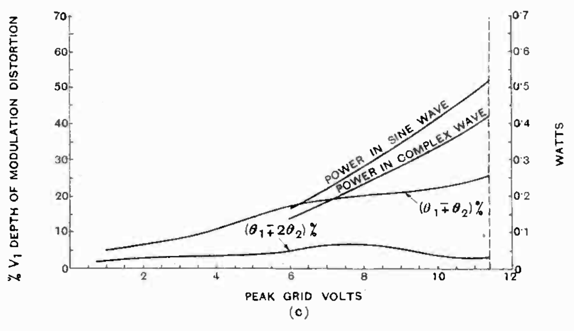


Fig. 6.—*Measurements by the new system on triode valves giving asymmetrical distortion.*

$$\frac{V_1}{V_1 + V_2} = 0.1 \quad \theta_1 = 1{,}000 \sim \theta_2 = 75 \sim.$$

(a) *PX25 (Osram).* $E_a = 400\,V$, $E_g = -32$, $I_a = 62.5\,mA$, $E_f = 4\,V$, $I_f = 1a$, $Load = 3{,}200\,\Omega$.

(b) *PX4 (Osram).* $E_a = 250\,V$, $E_g = -34.5$, $I_a = 48\,mA$, $E_f = 4\,V$, $I_f = 1a$, $Load = 3{,}200\,\Omega$.

(c) *AC/P (Mazda).* $E_a = 200\,V$, $E_g = -11.5$, $I_a = 17.5\,mA$, $E_f = 4\,V$, $I_f = 1a$, $Load = 6{,}000\,\Omega$.

The results of push-pull connections are shown in Fig. 9. It will be seen that the first side tone, given by asymmetrical distortion, cancels out. The second side tone does not. This is confirmed by the graphical results given in Figs. 10 and 11 which show respectively the static characteristics of Harries valves and pentodes in push-pull. The curvature is not cancelled in the latter case and disappears in the former.

The Failure of the Old Method of Distortion Measurement

It is easy to produce convincing examples showing the failure of the conventional method, using a sine wave input, to give physical measurements which indicate the existence of audible distortion (and which are comparable as between different valves and the like) by comparing the results of the conventional sine wave harmonic measurements on two pentodes with the results of the new method. This comparison is made in Figs. 12 and 13. Fig 12 shows the result of the conventional method of second and third harmonic measurement on a typical British commercial pentode " B." The corresponding results, with the same valve, of the new method are shown in Fig. 13. The old method is most deceptive. When the peak driving volts increase above about 3.5, the second harmonic falls and the third harmonic only rises quite moderately and the total harmonic content remains about constant until the output wattage with a sine wave input has risen to the remarkable figure of 3.5 watts. The total HT input wattage is only 8. The DC to AC conversion efficiency, according to a rating on these lines, is, therefore, no less than 43.5 per cent. Referring to the new measurements, however, the first side tone falls and the second side tone rises (corresponding to the production of a wide distortion spectrum) immediately the sine wave power output exceeds about 1.1 watts, and when the peak drive exceeds only about half of the maximum. The correct rating, to avoid the wide distortion spectrum, corresponds to a DC to AC conversion efficiency of only about 14 per cent. ; which is a very different story. The triode illustrated at the top of Fig. 6 has an input power of 25 watts and a sine wave power output at full drive of 5 watts, which is a power efficiency of 20 per cent. The triode is actually the more efficient valve. It is, however, very insensitive, as it requires about 30 volts peak to drive it as against about 4.5 volts peak in the case of the pentode. Turning to the Harries valve (graphed at the top of

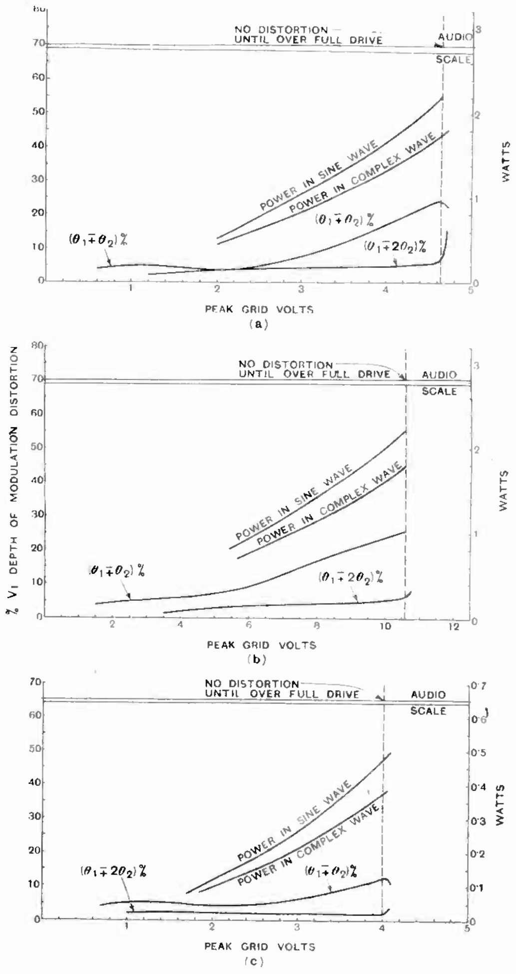


Fig. 7.—*Measurements by the new system on Harries valves giving asymmetrical distortion.*

$$\frac{V_1}{V_2 + V_1} = 0.1, \quad \theta_1 = 1{,}000 \sim, \quad \theta_2 = 75 \sim.$$

(a) *AC/Z.* $E_a = 250\,V$, $E_s = 250\,V$, $E_g = -5.5\,V$, $I_a = 32\,mA$, $E_f = 4\,V$, $I_f = 1a$, *Load* $= 6{,}000\,\Omega$.

(b) *AC/Y (average).* $E_a = 250\,V$, $E_s = 250\,V$, $E_g = -11\,V$, $I_a = 32\,mA$, $E_f = 4\,V$, $I_f = 1a$, *Load* $= 6{,}000\,\Omega$.

(c) *Y220.* $E_a = 150\,V$, $E_s = 150\,V$, $E_g = -4\,V$, $I_a = 10\,mA$, $E_f = 2\,V$, $I_f = 0.2\,a$, *Load* $= 12{,}000\,\Omega$.

Fig. 7) the second side tone does not commence to rise until about full drive (4.5 volts peak), when the power output under sine wave input conditions is about 2.2 watts. The DC power input is 8 watts and the DC to AC power conversion efficiency is about 27.5 per cent.†

triode is of an entirely different kind. The conventional method of measurement has indicated, therefore, that greater distortion exists in the case of the triode than in that of the pentode, when actually the reverse is the case. On the other hand, by the new method, the existence of the wide spectrum is in proportion to the value of the second side tone, which, as can be seen in Figs. 8 and 13, rises enormously with the pentode and, as shown in Fig. 6, remains negligible with the triode. The performance of the valves is completely specified by this knowledge of the value of the first and second side tones.

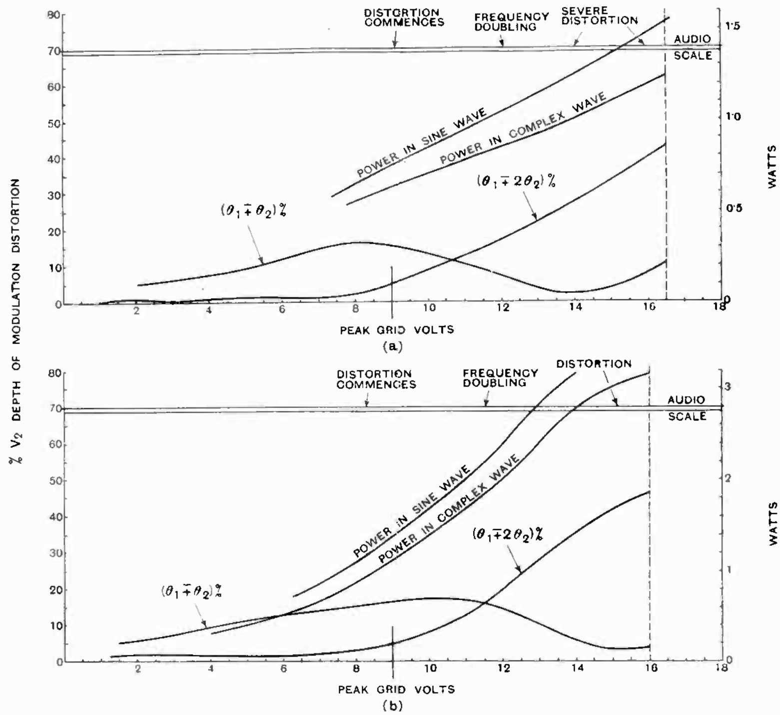


Fig. 8.—*Measurements by the new system on pentode giving asymmetrical distortion.*

(a) *RCA* '43. E_a = 135 *V*, E_s = 135 *V*, E_g = − 16.5 *V*, I_a = 34 *mA*, E_f = 25 *V*, I_f = 0.3 *a*, *Load* = 4,000 Ω.

(b) *Nat. Union* '42. E_a = 250 *V*, E_s = 250 *V*, E_g = − 16 *V*, I_a = 34 *mA*, E_f = 6.3 *V*, I_f = 0.7 *a*, *Load* = 7,000 Ω.

Furthermore, the actual values of the second and third harmonic of the pentode near full drive are respectively 10 per cent. and 5 per cent. The distortion spectrum has already spread to a very undesirable extent in the manner of Fig. 5 (*c*). Yet it is very easy, particularly by using a rather lower load than the normal, to obtain second and third harmonics with the triode of respectively 16 per cent. and 5 per cent. Under these circumstances it would appear that the triode was actually giving greater distortion than the pentode. In fact, however, all that has happened has been that the comparatively innocuous second side tone has become rather high due to the lower load, but the objectionable spread of distortion spectrum found with the pentode is absent. The distortion spectrum of the

† If this valve is substituted for the pentode in a receiver an improvement in audible quality is, of course, noticeable.

It is therefore submitted that in all cases, and particularly where saturation or overload effects may occur (causing symmetrical distortion) in transmitters, receivers and amplifiers, and in valves, then the side-tone analysis should be used and the apparatus specified in terms of the amplitudes and first and second side tones, or, in other words, in terms of the spread and total amplitude of the distortion spectra produced.

Relation of Side-Tone Measurements to the Old Sine Wave Harmonic Measurements

Having these results, it is possible, in certain restricted cases, and provided that the results are not extended to cases to which they do not apply, to interpret more correctly ordinary sine wave measurements. It will be observed by inspection, in comparing Figs. 12 and 13, for instance, that the rise of the distortion spectrum corresponds to fall of second harmonic and rise of third harmonic. In triodes and the like the second harmonic does not fall, but rises with the drive up to grid current. In practice, by observing the forms of the curves of second and third harmonic as a function of drive, the author finds it possible to obtain quite a good idea of the results which would be obtained by the correct method of side-tone analysis. For the purpose of rigid analysis and comparison for rating purposes it is necessary to employ side tone spectrum analysis as described herein. Isolated figures of second and third harmonics often mean almost nothing.

Brief Co-relation of Physical Distortion Measurements with Audible Results

It has been pointed out on various occasions that the distortion given by two Class A operated triodes in push-pull is very much less than

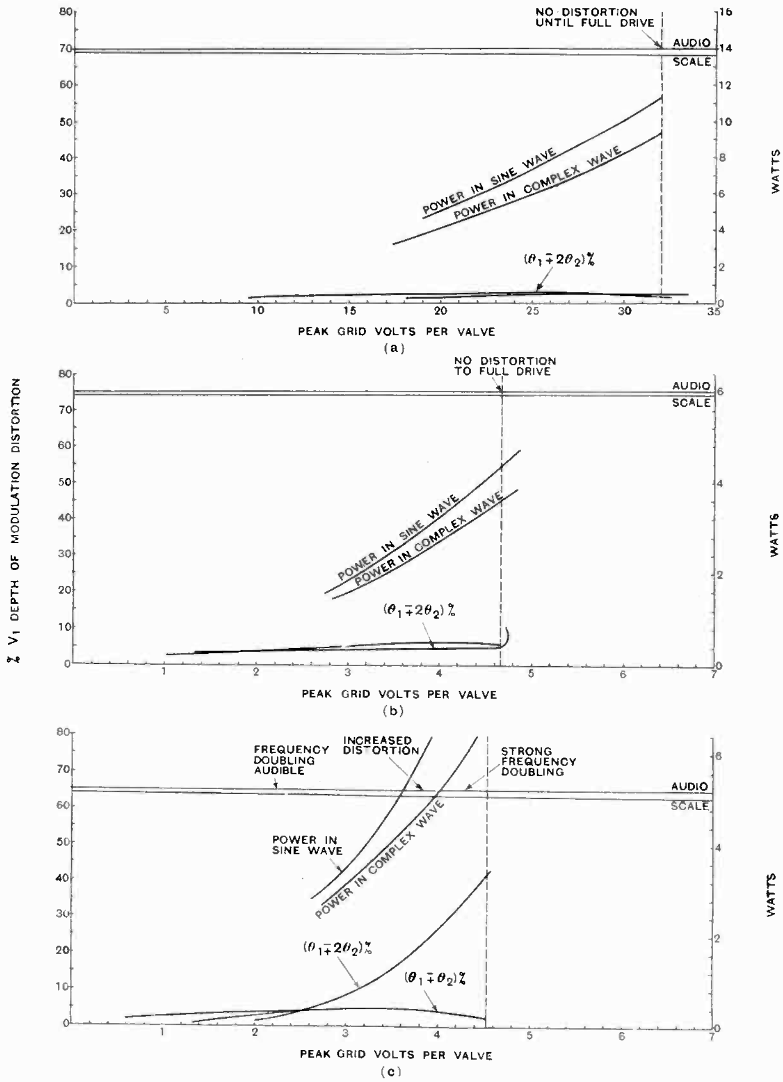


Fig. 9.—*Measurements by the new system on push-pull output triodes, Harries valves and typical commercial British pentodes giving respectively asymmetrical and symmetrical distortion.*

(a) 2 *PX25 Triodes.* $E_a = 250\ V$, $E_g = -32\ V$, $I_a = 64\ mA$ *each, Load* = 6,400 Ω.

(b) 2 *AC/Z Harries Valves.* $E_a = 250\ V$, $E_s = 250\ V$, $E_g = 5.5\ V$, $I_a = 32\ mA$ *each, Load* 12,000 Ω.

(c) 2 *Pentodes "B."* $E_a = 250\ V$, $E_s = 250\ V$, $E_g = -5.5 V$, $I_a = 32\ mA$ *each, Load* 13,800 Ω.

that given by probably any other standard method (for instance Bib. No. 6). The increased clarity and lack of "harshness" is very noticeable, provided of course that the associated equipment is sufficiently good and the transmission is sufficiently faithful itself to do justice to the amplifier. Indeed the results are then quite beyond comparison with those having a greater amount of distortion. It may be seen by referring to the top graph in Fig. 9 that this corresponds to conditions in which both first and second side tones are reduced to less than 5 per cent. depth of modulation.

Observation with ordinary commercial apparatus with triode valves shows that one of these, even when not used in push-pull (and therefore not cancelling the first side tone; but having at the same time only a very small second side tone and therefore only a very small spread of output distortion spectrum), is really extremely satisfactory under ordinary commercial reception conditions. Indeed, peaks of modulation of even the B.B.C.'s transmitters do not have a lower distortion level than this. It will be

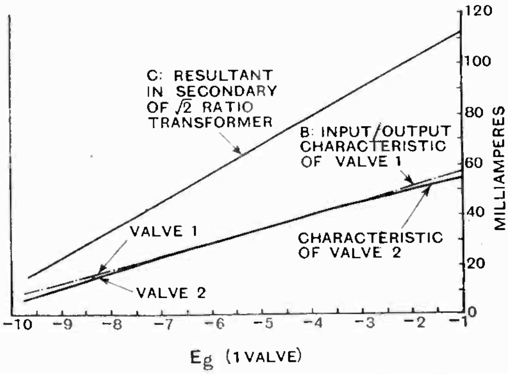


Fig. 10.—*The working input/output characteristics of two Harries valves in push-pull, both giving asymmetrical distortion. The resulting output characteristic for the pair is almost precisely a straight line. The distortion level is therefore low (see Fig. 9). Load plate to plate* 14,000 *ohms*, $E_a = 250$, $E_s = 250$, $E_g = -5.35$, $I_a = 32$ *mA per valve. Triodes give a similar result.*

seen by reference to Fig. 6 that this condition corresponds to a first side tone at full drive of between 20 and 30 per cent. depth of modulation, and a second side tone

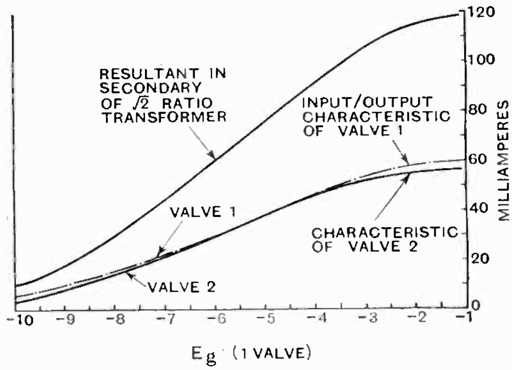


Fig. 11.—*The working input/output characteristics of two typical British commercial pentodes type "B" in push-pull, each giving symmetrical distortion. The curvature of the individual characteristics of the two valves is not cancelled out in push-pull, and remains as symmetrical distortion. (Compare with Fig.* 10.) *Load, plate to plate,* 13,800 *ohms*, $E_a = 250$, $E_s = 250$, $E_g = -5.8$, $I_a = 32$ *mA per valve.*

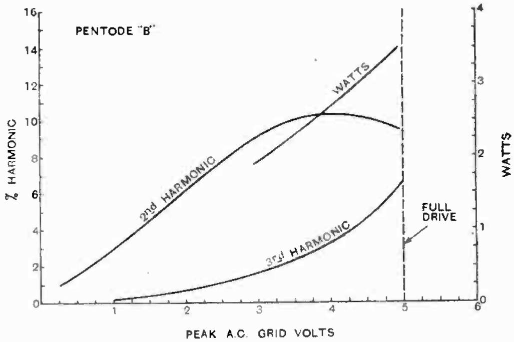


Fig. 12.—*The results of conventional harmonic analysis with a sine wave input of the distortion given by a pentode type "B."*

of the order of 5 per cent. modulation depth at full drive.

If, however, experiments are made with Class B valves or amplifiers in which positive

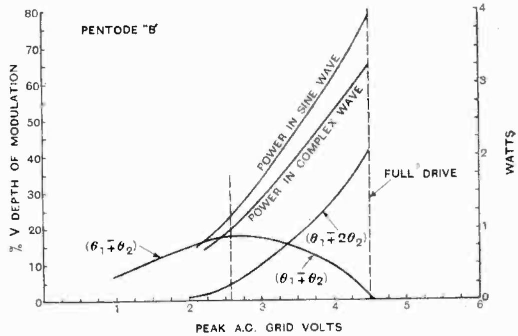


Fig. 13.—*Distortion measurements on pentode type "B" by the new method. (Compare with Fig.* 12.)

grid current or saturation effects are present, or with pentodes, the roughness or harshness of reproduction will be evident when the peaks run into that portion of the characteristics which corresponds to a wide distortion spectrum, or, in other words, into that portion which corresponds to the production, under conditions of the test described in this paper, of a second side tone which exceeds the order of 5 per cent. modulation depth and the production of a falling first side tone (Fig. 8). These results may be summarised as follows :—

Suggested Standards of Distortion

1. *High Quality*. Side tones must not exceed 5 per cent. modulation depth. It is possible that lower figures than this will be

appreciably better—if they can be obtained overall in communication systems.

2. *Good Commercial Quality.* First side tone not to exceed about 30 per cent. modulation depth at full drive. Second side tone at full drive not to exceed 5 per cent. modulation depth.

3. *Objectionable Distortion.* This is found in commercial conditions when the second side tone rises above about 5 per cent. modulation depth and the first side tone falls.

4. *"Undistorted Power Output."* This rating should be the power output given under conditions (2) using a sine wave having the same peak value as the complex wave used to measure the side tones.

Conclusions

The existing methods of harmonic distortion measurement are unsatisfactory, and it is hoped that the methods put forward in this paper will be adopted and will contribute in some measure to the cause of high fidelity reproduction and to the standardisation of amplitude distortion measurements.

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Book Reviews

Testing Radio Sets. Third Edition.

By J. H. Reyner, B.Sc., A.M.I.E.E., pp. 239+xi. 115 photographs and diagrams. Chapman and Hall, Ltd., 11, Henrietta Street, London, W.C.2. Price 10s. 6d.

Writers, dealing with such a rapidly changing subject as radio receiver technique, in the desire to avoid any appearance of being out-of-date, commonly exclude all reference to any other practice than that current at the date of publication.

Readers of such a book as the well-known "Testing Radio Sets" may expect, however, to handle models of all ages. In revising it for the third edition, the author has resisted the temptation to discard the material in the earlier editions treating of "eliminators," D.C. mains receivers, simple reaction type receivers, "aperiodic" R.F. amplification, and the simple screen grid valve. Nor does he assume, as one is inclined to do with contemporary types of receiver, that the designer knew his business; for considerable attention is given to the correction of design faults that would render a set inoperative. Again, while advocating equipment such as modern signal generators, he does not utterly discourage the tester who is obliged to work with a buzzer wavemeter.

It may be considered, however, that the author has gone too far in making no reference to well-established practice such as push-pull in any of its forms, or to variable selectivity or Q.A.V.C.; and in excluding R.F. pentodes and modern frequency-changer valves from all circuit diagrams. Again, although noisiness due to interference may seem to be a comparatively modern ailment of receivers, it is one from which the earlier types are not immune; and it is therefore surprising to find no reference to noise suppression. (The author has treated this subject in detail elsewhere, however.)

The comprehensiveness of the volume may be judged from the fact that considerable space is devoted to the design of attenuators and signal generators and the testing of components. The superheterodyne is also included. It should be mentioned that it is divided into two sections—Fault Testing and Laboratory Tests; some of the matters explained simply in the first are given more advanced treatment in the second.

The danger of haphazard testing is stressed, and a systematic step-by-step elimination of faults is elaborated, which, if the tester's self-discipline prevails, he will adopt. On the other hand, the author has wisely included a number of examples of exceptional faults, as a corrective of too rigid an adherence to simple general rules of receiver behaviour. But particular examples are nowhere allowed to usurp the prime place devoted to inculcating *system.*

Coming to actual methods of test, a wide variety is described: in the reviewer's opinion, perhaps too wide; for a single piece of apparatus—an impedance comparator—consisting of a valve oscillator (preferably a dynatron; which, however, is not mentioned) and a few accessories such as a variable condenser with open scale, would serve a great many purposes for which specialised gear is described. In particular there seems little justification for the introduction of an arbitrary "performance factor" for R.F. chokes and the like, when with the apparatus just mentioned it is so easy to measure the actual resistance and reactance (or equivalent capacity, positive or negative), which may far more usefully be fitted into other data about a circuit.

Such errors as were noticed were for the most part not likely to mislead; but it was rather surprising to find that in short wave work "dielectric losses are of secondary importance, in fact, less important than they are on normal broadcast wavelengths"; and the author does not seem to be quite able to make up his mind whether valve voltmeters do or do not impose a serious loss on a tuned circuit being measured.

The book is well produced and of interest to almost everybody within the wide field of radio technique. M. G. S.

Wireless Engineering

By L. S. PALMER, D.Sc., Ph.D., F.Inst.P., M.I.E.E. Pp. 544+xii, with 353 figs. Longmans, Green and Co., Ltd., 39, Paternoster Row, London, E.C.4. Price 21s. net.

As stated in the preface, this is a new edition of the same author's *Wireless Principles and Practice* (1927), "revised and brought up to date." In the issue of this journal for June 1928 the earlier work was very favourably reviewed, and it is with real regret that we find ourselves unable to offer a like welcome to its successor.

While *principles* do not alter, the last decade has seen such changes in nearly every branch of the *practice* of Wireless Engineering as would almost justify the use of that overworked adjective, "revolutionary"; it necessarily follows that any attempt to revise a nine-year-old textbook, however good originally, is doomed to failure; unless the author is prepared to rewrite almost every paragraph.

Since this book is offered under a new title, the reader is led to expect that a really thorough revision of this nature has been made, out-of-date matter eliminated, and diagrams of connections redrawn in conformity with modern practice. But on comparing the new volume with its predecessor, it is found that in the process of being "brought up to date" some 40 additional pages have been provided, yet of "revision" and elimination there is little trace other than the replacement of the bibliographies at the end of each chapter by new paragraphs, not always happily placed. For example, loudspeakers are given two pages (with three footnote references which do *not* mention the classical works of McLachlan), and these two pages are not, as one might reasonably expect, in the chapter on Telephony, but will be found at the end of Chapter IX, which is entitled "The Detection of High-Frequency Currents." A large proportion of the text and illustrations of 1927 are incorporated in the new book without alteration of any kind, with results which are somewhat startling. Much of this reprinted matter will chiefly interest archaeologists.

Lest your reviewer be accused of exaggeration, some quotations are given, which speak for themselves :—

". . . the Perikon detector, which is much used in America . . ." (p. 319).

". . . it is useless trying to build a high-frequency amplifier with more than six or seven valves. . . ." (p. 387).

". . . An amplifier of this type is shown in Fig. 219, in which detection is carried out by dulling the filament of the last valve with the separate filament rheostat." (p. 385.)

In a footnote to p. 404 we read :—"A note of amplitude A differs from one amplitude by B by C decibels, where $0.1 \log_e A/B = C$." Not only does this astounding statement contain the most remarkable arithmetical errors (of course $0.1 \log_e$ should be $20 \log_{10}$) but *this is the only place in the book where the decibel is mentioned!*

Chapter X, "Amplification of Oscillatory Currents" consists of 59 pages, in which all the diagrams of H.F. amplifiers employ triodes, the H.F. pentode is not mentioned at all, and the screen-grid tetrode does not appear as an amplifier, though a new section of a couple of pages mentions its use as a Dynatron oscillator, curiously enough at the end of the chapter on "Theory of the Wireless Valve," not in the chapter on oscillators as might have been expected. . . . . Almost every diagram of connections shows filament rheostats, but nowhere is there any sign of provision of negative grid-bias, even for L.F. amplifiers, let alone for H.F.

Among the commonplaces of to-day for which we sought unavailingly in both index and text may be mentioned the "variable-mu" principle (the omission of which, of course, involves the many types of "A.V.C." with some form of which few modern receivers are unprovided); valves with separately heated cathodes, which admit the utilisation of the voltage-drop in resistances in the cathode return circuit to provide "automatic" grid-bias; and Pentodes, whether H.F. or L.F. The superheterodyne receiver is dismissed in a paragraph of less than 1,000 words, a literal reprint from 1927, yet 34 pages are given up to "Spark and Arc" methods of generating oscillations.

On p. 23 we are warned of the evils of "end-effect" in sliding-contact receiving inductances; one wonders how many readers of to-day have ever seen such a thing outside the Science Museum?

The defects which we have felt it our duty to point out are clearly due to insufficient revision of a nine-year-old textbook dealing with a rapidly changing subject. Whether author or publisher is responsible it is impossible to say, but the effect is most unsatisfactory.

C. R. C.

Cours élémentaire de Télégraphie et Téléphonie sans Fil.

By F. Bedeau, pp. xi + 483 with 353 Figs. Paris. Librairie Vuibert.

This is the second edition of a work first published in 1931. It had the distinction of being awarded the Prix Hébert by the Académie des Sciences. The second edition is claimed to be a new book, dealing as it does with the great developments which have taken place in recent years. It commences with the magnetic needle of unit pole strength and develops the classical theory of electricity and magnetism, but always stressing those phenomena, such as resonance, which are of special importance in wireless. The section on alternating current theory concludes with a study of filters. Successive chapters deal with all the various branches of the subject in a very complete manner, including the recent developments such as multiple short-wave aerials and piezo-electric oscillators. The description is always clear and assisted by diagrams and analogies. Numerous references are given to original works. The book does not deal with practical construction but would be more correctly called a text book of the elementary theory of the subject.

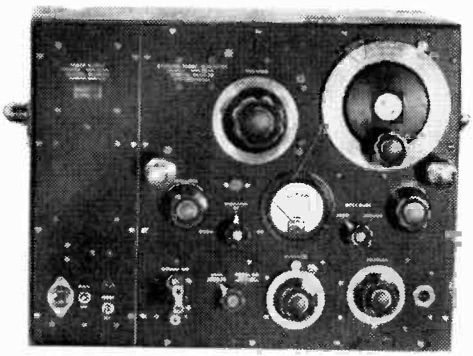
G. W. O. H.

The Physical Society's Exhibition

Many New and Improved Instruments for Radio Research

THE twenty-seventh Annual Exhibition of Scientific Instruments and Apparatus was held at the Imperial College of Science and Technology, South Kensington, on January 5th, 6th and 7th.

Comparing the progress in instrument design with that shown on previous occasions there can be little doubt that 1936 has proved a vintage year from the radio engineer's point of view. In addition to the new types of measuring apparatus which have been promptly supplied to satisfy the requirements of those engaged in television and short-wave research, the leading instrument firms have found time to produce revised versions of standard laboratory gear incorporating improvements which experience has shown to be desirable.



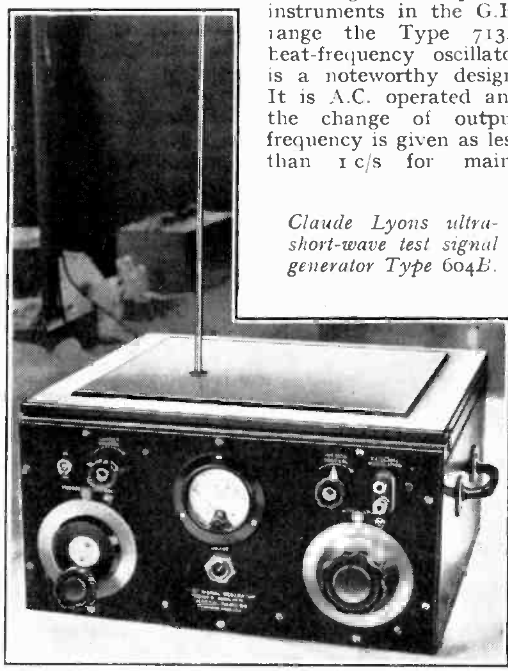
Claude Lyons G.R. Type 605A standard signal generator.

The new G.R. standard signal generator Type 605A shown by CLAUDE LYONS, LTD., is a very fine example of modern test equipment. It is designed to operate entirely from A.C. mains, though a battery supply can be easily substituted. The effects of mains fluctuation are controlled by "Raytheon" voltage regulators of the saturated core type giving an H.T. supply to the valves stable within 1 volt for inputs between 190 and 260 volts. The range of the carrier frequency is from 9.5 kc/s to 30 Mc/s in seven bands selected by a rotary switch. The accuracy of the voltage output is $\pm$ 0.1μV below 3 Mc/s, $\pm$ 0.2μV from 3 to 10 Mc/s and $\pm$ 0.4μV from 10 to 30 Mc/s. To eliminate frequency variation a buffer amplifier has been inserted between the carrier oscillator and the attenuator. Internal modulation is at 400 c/s and the external modulation characteristic is now constant within 1 db from 30 to 15,000 c/s. To compensate for long-period drifts in calibration, trimming adjustments for both inductance and capacity are provided. A built-in valve voltmeter takes the place of the thermocouple monitoring meter in earlier instruments.

The G.R. test signal generator Type 604B has been designed as a local source for ultra-high frequency research. It is arranged to supply either a known voltage across terminals at the end of a screened lead, or a constant field strength. A rod antenna is sectionalised in three lengths to generate field strengths in the ratio of 1, 10 and 100 with a constant input of 1 volt; the local voltage output (5 to 10,000 μV) is derived from a continuously variable attenuator of the capacity type. The frequency range of the instrument is 3 to 100 Mc/s and internal modulation at 400 c/s is provided. The external modulation circuit passes frequencies up to 200 kc/s.

Two excellent signal generators for the service man—the Lyons-Hickok Model OS10 and the Lyons-Monarch Model 12, both with potentiometer type attenuators—were also shown on this stand.

Among audio-frequency instruments in the G.R. range the Type 713A beat-frequency oscillator is a noteworthy design. It is A.C. operated and the change of output frequency is given as less than 1 c/s for mains fluctuations up to 12½ per cent. The frequency range is 10 to 20,000 c/s constant within 0.5 db from 30 to 10,000 c/s and within 1.4 db between

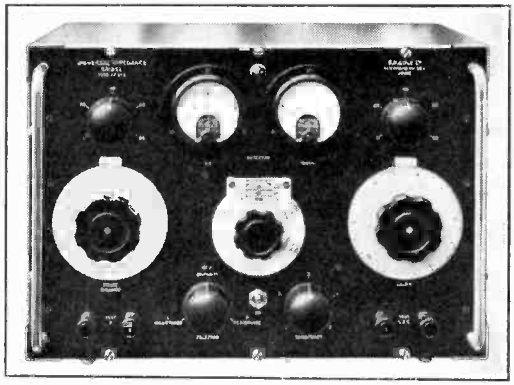


Claude Lyons ultra-short-wave test signal generator Type 604B.

10 and 16,000 c/s. Above 100 c/s the total harmonic content is less than 1 per cent. and the output is 130 volts on open circuit or 2 watts into 2,000 ohms. The main dial is calibrated at least every 100 c/s and a subsidiary calibrated condenser gives variations of ± 50 c/s at any part of the scale.

Claude Lyons G.R. Type 636A wave analyser.

The G.R. Type 636A wave analyser is an indispensable adjunct to the audio-oscillator. Essentially it is a heterodyne valve voltmeter with an intermediate-frequency amplifier incorporating two quartz crystal filters. The range covered is 20 to 16,000 c/s and the selectivity, which is, of course, constant throughout the range, corresponds to a drop of 6 db at 2 c/s and 40 db at 30 c/s off resonance with any given component of the waveform. The meter is provided with an internal multiplier giving a range from 0.2 millivolt to 2 volts and an external multiplier extends the range to 200 volts. The calibration error is within 2 per cent. in the case of frequency and 5 per cent. for voltages above 2 millivolts.

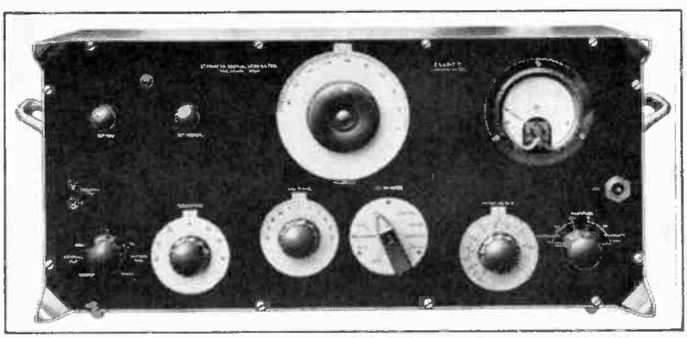


Marconi-Ekco Type TF373 universal impedance bridge.

A new precision air dielectric condenser (Type 722) with a temperature coefficient of capacity of 0.002 per cent. per degree C., is incorporated in the G.R. Type 724A wavemeter which covers 16 kc/s to 50 Mc/s with seven coils wound on "isolantite" formers and enclosed in rotatable bakelite cases. The maximum error throughout the range is 1 per cent.

Although the instrument had not arrived at the time we visited the stand, an interesting valve voltmeter (Type 726A) will be included in the G.R. range this year. An R.C.A. "microwave" triode is fitted at the end of a 5ft. screened cable and the meter and associated supply circuits for operation from A.C. mains are enclosed in the main body of the instrument. The accuracy is stated to be within 1 per cent. from 20 c/s to 50 Mc/s and 2.7 per cent. at 100 Mc/s. The input capacity is 8 $\mu\mu$F and the input circuit resonates at 500 Mc/s.

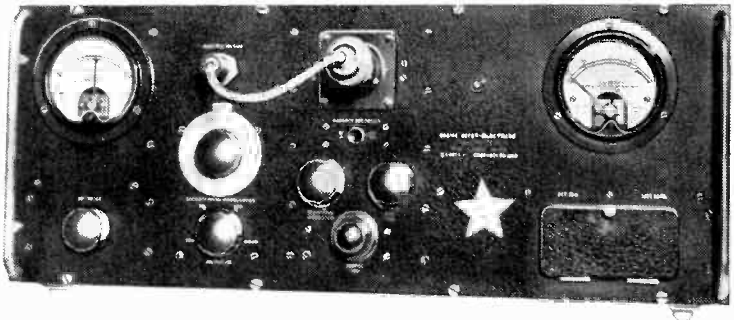
Mains operation for valve voltmeters would now appear to be universal and the Type TF336 of MARCONI-EKCO INSTRUMENTS, LTD., is designed for 50-cycle supplies from 200 to 250 volts. The meter



Marconi-Ekco Type TF 144 standard signal generator for mains or battery operation.

scale is linear from 0.3 to 5 volts R.M.S. and the input circuit is mica insulated and air spaced to maintain a high input impedance.

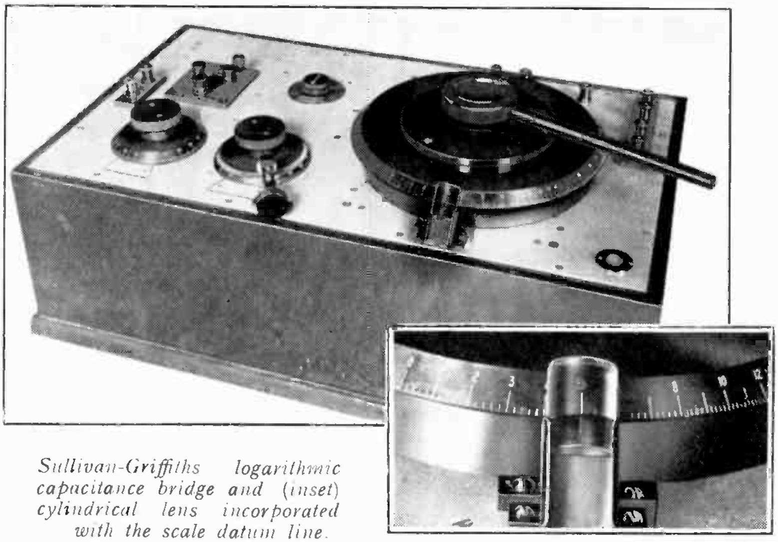
Many new instruments testify to recent intensive activity in the research and development sections of this firm, and many interesting refinements in mechanical design have been incorporated in all models. These include a precise method of locating detachable knobs and dials on their spindles, valveholders with replaceable sockets, redesigned coil formers of low temperature coefficient and a new method of turret mounting for waveband selection.



Marconi-Ekco Type TF 339 inter-electrode capacity test set. Capacity is given in terms of an attenuator setting.

The latter feature is incorporated in the new short-wave signal generator Type TF390, which provides a frequency range of 20 to 150 Mc/s with an output of 1 μV to 0.1 volt. An acorn valve oscillator is employed and the voltage across the slide-wire attenuator is measured by an acorn valve voltmeter. The instrument is available for battery or mains operation and the output appears at the end of a flexible screened cable.

The standard signal generator Type TF144 has been redesigned and is now available for alternative mains or battery operation. The screening has been improved and a spring stop has been fitted on the attenuator control to protect the thermocouple meter from accidental damage. A rotating turret of eight coils provides a frequency range of 85 kc/s to 25 Mc/s, and an important addition to the specification is a calibrated fine tuning control to facilitate selectivity measurements. A modified instrument for routine testing and alignment is available with alternative pre-set output frequencies.

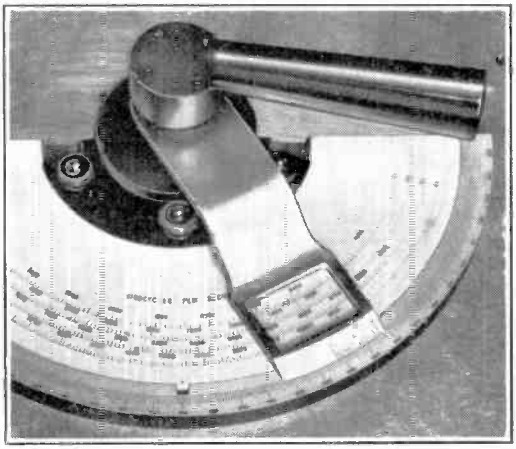


Sullivan-Griffiths logarithmic capacitance bridge and (inset) cylindrical lens incorporated with the scale datum line.

The beat-frequency oscillator Type TF195 has been improved in detail and a new wide-range beat-frequency "microvolter" Type TF336 provides a suitable source for investigating television amplifiers. The fundamental dynatron oscillators have a frequency of the order of 20 Mc/s and the beat frequency range is 50 to 150,000 c/s. A modified instrument with an upper limit of 3 Mc/s is in preparation.

Rapid determination of inductance, capacity and resistance is facilitated by the Type TF373 universal impedance bridge. This useful instrument is operated from A.C. mains and includes a 1,000-cycle oscillator, and a selective amplifier and valve voltmeter for detecting balance in L and C measurements. For resistance measurements a centre-zero meter is used and D.C. is derived from the power supply circuit. A selector switch automatically provides the appropriate circuit and the scales are direct reading. There are five ranges for each of the three quantities, with calibrations from 5 μH to 100 H, 5 $\mu\mu$F to 100 μF, and 0.05 ohm to 1 megohm. The bridge also measures condenser loss and coil magnification.

A separate instrument (Type TF329) giving direct meter scale readings of coil magnification is also available. A known E.M.F. at any frequency between 50 kc/s and 50 Mc/s is injected into a tuned circuit containing the coil to be measured. A valve voltmeter measures the volts developed across the condenser at resonance and the meter scale is calibrated to read $\omega L/R$, the range being 25 to 500. The frequency range of the oscillator is covered by a turret of eight coils and the tuning scale can be calibrated to read directly in frequency.

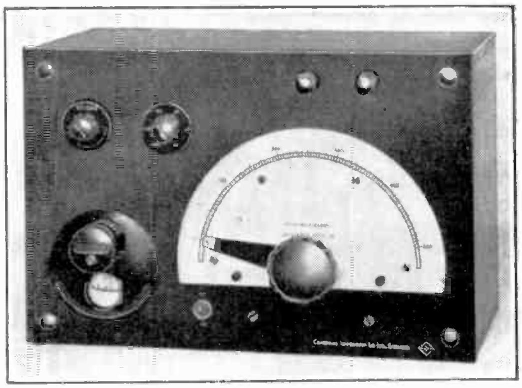


Direct reading scale of Sullivan-Griffiths dynatron oscillating wavemeter.

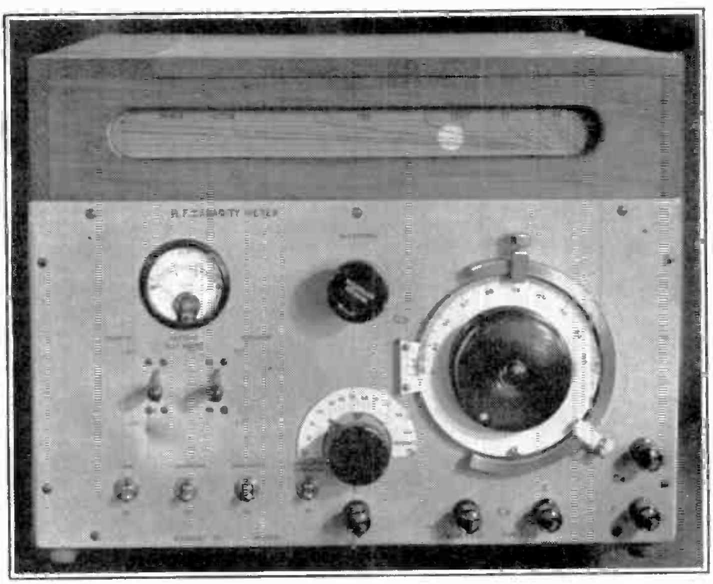
It is difficult to make a selection from remaining exhibits on the stand, each of which is deserving of detailed analysis, but we cannot do better than conclude with the inter-electrode capacity test set Type TF339. A tuned circuit with means for adjusting its dynamic resistance to a known value is energised from a 100 kc/s oscillator through an attenuator and the capacity to be measured. The indicator is an amplifier and voltmeter connected across the tuned circuit, and for a standard output reading the capacity is given in terms of the attenuator setting. The range is 0.0001 to 1.0 $\mu\mu$F.

The position held by H. W. Sullivan, Ltd., as manufacturers of standard wavemeters of the highest accuracy and stability, was once again confirmed by their exhibits this year. Further improvements have been effected in the method of mounting the Sullivan-Griffiths thermal-compensated inductance standards, and the residual temperature coefficient of less than 5 parts in 10^6 per degree C. has been rendered perfectly cyclic. In the case of the silica-insulated capacity sub-standards the equivalent series resistance has been reduced to 0.002 ohm at 1,000 kc/s and the temperature coefficient is less than 5 parts in 10^6 per degree F.

An important development is the fitting of direct reading scales to most of the Sullivan wavemeters. In the case of the dynatron sub-standard wavemeter (100 to 30,000 kc/s) with its frequency stability of



Cambridge high-frequency capacity meter.

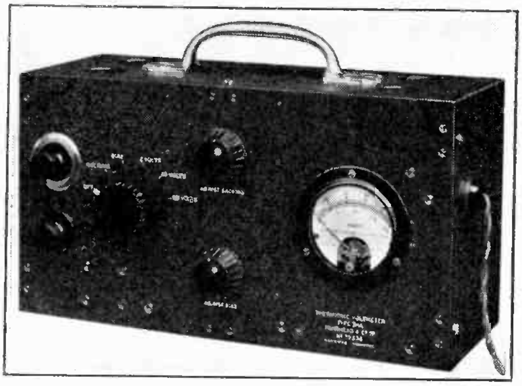


(Left) Tinsley RF capacitance and power factor tester.

2 parts in 10^6 the direct reading accuracy is 0.01 per cent. In the new Type R800 universal dynatron and absorption wavemeter (30 to 15,000 kc/s) the direct reading accuracy is 0.2 per cent. and the frequency stability 0.002 per cent. Another new sub-standard absorption wavemeter with an overall accuracy of 0.03 per cent. is of particular interest as its range of 5 to 42 metres covers the television wavelengths.

The Ryall-Sullivan precision heterodyne oscillator has been further improved and the output voltage over the entire range is constant within 0.1 db for changes of mains or battery voltage of $\pm$ 5 per cent.

A condenser of similar construction to that used in the beat oscillator forms the basis of the new Sullivan-Griffiths logarithmic capacity bridge. This gives a remarkably open scale for small capacities



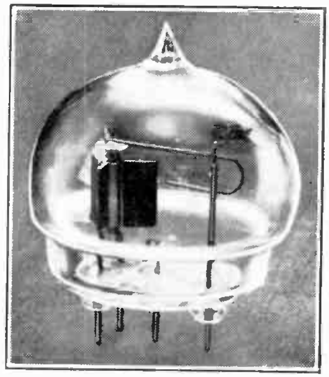
Muirhead thermionic voltmeter, Type 3-A.

and the range is 1 $\mu\mu$F to 200 μF with 0.2 per cent. accuracy throughout.

For the routine testing of mass produced condensers H. TINSLEY & Co. have produced a very convenient R.F. capacitance and power factor tester (Type 4505). The self-contained oscillator functions at 1 Mc/s and the capacity is measured by the substitution method in a tuned circuit of low loss, acceptance limit stops being provided on the master condenser. Resonance is indicated by a valve voltmeter with a built-in reflecting galvanometer. Since the voltage developed across the tuned circuit is a function of the resistance introduced by the condenser under test, the galvanometer scale if provided with a suitable calibration curve can be made to read power factor direct. The scales are interchangeable and the range of power factors that can be measured is 0.1 to 0.0001. The R.F. dielectric test set (Type 4206L) is now available with interchangeable electrode systems for liquid as well as solid dielectrics.

In the new high-frequency capacity meter shown by the CAMBRIDGE INSTRUMENT Co., LTD., a linear capacity scale is provided and multipliers in the bridge circuit give a range of 0 to 2500 $\mu\mu$F. On the lowest scale (0 to 50$\mu\mu$F) capacities can be read to 0.2 $\mu\mu$F. Balance is indicated by a centre zero pointer galvanometer and the self-contained battery-driven oscillator functions at a frequency of 200 kc/s. The bridge is remarkably stable from the point of view of hand capacity effects.

The range of the Cambridge versatile galvanometer has now been extended to radio frequencies by the provision of suitable vacuo-junctions specially adjusted to conform with the thermal scale on the meter.



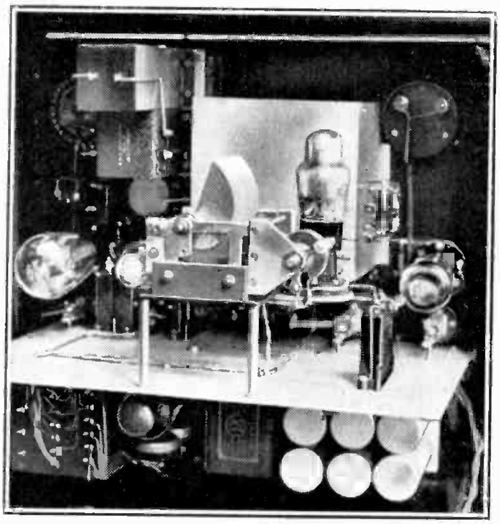
Standard Telephones ultra-short - wave amplifying and transmitting valve, Type 4316A.

In the latest resistance units and boxes shown by MUIRHEAD & Co., LTD., variations in the residual reactance due to leads and switch have been eliminated. Separate resistance elements are used for each step and the associated pairs of studs are brought in turn under two fixed brushes which are arranged to give the smallest possible inductive loop. Fixed attenuator units in moulded bakelite boxes were also shown. These are available in "H" or "T" sections up to 40 db per unit and can be joined in banks up to any number.

The thermionic voltmeters have been redesigned and the input impedance is now 2 megohms at 160 kc/s with an input capacity of 9 $\mu\mu$F. A linear meter scale above 0.2 volt is provided and the mains-operated instruments have three ranges of 0–2, 0–10 and 0–50 volts.

An improvement has been effected in the sensitivity of the Muirhead-Willans conduit microphone and the output is now 5 millivolts per dyne/cm^2 which compares very favourably with that of other high-fidelity microphones.

The new valve mutual conductance bridge is a development of the Type 1A inductance bridge and a similar plug and socket arrangement is employed



Muirhead resistance-capacity audio-frequency oscillator for rack mounting.

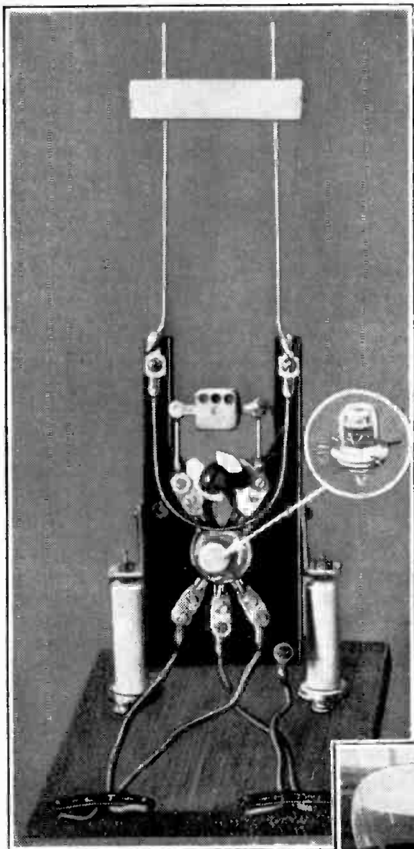
to adapt the circuit to valves of different types. Another notable addition is the resistance-capacity controlled audio-oscillator based on a circuit due to Dr. N. L. Yates Fish. A frequency variation of 10 : 1 is obtained with a single sweep of the condenser and three ranges cover the band from 20 to 20,000 c/s. Not the least important advantage of this type of oscillator is the improved waveform and stability at low frequencies.

The exhibits shown by STANDARD TELEPHONES AND CABLES, LTD., covered a wide field ranging from acoustic measurements to transmitting valves. The new Type 4021A moving coil microphone is fitted with an acoustic screen which acts as a reflector for sound arriving from the back and an absorber for sound directed towards the front of the diaphragm. The proportions are such that the frequency characteristic is flat within $\pm$ 6 db between 40 and 10,000 c/s for any angle of incidence.

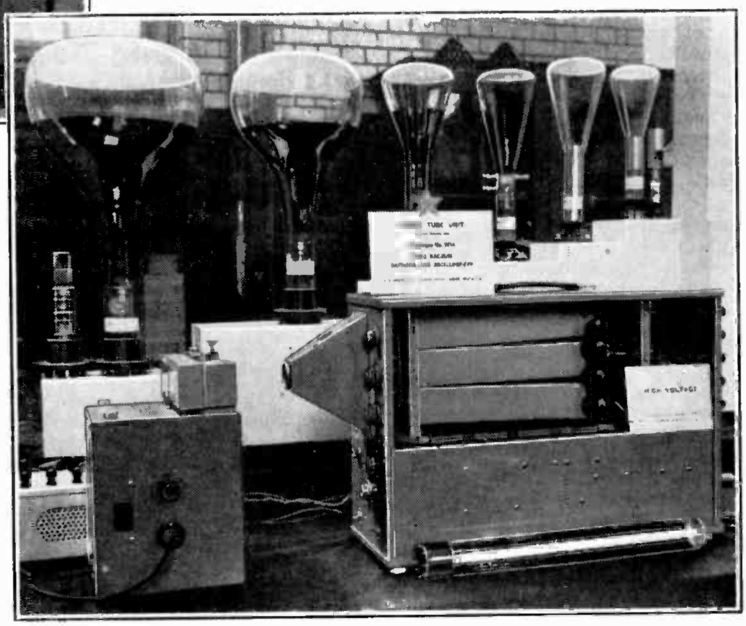
Cathode-ray technique was represented by a self-triggering transient recorder and a new portable A.C. operated oscillograph (Type 74320A) incorporating a gas-focused tube with a pre-amplifier covering 15–15,000 c/s and a linear time base having the same range. The sensitivity is of the order of 7.5 mm/volt.

Among the transmitting valves were many special designs for ultra-short-wave working of which the Type 4316A may be taken as an example in view of its suitability for low power experimental work. The thoriated tungsten filament requires 3.65 amp. at 2 volts and has a total emission of 400 mA. The electrode leads are well spaced and the valve is suitable for wavelengths down to less than 1 metre. A maximum anode dissipation of 30 watts is permissible and the working plate voltage is 450.

Efficient reception at ultra-high frequencies is possible with the Mazda "acorn" valves shown by the EDISON SWAN ELECTRIC CO., LTD. The Type A31 triode has a mutual conductance of 2 mA/V and an amplification factor of 25. The grid-cathode and grid-anode capacities are 1.0 $\mu\mu$F and 1.4 $\mu\mu$F respectively. One of these valves was shown in a low power 70 cm. transmitter, and a pentode (Type A41) in a probe type valve voltmeter. The heater current in both types is 0.25 amp. at 4 volts. Other interesting valves on this stand were the V312 and PA20 non-microphonic triodes



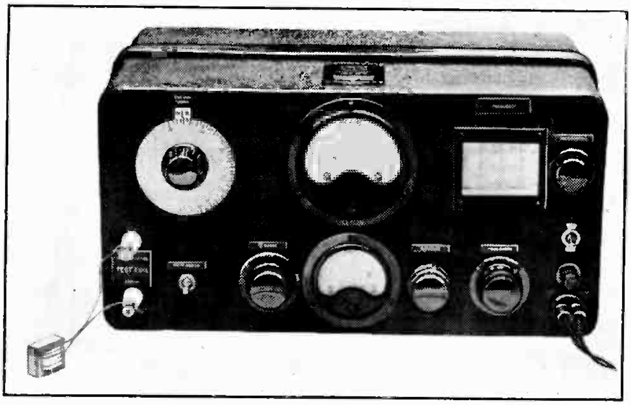
Low-powered 70 cm. transmitter incorporating a Mazda acorn valve (inset).



A part of the Cossor exhibit. In the foreground are the triple tube oscillograph unit and Type 3318 film camera.

and the exhibit also included a full range of Ediswan cathode-ray tubes, including the new 12-inch television tube.

Cathode-ray tubes and their associated equipment were the main feature of the exhibit of A. C. Cossor, Ltd. Most of the new gear is intended for general recording work and is built on the unit system. Two high-vacuum tube units incorporating all the necessary auxiliary circuits are available, No. 1 for use up to 3,000 volts and No. 2 for voltages up to 9,000. Mumetal screening gives protection from external fields and a useful feature is the provision of means for switching off the beam electrically or by a mechanical contact.



Salford "Q" meter for measurements of coil magnification.

Special 2-inch diameter high-vacuum tubes have been developed for the Triple Tube Unit in which the three screens are mounted adjacent to one another in the same plane for convenience in making simultaneous photographic records with new Cossor cameras. Two types have been developed, both making use of 35 mm. stock. The Type 3318 film camera gives records up to 12ft. in length at speeds from 1in. to 4ft. per sec. and is driven at constant speed through a reduction gear with interchangeable pinions by an induction motor designed for 50-cycle mains. In the Type 3317 drum camera a single record approximately 20in. in length is obtained. The drum is fitted with an ingenious release mechanism for removing the light-tight cover band after the camera is closed, and the clockwork drive gives controlled peripheral speeds up to 10ft./sec. and uncontrolled speeds up to approximately 90ft./sec.

A compact general purpose oscilloscope (Type 3323) using a gas-focused tube and incorporating a self-contained time base should prove of interest to the service man, and for television and other cathode-ray work a special wide-range amplifier flat within ± 1 db from 5 c/s to 2.2 Mc/s has been developed. It has a gain of 500, and the phase characteristic is stated to approach close linearity with respect to frequency.

Meters of the pivoted moving-coil type might be thought to have reached a state approaching finality in design, but each year seems to bring forward new types and modifications. Salford Electrical Instruments, Ltd., were showing new 3¼in. miniature portable instruments, including voltmeters of 10,000 ohms per volt for valve measurements. On this stand there was also a recently developed "Q" meter giving readings of coil magnification from 20 to 500 for frequencies from 100 kc/s to 5 Mc/s.

For many purposes high-speed pointer instruments with good damping are required and Ernest Turner Electrical Instruments, Ltd., have succeeded in solving the difficult problem of design. Their rapid indicating milliammeters move from zero to full-scale deflection in 82 milliseconds with an overswing of only 1 millisecond. Thermoammeters incorporating these movements have also been developed in which precautions have been taken to protect the control springs from the effects of R.F. eddy currents.

Low-reading rectifier type millivoltmeters and milliammeters making use of input transformers were included in the exhibit of Elliott Bros. (London), Ltd., and a new type of instrument rectifier in which the number of the elements can be varied was shown by Westinghouse.

For measurements on H.T. supply units for cathode-ray tubes a special electrostatic voltmeter with three ranges of 0–2,000, 0–4,000 and 0–8,000 volts has been introduced by Everett Edgcumbe & Co. A representative selection of "Radiolab" test instruments for service engineers was also a feature of this stand.

The Automatic Coil Winder and Electrical Equipment Co., Ltd., have developed a new range of service test instruments, including a capacity meter and a valve tester capable of accommodating current American as well as English types of valves. The latest Model 7 "Avometer" with a total of 46 ranges was also shown, and a skeleton movement was used to demonstrate the inertia-operated mechanical cut-out which takes the place of a fuse in this instrument.

Most of the new instruments shown by the Weston Electrical Instrument Co., Ltd., were concerned with photometry, but radio-testing instruments were well represented and included an improved service oscillator (Model E692), covering 100 kc/s to 25 Mc/s with plug-in coils, a mains-operated capacity meter, and a multi-range valve voltmeter (Model 669), also mains operated, with an input capacity of only 4 $\mu\mu$F.

Manufacturers of what might be termed basic components were well represented and in the remaining space at our disposal we would draw attention to the new ceramic cup, disc and tube condensers for ultra-high frequency circuits shown by the Dubilier Condenser Co., Ltd., the special screened cables for television and anti-interference aerial down leads produced by the Telegraph Construction and Maintenance Co., Ltd., and the compact permanent magnets giving fields of 1,500 c.g.s. units in 4 cm. gaps developed by Darwins Ltd., for use with magnetron oscillators.

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

437. WIRELESS WAVES REFLECTED FROM THE IONOSPHERE AT OBLIQUE INCIDENCE.—F. T. Farmer & J. A. Ratcliffe. (*Proc. Phys. Soc.*, 1st Nov. 1936, Vol. 48, Part 6, No. 269, pp. 839–849.)

A discussion of (P', f) curves taken simultaneously with two receivers distant 1 and 464 km respectively from the pulse emitter. "The chief points investigated were (a) the behaviour of waves of such frequency that they were just about to penetrate the F region, (b) the behaviour of waves just about to penetrate the E region, and (c) the way in which the absorption depends on angle of incidence." The experimental results of (a) agree qualitatively with deductions from a theorem of Martyn (1727 of 1935), but to obtain quantitative agreement the calculated curve must be displaced towards the smaller frequencies by 0.23 Mc/sec. Possible causes for this discrepancy are discussed. Penetration of the E region at normal and oblique incidence might throw light on the correctness or otherwise of including the Lorentz polarisation term in the equations of motion of the electron; the variable nature of E region prevented a definite conclusion on this point. "Measurement of the sunrise increase of absorption . . . indicated that the day-time absorption takes place in a region below the main deviating portion of E region, for echoes both from the E and from the F region." For an account of similar work with (P', t) curves *see* 3974 of 1936: the writers of the present paper state that the main phenomena recorded in the two papers are in agreement.

438. THE EXPERIMENTAL DETERMINATION OF THE VELOCITY OF RADIO WAVES [along the Ground: Velocity less than That of Light].—Colwell, Hall & Hill. (*Journ. Franklin Inst.*, Nov. 1936, Vol. 222, No. 5, pp. 551–562.)

A fuller description of the experiments referred to in 3972 of 1936. Diagrams of the transmitting and receiving equipment are given, with circuits of the phase shifter and pulse generator at the field station (which acts as the apparent reflector of the waves) and of the oscilloscope control equipment and sweep calibrator at the base station. The technique of the measurements is described; in general the base station was operated on 2398 kc/s and the field station on 1614 kc/s. Observational data are given; they indicate that the velocity of ground waves varies "between one-half and two-thirds the velocity of light" and is not a constant, though so far "it has been impossible to obtain sufficient data for correlation between velocity and other phenomena." "The strength of the ground wave varies during periods of atmospheric disturbance."

439. A SIMPLIFIED AUTOMATIC RECORDER FOR IONOSPHERIC HEIGHT MEASUREMENT [and the Error due to Variable Receiver Lag].—Colwell, Hall & Hill. (*Science*, 4th Dec. 1936, pp. 515–516.)

"The error just discussed has seemingly been neglected by many investigators . . . Statements have been made that the layer heights will change as much as 10 km in less than 1 minute. Such changes are probably caused by variations in the signal strength of the reflections and not by sudden fluctuations in the height of the layer."

440. A SELF-SYNCHRONISING TIME BASE FOR THE DISTANT OBSERVATION OF WIRELESS PULSE TRANSMISSIONS [Circuit with Time Base Locked to Received Echo Groups which are delineated on Unobscured Portion of Time Base].—S. H. W. H. Falloon & F. T. Farmer. (*Proc. Phys. Soc.*, 1st Nov. 1936, Vol. 48, Part 6, No. 269, pp. 865–868.) Circuit based on Scholz's design (1934 Abstracts, p. 552).

441. NEW EXPLANATION OF THE TRANSIT OF SHORT WAVES ROUND THE EARTH.—O. von Schmidt: Schneeweiss. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 17, 1936, pp. 443–446.)

For a previous paper on the writer's idea of "wandering reflection," found by him in seismic phenomena, and Picht's criticism of his application of it to optical phenomena, *see* 1934 Abstracts, p. 433. The present paper begins by enumerating the difficulties in the way of explaining long-distance transmission of short waves by the idea of multiple reflections between ionosphere and earth's surface; as, however, the only alternative explanation—that of refraction in the ionosphere—has already been discredited (Försterling & Lassen, 1932 Abstracts, p. 87), a new theory is badly needed. In Fig. 4 the curve F shows the skip distances as a function of wavelength, as calculated according to Försterling & Lassen: this deviates considerably from the crosses which mark the actually measured distances. On the other hand, the curve S is barely distinguishable from that given by these crosses, and this curve is one calculated by Schneeweiss (in his 1935 Berlin Diploma thesis) from the writer's "wandering reflection" theory. This theory is illustrated in Fig. 3 (an upside-down version of Fig. 1, which shows the "wandering reflection" phenomenon in explosion-wave propagation); the waves leave the earth at A and meet the ionospheric layer (at E) at the limiting angle of incidence i; those with a smaller angle α are refracted and penetrate into the layer. The limiting rays, however, skim along just inside the ionosphere, following the surface of separation with a phase-velocity v_2 which ("as all writers maintain") is greater than the velocity v_1 $(= c)$; continuously "raining down" rays to the earth always at the fixed limiting angle i (such that $\sin i = v_1/v_2$) which is independent of whether continents, oceans, plains or mountains are below.

A further assumption, based on the very definite experimental observation of the independence of round-the-earth time on time of day and year, leads to a newer version of the writer's theory; namely that the passage takes place in a *non-dispersive medium, probably a vacuum* (but possibly a special ionisation condition where $v_2 = c$), the surface of demarcation involved being that between the upper limit of the ionosphere and the vacuum above it. With certain other assumptions changed to suit the new picture, the same agreement with the measured skip distances as that found by Schneeweiss is obtained, the relation now being $\sin i = v_1/c$ $(v_1 < c)$ instead of $\sin i = c/v_2$ $(v_2 > c)$. Taking the height of the upper ionospheric limit as 230 km, the constant circuit time works out to 0.1385 sec. compared with the observed value of 0.138 sec. As regards vertical reflection, according to the new theory this occurs chiefly in highly ionised air, so that transit time would be expected to vary, as it is found to do, with wavelength and with the time of day and year. A critical test for the theory will be on the question of the constancy of the downcoming angle.

442. STUDY ON THE PROPAGATION OF HIGH-FREQUENCY RADIO WAVES [with Definitions and Calculations of "Class A" and "Class B" Attenuations: Method of measuring Downcoming Angles: Data: Relationship with Field Intensity: etc.]—Namba, Maeda & Tsukada. (*Journ. I.E.E. Japan*, Sept. 1936, pp. 946–959: English summary pp. 67–72.)

443. ON THE VARIATION OF THE GAIN OF SHORT-WAVE BEAMS FOR WAVES PASSING THROUGH THE SUNRISE ZONE.—M. Nakagami & K. Miya. (*Journ. I.E.E. Japan*, July, 1936, p. 851: Japanese only.)

444. EFFECT ON THE IONOSPHERE OF THE PARTIAL SOLAR ECLIPSE OF 19TH JUNE, 1936.—Aschenbrenner, Goubau, Petersen & Zenneck. (*Hochf:tech. u. Elek:akus.*, Dec. 1936, Vol. 48, No. 6, pp. 181–182.)

(P', t) records are shown (Figs. 1–3) for the three days 18th/20th June over the early morning hours on wavelengths of 153, 78 and 46 m. The record taken during the eclipse shows "that about 15 min. after the time at which the eclipse was a maximum at a height of 200 km, there was a marked decrease in electron concentration."

445. AURORAL PHENOMENA AND THE BEHAVIOUR OF THE IONOSPHERE DURING A TOTAL SOLAR ECLIPSE [Effects of Electron Diffusion].—L. Vegard. (*Nature*, 5th Dec. 1936, Vol. 138, p. 974.)

"The coronal structure of the upper atmosphere produced on the day side will spread (diffuse) into the night region . . . counteract the night contraction, and support the maintenance of 'a coronal distribution' on the night side of the earth. . . . In this way we may also account for the fact . . . that the reflecting layers maintain their conductivity and reflecting power during a total solar eclipse. . . The spreading or diffusion process essentially effected by free electrons has also to be taken into account in any estimate of the rate of recombination from changes of ion concentration derived from radio-echo measurements."

446. AUDIBILITY OF A LIMITING WAVE (10 M) AND SOLAR PHENOMENA.—K. Stoye & E. Fendler. (*E.N.T.*, Nov. 1936, Vol. 13, No. 11, pp. 397–400.)

For previous work *see* 1696/7 of 1936. The audibility in Germany of distant stations in the 10 m band from Oct. 1935 to April 1936 is here shown in Fig. 1 and is shortly described; Fig. 2 gives a comparison between audibility and the magnetic character number for each day in 28-day periods. "Both the days of magnetic disturbance or quiet and the days of bad or good reception on 10 m occur in groups or vertical lines, showing a period of 27 or 28 days. . . . At sunspot minimum good reception of European stations occurs on days with low magnetic character number; at sunspot maximum good reception of distant traffic coincides with days of high magnetic character number, while good reception of European traffic occurs on days of low magnetic character number."

447. ON THE FALL OF SHORT-WAVE INTENSITY OF SHORT DURATION.—Ohno, Nakagami & Miya. (*Journ. I.E.E. Japan*, Aug. 1936, p. 938: Japanese only.)

448. IONOSPHERIC ANOMALIES OF SUDDEN ONSET [Connection between Short-Wave Signals and Long-Wave Atmospherics].—Bureau & Maire. (*See* 458.)

449. Radio Fadings and Bright Solar Eruptions [Hydrogen Eruption near Large Sunspot followed closely by Abnormal Ionospheric Conditions: Correlation suggested between Bright Eruptions and Marked Radio Fadings].—H. W. Newton. (*Nature*, 12th Dec. 1936, Vol. 138, p. 1017.) The sunspot in question is one of three referred to in *Nature*, 5th Dec. 1936, Vol. 138, p. 965.

450. The Emission of Electrons by the Sun and Its Relation to Terrestrial Magnetic Phenomena [Rapid Decrease with Height of Sun's Magnetic Field may explain Lag in Occurrence of Terrestrial Magnetic Storms after Solar Eruptions].—D. Barbier. (*Comptes Rendus*, 9th Nov. 1936, Vol. 203, No. 19, pp. 920–922.)

451. On the Propagation of High-Frequency Waves around 30 Mc/s in the case of the So-Called "New Radio Transmission Phenomenon" [Dellinger Effect], *and* Measurements of the Electron Density in the E Layer during the "Dellinger Effect" of 2nd April, 1936.—Ohno & Shimizu: Maeda. (*Journ. I.E.E. Japan*, May, 1936, p. 724: p. 725: Japanese only.)

452. The Influence of the Magnetic Field on the High-Frequency Characteristic of the Ionised Gases [Experiments with Wavelengths 2.36 – 10 m (and 30 m) in Argon and Air at Pressures down to 2×10^{-4} mm of Mercury].—Y. Asami & M. Saito. (*Journ. I.E.E. Japan*, Aug. 1936, pp. 882–885: long English summary pp. 56–58.)

453. Electric Waves along Corona-Covered Wires [Description of Apparatus for Demonstration of Luminous Standing Waves of Ultra-High Frequency on Adjustable Parallel Wires in Low-Pressure Carbon Dioxide].—I. Ebeling. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 17, 1936, pp. 463–464.) The writer points out in conclusion that the conditions found by van der Pol and by Appleton, in the condensers of their ionised-gas researches, exist in the apparatus here described.

454. The Life of Ions in Ionised Gases.—Y. Asami & T. Katayama. (*Journ. I.E.E. Japan*, Sept. 1936, p. 1024: Japanese only.) For Danzer's work, here referred to, *see* 1929 Abstracts, p. 500.

455. Absolute Values of the Electron Drift Velocity in Nitrogen, Helium, Neon and Argon [measured by Electrical Shutter Method: Occurrence of Occasional Inelastic Collisions].—R. A. Nielsen. (*Phys. Review*, 15th Nov. 1936, Series 2, Vol. 50, No. 10, pp. 950–954.) *See* also 2348 of 1936.

456. Red and Sunlit Auroras and the State of the Upper Atmosphere [Transitions between States of Excited Oxygen Atoms: Relative Intensities of Spectral Lines: Very Variable Ozone Concentrations].—L. Vegard. (*Nature*, 28th Nov. 1936, Vol. 138, pp. 930–931.)

457. The Illumination of the Atmosphere [Derivation of Formula].—P. Gruner. (*Helvet. Phys. Acta*, Fasc. 7, Vol. 9, 1936, pp. 596–601: in German.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

458. Ionospheric Anomalies of Sudden Onset [Disappearances of Short-Wave Signals coinciding with Increase of Intensity of Atmospherics on Long Waves].—R. Bureau & J. Maire. (*Comptes Rendus*, 7th Dec. 1936, Vol. 203, No. 23, pp. 1275–1278.)

459. Electroconvective Vortices [may underlie Certain Cloud Formations, etc.].—D. Avsec & M. Luntz. (*Comptes Rendus*, 30th Nov. 1936, Vol. 203, No. 22, pp. 1140–1142.)

460. Radio-Meteorographs [Survey].—K. O. Lange. (*Bull. Amer. Meteorolog. Soc.*, May, 1936: 24 pp.)

PROPERTIES OF CIRCUITS

461. Some Properties of Valve Oscillators with Coupled Circuits.—R. R. Nimmo. (*Phil. Mag.*, Dec. 1936, Series 7, Vol. 22, No. 151, pp. 1057–1079.)

The circuits discussed are those in which the valve, with non-linear characteristics, is in parallel with the oscillating circuit; they are distinguished from "arc-maintained circuits" in which the arc is in series with an oscillating circuit. The dynatron and back-coupled valve oscillators are discussed theoretically; it is found that with a simple dynatron oscillator "the amplitude of oscillation is increased by the secondary [circuit] only if the frequency of oscillation of the circuit as a whole is lower than the resonant frequency of the secondary." Similar results are found for the back-coupled oscillator, though its mechanism is different from that of the dynatron. The discontinuous frequency changes produced by cyclic alteration of the mutual inductance between the primary and secondary coils are also discussed after an investigation of the stability of the oscillations. Experiments are described which gave results in "reasonable accord" with the theory.

462. On the Effect of a Secondary Circuit on Quenched Oscillators.—S. Uda & T. Takeya. (*Journ. I.E.E. Japan*, Sept. 1936, pp. 964–967: Japanese only.)

463. High-Q Tuned Coupled Circuits [treated by Reduction to Simple Equivalent Coupled Pair: Universal Resonance Curves: Band-Width Formulae: Definition of "Transitional" Coupling: etc.].—C. B. Aiken. (*Proc. Inst. Rad. Eng.*, Nov. 1936, Vol. 24, No. 11, p. 1418: summary only.)

464. Some Deductions from Thévenin's Theorem.—H. Wigge. (*Arch. f. Elektrot.*, 21st Nov. 1936, Vol. 30, No. 11, pp. 754–759.)

Thévenin's theorem and the reciprocal relation which regards a generator as a current source with an internal conductance in parallel are combined to give rules for network calculation; the general condition for the decoupling of any two branches of a network is deduced.

465. On Auto-Parametric Excitation of Oscillations.—Migulin. (*Tech. Phys. of USSR*, No. 10, Vol. 3, 1936, pp. 841–859.) German version of the Russian paper dealt with in 3328 of 1936.

466. On Two Methods for the Calculation of Variable Régimes, starting from Permanent Régimes [Carson's Use of Laplace-Type Integral Equation: Fourier Integral Method].—G. & R. Julia. (*Bull. Soc. franç. des Élec.*, Oct. 1936, Vol. 6, pp. 975–1046.)

467. On the Extension of the Properties of the Quadripole to Equilibrated Polyphase Networks of the Most General Type.—R. Julia & J. Fallou. (*Bull. Soc. franç. des Élec.*, Nov. 1936, Vol. 6, pp. 1081–1118.)

468. "Klirr" Factor and Its Compensation.—C. L. Kober. (*E.N.T.*, Nov. 1936, Vol. 13, No. 11, pp. 379–382.)

Calculations are given of the distortion in non-linear transmission and amplifier systems with anode retroaction. Formulae are derived for the "klirr" factor for single- and multiple-grid valves, in particular pentodes and octodes (eqns. 14a, 17). "The effect of anode retroaction on 'klirr' factor compensation by pre-distortion is investigated; it is found that anode retroaction makes complete compensation impossible to obtain. 'Klirr' factor compensation by pre-distortion is only effective for that part of the non-linear distortions which is not due to anode retroaction. This compensation could be made for octodes but would require a pre-octode to make the necessary adjustment of the characteristics."

469. Determination of Systems of Orthogonal Circles for the Representation of Vectorial Relations [illustrated by Application to the Vectorial Quantities connected with the *T*-Network].—H. Kafka. (*Arch. f. Elektrot.*, 21st Nov. 1936, Vol. 30, No. 11, pp. 712–728.)

470. Generalised Characteristics of Linear Networks [with Curves].—E. K. Sandeman. (*Wireless Engineer*, Dec. 1936, Vol. 13, No. 159, pp. 637–646: *Elec. Communication*, Oct. 1936, Vol. 15, No. 2, pp. 115–128.)

It is pointed out finally that in certain cases (*e.g.* where valves are used as separating elements) it is possible to combine the curves of several networks by adding or subtracting ordinates directly: thus the preliminary investigation can be made entirely in terms of the generalised curves, sliding them over one another until a composite curve of the required form is obtained.

471. Calculation of Passive Linear Impedance Networks using Frequency Transformation.—T. Laurent. (*E.N.T.*, Nov. 1936, Vol. 13, No. 11, pp. 365–378.)

Two different methods have been employed in the investigation of impedance networks: (1) the "non-stationary" method, in which the electrical properties are expressed as functions of the time, and (2) the "stationary" method, in which the properties are expressed as functions of frequency. Here the advantages and disadvantages of these methods are first discussed; the "stationary" method is found to have very great practical importance and is chosen as the subject of investigation, with special reference to the mathematical methods employed (*cf.* 823 of 1936). Curves of simple frequency functions are shown (Fig. 3) and 15 examples are given of the use of frequency transformations, providing a general idea of their fundamental principles. The examples include networks for the removal of attenuation distortion, for phase rotation, filter chains, etc., discussions of successive and partial frequency transformation, etc.

472/3. Frequency Multiplication by means of Magnetrons.—A. A. Slutzkin. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 6, 1936, p. 1814: *Physik. Zeitschr. der Sowjetunion*, No. 2, Vol. 10, 1936, pp. 264–265: in German.) It is suggested that use can be made of the fact that the anode current in a magnetron passes through a maximum twice during one period, and a circuit is shown which has proved satisfactory for frequency doubling on wavelengths between 100 and 50 m. Tests on shorter waves will follow shortly.

474. On the Influence of the Displacement Current on the Alternating-Current Resistance [Wire Ring Circuit broken by Condenser].—Wessel. (*See* 521.)

475. Papers on Wide-Band and Coaxial Cables.—Ochem: Wild: Kaden. (*See* 594/597.)

TRANSMISSION

476. Electron Space-Charge Oscillation in the Magnetron.—J. J. Müller. (*Hochf. tech. u. Elek:akus.*, Nov. 1936, Vol. 48, No. 5, pp. 155–158.)

Magnetron oscillations of two types are distinguished, dynatron oscillations (§ I) and electron space-charge oscillations (§ II) which are due to the same mechanism as that studied by Dick in connection with B-K oscillations (*see* 2120 of 1936). The magnetron, however, requires a special device for capturing from the electron cloud those electrons which have given up their energy to the external system. There must either be plates at either end of the anode (Fig. 1), at a positive potential, or the magnetic field must be oblique to the cathode (Fritz, 3379 of 1935). Optimum values of an electric field component parallel to the magnetic field can then be found, giving maxima of the h.f. intensity (Figs. 2, 3). Fig. 4 shows the variation of wavelength with magnetic field for split and unsplit anodes, for a given filament temperature; the frequency is found by geometrical integration of the curves for the electron paths (§ III). The wavelength increases with the filament temperature (Fig. 5); Fig. 6 gives experimental curves showing the effect, on the frequency, of tuning the external system. The importance of the anode slits is discussed in § IV in connection with questions of energy and frequency; experiments were made with a three-slit magnetron with an end plate and an external oscillating system of three parallel wires. Polar diagrams were taken which show two types of oscillation, one in which two anode segments oscillate cophasally in opposition to the third (Fig. 10) and one in which the magnetron forms a rotating, three-phase generator (Fig. 11) which may be used to emit rotating fields. In this case the end plate must be used, as the oblique position of the magnetic field is not permissible. The frequency is found to be independent of the number and position of the slits. Other possible electron-capturing devices are referred to (§ v : *see* also Groszkowsky & Ryżko, 2555 of 1936); the oscillations can be modulated by l.f. variation in the potential of the capturing device.

477. RECENT INVESTIGATIONS ON DECIMETRE-WAVE TRANSMITTERS WITH SPLIT-ANODE MAGNETRONS.—F. W. Gundlach. (*Hochf: tech. u. Elek:akus.*, Dec. 1936, Vol. 48, No. 6, pp. 201–214.)

A summary is first given of known forms of the split-anode magnetron (§ II) and of the theoretical principles underlying their action (§ III, incorrectly numbered § II). Methods of measurement of the various quantities associated with magnetron emitters are then discussed (§ IV). Frequency measurement by a development of Mulert's interference method (1934 Abstracts, p. 149) is described ; changes of frequency of the order of magnitude of audio frequencies could be measured by it. Known methods of measuring the h.f. power developed and the efficiency are discussed, with the sources of error ; in particular that of Wolff, Linder & Braden (986 of 1935). § V describes the behaviour of the split-anode magnetron in action ; (a) the conditions required for oscillation production, (b) the frequency, with particular reference to the effect of the external Lecher-wire system and the changes produced by anode-voltage variations (Fig. 4). The magnetron is found to produce a pure frequency only when it is driven by pure direct voltage from accumulators. The required degree of constancy of the voltage sources are determined. The working point can, however, be chosen so that small variations of anode voltage do not affect the frequency (Fig. 4B). Fig. 5 gives a working diagram for a four-slit magnetron, showing the oscillation limits and the influence of anode-voltage variation on frequency. § VC describes investigations of the oscillation amplitude (measurements of effect of anode-voltage variation, Figs. 6, 7). Figs. 8–11 show working diagrams under various conditions. It is found that " in the optimum working region the oscillatory current increases with the magnetic induction but is largely independent of the anode voltage. The working points for maximum efficiency, for given magnetic induction, are at the lowest possible anode voltage, just beyond the onset of oscillation." The effects of filament emission and space charge are discussed in § VD (Fig. 13) ; known means of decreasing the disturbing effect of retroactive heating are summarised.

478. THE MAGNETRON [Priority of Invention of Split-Anode Push-Pull Method].—K. Okabe. (*Wireless Engineer*, Nov. 1936, Vol. 13, No. 158, p. 595.)

479. PAPERS ON MAGNETRON OSCILLATORS. (*See* also 473 and 530/532.)

480. A NEW METHOD FOR THE PRODUCTION OF ULTRA-SHORT-WAVE OSCILLATIONS. — K. Okabe, M. Hisida & K. Owaki. (*Journ. I.E.E. Japan*, July, 1936, p. 850 : Japanese only.) *See* also 61 of January.

481. A VERSATILE CRYSTAL-CONTROLLED ULTRA-HIGH-FREQUENCY TRANSMITTER [100-Watt Design, including " Vodas " for Telephone Working : 14, 28 and 56 Mc/s].—Grosselfinger & Prosser. (*QST*, Dec. 1936, Vol. 20, pp. 17–26 and 112.)

482. LECHER-WIRE SYSTEM WITH A DOUBLY-FOLDED EXTENSION [giving Magnetic and Electric Decoupling of the Two Parts of the Extension].—Philips Company. (*Hochf: tech. u. Elek:akus.*, Nov. 1936, Vol. 48, No. 5, p. 180 : German Patent 630 463 of 10.7.34.)

483. HIGH-FREQUENCY MODULATION OF ULTRA-SHORT WIRELESS WAVES [Use of Short Parallel-Wire Transmission Lines of Certain Lengths permits Amplitude Modulation free from Frequency Modulation].—S. S. Banerjee & B. N. Singh. (*Nature*, 21st Nov. 1936, Vol. 138, p. 890 : short preliminary note only.)

484. MODULATION METHOD PARTICULARLY SUITED TO TELEVISION.—Krawinkel. (*See* 600.)

485. THE FREQUENCY CHARACTERISTICS OF THE PARALLEL-TYPE " THYRATRON " OSCILLATORS.—N. Yamada & M. Misu. (*Journ. I.E.E. Japan*, June, 1936, p. 787 : Japanese only.)

486. SOME PROPERTIES OF VALVE OSCILLATORS WITH COUPLED CIRCUITS.—Nimmo. (*See* 461.)

487. AN ALL-BAND 'PHONE TRANSMITTER USING BEAM POWER TUBES [Type 6L6G in Modulator and RK-39 in R.F. Power Amplifier].—G. Mathis & J. B. Carter. (*QST*, Dec. 1936, Vol. 20, pp. 32–34 and 76, 78.) For the RK-39 transmitting beam power valve *see* also 539, below.

488. A NEW 5-KW BROADCAST TRANSMITTER [Type 355 D 1, High Fidelity, with Stabilised Feed-Back].—L. G. Young. (*Bell Lab. Record*, Nov. 1936, Vol. 15, No. 3, pp. 72–75.)

489. A NEW HIGH-EFFICIENCY POWER AMPLIFIER FOR BROADCAST TRANSMITTERS.—G.W.O.H: Doherty. (*Wireless Engineer*, Dec. 1936, Vol. 13, No. 159, pp. 627–629.) Editorial on the amplifier dealt with in 4020 in 1936.

490. ON THE PARALLEL MODE EFFECT IN R.F. PUSH-PULL AMPLIFIERS [Existence of Anode-Potential Components which are In Phase : causing Slight Phase Change in Output Current].—W. G. Baker. (*A.W.A. Tech. Review*, Oct. 1936, Vol. 2, No. 4, pp. 120–126.) This phase change " would be taken up naturally in the tuning as far as the fundamental component is concerned."

491. A FEED-BACK COMPANDOR, *and* A GRAPHICAL ANALYSIS OF THE [Volume-] COMPRESSOR CIRCUIT.—K. Kobayashi. (*Journ. I.E.E. Japan*, May & June, 1936, pp. 723 & 790: Japanese only.)

492. SCREENING ARRANGEMENT FOR H.F. LEADS [Screen partly consists of Semiconductor which Absorbs, not Reflects, the High Frequency].—R. Huber. (*Hochf:tech. u. Elek:akus.*, Nov. 1936, Vol. 48, No. 5, p. 180: Swiss Patent 183 565 of 2.5.34.)

RECEPTION

493. THE SUPER-REGENERATIVE RECEIVER [Survey of Theoretical Material, presented Non-Mathematically: Writer's Experimental Results].—M. G. Scroggie. (*Wireless Engineer*, Nov. 1936, Vol. 13, No. 158, pp. 581–592.)

About 15 kc/s is suggested as a good compromise for the quenching frequency: "low-loss" construction should replace too much retroaction: anode injection preferable to grid: successful use of octode frequency-changer for combined quenching and regenerating: "the world's simplest super-regenerative circuit" (octode working as squegger): etc.

494. THE EXPERIMENTAL RESULTS REGARDING THE SUPER-REGENERATIVE RECEPTION OF DECIMETRE WAVES [" Acorn " Valves better than "Modulation-Grid" Valves (which sometimes show a Hysteresis Phenomenon of Wavelength when Modulation-Grid Potential is varied): etc.].—Nishimura, Goto & Hashimoto. (*Journ. I.E.E. Japan*, Aug. 1936, pp. 861–866: English summary p. 54.)

495. IMPROVING THE SUPER-REGENERATIVE SET [Advantages of "Saw-Tooth" Quenching: Practical Application, using One Multiple Valve as Quench Generator and Wave-Form "Corrector"].—E. L. Gardiner. (*Wireless World*, 25th Dec. 1936, Vol. 39, pp. 665–667.)

496. NOISE REDUCTION OF ULTRA-SHORT-WAVE SUPER-REGENERATIVE RECEIVER [using "Anti-Phase" Quenching].—T. Hayasi & S. Yamagiwa. (*Journ. I.E.E. Japan*, Sept. 1936, pp. 960–963: short English summary p. 73). *See* also 4022 of 1936.

497. CIRCUIT DESIGN OF A MODERN AMATEUR ULTRA-HIGH-FREQUENCY SUPERHETERODYNE [embodying the Lamb Noise-Silencer for Ignition Interference: Strength Adjustment for I.F. Beat Oscillator: etc.].—K. Miles. (*QST*, Dec. 1936, Vol. 20, pp. 39–40 and 80, 82, 84, 86.)

498. JOINT CO-ORDINATION COMMITTEE, ON RADIO RECEPTION, OF EDISON ELECTRIC INSTITUTE: METHODS OF MEASURING RADIO NOISE.—(At Patent Office Library, London: Cat. No. 76 638: 8 pp.)

499. A STUDY OF THE CHARACTERISTICS OF NOISE.—V. D. Landon. (*Proc. Inst. Rad. Eng.* Nov. 1936, Vol. 24, No. 11, pp. 1514–1521.) A summary was dealt with in 2583 of 1936.

500. THEORETICAL FOUNDATIONS OF BROADCAST INTERFERENCE ELIMINATION AND THE TECHNIQUE OF ITS MEASUREMENTS [Remarks on Paper by W. Oehlerking].—W. Himmelreicher. (*Hochf:tech. u. Elek:akus.*, Nov. 1936, Vol. 48, No. 5, pp. 177–179.)

For the paper in question *see* 2983 of 1936. The present writer discusses a number of points therein which he has found to be directly contradicted by his practical experience; in particular he finds that the protective condenser should be connected between the mains and the cover of the machine producing the interference and not, as Oehlerking suggests, between the mains and an earth connection. Himmelreicher also prefers to treat disturbances as transient phenomena, rather than as a development of quasi-stationary processes. After discussing other theoretical points, he stresses his view that the most suitable means of eliminating interference in any particular case are most satisfactorily found by trial and error rather than by theoretical considerations.

501. STUDY OF THE BROADCAST INTERFERENCE PRODUCED IN CERTAIN CASES BY RURAL TELEPHONE INSTALLATIONS.—G. Letellier. (*Ann. des Postes, T. et T.*, Aug. 1936, Vol. 25, No. 8, pp. 767–791.)

502. INTERFERENCE FROM TELEVISION [Causes and Elimination].—F. R. W. Strafford. (*Wireless World*, 11th Dec. 1936, Vol. 39, pp. 630–631.) *Cf.* 83 of January.

503. REJECTING WHISTLES [Known Types of Tunable Filters, and the Author's "Balance Filter"].—P. K. Turner. (*Wireless World*, 4th Dec. 1936, Vol. 39, pp. 588–591.)

504. RMA'S RECOMMENDATIONS ON ALLOCATION, AS PRESENTED TO THE FCC [based on Fidelity Curves, etc., of Broadcast Receivers: Three Types of Interference related to the Intermediate Frequency: Need for Collaboration to provide a Protected I.F.].—L. C. F. Horle. (*Rad. Engineering*, Nov. 1936, Vol. 16, pp. 10–13.)

505. SIDEBAND PHASE DISTORTION [Correspondence].—Wright & Johnstone. (*Wireless Engineer*, Dec. 1936, Vol. 13, No. 159, pp. 634–635.)

The writers of the paper dealt with in 86 of January now correct their results in accordance with the Editorial. Callender refers to his previous treatment (1932 Abstracts, p. 638): as regards complicated cases such as in television, he considers that "no likely combination of circuits will give such distortion provided that they are all accurately aligned to the signal (or symmetrically staggered) and provided that the h.f. frequency characteristic is exactly symmetrical; *e.g.*, Q values of each circuit of a 2-circuit band-pass should be equal, etc."

506. CONTRAST AMPLIFICATION [Risks of Harmonic Distortion in Ordinary Volume-Expansion Methods: a New American System claimed to be Free from These].—W. N. Weeden. (*Wireless World*, 18th Dec. 1936, Vol. 39, pp. 636–638.)

507. Controlling Regeneration [Feedback-Microvolts/Frequency Curve flattened to nearly Zero (*i.e.* " Frequency Factor " reduced to nearly Unity) would give Satisfactory Fixed Regeneration: Theory and Experiment].—G. Oberweiser. (*Rad. Engineering*, Nov. 1936, Vol. 16, pp. 24–26.)

508. Negative Feed-Back Amplification [Effect of Input Transformer: etc.].—W. T. Cocking. (*Wireless World*, 25th Dec. 1936, Vol. 39, pp. 669–670.) For previous work *see* 100 of January.

509. A Rectified Differential Feed-Back Type Detector.—K. Kobayashi. (*Journ. I.E.E. Japan*, Sept. 1936, p. 1026: Japanese only.)

510. " Heterotone " C.W. Telegraph Reception: an Improvement giving Modulated-C.W. Advantages over Heterodyne Reception [Increased Apparent Loudness, Reduced Fatigue, etc.].—J. J. Lamb. (*QST*, Nov. 1936, Vol. 20, pp. 16–18 and 76, 78.)

511. A Single-Sideband Short-Wave Receiver [with Automatic Carrier Re-Supply Adjustment: for Reception of G.P.O. Test Transmissions].—G. Rodwin. (*Bell Lab. Record*, Aug. 1936, Vol. 14, No. 12, pp. 405–410.)

512. A Moving-Coil Tuning System for the High-Frequency Receiver: a New Approach to the Coil-Changing Problem in Multi-Band Sets.—J. Millen. (*QST*, Dec. 1936, Vol. 20, pp. 30–31 and 74, 76.) With rack-and-pinion movement and double side-wipe 4-point contacts.

513. The " Magic Brain " Receiver [Shielded Unit Assembly containing R.F. Coil Structure, Switching Circuits, Alignment Adjustments, and Selector Dial Mechanism].—K. A. Chittick. (*Rad. Engineering*, Nov. 1936, Vol. 16, pp. 5–7 and 28, 29.)

514. The Simplest Mains Set [One-Valve Headphone Receiver].—D. Symon. (*Wireless World*, 11th Dec. 1936, Vol. 39, p. 629.)

515. An All-Purpose Radio Receiver for Mobile Applications [Type 20, for Private Flyer or Emergency Service in Transport Planes].—K. O. Thorp. (*Bell Lab. Record*, Sept. 1936, Vol. 15, No. 1, pp. 2–6.)

516. Remote Control for Radio Receivers [27A Control Unit for Aircraft Receiver Type 20].—J. C. Bain. (*Bell Lab. Record*, Oct. 1936, Vol. 15, No. 2, pp. 49–51.) *See* 515, above.

517. The 6H5 Tuning Indicator Tube [with Fluorescent Target].—Raytheon Company. (*Rad. Engineering*, Nov. 1936, Vol. 16, p. 33.)

518. The Signal Generator at Work [Requirements of a Satisfactory Generator: Receiver Tests (including Harmonic Distortion and A.F. Cross Modulation): Common Failings and Their Results: A.W.A. Designs].—L. G. Dobbie. (*A.W.A. Tech. Review*, Oct. 1936, Vol. 2, No. 4, pp. 127–147.)

519. The Testing of the Sensitivity of Radio-Telegraphic Receivers [in Presence and Absence of Background Noise].—Darecki & Kedzierski. (*Wiadomości i Prace* [" *WPPIT* "], Warsaw, No. 3/4, Vol. 7, 1936, pp. 45–46: in Polish.)

520. Some Notes on Intermediate-Frequency Transformer Testing [Transfer Impedance at Resonance (γ) as Index of Selectivity and Gain: Measured by Piston Attenuator: Design of Tester: etc.].—R. M. Huey. (*A.W.A. Tech. Review*, Oct. 1936, Vol. 2, No. 4, pp. 113–119.)

AERIALS AND AERIAL SYSTEMS

521. On the Influence of the Displacement Current on the Alternating-Current Resistance [Theoretical Investigation of a Wire Ring broken by a Condenser, the Whole immersed in a Common Dielectric].—W. Wessel. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 17, 1936, pp. 472–475.)

In certain measurements of dielectric losses in aqueous solutions and alcohols at ultra-high frequencies it was found desirable, for simplicity of construction, to immerse not only the condenser but also the inductance of the resonant circuit in the dielectric. With the high frequencies and dielectric constants employed it was obvious that a fairly large displacement current would occur, and it became necessary to consider how far this would alter the self-inductance, capacity, and dissipative resistance of the circuit from the value calculated for lower frequencies. In a more complicated form the problem was dealt with by Hallén (1931 Abstracts, p. 269). The present treatment leads to a simpler integral equation (11) for the additional field due to the displacement current; this moreover is in a form which makes clear its relation to the ordinary oscillation equation (12). Fig. 2 shows the calculated percentage shift $\Delta\lambda/\lambda$ of the natural wavelength, produced by the displacement current, as a function of the ratio of ring circumference to wavelength; Fig. 3 gives the radiation resistance of the wire circuit as a function of the same ratio.

522. Collapsible Short-Wave or Ultra-Short Wave Aerial [Elastic Aerial unrolls from Drum and automatically extends Telescopic Insulating Sheath].—E. Wilckens: J. Pintsch & Co. (*Hochf:tech. u. Elek:akus.*, Dec. 1936, Vol. 48, No. 6, p. 215: German Patent 636 021 of 4.3.1934.)

523. Current and Voltage Distribution on Tower Aerials [Effect of Variation of Impedance along Tower].—E. Siegel. (*Hochf:tech. u. Elek:akus.*, Nov. 1936, Vol. 48, No. 5, pp. 164–170.)

Calculations are given to illustrate the effect of variable impedance along an emitting aerial on the current and voltage distribution in the aerial. The ohmic resistance is neglected; the earth is regarded as a perfect conductor. An aerial consisting of two parts of unequal impedance is discussed in § II (curves of current distribution, Fig. 2). In § III the theory of the aerial whose impedance varies exponentially with the length is worked out from first principles; some characteristic types of tower construction are discussed in detail, including a tower with additional capacity at the top (§ v, Fig. 7) and a combined tower, tapering at the foot and the top (§ vi, Fig. 8). The general conclusion is drawn that "the current curve is distorted from the sinusoidal form, so that increasing impedance in the region of increasing current and decreasing impedance in the region of decreasing current have the effect of electrical lengthening, while increasing impedance in the region of decreasing current and decreasing impedance in the region of increasing current have the effect of electrical shortening of the aerial."

524. The Grounded Vertical Radiator [Shunt-Excited Aerial].—J. F. Morrison. (*Bell Lab. Record*, Aug. 1936, Vol. 14, No. 12, pp. 387–392.) Account of preliminary tests of the system referred to in 113 of January.

525. Directive Antenna solves Coverage Problem [Array of Two Towers and Central Vertical Wire, giving Oval Diagram, successful at WJAR, Providence].—J. F. Morrison. (*Bell Lab. Record*, Sept. 1936, Vol. 15, No. 1, pp. 17–20.)

526. The All-Around Radiation Characteristics of Horizontal Antennas: Utilising Directive Properties to increase Transmission Effectiveness [with Charts for 10 and 20 Metre Wavelengths].—G. Grammer. (*QST*, Nov. 1936, Vol. 20, pp. 19–22 and 41, 56, 58, 62, 64, 66, 68, 72.)

527. Plain Talk about Rhombic Antennas: Some Experiences with "Hay-Wire" Diamonds [for Transmission & Reception: Very Good Results].—R. A. Hull & C. C. Rodimon. (*QST*, Nov. 1936, Vol. 20, pp. 28–29 and 74, 100, 102, 106.)

528. The Community Aerial System of Broadcast Distribution [and the Kolster-Brandes "Rejectostat" Amplifier].—C. W. Earp & S. Hill. (*Elec. Communication*, Oct. 1936, Vol. 15, No. 2, pp. 129–135.)

529. High-Frequency Cable [Copper Conductor surrounded by Alternate Layers of Insulator and Metal: Action regarded as Condenser Chain of Infinite Impedance at Broadcast Frequencies].—Huber. (*Hochf:tech. u. Elek:akus.*, Dec. 1936, Vol. 48, No. 6, pp. 215–216: Swiss Patent 182 218 of 2.4.1935.)

VALVES AND THERMIONICS

530. The Effect of Vacuum on the Power Output and Efficiency of a Magnetron Oscillator.—A. P. Maidanov. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 6, 1936, pp. 1661–1677.)

A method has been developed by the author for determining the effect of the degree of vacuum, and of the nature of the gas, on the power output and efficiency of a magnetron. Experiments were carried out on valves containing air, hydrogen, helium, and mercury vapour, and in the measurements made the additional filament emission due to the bombardment of the filament by charged particles was taken into account.

The results obtained seem to indicate that there are three ranges of vacuum, as follows:—(1) a wide range of high vacuum for which the power output and efficiency are independent of the vacuum; (2) a narrow intermediate range for which these values decrease somewhat; and (3) a third range which is reached abruptly with further softening and for which the oscillations are very small or disappear altogether. A theoretical interpretation of the above conclusions is given and a number of practical suggestions are stated with regard to the manufacture of magnetrons.

531. The Velocity Distribution of Electrons in a Hard Vacuum under the Influence of a Magnetic Field.—I. M. Wigdorchik. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 6, 1936, pp. 1657–1660.)

It has been observed by a number of investigators that when a magnetic field of a value above the critical is applied to a magnetron, and an auxiliary electrode is placed near the anode/cathode system, a current flows to this electrode, even if its potential is below that of the cathode. In the present paper an account is given of an experimental investigation of this phenomenon. It appears from the results obtained that its cause is a certain distribution of the electron velocities which takes place as a result of interaction of rotating electrons. Further work on the subject is in progress.

532. Magnetron Oscillators.—G. W. O. H.: Kilgore. (*Wireless Engineer*, Nov. 1936, Vol. 13, No. 158, pp. 573–575.) Editorial on the paper dealt with in 3768 of 1936. Incidentally, the classification of magnetrons into "transit-time" and "dynatron" types is preferred to Kilgore's "electron" and "negative resistance" convention.

533. The Present Limitations and Future Possibilities of Voltage Amplification by Thermionic Valves.—F. M. Colebrook. (*Journ. Scient. Instr.*, Dec. 1936, Vol. 13, No. 12, pp. 381–385.)

"Thus, both in relation to the e.m.f. of thermal agitation and to the noises generated inside the valve, the principal requirement is more exact knowledge, particularly as far as radio frequencies are concerned." As regards limitations due to transit time, exploitation of the focused beam technique is suggested as a likely solution: "the ordinary valve structure, with grid control of anode current by direct action on the space charge, appears to be inherently unsuitable for use at wavelengths shorter than a few tens of metres."

534. The Theory of the Mean Square Variation of a Function formed by adding Known Functions with Random Phases, and Applications to the Theories of the Shot Effect and of Light.—E. N. Rowland. (*Proc. Camb. Phil. Soc.*, Dec. 1936, Vol. 32, Part 4, pp. 580–597.)

535. On the Possibility of an Elimination of the Noises in Valve Amplifiers.—G. Braude. (*Tech. Phys. of USSR*, No. 10, Vol. 3, 1936, pp. 860–880: in German.)

The factors involved in the noise of valve amplifiers are (1) shot effect, (2) flicker effect, and (3) thermal agitation. Of these, (2) only occurs at low frequencies, and can easily be subjugated by providing a double path of amplification, one dealing with all frequencies above 1000 c/s and the other confined to the small range 0–1000 c/s: the input resistance of this second half may be made very high, so that the signal strength there will be so great as to overcome all noise due to flicker effect (p. 879). As regards shot effect, theory indicates that valves working in a temperature saturated régime should display practically none of this. Experiment, however, shows that the present valves, in this régime, actually give more noise due to shot effect than to thermal agitation, owing to the presence of positive ions. The construction of valves free from such ions, however, is possible though difficult; the two requirements are a high vacuum and a low enough working voltage, which however must give an adequately high amplification coefficient. The principles of such construction will be dealt with in a later paper; the present work considers the possibility of the suppression by the incoming signal, or the actual elimination, of the noise due to the third factor—thermal agitation in the anode resistances and in the electron stream itself.

The first principle considered, the increase of the input ohmic resistance and a simultaneous compensation of its harmful self capacity, actually increases the thermal agitation but allows its noise to be overcome by the still more increased signal. Various methods exist for doing this, including the author's circuit of Fig. 1 and his plan of "wattless retroaction." A further paper will deal with this latter method. Arrangements based on this first principle help also to suppress the other types of amplifier noise. The second principle discussed is for the prevention, rather than the suppression, of thermal noise: it is based on the fact that the latter is proportional only to the *real* component of the total resistance, so that if the input and inter-stage resistances are made practically wattless there will be practically no thermal noise. The resulting frequency and phase distortions have then to be corrected by what the author calls "noise-correcting" circuits, to distinguish them from the ordinary correction circuits. This principle is developed at considerable length (pp. 864–871), special reference being made to the amplification of photocurrents. Fig. 6 shows a correcting circuit where the necessity for a very low ohmic resistance for the correcting inductance is avoided: the coil is wound with wire of small diameter and high resistivity so as to eliminate eddy currents and skin effect, and is connected in a bridge circuit. This circuit is very effective but requires a completely separate feed to the correcting stage. The transformer circuit of Figs. 7/9 avoids this difficulty: Fig. 10 shows a complete arrangement with high-frequency correction by transformer and low-frequency correction by decoupling resistance. Fig. 11 gives a correcting circuit without inductance coils, Fig. 12 a "mixed" circuit which, for low values of anode resistance and high values of inductance, becomes the earlier circuit of Fig. 5. In pp. 877–878 the writer deals with the reduction of thermal noise by the introduction, into the anode network, of a very high ohmic resistance or an almost purely inductive resistance.

"To sum up, I maintain in any case that, contrary to numerous statements in the literature, thermal-agitation noise in the resistances may in principle be absolutely eliminated." In principle, the ordinary valve amplifier can be made freer from noise than a secondary electron multiplier, which works in a régime of electron-current saturation where shot effect is at its full strength: the fact that, at present, actual valve amplifiers give much more noise than the multipliers is, as pointed out earlier in the paper, due to factors of no theoretical importance (ionisation in the valves, etc.) "which by further development of thermionic valves can and must be eliminated."

536. INVESTIGATIONS ON THE "KLINGEN" [Microphonic Effect] OF AMPLIFIER VALVES: PART 2.—Graffunder & Rothe. (*Telefunken-Röhre*, 15th Nov. 1936, No. 8, pp. 147–157.)

For Part I *see* 2631 of 1936. The present part continues the discussion on the quantitative determination of microphonic behaviour, not so much under mechanical shock as under the influence of a sound field: under the conditions, in fact, provided by a broadcast receiver with built-in loudspeaker. The important factors are the acoustic retroaction R_{ac} of the apparatus and the microphonicity coefficient K of the valves. The experimental measurement of K on a large number of valves of different types, by the loudspeaker-field method of pp. 149–152, gives good agreement with the results of the "drop-test" method described in Part I. R_{ac}, which is the number of microbars of sound pressure produced by 1 millivolt on the grid of the exposed valve, at the site of this valve, is also easily measured (pp. 152–153); but an even simpler and more useful quantity to measure is the "microphonicity value" (indicating the danger, in the whole apparatus, of microphonic effects, and shown schematically in Fig. 5) which, when only disturbance from the acoustic field is considered, equals the product $R_{ac} \times K$. There is a danger of acoustic self-excitation as soon as $R_{ac} \times K > 1$. Of Figs. 6/8, the first shows a not "endangered" receiver, the second an "endangered" one, and the third shows the improvement (curve b) produced by a rubber layer between chassis and cabinet.

537. CURRENT DISTRIBUTION: PART 4—CURRENT-DISTRIBUTION MODULATION.—Rothe & Kleen. (*Telefunken-Röhre*, 15th Nov. 1936, No. 8, pp. 158–174.)

For previous parts *see* 2630 of 1936. Author's summary:—"By current-distribution modulation is understood any modulation or control in which the electrons pass through an accelerating grid and are then influenced by a control grid. This type of modulation is examined for the case of current densities so small that electron space charges have no effect. On the ground of measured characteristic curves it is seen that in this case the electrons, which are deflected in the plane of the accelerating grid away from their original path, are controlled through total reflection in the plane of the control grid. Thus for the shape of the characteristic curve the current-distribution equation of the Below region holds good; but in this equation the effective potential of the control grid must be replaced by the potential of the 'saddle point' between grid wires [Fig. 3; "since the control grid is at a negative potential and both neighbouring electrodes at a positive, there is in the plane of symmetry between each two grid wires a singular point, a 'saddle point' of potential "]. The agreement between measured and calculated characteristics is satisfactory. Current-distribution control plays an important rôle in space-charge-grid valves, hexodes, heptodes, penta-grid-converters and octodes."

538. "ELECTRONICS AND ELECTRON TUBES" [Book Review].—E. D. McArthur. (*Wireless Engineer*, Dec. 1936, Vol. 13, No. 159, p. 633.)

539. OPERATING NOTES ON THE TRANSMITTING-TYPE BEAM POWER TUBE [Type 807, Transmitting Counterpart of the 6L6].—G. Grammer. (*QST*, Dec. 1936, Vol. 20, pp. 28–29 and 70, 72.)

For data of this RCA–807 valve, and of the somewhat different RK–39, see *ibid.*, pp. 100, 102. 15 watts output at 28 Mc/s, with a plate input of 30 watts, was obtained with a 7 Mc/s crystal, by doubling in the oscillator plate and re-doubling in the 807 stage; 400 volts or less on the plate. *See* also 487, above.

540. THE CHARACTERISTICS OF THERMIONIC RECTIFIERS.—Aldous. (*See* 691.)

541. A.W.A. INTER-ELECTRODE CAPACITY-METER TYPE R 1782 FOR SCREEN-GRID VALVES [Direct-Reading R.F. Capacity Bridge using Broadcast Receiver as Null Indicator: and the Effect of Residual Inductance of Connections to Earthed Electrodes].—L. G. Dobbie & R. M. Huey. (*A.W.A. Tech. Review*, Oct. 1936, Vol. 2, No. 4, pp. 107–112.)

542. EXPERIMENTS ON THE THEORY OF THE ELECTRON EMISSION UNDER THE ACTION OF HIGH FIELD STRENGTHS ["Cold Emission"].—E. W. Müller. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 17, 1936, pp. 412–415: Discussion (Schottky) pp. 415–416.)

"As would be expected from theory, field emission produces no cooling of the cathode. Moreover, the velocity distribution of the field electrons shows that the electrons leave the cathode without surmounting a potential threshold. On the other hand it is found that the dependence of the field current on the work function is considerably stronger than would be assumed from the present wave-mechanical theory of the penetration of a potential threshold." The $\phi^{3/2}$ in the exponent of the *e*-function would be more correctly replaced by ϕ^3, the field strength necessary for emission being very much smaller than would be expected from theory, if the work function is small, and rising only for high work functions to approximately the theoretical value.

543. THIS MATTER OF CONTACT POTENTIAL [Term should be used in Its True Meaning only, *Not* to denote Combination of Spurious Voltages affecting Valve Operation].—R. M. Bowie. (*Proc. Inst. Rad. Eng.*, Nov. 1936, Vol. 24, No. 11, pp. 1501–1513.)

544. PAPERS ON SECONDARY EMISSION. (*See* 604/605: *also* Braude, 535.)

545. "ORIENTED" OXIDATION OF BARIUM [Depending on Conditions of Evaporation Process, either Random Orientation of Barium Crystallites or Preferential Orientation can be obtained: the Latter yields Oriented Oxide Layers].—W. G. Burgers & Ploos van Amstel. (*Physica*, Dec. 1936, Vol. 3, No. 10, pp. 1057–1063: in English.)

546. TEXTURE OF THINLY ROLLED TUNGSTEN FOIL [does not yield Oriented Oxide Layer].—Burgers & van Amstel. (*Physica*, Dec. 1936, Vol. 3, No. 10, pp. 1064–1066: in English.)

547. THE DISSOCIATION OF HYDROGEN BY TUNGSTEN [Empirical Formula for Rate of Production of Hydrogen Atoms by Hot Tungsten Filament].—G. Bryce. (*Proc. Camb. Phil. Soc.*, Dec. 1936, Vol. 32, Part 4, pp. 648–652.)

548. THE MECHANISM OF THE PRODUCTION OF ATOMIC HYDROGEN BY HOT TUNGSTEN.—J. K. Roberts & G. Bryce. (*Proc. Camb. Phil. Soc.*, Dec. 1936, Vol. 32, Part 4, pp. 653–656.)

DIRECTIONAL WIRELESS

549. THE AUTOMATIC RADIO COMPASS [Type R.C.5] AND ITS APPLICATIONS TO AERIAL NAVIGATION.—H. Busignies. (*Elec. Communication*, Oct. 1936, Vol. 15, No. 2, pp. 157–172.)

An early form of this compass was dealt with in 1931 Abstracts, p. 43 (particularly the end part). In the new commercial form the loop aerial revolves 300 times per minute, so that reception maxima and minima occur ten times a second. The loop axis carries a diphased current generator (semi-circular revolving potentiometer with 8 brushes) giving current also of 10 c/s which creates a rotating field in a magnetic stator.

550. DIRECT-READING DIRECTION-FINDER [with Rotating Frame Aerial: Signals passed to Glow Discharge Tube: Polar Diagram of Field Strength seen on Ground-Glass Screen].—J. Marique: S. A. Internationale de Télég. sans Fil. (*Hochf:tech. u. Elek:akus.*, Dec. 1936, Vol. 48, No. 6, p. 216: French Patent 796 057 of 4.1.1935.) Fig. 12 (incorrectly numbered Fig. 10) shows the scheme. For an early paper *see* 1931 Abstracts, pp. 618–619.

551. DIRECT-READING DIRECTION-FINDING METHOD USING A ROTATING DIRECTIONAL SYSTEM [Direction shown by Cathode-Ray Tube with Spot deviated (a) by Rotation Frequency of Directional System, (b) by Output Energy of Directional Receiver].—M. Dieckmann & F. Berndorfer. (*Hochf:tech. u. Elek:akus.*, Dec. 1936, Vol. 48, No. 6, p. 216: German Patent 635 793 of 8.12.1934.) Fig. 10 (incorrectly numbered Fig. 12) shows the scheme.

552. PREVENTING COLLISION IN THE AIR [Cathode-Ray "Collision Preventer" of Radio Dept., N.P.L.], *and* AN AMERICAN RADIAURA [Hefele System].—(*Aeroplane*, 5th Aug. 1936, p. 177: 12th Aug. 1936, pp. 212–213.)

553. IMPROVED DIRECTION FINDER [Marconi-Adcock Aerial System at Distance from Receiver, or Two Receivers operated simultaneously at Centre of Common Aerial System].—Marconi Company. (*Wireless Engineer*, Nov. 1936, Vol. 13, No. 158, p. 596.) Notice of leaflet on Type DFg.10.

554. A STUDY OF RADIO BEACONS FREE FROM NIGHT ERRORS.—L. E. Shtillerman & A. N. Plemyannikov. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1936, pp. 12–24.)

It is pointed out that in the case of radio beacons using loop aerials the night effect, *i.e.* the variation and displacement of the polar diagram, is due to the presence in the radiated field of a horizontally polarised component perpendicular to the plane of radiation. If, however, "TL" aerials (Adcock aerials with "transmission line" feed—*see* Diamond, 1933 Abstracts, p. 508) are used, this component is not radiated, and experiments conducted in Russia have shown that with such aerials the direction of the polar diagram remains constant within $\pm 1°$ independently of the distance and time of transmission.

In the present paper the operation of a beacon using four vertical aerials at the corners of a square, with a fifth aerial in the centre, is discussed in detail, and methods are indicated for tuning the system. Reference is made to the experimental results obtained and a description is given of a specially developed goniometric unit, including the values of the various components.

555. ON THE DESIGN OF THE GONIOMETRIC SYSTEM FOR A FIXED-LOOP DIRECTION FINDER.—P. V. Karmalin. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1936, pp. 24–30.)

The relative advantages and disadvantages of direction finders using fixed and rotating loop aerials are discussed, and a study is presented of the fundamental principles underlying the design of the goniometric system for a fixed-loop direction finder (Bellini-Tosi). The operation of the system is examined in detail, and conditions are determined in which the maximum efficiency is obtained. On the basis of this investigation it is recommended that the frequency range of the system should be split up into a number of steps, with capacities of different values for each step, shunted across the field coils. In conclusion an outline is given of the procedure which should be followed in designing the system.

ACOUSTICS AND AUDIO-FREQUENCIES

556. THE BEHAVIOUR OF THE OUTPUT CIRCUIT [Single-Valve, with Transformer with Short Air Gap in Core] TO TRANSIENTS.—N. W. McLachlan. (*Wireless Engineer*, Dec. 1936, Vol. 13, No. 159, pp. 630–633.) "It is often assumed that any device which has a flat response characteristic (for sine-wave input) over a wide frequency range will reproduce transients with but little distortion. Are we justified in making this assumption where an output transformer and its associated power valve are concerned ?"

557. QUASI-TRANSIENTS IN CLASS B AUDIO-FREQUENCY PUSH-PULL AMPLIFIERS [Periodically Recurring Exponential Terms, due to Leakage Inductance of Output Transformer or Choke, hitherto Neglected : Theory and Experimental Confirmation].—A. Pen-Tung Sah. (*Proc. Inst. Rad. Eng.*, Nov. 1936, Vol. 24, No. 11, pp. 1522–1541.)

558. "KLIRR" FACTOR [of Non-Linear Distortion] AND ITS COMPENSATION.—Kober. (*See* 468.)

559. THE LINEARISATION OF TELEPHONE AMPLIFIERS BY THE COMPENSATION METHOD [Calculation of Conditions for which Second Harmonic is compensated in Cascade Amplifier : Design of Amplifier giving Sufficient Freedom from Cross-Talk in Carrier-Frequency System].—H. Wessels. (*E.N.T.*, Nov. 1936, Vol. 13, No. 11, pp. 383–389.)

560. THE 86 TYPE AMPLIFIER [Gain of 98.5 Db and about 15 Watts Output].—V. M. Cousins. (*Bell Lab. Record*, Aug. 1936, Vol. 14, No. 12, pp. 400–404.)

561. MORE ABOUT THE LOW-COST HIGH-FIDELITY AUDIO AMPLIFIER [using "Beam" Valves].—(*QST*, Nov. 1936, Vol. 20, pp. 34 and 96, 98.) Further notes on A. G. Hull's amplifier dealt with in 3436 of 1936.

562. WIDE-RANGE RECORD REPRODUCTION ["Audak" Magnetic Pick-up with Level Response up to 8000 c/s].—(*Wireless World*, 18th Dec. 1936, Vol. 39, p. 659.) *See* also 3059 of 1936.

563. SOUND RECORDING [and Probable Direction of Development of Home Recorders].—S. R. Eade. (*Wireless World*, 27th Nov. & 4th Dec. 1936, Vol. 39, pp. 564–567 & 593–595.)

564. MEASURING THE FIELD IN THE MAGNET AIR-GAP OF A M.C. LOUDSPEAKER [using an Exploring Coil pulsating at Mains Frequency].—H. Gilloux. (*Toute la Radio*, Dec. 1936, No. 35, Supplement [*La Technique Professionelle Radio*], pp. 153–156.)

565. AN APPARATUS FOR GROWING CRYSTALS BY TEMPERATURE DEPRESSION.—D. Beneschevitsch. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 6, 1936, pp. 1722–1725.) Schwartz's work on Rochelle salt crystals for microphones, etc., is referred to (1933 Abstracts, p. 164).

566. CONTRIBUTION TO THE THEORETICAL AND EXPERIMENTAL INVESTIGATION OF THE FLEXURAL OSCILLATIONS OF RECTANGULAR PLATES WITH FREE EDGES [Nodal Lines approximately Parallel to Edges : Natural Frequencies calculated and measured].—B. Pavlík. (*Ann. der Physik*, Series 5, No. 6, Vol. 27, 1936, pp. 532–542.)

567. Reproduction of Transients by a Horn Loudspeaker [Theory].—McLachlan & McKay. (The title of the paper dealt with in 160 of January should have been translated as above, and the text of the abstract changed correspondingly: the work deals with "horn and hornless" loudspeakers.)

568. The Non-Linear Distortion of Carbon Microphones [and Its Reduction by Special Shape of Moving Electrode].—T. Korn. (*Wiadomości i Prace* ["*WPPIT*"], Warsaw, No. 3/4, Vol. 7, 1936, pp. 51–54: in Polish.)

569. Point Condenser Microphone for Measuring Purposes.—L. A. Varshavsky & K. I. Suponin. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1936, pp. 73–79.)

570. A New Stringed Musical Instrument, the "Bass Violin" [with 'Cello Range but played like Violin].—D. Raïsky. (*Comptes Rendus*, 30th Nov. 1936, Vol. 203, No. 22, pp. 1137–1138.)

571. Electronic Music and Instruments [Survey].—B. F. Miessner. (*Proc. Inst. Rad. Eng.*, Nov. 1936, Vol. 24, No. 11, pp. 1427–1463.)

572. The Eddy Formation in Edge Tones [as in Organ Notes: studied by the Zeiss-Ikon "Time Magnifier," giving 3000 Half-Size Film Pictures per Second].—Krüger & Casper. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 17, 1936, pp. 416–423.)

573. On the Nature of Aural Harmonics [in terms of Non-Linearity and Asymmetry].—Stevens & Newman. (*Proc. Nat. Acad. Sci.*, Nov. 1936, Vol. 22, No. 11, pp. 668–672.)

574. The Vibration Pattern of a Wall transmitting Sound [determined by exploring Wall Surface with Electromagnetic Device: Increase in Complexity with Increase of Frequency: Effect of Warble Tone].—J. E. R. Constable & G. H. Aston. (*Proc. Phys. Soc.*, 1st Nov. 1936, Vol. 48, Part 6, No. 269, pp. 919–922: Discussion pp. 922–923.)

575. Vibration of a Building Partition at Audio-Frequencies.—J. E. R. Constable. (*Proc. Phys. Soc.*, 1st Nov. 1936, Vol. 48, Part 6, No. 269, pp. 914–918: Discussion pp. 922–923.)

"A simple [electromagnetic] device for observing the vibration of a partition has been used for determining the resonance frequencies and associated resistance coefficients of a sheet of window glass."

576. Automatic Measurement of Transmission [200–10 000 c/s].—T. Slonczewski. (*Bell Lab. Record*, Oct. 1936, Vol. 15, No. 2, pp. 56–61.)

577. Logarithmic Valve-Voltmeter for Audio-Frequencies [and Its Application to Investigations on Loudspeakers, Absorption by Walls, etc.].—Holle & Lubcke. (*See* 282 of January).

578. Asymmetry Effect of the Rayleigh Disc in Stationary Air Currents.—J. N. Egorov. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 6, 1936, pp. 1795–1798.)

579. Frequency-Modulated Generators.—Barber. (*See* 642.)

580. Acoustical Levels [of Various Noises and Orchestral Effects: Table of Sound Pressures, Particle Velocities, Decibels, etc.].—(*Rad. Engineering*, Nov. 1936, Vol. 16, p. 18.)

581. A Study of the Characteristics of Noise.—V. D. Landon. (*Proc. Inst. Rad. Eng.*, Nov. 1936, Vol. 24, No. 11, pp. 1514–1521.) A summary was dealt with in 2583 of 1936.

582. Buried Telephone Wire.—D. A. Quarles. (*Bell Lab. Record*, Nov. 1936, Vol. 15, No. 3, pp. 66–71.) *See* also 3837 of 1936.

583. Theory of the Diffraction of Light by Supersonic Waves.—Extermann & Wannier. (*Helvet. Phys. Acta*, Fasc. 7, Vol. 9, 1936, pp. 520–532: in French.)

Lucas & Biquard's treatment is "correct, but unfortunately has not led to complete numerical results. On the other hand, the simplified theory of Raman & Nath gives results which are only correct for small thicknesses of the medium which is stratified . . ." [*cf.* 3083 of 1936.] The writers' treatment follows lines indicated by Brillouin.

584. Diffraction of Light by Ultrasonic Waves [Calculated Diffraction Patterns at Oblique Incidence for Different Thicknesses of Supersonic Beam].—C. R. Extermann. (*Nature*, 14th Nov. 1936, Vol. 138, p. 843.)

585. The Demonstration of the Chladni Figures of Oscillating Piezo-Quartz by the help of Light Diffraction at Supersonic Waves.—R. Bär. (*Helvet. Phys. Acta*, Fasc. 7, Vol. 9, 1936, pp. 617–625: in German.)

586. New Optical Diffraction Phenomena at Oscillating Solids [with the Light Ray reflected from the Surface instead of penetrating the Solid].—L. Bergmann. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 17, 1936, pp. 441–443.) Further development of the work dealt with in 194 of 1935.

587. On the Propagation of a Supersonic Solitary Wave [studied by Schlieren Method].—Oyama. (*Journ. I.E.E. Japan*, June, 1936, pp. 743–746: short English summary p. 40.)

588. The Absorption of Supersonic Waves by Liquids [Water and Organic Liquids: Frequencies up to 11.14 Mc/s: Absorption Coefficients 3–100 Times greater than Theoretical Values: "Square of Frequency" Law not always Valid].—P. Biquard. (*Ann. de Physique*, Sept. 1936, 11th Series, Vol. 6, pp. 195–304.)

589. A New Compact Under-Water Telephone Set by means of Supersonic Carrier Waves [using a "Roll"-Type Magnetostrictive Vibrator—Thin Nickel Plate rolled into Cylinder].—T. Tsumura. (*Journ. I.E.E. Japan*, Aug. 1936, pp. 892–895: English summary pp. 59–61.)

590. Echo Sounding: New British Admiralty Recorder Echo Sounders, *and* Recent Improvements in the Ultrasonic Echo Sounding Apparatus [including the Scam Touly Electrolytic Recorder].—(*Hydrographic Review*, Nov. 1936, Vol. 13, No. 2, pp. 78–87: pp. 106–113.)

591. Intense Sound Vibrations age Whiskey in Seven Hours.—Chambers. (*Sci. News Letter*, 14th Nov. 1936, p. 317.)

592. The Measurement of Sound Velocity in Liquid Oxygen [as Function of Temperature and Frequency].—H. W. Liepmann. (*Helvet. Phys. Acta*, Fasc. 6, Vol. 9, 1936, pp. 508–510: in German.) Contrary to Osterberg's report (2768 of 1936), no disappearance of the piezoelectric effect in quartz was found between −183 and −212°C.

593. The Constancy of the Velocity of Sound at Sonic Frequencies [proved within Limits by Comparisons of Wave Form of Complex Sounds at Different Distances from Source].—F. A. Walch. (*Proc. Phys. Soc.*, 1st Nov. 1936, Vol. 48, Part 6, No. 269, pp. 899–913: Discussion p. 913.)

PHOTOTELEGRAPHY AND TELEVISION

594. The Coupling Impedance of Coaxial Cables.—H. Ochem. (*Hochf:tech. u. Elek:akus.*, Dec. 1936, Vol. 48, No. 6, pp. 182–191.)

It is shown (§ I) that the coupling of coaxial screened cables to any external circuits can be regarded as due to a "coupling impedance." This is calculated (§ IIa) for the case when the external conductor forms a closed screen round the inner conductor; Fig. 3 shows a graphical construction for the current distribution throughout the thickness of a screen regarded as divided into four layers. The connection of the coupling and apparent internal impedances with the equivalent thickness of the conducting layer of the screen is discussed. In § IIb the coupling impedance is calculated for the case when the external conductor consists of bands or wires wound round the internal conductor (Fig. 6 gives a measured curve for this). It is found that at high frequencies the determining factor is the longitudinal magnetic field produced by the currents flowing away through the screen and following its windings. The effectiveness of such screens is decreased by the field. § IIc gives the calculations for screens consisting of several layers. § III describes the measurement of the coupling impedance with the circuit shown in Fig. 8. The wide-band cable is discussed in § IV as an example of a coaxial cable with a two-layer screen; Fig. 9 shows the coupling impedance of various designs, Fig. 10 the coupling impedance as a function of the angle at which the band forming the screen is wound round the conductor. The mutual coupling impedance of two neighbouring coaxial cables is calculated in § V and shown in Fig. 12.

595. The Influence of High-Frequency Emitters on Wide-Band Cables.—W. Wild. (*Hochf:tech. u. Elek:akus.*, Dec. 1936, Vol. 48, No. 6, pp. 191–201.)

Penetration of signals from a h.f. emitter into a cable is discussed from a physical point of view in § II. The theory giving the horizontal field strength due to the emitter and the currents induced in the cable screens is worked out in § III; in § IV measurements on an actual cable are described which agree well with the theory. The coupling impedance of a coaxial cable is discussed in § V (*see* also Ochem, above); the disturbing voltages to be expected at the end of the cable are calculated in § VI, with a discussion of the effect of the direction and velocity of propagation of the waves within and without the cable, and compared with actual values in § VII. It is found that, in the frequency range of wireless emitters, the effect of the disturbing voltage is below the limit of permissible interference and indeed, for frequencies above 150 kc/s, is less than the noise level of thermal agitation.

596. The Attenuation and Transit Time of Wide-Band Cables [Calculations: Agreement with Measurement].—H. Kaden. (*Arch. f. Elektrot.* 21st Nov. 1936, Vol. 30, No. 11, pp. 691–712.)

Two forms of the wide-band cable, the coaxial (unsymmetrical) and the symmetrical, are shown in Fig. 1. The elementary theory of the coaxial cable with homogeneous conductors is given, with curves for variation of attenuation with the ratio of the radii (Fig. 4) and with frequency (Fig. 5). Coaxial cables in which the external conductor is spirally wound (Fig. 6) possess the attenuation curves shown in Figs. 9, 10. Formulae for leakage from coaxial cables and for the effect of varying the dimensions of the cable are found. Differences in transit time for various frequencies, with group-time and phase-time distortion, are worked out. Methods of measurement of the transmission constants at high frequencies are shortly described; measured values are found to agree well with those calculated. In an appendix, the calculations are carried through for the eccentric (symmetrical) cable, using a conformal transformation to determine the field distributions. It is found that the transit-time distortion is the same for all cables which have the same attenuation. The smaller the attenuation, the smaller are the differences in transit time.

597. Cross-Talk between Parallel Coaxial Cables.—H. Kaden. (*E.N.T.*, Nov. 1936, Vol. 13, No. 11, pp. 389–397.)

The cross-talk from the coaxial cable (1, 2) to the coaxial cable (3, 4) through the external-conductor system (2, 3) (Fig. 4) is calculated; the special cases of electrically short (Fig. 5) and long cables, and the limiting case of two cables in contact, are considered. Methods and results of measurements of the coupling impedance (Figs. 8, 9), of cross-talk attenuation at the near end (Fig. 10) and far end (Fig. 11), and of the cable attenuation (Fig. 12), are shortly described. The coupling impedance of the external-conductor system, which brings about the cross-talk, is found to decrease markedly at high frequencies, so that the cross-talk attenuation increases with frequency. "For long cables, the cross-talk attenuation is always greater at the near end than at the far end. . . . It thus becomes easier to obtain parallel working, free from attenuation, between coaxial cables as the frequency increases."

598. THE PRINCIPLES OF THE CATHODE-RAY PICTURE ANALYSER WITH STORAGE ACTION.—R. Urtel. (*Hochf:tech. u. Elek: akus.*, Nov. 1936, Vol. 48, No. 5, pp. 150–155.)

The principles underlying the action of the various present forms of picture analyser (*see* these Abstracts *passim*) are here analysed, and the conditions on which the design and dimensions of the "storing" scanner (in which the capacities corresponding to the separate picture elements are charged up between successive scannings) must be based are discussed. The treatment is restricted to analysers using intensity modulation and single-channel transmission; they are divided into three groups of which the "storing" type (Fig. 3) is discussed. The electrical conditions for satisfactory working (§ IV) are derived by considering an elementary scanner circuit (equivalent circuit Fig. 8). In § V the working of various designs, including the iconoscope (Fig. 10), is analysed.

599. TELEVISION RECTIFIER TYPE VLS 61 [giving 3 mA at 6000 V in Half-Wave Circuit: barely over 5 Inches High].—Standard Telephones & Cables. (*Elec. Communication*, Oct. 1936, Vol. 15, No. 2, p. 173.)

600. MODULATION DEVICE PARTICULARLY SUITED TO TELEVISION.—G. Krawinkel. (*Hochf: tech. u. Elek:akus.*, Nov. 1936, Vol. 48, No. 5, p. 179: German Patent 630 688 of 12.6.34.)

The valves of a push-pull circuit (Fig. 1) have a strong negative bias so that each only passes a half-wave of the h.f. oscillation (led in at *a*, *b*), with amplitude determined by the modulation voltage (led in at *m*, *n*). A reversing valve shifts the phase of one half-wave by 180°; the sum of the two h.f. half-waves at the output terminals no longer contains the modulation frequency.

601. HIGH-FREQUENCY MODULATION OF ULTRA-SHORT WIRELESS WAVES.—Banerjee & Singh. (*See* 483.)

602. PAPERS ON NOISES IN VALVE AMPLIFIERS. (*See* 533/536.)

603. THE FLUCTUATION NOISES IN A PHOTO-AMPLIFIER.—A. A. Sokolov. (*Elektrichestvo*, No. 18, 1936, pp. 37–41.)

After a short exposition of the existing theories of fluctuation noises, an account is given of experiments carried out with photocells. Curves are plotted showing the effect of the photocurrent and the light intensity on the noise in a vacuum cell, and an optimum signal/noise ratio is derived. With regard to the gas-filled cells, it appears that the noise in these is stronger than in vacuum cells. These experiments have also shown that the noise is independent of the spectrum of the light falling on the cell. A brief summary of the conclusions reached is added.

604. ON THE SECONDARY EMISSION OF ELECTRONS FROM CAESIUM-OXYGEN CATHODES.—P. V. Timofeev & A. I. Pyatnitski. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 6, 1936, pp. 1641–1648.)

For previous work on these cathodes *see* 2729, 3501 and 3873 of 1936. The present paper deals with an experimental investigation undertaken to determine the relationship between the secondary emission and the thickness of the oxidised layer of the metal on which caesium is deposited. The effect of the thickness of the caesium layer on the secondary emission was also investigated. The experiments were carried out with cathodes prepared on silver, nickel, copper, molybdenum and tungsten plates. An analysis is given of the results obtained and a number of curves are shown. The following two main conclusions are reached:—(1) the highest secondary emission is obtained from cathodes prepared on a silver base and having silver oxide 200 molecular layers thick, and (2) the layer of caesium for the highest emission is thinner than that which is required for the maximum photoeffect.

605. ON THE SECONDARY EMISSION OF ELECTRONS FROM THIN FILMS DEPOSITED ON GLASS.—A. V. Afanas'eva, P. V. Timofeev & A. S. Ignatov. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 6, 1936, pp. 1649–1656.)

It is known that under electron bombardment secondary electrons are emitted not only from metallic surfaces but also from insulators. In the latter case, however, direct observations are rather difficult and in the present paper a method is suggested for determining the maximum emission from glass by studying this effect on a thin metal layer deposited on it. The theory of the method proposed is discussed and an account is given of experiments carried out with molybdenum, nickel, and tungsten layers. One of the conclusions reached on the basis of the results obtained is that the ratio of the number of the secondary electrons emitted from glass to the number of primary electrons cannot exceed 1.5/1.

606. THE APPLICATION TO PHOTOGRAPHY OF A METHOD OF AMPLIFYING THE ENERGY OF PHOTONS [Acceleration of Photoelectrons by Electric Field: Astronomical Applications].—A. Lallemand. (*Comptes Rendus*, 16th Nov. 1936, Vol. 203, No. 20, pp. 990–991.) *See* also 4196 of 1936.

607. PHOTOELECTRIC SENSITISATION OF POTASSIUM BY MEANS OF HYDROGEN [only effective for Thick Layers of Potassium].—J. J. Brady & J. H. Rochel. (*Phys. Review*, 1st Nov. 1936, Series 2, Vol. 50, No. 9, p. 870.)

608. THE INFLUENCE OF LIGHT AND HEAVY HYDROGEN ON THE SELECTIVE PHOTOEFFECT OF THE ALKALI METALS [Replacement of Hydrogen by Heavy Hydrogen in Composite Cathodes shifts Selective Maximum towards Shorter Wavelengths: Resulting Deductions on the Intermediate-Layer Mechanism].—W. Kluge & W. Uhlmann. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 17, 1936, pp. 431–436.)

609. The Complete Equation of State of One, Two and Three-Dimensional Gases of Hard Elastic Spheres [Theory giving Adsorption Isotherms].—L. Tonks. (*Phys. Review*, 15th Nov. 1936, Series 2, Vol. 50, No. 10, pp. 955–963.) Theory with bearing on behaviour of monatomic films of Cs on W. *See* 3502 of 1936.

610. The Selective Reflection from Silver and Zinc in Polarised Light and Its Relation to the Selective Photoelectric Effect [Confirmation of Occurrence of Photoelectric Maxima in Position of Characteristic Optical Vibrations], *and* The Optical Behaviour of Fuchsin in Polarised Light [Agreement of Theoretical Formulae and Practical Results].—F. Hlučka. (*Zeitschr. f. Physik*, No. 3/4, Vol. 103, 1936, pp. 237–245: pp. 246–249.) For previous work *see* 3991 of 1935.

611. Variation of the Dielectric Constant of Silver Bromide under Illumination [H.F. Beat Method of measuring Illumination Effects with Photosensitive Substances by determining Dielectric Constant: Theoretical Discussion of Photochemical Processes].—J. Martens. (*Zeitschr. f. Physik*, No. 3/4, Vol. 103, 1936, pp. 217–236.)

612. Contribution to the Theory of Photoelectric Phenomena at the Boundary Surfaces of Electronic Semiconductors [and the Mechanism of the Barrier-Layer Photocell].—G. Liandrat. (*Ann. de Physique*, Oct. 1936, 11th Series, Vol. 6, pp. 391–454.)

The writer concludes that this photoeffect presents none of the paradoxical characteristics which seem to be attributed to it: it is even a much simpler phenomenon than the photoelectric emission of complex surfaces *in vacuo*. The essential facts determining the order of magnitude and the direction can be reduced to three:—in a semiconducting or insulating crystalline network the photoelectrons retain a notable portion of their kinetic energy after thousands of free transits: in the lattice of a metal, on the other hand, they lose it very rapidly and become ordinary "conduction" electrons: between the semiconductor and the metal, a thin layer of crystalline structure and high resistance controls the appearance of a potential difference between the semiconductor and the metal. The photoelectrons coming from the semiconductor traverse the barrier layer with a kinetic energy whose maximum value quantitatively satisfies the Einstein relation. The secondary modifications of the barrier-layer conductivity must be attributed to the later behaviour of electrons arising from the semiconductor but arrested in the barrier layer by the antagonistic electric field. An internal primary photoeffect corresponding to the light absorbed in this layer itself, if it exists at all, can only play a negligible rôle (*cf.* 3583 of 1935).

The photoemission current increases under the action of an accelerating electric field, apparently as a result of a decrease in work function, more or less comparable with the Schottky effect: at any rate, the Schottky relation is approximately observed and can even yield a correct evaluation of the thickness of the barrier layer.

613. Properties of a Selenium Barrier-Layer Photocell in the "Ballistic" Measuring Method.—H. König. (*Helvet. Phys. Acta*, Fasc. 7, Vol. 9, 1936, pp. 602–610: in German.) For previous work *see* 671 of 1936.

614. X-Ray Characteristics of Barrier-Layer Photocells, *and* Fatigue Phenomena of Barrier-Layer Photocells.—H. Suzuki. (*Journ. I.E.E. Japan*, June, 1936, pp. 734–738: July, 1936, pp. 796–800: Japanese only, with curves and tables.)

615. On the Brightness of a Fluorescent Screen subjected to Variable Excitation.—Yu. V. Golbreich & P. V. Shmakov. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 6, 1936, pp. 1692–1704.)

For previous work *see* 3556 of 1936. Each point of a fluorescent screen traversed by an electron beam glows with an average brightness depending on the amount of light emitted both during the excitation period and during the after-glow. In this paper a formula (15) is derived determining the average brightness of a fluorescent point as a function of the duration of the direct excitation and of the after-glow. A similar formula (16) is also derived for a point lying in a portion of the screen where two lines of the image overlap and the point therefore receives a double impulse during a frame period. These and other theoretical conclusions were checked experimentally and a number of practical recommendations are given.

616. Ultra-Violet Luminescence of Sodium Chloride [measured with Photon Counter: Normal and Deformed Crystals exposed to X-Rays and irradiated by Visible Light: Additional Ultra-Violet Radiation from Deformed Crystals: Relation to Colour Centres].—M. Schein & M. L. Katz. (*Nature*, 21st Nov. 1936, Vol. 138, p. 883.) For colour centres *see*, for example, 1532 of 1936.

617. Visible Conduction by Electron Substitution in Crystals of Alkali Iodide [Passage of Electrons through Crystal rendered visible by Movement of Cloud of Colour Centres which they form with Positive Metallic Ions].—E. Mollwo. (*Göttinger Nachrichten, math.-phys. Klasse*, New Series, No. 20, Vol. 1, pp. 215–220.)

618. Infra-Red Absorption Spectra of Photochemically Sensitised Alkali Halide Crystals [Sensitisation by Addition of KNO_3 & KOCN is due to Chemical Reaction between These Substances and Excess Alkali Atoms in Crystal].—K. Korth. (*Göttinger Nachrichten, math.-phys. Klasse*, New Series, No. 21, Vol 1, pp. 221–227.)

619. Mode of Connection of Excess Potassium in Potassium Halide Crystals [Formation of "K" Absorption Centres: "K" Centres as Electron Sources for Photoelectric Conduction].—O. Stasiw. (*Göttinger Nachrichten, math.-phys. Klasse*, New Series, No. 1, Vol. 2, pp. 1–7.)

620. INVESTIGATIONS ON THE EFFECT OF VARIOUS SUBSTITUENTS [Atomic Groups introduced into the Nitrobenzol Complex] AND THEIR POSITION [in the Benzole Ring] ON THE KERR EFFECT.—O. Hilke. (*Zeitschr. f. Physik*, No. 5/6, Vol. 103, 1936, pp. 350–367: 368–386: 387–394.)

Part I: Purification of nitrobenzol in order to decrease the conductivity; investigations on the effect of the materials composing the plates [of the cell] on the conductivity and on the bending of the electric field in the slit of the Kerr cell. Part II: The effect of positive and negative groups in the para-position on the magnitude of the Kerr effect (positive groups increase the Kerr effect, negative groups decrease it). Part III: Investigations on the frequency variation of the dielectric constant of nitrobenzol; contributions to the theory of the Kerr effect.

621. VARIATION OF DIELECTRIC CONSTANT OF NITROBENZENE/BENZENE MIXTURE.—Piekara. (*See* 653.)

622. THE OPTICAL PROPERTIES OF NONPOLAR LIQUIDS [Theory of Refraction, Kerr Effect and Light Scattering for Liquids with Nonpolar Axially Symmetric Molecules: Quasi-Crystalline Molecule Grouping produces Anisotropic Polarisation Field].—H. Mueller. (*Phys. Review*, 15th Sept. 1936, Series 2, Vol. 50, No. 6, pp. 547–559.)

623. THE LUMINOUS EFFICIENCY OF THE POSITIVE COLUMN OF A DISCHARGE IN SODIUM VAPOUR [200 Lumens/Watt obtained].—Klarfeld & Taraskov. (*Tech. Phys. of USSR*, No. 10, Vol. 3, 1936, pp. 881–892: in English.)

624. THE PRODUCTION OF WHITE LIGHT WITH A SINGLE LUMINESCENT TUBE [Discharge Tube coated with Calcium Tungstate containing Samarium].—G. Claude. (*Comptes Rendus*, 7th Dec. 1936, Vol. 203, No. 23, pp. 1203–1206.)

625. SPECTRAL ENERGY DISTRIBUTION AND LUMINOUS OUTPUT OF THE DISCHARGE IN MERCURY VAPOUR AT HIGH PRESSURES, *and* THE LUMINOUS INTENSITY OF THE MERCURY VAPOUR DISCHARGE AT HIGH PRESSURES.—Krefft, Larché & Rössler: Rompe & Thouret. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 17, 1936, pp. 374–377: pp. 377–380.)

MEASUREMENTS AND STANDARDS

626. FREQUENCY, POWER AND EFFICIENCY MEASUREMENTS ON MAGNETRON-GENERATED MICRO-WAVES.—Gundlach. (*See* 477.)

627. LECHER-WIRE SYSTEM WITH A DOUBLY-FOLDED EXTENSION.—Philips Company. (*See* 482.)

628. ON THE MEASUREMENT OF THE NATURAL WAVE-LENGTH OF WIRE CIRCUITS WITH AN ULTRA-SHORT WAVE.—H. Ataka & T. Urano. (*Journ. I.E.E. Japan*, June, 1936, pp. 747–751: Japanese only.)

629. A CONSIDERATION ON THE WAVEMETER FOR DECIMETRE WAVES.—H. Ataka & N. Mori. (*Journ. I.E.E. Japan*, July, 1936, pp. 803–806: Japanese only.)

630. A HARMONIC METHOD OF INTERCOMPARING THE OSCILLATORS OF THE NATIONAL STANDARD OF RADIO FREQUENCY [giving Increased Accuracy].—E. G. Lapham. (*Proc. Inst. Rad. Eng.*, Nov. 1936, Vol. 24, No. 11, pp. 1495–1500: *Journ. of Res. of Nat. Bur. of Stds.*, Oct. 1936, Vol. 17, No. 4, pp. 491–496.)

In the older method, where the recorder works on the fundamental frequency, one small division represents a frequency change of 4 in 100 million; when (according to the new method) the frequency difference is measured on the 10th harmonic, the corresponding frequency change is 0.5 in 100 million.

631. LIMITS OF CONSTANCY OF ELECTRIC OSCILLATORY CIRCUITS [Use of Ceramic Materials and Temperature-Compensated (Two-Condenser) Circuits: Measurements].—L. Rohde. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 17, 1936, pp. 464–468.)

For previous work *see* 501 of 1935 and 1537 of 1936: *also* Habermann, 281 of 1936. The wave-length formula of the equivalent circuit of the simple temperature-compensated circuit with two condensers, one having a positive and the other a negative temperature coefficient, is given. The formula involves, in addition to the major circuit components, the self-inductances of the leads and condensers, inductance reduction due to the short-circuiting effect of the screening of the containing box (ultimately made of an externally metallised ceramic material), self-capacity of coil, etc: so that the design of a practical, boxed-in circuit is a much more complex affair than that of an open lay-out. The results with the final design were as follows:—

The mechanical constancy was of the order of 5×10^{-7}. The elimination of temperature effects was the more complete, the smaller the absolute temperature coefficients of all the various components: the actual variation achieved was about $\pm 1 \times 10^{-7}$ per degree. The insertion of the circuit in an oscillation-generating circuit introduces the greatest inconstancy: for instance, a change in valves may in the most favourable circumstances bring a variation of the order of 10^{-5}. In bridge and transformer circuits the variation is only 10^{-6}. "There are many cases where the high *relative* constancy [around 10^{-7}) can be fully utilised; as for instance in all arrangements where the absolute value can be re-set from time to time."

632. ON THE STABILITY OF A FREQUENCY MONITOR FOR BROADCAST TRANSMITTER.—Itow & Yokoyama. (*Journ. I.E.E. Japan*, Aug. 1936, p. 941: Japanese only.)

633. A VERY STABLE LOW-FREQUENCY OSCILLATOR.—H. Yoda. (*Journ. I.E.E. Japan*, May, 1936, p. 727: Japanese only.)

634. Low-Frequency Quartz Plates of Zero Temperature Coefficient, *and* Quartz Plates of Zero Temperature Coefficient.—H. Yoda. (*Journ. I.E.E. Japan*, June, 1936, p. 786: August, p. 937: Japanese only.)

635. Oscillations of Hollow Quartz Cylinders cut along the Optic Axis.—Tsi-Zé Ny, Ling-Chao Tsien and Sun-Hung Fang. (*Proc. Inst. Rad. Eng.*, Nov. 1936, Vol. 24, No. 11, pp. 1484–1494.) For *Comptes Rendus* Notes *see* 4171 of 1936: for letter to *Nature*, 1934 Abstracts, p. 569.

636. Spherical Piezoelectric Resonators.—S. Kamieński. (*Wiadomości i Prace* [" *WPPIT* "], Warsaw, No. 3/4, Vol. 7, 1936, pp. 54–58: in Polish.)

Longitudinal and transverse vibrations are studied, with the influence of the position of the crystallographic axes on frequency and amplitude. The current maximum and the frequency minimum correspond to the optical axis perpendicular to the direction of the field. The temperature coefficient of frequency is measured: it varies with the angle of the field and becomes a minimum in the XY plane. The damping also varies with this angle and reaches a minimum for the plane perpendicular to the optical axis.

637. Contour Vibration, especially of the Third Mode, of Circular X-Cut Oscillating Quartz Plate, *and* Contour Vibration of Rectangular X-Cut Oscillating Quartz Plate.—Koga: Koga & Shoyama. (*Journ. I.E.E. Japan*, May & July, 1936, pp. 726 & 852: Japanese only.)

638. On the New Type Piezoelectric Transducer [using Specially Shaped Rochelle Salt Crystal].—H. Ando. (*Journ. I.E.E. Japan*, May, 1936, p. 728: Japanese only.)

639. Dielectric Constant, Conductivity, and Piezoelectric Effect of Rochelle Salt Crystals [Dielectric Constant measured as Function of Field-Strength and Temperature: " False Pyroeffect " a Consequence of Piezoelectric Effect: Only Three Piezoelectric Moduli: Hints for Possible Practical Application of Rochelle Salt].—H. Körner. (*Zeitschr. f. Physik*, No. 3/4, Vol. 103, 1936, pp. 170–190.) For previous work *see* 2763 of 1935.

640. Self-Oscillation in a Retroacting Thermal Conductor [Theoretical Analysis of Action of Mains-Operated Isothermal Oven: Comparison with Experimental Results].—L. B. Turner. (*Proc. Camb. Phil. Soc.*, Dec. 1936, Vol. 32, Part 4, pp. 663–675.)

641. Clocks showing Mean and Sidereal Time Simultaneously [Wheel Train giving Precise Ratio between Solar and Secular Day: Dead-Beat Seconds Hands on Both Dials given by Synchronous Motor Drive].—F. Hope-Jones. (*Nature*, 28th Nov. 1936, Vol. 138, pp. 931–932.)

642. Frequency-Modulated Generators [using Electronic Variable Capacity: Use in measuring Response of Tuned R.F. or I.F. Amplifiers, A.F. Amplifiers and Filters, and in aligning Inter-Stage Couplers and Expanding Selectors].—A. W. Barber. (*Rad. Engineering*, Nov. 1936, Vol. 16, pp. 14–16.)

643. The Signal Generator at Work.—Dobbie. (*See* 518.)

644. Notes on the Field-Intensity Measurement of High-Frequency [Short] Radio Waves.—K. Maeda. (*Journ. I.E.E. Japan*, Aug. 1936, pp. 886–891: English summary p. 58.)

" The f.i. of short waves should be the maximum value of either the horizontal or the vertical component of the electric field measured for a suitable duration of time, say one minute." A vertical aerial is better than a horizontal or loop aerial: the measured field-intensity figure should be supplemented by a statement of the condition of the earth at the measuring point. An appendix deals with static noise.

645. A New Instrument for the Measurement of Phase Modulation in Broadcasting Transmitters [of Special Importance in Common-Wave Systems].—F. Gutzmann. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 17, 1936, pp. 475–479.)

The evil effects of accidental phase modulation: previous methods of measuring: principle of the new instrument: its practical form: results and various possible applications. The instrument has been developed by the Lorenz Company, on the principle of converting a purely phase-modulated wave from the transmitter into a purely amplitude-modulated wave, by the addition to it of an unmodulated wave, from a local oscillator, whose phase and amplitude can be adjusted. This oscillator is quartz controlled, battery driven, and so protected against large temperature variations that the necessary constancy of 2×10^{-8} can be maintained over short periods. Undesired phase and amplitude modulation is below 0.03 per thousand, and screening is so good that even when working in the operating room of a 100 kw station there is no appreciable " mitnahme."

646. Calculation of the H.F. Impedance of Iron-Free Coils [Formula for Field within Coil Itself].—J. Hak. (*Hochf:tech. u. Elek: akus.*, Nov. 1936, Vol. 48, No. 5, pp. 160–164.)

Calculations and curves are here given which should assist in a more accurate determination of the field within the cross-section of the coil itself. A " form coefficient " K is defined (eqn. 4) which depends on the shape of the coil and the distance apart of the windings; a method of determining K in any case is given and carried out for single-layer cylindrical coils (§ v) and short multiple-layer coils (§ vi). A formula for the total impedance of the coil is given in § viii.

647. Iron-Free Cylindrical Coils with Non-Uniform Winding Density for the Production of Homogeneous Fields.—J. Hak. (*Arch. f. Elektrot.*, 21st Nov. 1936, Vol. 30, No. 11, pp. 736–745.)

Calculations and curves are here given for the axial field component of cylindrical coils in which the density of the windings increases (a) linearly, (b) quadratically, from the middle of the coil to the two ends. It is found that a very homogeneous field can be obtained near the middle of the coil. There is an optimum form of the coil for each type of winding. Examples are given to illustrate the practical design of these coils. Coils with a field as uniform as possible over their whole length are briefly discussed. For the calculation of the impedance of air-cored coils *see* 646, above.

648. A Capacitance Attenuator and Its Application to the Measurement of Very Small Capacitances [as Small as 0.001 $\mu\mu$F, to within 0.0001 $\mu\mu$F: within 1% for Larger Capacitances].—N. F. Astbury & T. Iorwerth Jones. (*Journ. Scient. Instr.*, Dec. 1936, Vol. 13, No. 12, pp. 407–411.)

"The resistance type of attenuator built up of 'transmission line' units has serious disadvantages. An instrument of this type presents such a complicated network of reactances, both visible and invisible, that the prediction of its behaviour at high frequencies is almost impossible. The capacitance attenuator is much simpler and has corresponding advantages."

649. Some Uses of a Calibrated Variable Condenser [Substitution Method for measuring Small Capacities and Related Electrical Quantities].—L. G. H. Huxley & K. N. Middleton. (*Phil. Mag.*, Dec. 1936, Vol. 22, No. 151, pp. 1158–1165.)

650. A. W. A. Inter-Electrode Capacity-Meter for Screen-Grid Valves.—Dobbie & Huey. (*See* 541.)

651. Some Notes on Intermediate-Frequency Transformer Testing.—Huey. (*See* 520.)

652. A Critical Experimental Investigation of the "Force" Method of determining the Dielectric Capacity of Conducting Liquids at Low Frequencies: Univalent Electrolytes in Aqueous Solution [with Discussion of Discrepancies between Experimental Results and Debye-Falkenhagen Theory].—W. J. Shutt & H. Rogan. (*Proc. Roy. Soc.*, Series A, 2nd Nov. 1936, Vol. 157, No. 891, pp. 359–372.)

653. Electrical Saturation and Critical Dissolution Point [Measurements of Variation of Dielectric Constant of Mixture of Nitrobenzene and Benzene in Electric Field show Anomalous Behaviour near Critical Dissolution Point].—A. & B. Piekara. (*Comptes Rendus*, 23rd Nov. 1936, Vol. 203, No. 21, pp. 1058–1060.)

654. Measurement at High Frequency of the Dielectric Constant of Some Mineral Salts in Dilute Solutions in Different Solvents [Frequencies up to around 1.7 Mc/s: Results confirm neither the Debye Theory nor the Theory of Propagation in an Ionised Medium].—M. Beauvilain. (*Ann. de Physique*, Oct. 1936, 11th Series, Vol. 6, pp. 502–560.)

655. Precision Measuring Apparatus for determining the Molecular Polarisation of Non-Dissociating Liquids [Double Beat Method with Quartz-Controlled Emitter: Results for Organic Liquids].—G. Rösseler. (*Zeitschr. f. Physik*, No. 3/4, Vol. 103, 1936, pp. 191–216.)

656. Static Measurement of Peak Voltages of All Frequencies.—Olga Lintner. (*Hochf: tech. u. Elek:akus.*, Nov. 1936, Vol. 48, No. 5, pp. 158–160.)

The method used is a modification of Schuhfried's photocell-voltmeter (3121 of 1936) in which the photocell is replaced by a rectifying valve. The circuit is given in Fig. 1. The potential of the electrometer string is shown in Fig. 2; the inertia of the string makes it take up a position corresponding to *m*, the mean value of its potential, and differing from its rest position by an amount equal to the amplitude of the potential variations. The method is found to be independent of frequency within wide limits and very sensitive. Its advantages over the photocell method are that "it needs no calibration and the peak voltages are given whatever the form of the voltage curve." Experimental tests are described, with an example of measurement of standing waves of length 4 m on a Lecher-wire system (Fig. 4).

657. A New Indicating Voltmeter for High Voltages.—Suzuki & others. (*Journ. I.E.E. Japan*, Aug. 1936, p. 940: Japanese only.)

658. Measurement of Small Current with Flashing of the Discharge Tube [Flashes per Second counted].—Narasaki & Fujioka. (*Journ. I.E.E. Japan*, Aug. 1936, p. 943: Japanese only.)

659. Time of Damping of Measuring Instruments [Its Relation to Fundamental Characteristics and Working Conditions: etc.].—V. O. Arutunov. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1936, pp. 68–73.)

660. Temperature Compensation of Millivoltmeters.—H. B. Brooks. (*Journ. of Res. of Nat. Bur. of Stds.*, Oct. 1936, Vol. 17, No. 4, pp. 497–555.)

661. The Use of the Ballistic Galvanometer as a Zero Instrument.—G. Dupouy. (*Comptes Rendus*, 16th Nov. 1936, Vol. 203, No. 20, pp. 987–989.)

SUBSIDIARY APPARATUS AND MATERIALS

662. Large-Surface Cathode Steadily Heated by Re-Radiation from the Anode.—Haefer. (*Zeitschr. f. Physik*, No. 5/6, Vol. 103, 1936, pp. 277–302.)

The practical construction of the cathode in question was referred to in 138 of 1936. The present paper deals with a number of theoretical and experimental questions of the connection between current, voltage, and temperature, the stabilisation of the heating by a series resistance or by space-charge, the heating-up processes and the minimum amount of heating preliminary to the re-radiation process. The cathode and anode temperatures are calculated and the voltage/current characteristics for the region of saturation current deduced. The conditions of stability are discussed in the light of the isothermal field (Figs. 9, 11). The experimental determination of the form of the characteristics is described; the lowest stable temperature is found to decrease as the battery voltage increases. Characteristic curves for the preliminary heating are also determined (Figs. 19–21). The experiments verify that the fundamental equations form a correct basis for the calculation of practical large-surface cathodes and black bodies. An inverted arrangement (Fig. 24), with internal anode and external cathode, is given for the construction of black bodies of very high temperature.

663. THE APPLICATION TO PHOTOGRAPHY OF A METHOD OF AMPLIFYING THE ENERGY OF PHOTONS.—Lallemand. (*See* 606.)

664. ON THE BASES OF THE GEOMETRICAL OPTICS OF ELECTRONS, AND ITS APPLICATIONS IN ENGINEERING AND SCIENCE [including Analysis of Electron Motion in Superposed Axially Symmetrical Electric and Magnetic Fields].—Majewski. (*Wiadomości i Prace "WPPIT"*, Warsaw, No. 3/4, Vol. 7, 1936, pp. 58–83: in Polish, with French summary.)

665. MINIATURE CATHODE-RAY TUBE ANNOUNCED: TYPE RCA 913, WITH METAL CONSTRUCTION, SOON AVAILABLE.—(*QST*, Dec. 1936, Vol. 20, p. 37). In metal envelope like that of the 6L6 except for glass viewing screen. Brilliant image with anode volts as low as 250: electrostatic deflection. Anticipated price below 5 dollars. *See* also *Rad. Engineering*, Nov. 1936, p. 33.

666. "CATHODE-RAY OSCILLOGRAPHY" [Criticism of Book].—Cosens: MacGregor-Morris & Henley. (*Wireless Engineer*, Dec. 1936, Vol. 13, No. 159, pp. 635–636.) *See* also 3911 of 1936.

667. "LE TUBE À RAYONS CATHODIQUES."—Chrétien. (At Patent Office Library, London: Cat. No. 76 824: 64 pp.)

668. CATHODE-RAY "DUST" OSCILLOGRAM [Records almost independent of Electron Velocity: Linear Recording Speed already attained 2×10^5 cm/sec.].—Suzuki & Tsuji. (*Journ. I.E.E. Japan*, Aug. 1936, pp. 898–902: English summary p. 61.)

A mixture of powdered red lead and yellow sulphur, or lycopodium powder, is dusted on an ebonite plate which has been exposed to the ray. The fact that dusting the far side of the plate also yields an oscillogram (though a less clear one) suggests the possibility of using a sealed-off type of cathode-ray tube.

669. A SIMPLE ELECTROGRAPHIC OSCILLOGRAPH.—Selényi. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 17, 1936, pp. 487–491.)

For previous papers on electrography, including its application to picture telegraphy, *see* 3983 of 1935 and 1869 of 1936. The present paper describes a simple practical application of the principle to an oscillograph for purposes hitherto served by loop or cathode-ray instruments. The apparatus somewhat resembles an old-fashioned cylinder phonograph, driven by hand. The records are visible at once, are easily effaced, but can also easily be fixed. The upper frequency limit would appear to lie at about 100 kc/s. "Further, more complete models, including some with multiple recording on a perforated paper band, are in preparation." Among the specimen records are those of the current and potential of a relaxation oscillation and the damped oscillations of a condenser discharge.

670. A SELF-SYNCHRONISING TIME BASE FOR THE DISTANT OBSERVATION OF WIRELESS PULSE TRANSMISSIONS.—Falloon & Farmer. (*See* 440.)

671. A CONTINUOUSLY VARIABLE PHASE-SHIFTING DEVICE [for Cathode-Ray-Oscillograph Time Base].—Pulley. (*Wireless Engineer*, Nov. 1936, Vol. 13, No. 158, pp. 593–594.)

672. ON THE BRIGHTNESS OF A FLUORESCENT SCREEN SUBJECTED TO VARIABLE EXCITATION.—Golbreich & Shmakov. (*See* 615.)

673. FLUORESCENCE OF SOME PURE BODIES [Organic Compounds containing Oxygen].—Canals & Peyrot. (*Comptes Rendus*, 16th Nov. 1936, Vol. 203, No. 20, pp. 998–999.)

674. THE EXCITATION OF PHOSPHORS IN THE NEON DISCHARGE.—Rüttenauer. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 17, 1936, pp. 384–387.)

Pirani and the author have successfully used the excitation of phosphors to improve the output of low-pressure mercury-vapour lamps. The present experiments show that both zinc-sulphide and zinc-silicate phosphors are made luminous by ultra-violet and Schumann radiation of the neon discharge. The silicate phosphor must be of a special type.

675. THE SENSITISATION OF PHOSPHORS. II [Description of Further Examples].—Rothschild. (*Physik. Zeitschr.*, 1st Nov. 1936, Vol. 37, No. 21, pp. 757–763.)

676. SOME NOTES ON LUMINESCENCE.—Schmidling. (*Rad. Engineering*, Nov. 1936, Vol. 16, pp. 21–23.)

677. PHOTOGRAPHIC PLATES SENSITISED WITH SODIUM SALICYLATE [have Increased Contrast and Sensitivity in Visible as well as Ultra-Violet Spectrum].—T. Kiu. (*Comptes Rendus*, 30th Nov. 1936, Vol. 203, No. 22, pp. 1144–1146.)

678. A NEW HIGH-VACUUM PLUNGER PUMP.—Sone & Moritomo. (*Journ. I.E.E. Japan*, July, 1936, pp. 45–46: summary only, in English.)

679. AN INVESTIGATION OF THE EVACUATION PROCESS OF ION APPARATUS.—G. P. Bel'govski. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 6, 1936, pp. 1678–1691.)

In the manufacture of vacuum and gas-filled tubes it is essential to know the minimum duration of the evacuating process which would ensure that the pressure of the gases liberated from the components of the tube, after the pump has been disconnected, will not exceed a certain value. In the present paper an attempt is made to give this information on the basis of theoretical as well as experimental investigation.

A formula (6) is derived showing the variation of pressure in a vessel which is continuously evacuated and in which a component of the tube is maintained at a constant temperature. Another formula (7) is also derived showing the rise of pressure in the vessel after the pump has been disconnected. A number of experiments were carried out with mercury-vapour rectifiers and the practical value of the above formulae was sufficiently demonstrated. An attempt to use phosphor and barium getters in these valves gave negative results. The paper is concluded by a number of practical suggestions.

680. NEW TYPES OF VACUUM-TIGHT CERAMIC/METAL JOINTS.—Handrek. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 17, 1936, pp. 456–459.)

The writer recalls the methods described in his previous paper (539 of 1935), in which glass was used as the intermediary; he also mentions the use of soft solder for porcelain/metal joints, given by Espe & Knoll in their book on high-vacuum technique (3043 of 1936). He then describes a new process, by which mechanically strong and vacuum-tight joints can be made even between materials of such different expansion coefficients as copper and Calit (165×10^{-7} and 78×10^{-7} respectively). The principle is that the metal is forced to accommodate its expansion to that of the ceramic material, being applied to the latter while already under strain—*e.g.* "shrunk on"; the joint is then made vacuum-tight by a coating of glass or other material selected to suit the ceramic. Since the joint is no longer merely an elastic "edge joint," the new process gives much stronger results and can be used for joining metal tubes with ceramic tubes and for lead-in connections of high current capacity.

681. AN ADJUSTABLE VACUUM LEAK.—Smythe. (*Review Scient. Instr.*, Nov. 1936, Vol. 7, No. 11, p. 435.)

682. INVESTIGATIONS ON THE "SPRAY" DISCHARGE [with Cathodes whose Insulating Layer consists of an Electrolytic Al_2O_3-Film: Influence of Nature of Cathode Surface: Behaviour of Restriking Voltage: Influence of Remanent Charges in Insulating Layer: Push-Pull Circuit with Low Restriking Voltage and Excellent Rectifier Action].—Schnitger. (*Zeitschr. f. Physik*, No. 3/4, Vol. 102, 1936, pp. 163–182.) *See* also Fricke, 825 of 1935.

683. IMPULSE BREAKDOWN VOLTAGE AND IMPULSE BREAKDOWN IN A HOMOGENEOUS FIELD AT LOW PRESSURES (100 TO 760 mm) [Validity of Paschen's Law: Correcting Factors for Gas Density: Steps in Time/Voltage Curves are probably Intermediate Form between Spark and Glow Discharges].—Köhler. (*Arch. f. Elektrot.*, 14th Aug. 1936, Vol. 30, No. 8, pp. 528–552.)

684. PROCESS FOR THE DIRECT, SEMILOGARITHMIC RECORDING OF LANGMUIR-PROBE CHARACTERISTICS [in the Plasma of Gaseous Discharges: using the C-R Oscillograph: Results with Mercury-Vapour Rectifiers, including Effect of Magnetic Field].—Hermann. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 17, 1936, pp. 482–487.)

685. ON THE THEORY OF EXPLORING ELECTRODES IN GASEOUS DISCHARGES.—B. I. Davydov & L. I. Zmanovskaya. (*Tech. Phys. of USSR*, No. 8, Vol. 3, 1936, pp. 715–728: in German.)

The theory of the method, as expounded by Langmuir & Mott-Smith, is discussed in the present paper and it is shown that it only holds good for tubes operating at low pressures, for which the radius of the probe can be made small in comparison with the lengths of the free paths of the electrons and ions. For tubes operating at higher pressures the theory has to be modified, and this is accomplished in the present paper by the use of the ordinary equations of diffusion in an electric field. Volt/ampere characteristics of both spherical and cylindrical probes are calculated and methods are indicated for determining at a given point the temperature and concentration of electrons and the potential. The values so obtained are considerably higher than those derived from the original theory.

686. AN INVESTIGATION OF GASEOUS DISCHARGES SYMMETRICAL ABOUT THE TUBE AXIS, BY THE METHOD OF SOUNDING ELECTRODES [Probes].—Rodin. (*Journ. of Tech. Phys.* [in Russian], No. 9, Vol. 6, 1936, pp. 1502–1512.)

An account of experiments carried out with discharge tubes filled at low pressure with either mercury vapour or a mixture of mercury vapour and argon. The tubes used were provided with two collecting electrodes, and the following observations were made:—(a) the effect of the gas pressure on the velocity distribution of the electrons near the cathode; (b) the effect of the gas pressure on the potential variation along the tube envelope; and (c) a comparison between the potential variations along the tube axis and envelope. The results obtained are shown in a number of tables and curves and discussed from the standpoint of the general theory of gaseous discharges.

687. THE USE OF A THERMOELECTRIC EXPLORING ELECTRODE IN STUDYING GASEOUS DISCHARGE.—Gorshkov & Maslakovets. (*Journ. of Tech. Phys.* [in Russian], No. 9, Vol. 6, 1936, pp. 1513–1519: *Tech. Phys. of USSR*, No. 9, Vol. 3, 1936, pp. 824–831: in German.)

A preliminary communication on the use of a thermo-couple as a sounding electrode for studying gaseous discharges. A number of experiments were carried out with tubes filled with mercury vapour at a pressure of 0.001 mm Hg and containing a thermo-couple connected to a mirror galvanometer. It appears from these experiments that a new method has been made available for determining the space potential and the electron temperature. The possibility is also indicated of using this for determining the temperature of the gas at a given point in the discharge.

688. On the Constitution of the Hot-Cathode Discharge in the Neighbourhood and Interior of Hollow Hot Cathodes [Indirectly Heated Oxide-Coated Cathodes].—Richter. (*Zeitschr. f. tech. Phys.*, No. 9, Vol. 17, 1936, pp. 306–315.)

From the author's summary :—" With the help of some 1200 Langmuir-probe curves, the hot-cathode discharge in the neighbourhood and on the axis of an indirectly heated hollow cathode is described. The potential distributions found correspond to those found by Compton & Eckart for the low-voltage arc with filament cathode. Potential, electron-temperature and electron-current distributions were measured for various values of anode current, heating voltage, and gas pressure, and for varying cathode geometry and type of gas filling " [He, Ar, Kr and Hg vapour].

689. A New Process of Negative Ion Formation [Positive Ions of Hg pick up Two Electrons when driven on to Negative Electrode : Accommodation Coefficient for Positive Ions reflected from Tungsten Filament : Inadequacy of Classical Momentum Considerations].—Arnot & Milligan. (*Proc. Roy. Soc.*, Series A, 1st Sept. 1936, Vol. 156, No. 889, pp. 538–560.)

690. Statistical Theory of Adsorption with Interaction between the Adsorbed Atoms.—Peierls. (*Proc. Camb. Phil. Soc.*, July, 1936, Vol. 32, Part 3, pp. 471–476.)

691. The Characteristics of Thermionic Rectifiers [Assuming Infinite Smoothing Capacity and No Emission Limitation, Three-Halves Power Law Characteristic yields Simple Formulae].—W. H. Aldous. (*Wireless Engineer*, Nov. 1936, Vol. 13, No. 158, pp. 576–580.) For anode watts, output volts and peak current ; error less than 1%.

692. Hot-Cathode Mercury-Vapour High-Tension Supply Equipment for Broadcasting Stations.—Rabuteau. (*Elec. Communication*, Oct. 1936, Vol. 15, No. 2, pp. 141–156.)

Including discussions of the influence of the characteristics of the rectifier circuit on the valve performances, and of the future possibilities of grid-controlled rectifiers—whose development, however, seems not yet sufficiently advanced for regular use in broadcasting.

693. Constant Current Rectifiers [with Special Ballast Circuit avoiding Ballast Loss and Low Power Factor].—Westinghouse Company. (*Journ. Scient. Instr.*, Dec. 1936, Vol. 13, No. 12, pp. 421–422.)

694. Large Rectifiers without Vacuum Pump [200 A, 600 V, Iron Container, with Direct Air-Cooling].—Dällenbach & Gerecke. (*E.T.Z.*, 13th Aug. 1936, Vol. 57, No. 33, pp. 937–940.) Further development of the rectifiers referred to in 1934 Abstracts, p. 220, l–h column.

695. An End-of-Life Meter [indicating Approach of End of Normal Life in Grid-Controlled Gaseous Rectifiers].—Lord & Livingston. (*Electronics*, Sept. 1936, Vol. 9, No. 9, pp. 26–27.)

696. A New Method for Investigating Conduction Phenomena in Semiconductors.—Fairbrother. (*See* 134 of January.)

697. Artificial Barrier Layers on Electronic Semiconductors of Different Conduction Types [" Deficiency " and " Surplus " Types].—Hartmann. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 17, 1936, pp. 436–439.)

For a preliminary note *see* 4205 of 1936. A semiconductor like zinc oxide is called a " reduction " semiconductor because its conductivity decreases with increased oxygen content and increases with reduction, which produces surplus metal atoms whose valency electrons become available for current conduction. This mechanism, which gives a negative Hall constant, is called " surplus " conductivity in contrast to that of " oxidation " semiconductors like cuprous oxide, whose conductivity increases with added oxygen and involves in its mechanism the theoretically postulated " electron gaps " (giving a positive Hall constant) of Heisenberg & Peierls. For Jusé's independent work on artificial barrier layers *see* 2048 of 1935.

698. On Some Relations between Physical Properties of Metallic Oxides [used as Heat-Resisting Insulating Materials] and the Variation of Their Electrical Conductivities with Temperature.—Shimizu & Nishifuji. (*Journ. I.E.E. Japan*, Aug. 1936, pp. 868–874 : English summary p. 55.)

699. Studies on the Oxidation of Metals. Part IV. The Oxide Film on Aluminium.—Preston & Bircumshaw. (*Phil. Mag.*, Oct. 1936, Series 7, Vol. 22, No. 148, pp. 654–665.)

700. An Investigation of the Oxidising Process for Aluminium Anodes used for Electrolytic Condensers.—V. T. Renne & L. G. Schlachter. (*Journ. of Tech. Phys.* [in Russian], No. 10, Vol. 6, 1936, pp. 1705–1711.)

A report on experiments carried out to determine the optimum conditions for forming aluminium anodes. The anodes experimented with were made of aluminium foils 0.05-0.15 mm thick, and the effect of their chemical composition on the forming process was investigated. Solutions of citric acid, ammonium molybdate and ammonia, and of boric acid and borax, were used for electrolytes and their maximum and sparking voltages and specific resistances were determined for various concentrations and temperatures. The actual forming was carried out with different current densities, temperatures, and types of voltages (direct, alternating, rectified) and with the addition of chlorine in the electrolyte. The results obtained are shown in a number of curves and a summary of the conclusions reached is appended.

701. VARIABLE CONDENSER FOR RECEIVERS WORKING WITH LOUDSPEAKERS [Mechanical-Acoustic Reaction avoided by covering Plates with Lead].—Schäfer & Hammer: Telefunken. (*Hochf:tech. u. Elek:akus.*, Sept. 1936, Vol. 48, No. 3, p. 109: German Pat. 629 811 of 9.2.1926.)

702. PLASTICS IN INSTRUMENT DESIGN.—Rowell. (*Journ. Scient. Instr.*, Sept. 1936, Vol. 13, No. 9, pp. 277–282.)

703. PLASTICS FOR USE IN ELECTRICAL ENGINEERING. PART I—A GENERAL ACCOUNT OF MANUFACTURING TECHNIQUE, AND A DESCRIPTIVE CLASSIFICATION. PART II—DESCRIPTIVE NOTES ON CERTAIN SYNTHETIC RESIN PLASTICS USED IN ELECTRICAL ENGINEERING.—Dunton & Caress. (*Journ. I.E.E.*, Oct. 1936, Vol. 79, No. 478, pp. 462–475 and 475–482.)

704. AN INVESTIGATION OF THE AMORPHOUS STATE: VIII—"STRUCTURAL" DIELECTRIC LOSSES IN PLASTIFIED GLUCOSE.—Alexandrov, Kobeko & Kuvshinski. (*Tech. Phys. of USSR*, No. 9, Vol. 3, 1936, pp. 769–777: in English.) For previous work on these "structural" losses *see* 3579 of 1936.

705. ON THE PLASTIFICATION OF POLYSTYROLS [Superficial Cracking and Its Elimination: Production of Flexible Polystyrol with Low Dielectric Loss].—Dalesky & Korzhavin. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1936, p. 80.)

706. LIMITS OF CONSTANCY OF ELECTRIC OSCILLATORY CIRCUITS [Temperature-Compensated, with Ceramic Materials].—Rohde. (*See* 631.)

707. ON THE DIELECTRIC BEHAVIOUR OF COLLOIDAL SYSTEMS—II. ELECTRICAL EFFECT ON THE DISPERSED SYSTEM OF FIBROUS MATERIALS.—Nishi & Fukuwatari. (*Jap. Journ. of Eng., Abstracts*, 1936, Vol. 14, p. 105.)

708. ON THE THERMAL BREAKDOWN OF SOLID DIELECTRICS [Glass: Wagner-Fock Law not followed: etc.], *and* SOME CONSIDERATIONS ON PURE THERMAL BREAKDOWN OF SOLID DIELECTRICS.—Nakanisi: Shimizu. (*Journ. I.E.E. Japan*, Sept. 1936, pp. 967–976: pp. 977–982: English summaries pp. 73–76: pp. 76–77.)

709. MEASUREMENT OF THE TRUE SPECIFIC HEAT OF SILVER, NICKEL, β-BRASS, QUARTZ CRYSTAL AND QUARTZ GLASS BETWEEN + 50 AND 700°C BY AN IMPROVED METHOD [with Discussion of Expansion Coefficients of Quartz Crystal and Change from α- to β-Quartz].—Moser. (*Physik. Zeitschr.*, 1st Nov. 1936, Vol. 37, No. 21, pp. 737–753.)

710. ELECTRICAL PROPERTIES OF QUARTZ PRODUCED BY THE LOMONOSOV FACTORY [including Non-Transparent Quartz and Vitreosil].—Kobeko & others. (*Izvestiya Elektroprom. Slab. Toka*, No. 8/9, 1936, pp. 51–56.)

711. MOLECULAR ROTATION IN ORGANIC CRYSTALS [Camphor, Cyclohexane, etc.].—A. H. White. (*Bell Lab. Record*, Sept. 1936, Vol. 15, No. 1, pp. 11–14.) For a previous paper on camphor *see* 773 of 1936.

712. THE DIELECTRIC LOSS OF THE INSULATING MIXTURES [*e.g.* of Impregnating Liquids: Separation of Conduction and Absorption Components: Conclusions].—Shichiri & Hirai. (*Journ. I.E.E. Japan*, Aug. 1936, pp. 902–905: English summary p. 62.)

713. THE OXIDATION OF TRANSFORMER OIL.—ter Horst & Krijgsman. (*Physica*, Dec. 1936, Vol. 3, No. 10, pp. 1082–1084: in English.)

714. HIGH-FREQUENCY LOSSES AND MOLECULAR PROPERTIES OF POLAR SOLUTIONS [Experimental Tests of Formulae of Dipole Theory].—Martin. (*Physik. Zeitschr.*, 1st Oct. 1936, Vol. 37, No. 19, pp. 665–677.)

715. THE ANOMALOUS DISPERSION IN DIPOLE LIQUIDS [Conclusions from Various Recent Absorption Measurements].—Malsch. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 17, 1936, pp. 423–425.) The necessity is deduced of the assumption of a relaxation time for the dipole structure as well as for the dipole itself. Tests with electrolytic solutions in glycerine indicate the existence of natural oscillations of ionic complexes in the region of short electric waves.

716. NEW MAGNETIC ALLOY [Alnico: with Comparative Curves].—General Electric Company. (*Journ. Scient. Instr.*, Oct. 1936, Vol. 13, No. 10, pp. 336–337.) *See* also 1610 & 2824 of 1936.

717. NICKEL-IRON ALLOYS [and the Inherent Wrongness of the Wattless Component Method of representing Permeability].—Hughes: McLachlan. (*Electrician*, 11th Sept. 1936, Vol. 117, p. 305.) Prompted by McLachlan's article (4224 of 1936).

718. MAGNETIC CHARACTERISTICS OF NICKEL-IRON ALLOYS WITH ALTERNATING MAGNETISING FORCES [in Region of Max. D.C. Permeability, A.C. Permeability of Thin Mumetal and Permalloy Laminations (around 50 c/s) Less than One-Tenth D.C. Value: for Comparatively High Magnetising Forces A.C. and D.C. Values practically Identical: Dissymmetry in B–H Loops for A.C., especially near Region of Max. D.C. Permeability: etc.].—Hughes. (*Journ. I.E.E.*, Aug. 1936, Vol. 79, No. 476, pp. 213–223.)

719. THE VARIATION OF THE MAGNETIC PROPERTIES OF FERROMAGNETIC LAMINAE WITH FREQUENCY [0–3 × 10⁶ c/s: Silicon Steel, Mumetal and Rhometal].—Dannatt. (*Journ. I.E.E.*, Dec. 1936, Vol. 79, No. 480, pp. 667–680.)

Among other results, permeability is found to be practically independent of H at very high frequencies; it is deduced from this that hysteresis loss must disappear, so that the latter can no longer be cited as the cause of power-factor values above the theoretical limiting figure 0.707. These are now attributed to additional eddy loss produced by *transverse* components of the flux. The observed variation of permeability with frequency, appearing between 10^4 and 10^5 c/s, with a greatly reduced rate of fall around 10^6 c/s, is believed to be due primarily to the depth of penetration of flux approaching a magnitude of the same order as the average linear dimension of the self-saturated magnetic domains: molecular viscosity may account for the changes in the intermediate-frequency range.

720. Iron-Free Cylindrical Coils with Non-Uniform Winding Density for the Production of Homogeneous Fields.—Hak. (*See* 647.)

721. Aluminium in High-Frequency Technique.—Rohde & Schwarz. (*Funktech. Monatshefte*, Oct. 1936, No. 10, pp. 373–376.)

722. New Type of High-Voltage Generator ("Rumbatron").—(*Science*, 16th Oct. 1936, Vol. 84, Supp. p. 9.) Using electrons instead of the atomic nuclei of the "Cyclotron." Energies equivalent to 5 million electron-volts will be attained in one journey through the cylinder.

723. A New Method of Producing Constant Direct Voltages for Counter Arrangements [Circuit using Glow-Discharge Tube with Several Discharges in Series giving Terminal Voltage of about 950 V].—Alexopoulos. (*Naturwiss.*, 17th July, 1936, Vol. 24, No. 29, p. 462.)

724. An Electronic Regulator for D.C. Generators [using Grid-Controlled Arc-Discharge Tubes as Rectifiers controlled by Diode to supply Field Current].—Gulliksen. (*Elec. Engineering*, Aug. 1936, Vol. 55, No. 8, pp. 873–875.)

725. A D-C Controlled Voltage Regulator [Transformer with Additional D-C Winding to vary Core Saturation].—Odessey. (*Elec. Engineering*, Sept. 1936, Vol. 55, No. 9, pp. 956–960.)

726. Limited-Impulse and Delay Relays [using A.C. Mains-Driven Valve Circuits: Numerous Applications].—Noble. (*Electronics*, Aug. 1936, Vol. 9, No. 8, pp. 28–30.)

727. A New Automatic Switch for Fault Recorders [Relay working only when System Voltage falls suddenly with a Predetermined Minimum Gradient to a Predetermined Value].—Boekels & Krannich. (*E.T.Z.*, 23rd July, 1936, Vol. 57, No. 30, pp. 861–863.)

728. A Mechanical Counter of High Resolving Power [for Statistically Distributed Impulses: Very Light Reed driven by Polarised Electro-Magnet moves Very Small Clockwork Balance Wheel: Time Constant 0.005 sec.]. — Flammersfeld. (*Naturwiss.*, 14th Aug. 1936, Vol. 24, No. 33, pp. 522–523.)

729. Sensitive D.C. Recorder [Adaptable also for A.F. Response Curves, etc.].—Elliott Brothers. (*Journ. Scient. Instr.*, Dec. 1936, Vol. 13, No. 12, p. 423.)

730. The Generation of Illuminating Sparks for High-Frequency Cinematography by means of Valves [Optimum Ratio Oscillation - Frequency / Spark - Frequency found to be 4/1: a 1.5 kW Valve gives Spark bright enough for 70 000 Pictures per Second].—Zimmermann. (*Zeitschr. V.D.I.*, 29th Aug. 1936, Vol. 80, No. 35, p. 1092: summary of Berlin Dissertation.)

STATIONS, DESIGN AND OPERATION

731. Federal Communications Commission Hearing: I.R.E. Statement on Broadcasting Allocation.—(*Proc. Inst. Rad. Eng.*, Nov. 1936, Vol. 24, No. 11, pp. 1407–1413.)

732. RMA's Recommendations on Allocation.—Horle. (*See* 504.)

733. Clear Channel, High Power and Short-Wave Broadcasting urged by RMA at FCC Hearing.—(*Rad. Engineering*, Nov. 1936, Vol. 16, pp. 30 and 34.)

734. Quartz-Controlled Common-Wave Transmitters with Intermittent or Continuous Indirect Regulation of Frequency over Cables [and the Döberitz/Strelitz and Turin/Trieste Results].—Schulze-Herringen. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 17, 1936, pp. 468–472.) *See* also Vilbig & Brückmann, 4234 (and 4235) of 1936.

735. Synchronisation of Common-Wave Broadcasting System by Auxiliary Frequency [of 10^4 c/s which, superposed on a High Frequency, gives Sidebands of which One is the Common Frequency].—Prokott. (*Hochf:tech. u. Elek:akus.*, Nov. 1936, Vol. 48, No. 5, p. 179: German Patent 631 106 of 17.8.34.)

736. A New Instrument for the Measurement of Phase Modulation in Broadcasting Transmitters.—Gutzmann. (*See* 645.)

737. Recorded Interval Signals [German System using Track on Glass Disc].—von Braunmühl. (*Wireless World*, 27th Nov. 1936, Vol. 39, pp. 569–570.)

738. How the B.B.C. puts the Clock Back [Mobile Recording Equipment].—(*Wireless World*, 11th Dec. 1936, Vol. 39, p. 619.)

739. The France/Algeria Radiotelephone Service: Modifications introduced and Results obtained.—Rigal. (*Ann. des Postes, T. et T.*, Aug. 1936, Vol. 25, No. 8, pp. 744–766.) Arrangements to combat cross-talk troubles caused by selective fading: automatic speech-level control at the transmitter: secrecy.

740. Co-ordination of Radio and Land-Line Services [Book Review].—(*Wireless Engineer*, Nov. 1936, Vol. 13, No. 158, p. 580.) Notice of the "Proceedings of the International Telephone Consultative Committee (plenary meeting at Budapest: English Edition)."

741. Wireless Signals for the Use of Seamen and Urgent Notices to Mariners [Proposed Form for Message].—(*Hydrographic Review*, Nov. 1936, Vol. 13, No. 2, pp. 66–68.)

GENERAL PHYSICAL ARTICLES

742. The Eigenvalues of Electromagnetic Angular Momentum [in Usual Electrodynamics and Born's New Field Theory can only be Integral Multiples of h].—Pryce. (*Proc. Camb. Phil. Soc.*, Dec. 1936, Vol. 32, Part 4, pp. 614–621.)

743. On a Relativistically Invariant Formulation of the Neutrino Theory of Light.—Kronig. (*Physica*, Dec. 1936, Vol. 3, No. 10, pp. 1120–1132: in English.)

744. The Kinetic Ether Theory and Its Numerical Foundation.—Fricke. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 17, 1936, pp. 491–496.) "The new theory combines the advantages of all previous theories, and the difficulties resulting from the Michelson experiment disappear."

744 *bis*. The Foundations of Electrodynamics [New Suggestion].—Schlomka. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 17, 1936, pp. 459–463.)

Author's summary:—In the usual structure of electrodynamics the electric and magnetic field strengths are first defined as physical quantities and are then connected together by the system of Maxwell equations. For the simplified solution of this system, scalar and vector potentials are introduced which remain to a certain extent indefinite: no physical significance is given to these auxiliary quantities. In contrast to this, in the proposed new structure we start with unambiguously defined potentials whose physical significance and spatial and temporal variations are taken from experience. This new structure of electrodynamics has certain advantages as regards theory; as regards experiment it offers completely new methods of attack.

745. The Poynting Theorem in Electrotechnics [Transients, Alternators, Transformers, Skin Effect: etc.)—Darrieus. (*Bull. Soc. franç. des Élec.*, Sept. 1936, Vol. 6, pp. 893–920.)

746. The Electrostriction of Highly Compressed Gases [Measurement of Pressure and Temperature Variations: Deviation from Theoretical Value: Formation of Double Molecules in Electric Field].—Jaumann & Kinder. (*Zeitschr. f. Physik*, No. 3/4, Vol. 103, 1936, pp. 263–275.)

747. Ionisation of Air by Lenard Rays.—Taylor. (*Journ. of Res. of Nat. Bur. of Stds.*, Sept. 1936, Vol. 17, No. 3, pp. 483–490.)

748. Electric Birefringence of Liquid Nitrogen and Oxygen [Experimental Results differ from Those calculated by Langevin's Theory from Data in Gaseous State].—Guillien. (*Physica*, No. 1936, Vol. 3, No. 9, pp. 895–903: in French.) For a paper by Keesom & Guillien on mixtures of liquid nitrogen and oxygen see *ibid.*, pp. 939–946.

MISCELLANEOUS

749. Fractional Calculus [Properties of Fractional Integral with Infinite Lower Limit of Integration].—Fabian. (*Phil. Mag.*, Dec. 1936, Vol. 22, No. 151. pp. 1108–1116.) *See* also 351 & 1633 of 1936.

750. A Solution of Current Distribution on Any Section by Integral Equation.—Sakamoto. (*Journ. I.E.E. Japan*, Aug. 1936, pp. 895–897: Japanese only.)

751. Approximation to Periodic Functions by Trigonometrical Polynomials [Optimum Errors for Given Mode of Approximation].—Favard. (*Comptes Rendus*, 30th Nov. 1936, Vol. 203, No. 22, pp. 1112–1124.) For a previous Note, on Tchebicheff polynomials, *see* 3267 of 1935.

752. The Superposition of Two Sine Curves [Irregular Distribution along Time Axis of Intervals during which Sum of Two Sine Curves of Incommensurable Frequency is greater than a Certain Limit].—Hostinský. (*Comptes Rendus*, 9th Nov. 1936, Vol. 203, No. 19, pp. 918–919.)

753. On the Recurrence Formulae of the Lamé Functions of Different Degrees [found by Method applicable to All Functions occurring in Harmonic Analysis].—Sharma. (*Phil. Mag.*, Dec. 1936, Series 7, Vol. 22, No. 151, pp. 1123–1129.)

754. Significant Figures in Statistical Constants [Argument as to Practical Rule].—Roessler & others. (*Science*, 13th and 27th Nov. 1936, p. 437 and 483–484.)

755. Certain Vibration Problems solved by means of an Analogous Problem in Heat Conduction [Mathematical Method].—Green. (*Phil. Mag.*, Dec. 1936, Series 7, Vol. 22, No. 151, pp. 1079–1088.) *See* also 31 of 1935.

756. Early Steps towards Radio [including Dolbear's 1882 and Hughes's 1879 Experiments using Hertzian Waves].—(*World-Radio*, 13th Nov. 1936, Vol. 22, p. 12.)

757. Which are the Short Waves? [Suggested More Rigid Classification].—Devereux. (*Wireless World*, 30th Oct. 1936, Vol. 39, pp. 444–446.)

758. National Socialist Patent Law.—Möller. (*Funktech. Monatshefte*, Oct. 1936, No. 10, pp. 364–365.)

759. "Wireless Engineering" [Book Review].—Palmer. (*Journ. Scient. Instr.*, Dec. 1936, Vol. 13, No. 12, p. 425.)

760. " PRINCIPLES OF RADIO ENGINEERING " [Book Review].—Glasgow. (*Electronics*, Sept. 1936, Vol. 9, No. 9, p. 32.)

761. CIRCUITS FOR POLITICS [P.A., etc., System designed by Engineering Staff of Republican National Committee].—Rahmel & Warriner. (*Electronics*, Sept. 1936, Vol. 9, No. 9, pp. 12–14.)

762. THE STORY OF THE BELL TELEPHONE LABORATORIES.—(*Electronics*, Sept. 1936, Vol. 9, No. 9, 16 pp.)

763. THE ACTIVITIES OF THE PHYSIKALISCH-TECHNISCHE REICHSANSTALT IN 1935.—Erk. (*Zeitschr. V.D.I.*, 19th Sept. 1936, Vol. 80, pp. 1150–1152.)

764. THE FOREIGN WIRELESS EXHIBITIONS [Remarks on Radiolympia and Berlin.]—(*L'Onde Élec.*, Nov. 1936, Vol. 15, No. 179, pp. 721–728.)

765. THE 13TH GREAT BERLIN RADIO EXHIBITION.—(*Funktech. Monatshefte*, Sept. & Oct. 1936, Nos. 9 & 10, pp. 321–333 & 365–370.) For a *Wireless World* account of this exhibition *see* 4302 of 1936.

766. THE 13TH GREAT GERMAN RADIO EXHIBITION, BERLIN 1936 [Illustrated Notes on Latest Types of Receiver, Television, etc.].—Krawinkel. (*E.T.Z.*, 8th Oct. 1936, Vol. 57, No. 41, pp. 1169–1171.)

767. THE 13TH INTERNATIONAL WIRELESS EXHIBITION, PARIS.—Adam. (*Génie Civil*, 3rd Oct. 1936, Vol. 109, pp. 277–281.)

768. THE 14TH SALON OF WIRELESS [Paris Autumn Exhibition].—(*L'Onde Élec.*, Nov. 1936, Vol. 15, No. 179, pp. 675–720.)

769. NEW YORK RADIO SHOW.—(*Wireless World*, 6th Nov. 1936, Vol. 39, pp. 480–482.)

770. WIRELESS EXPORTS: SOME INTERESTING FACTS REVEALED BY AN EXAMINATION OF OFFICIAL FIGURES.—(*World-Radio*, 9th Oct. 1936, Vol. 23, p. 8.)

771. THE YEAR'S PROGRESS [in Wireless Communication].—Chetwode Crawley. (*Wireless World*, 25th Dec. 1936, Vol. 39, pp. 662–664.)

772. PAPERS PRESENTED TO THE 3RD CONGRESS OF THE ENGINEERING SOCIETY OF JAPAN (ELECTRICAL SECTIONS), APRIL, 1936.—(*Journ. I.E.E. Japan*, May, 1936, Vol. 56, [No. 5], No. 574: list in English pp. 29–36, summaries in Japanese only.)

773. AN INTERNATIONAL RADIO VOCABULARY [Advance Announcement of First Edition of " The International Electrotechnical Vocabulary "].—(*Wireless Engineer*, Dec. 1936, Vol. 13, No. 159, p. 636.)

774. CHANGES IN SCIENCE EDUCATION URGED BY INDUSTRIAL PHYSICISTS.—(*Sci. News Letter*, 21st Nov. 1936, pp. 334–335.)

775. DRAMA AND RADIO METHODS USED TO DEMONSTRATE SCIENCE.—(*Sci. News Letter*, 21st Nov. 1936, p. 330.)

776. ANOTHER NOTE ON SCIENTIFIC WRITING [and the Importance of a " Contra-Narcissistic " Principle].—Boring. (*Science*, 20th Nov. 1936, pp. 457–459.) Prompted by Urbach's letter (429 of January).

777. ELECTRICAL PHENOMENA IN HUMAN BEINGS AND ANIMALS.—Koch. (*Rev. Gén. de l'Élec.*, 4th July, 1936, Vol. 40, No. 1, pp. 14–16.) Long summary of the German paper dealt with in 379 of 1936.

778. ELECTRICAL STUDIES OF LIVING TISSUE [Data from Frogs not applicable directly to Human Beings: Frog Tissue a Pure Resistance, Human Tissue a Resistance with Relatively High Shunt Capacitance].—Conrad, Haggard and Teare. (*Elec. Engineering*, July, 1936, Vol. 55, No. 7, pp. 768–772.)

779. INFLUENCE OF ELECTRICAL INSULATION ON LIVING CREATURES AND PHYSICO-CHEMICAL PHENOMENA.—Boutaric: Vlès. (*La Nature*, 15th May, 1936, pp. 433–437.) Survey of the researches of Vlès (2891 of 1936).

780. A LOW COST ELECTROCARDIOPHONE FOR TEACHING PURPOSES [using Piezoelectric Microphone].—Rentschler. (*Science*, 26th June, 1936, Vol. 83, pp. 627–628.)

781. CINERADIOGRAPHY [including Its Combination with Electrocardiography]. — Reynolds. (*Journ. I.E.E.*, Oct. 1936, Vol. 79, No. 478, pp. 389–400.) The cover of the camera unit incorporates a source of red radiation directed towards the fluorescent screen in order to " kill " the afterglow (*cf.*, for example, Lewschin & Antonow-Romanowsky, 1934 Abstracts, p. 627).

782. PHYSICAL INSTRUMENTS IN X-RAY AND RADIUM THERAPY.—Mayneord. (*Journ. Scient. Instr.*, Aug. 1936, Vol. 13, No. 8, pp. 245–251.)

783. ENGLISH TRANSLATIONS OF GERMAN BOOKS ON SHORT-WAVE THERAPY [Notices].—Schliephake: Holzer & Weissenberg. (*Electronics*, Sept. 1936, Vol. 9, No. 9, p. 68.)

783 *bis*. " ELECTRICITY IN THERAPEUTICS " [Book Review].—Cross. (*Electrician*, 25th Dec. 1936, Vol. 117, p. 790.)

784. " PHYSIK UND TECHNIK DER ULTRAKURZEN WELLEN ": VOLS. I AND II [Book Reviews]. Hollmann. (*Electrician*, 11th Sept. & 16th Oct. 1936, Vol. 117, pp. 306 & 467.)

785. ACTION OF ULTRA-SHORT RADIO WAVES ON BACTERIA & INSECTS [Bibliography].—(*Science Library Bibliographical Series*, No. 259, 1936: at Science Library, Science Museum, South Kensington, London.)

786. THE APPARATUS OF ELECTRO-MEDICINE.—Nitka. (*Zeitschr. V.D.I.*, 19th Sept. 1936, Vol. 80, pp. 1153–1158.)

787. NON-THERMAL EFFECTS OF ELECTRICAL OSCILLATIONS ON COLLOIDS [Calculations of Induction Forces between Dipoles and Multipoles: Biological Effects].—Krasny-Ergen. (*Hochf:tech. u. Elek:akus.*, Oct. 1936, Vol. 48, No. 4, pp. 126–133.) *See* also 3732 of 1935 and 382 of 1936. *Also* 793, below.

788. ELECTROLYTIC PROCESSES IN THE BODY AS THE CAUSE OF DEATH IN ELECTRIC SHOCK FATALITIES.—von Holstein-Rathlou. (*E.T.Z.*, 12th Nov. 1936, Vol. 57, No. 46, p. 1335: Book Review.)

789. A POSSIBLE CORRELATION BETWEEN THE INTENSITY OF COSMIC RAYS AND THE SPEED OF CERTAIN CHEMICAL REACTIONS.—Reboul. (*Comptes Rendus*, 20th July, 1936, Vol. 203, pp. 245–246.)

790. THE RADIOACTIVE PHENOMENA OF SECOND ORDER AND ARTIFICIAL ORIGIN REPORTED BY REBOUL [Photographic and Other Effects are due to Formation & Action of Ozone, not to Radiation].—Eichenberger: Reboul. (*Helvet. Phys. Acta*, Fasc. 6, Vol. 9, 1936, pp. 467–489: in French.) Confirmed by Fierz, *ibid.*, pp. 490–491.

791. LIBERATION OF ELECTRICAL ENERGY BY MELTING ELECTRETS.—Frei & Groetzinger. (*Physik. Zeitschr.*, 15th Oct. 1936, Vol. 37, No. 20, pp. 720–724.)

792. THE PERMANENT POLARISATION OF ELECTRETS [Conditions for Depolarisation: Effect of Melting, H.F. Fields, etc.].—Groetzinger & Kretsch. (*Zeitschr. f. Physik*, No. 5/6, Vol. 103, 1936, pp. 337–349.)

793. TWO CONDUCTING, INSULATED SPHERES IN A HOMOGENEOUS ELECTRIC FIELD [Calculation of Field and Energy: Spheres tend to Position in which Line joining Centres is Parallel to External Field: This explains Formation of " Strings of Pearls " by Colloid Particles in Short-Wave Fields].—Krasny-Ergen. (*Ann. der Physik*, Series 5, No. 5, Vol. 27, 1936, pp. 459–471.) *Cf.* 787.

794. THE LIFE OF VALVES IN INDUSTRIAL DEVICES [15–20 Thousand Hours].—Fairchild. (*Electronics*, Sept. 1936, Vol. 9, No. 9, p. 11.)

795. A NEW RUSSIAN JOURNAL, "*Automatics & Telemechanics*" [in Russian].—(Published by the Academy of Sciences of the U.S.S.R., Mal Xarutonevsky per., d.4, Moscow: six times yearly.)

796. THE " BAUKASTEN " [" Kit Set "] PRINCIPLE IN THE DESIGN OF TELEMETERING DEVICES [Suggestion of Universal Device for Telemetering and Control, built up of Separate Elements to suit Different Working Conditions].—Gavrilov. (*Automatics & Telemechanics* [in Russian], No. 2, 1936, pp. 11–19.)

797. THE USE OF ELECTRON TUBES IN TELEMECHANICS [Cathode Ray as Inertia-less Selector and Contactor: Special Designs].—Petrov & Solenik. (*Automatics & Telemechanics* [in Russian], No. 2, 1936, pp. 21–30.)

798. GRID GLOW TUBE MEASURES COMMUTATOR ROUGHNESS.—Harrison. (*Electronics*, Sept. 1936, Vol. 9, No. 9, p. 59.)

799. ELECTRONIC VOLTAGE REGULATOR FOR LAMP TESTING [Accuracy within ± 0.1%].—Brady & Bernhardt. (*Electronics*, Sept. 1936, Vol. 9, No. 9, pp. 36, 38 and 40.)

800. ELECTRO-MAGNETIC DEVICE FOR LOCATING BROKEN NEEDLES IN RUGS AND CARPETS.—(*Gen. Elec. Review*, Oct. 1936, Vol. 39, No. 10, p. 511.)

801. THE ELECTRICAL RESISTANCE OF WOOD AND ITS VARIATION WITH MOISTURE CONTENT.—Narayanamurti. (*Current Science*, Bangalore, Aug. 1936, Vol. 5, No. 2, pp. 79–80.)

802. VIBRATION-MEASURING PROCESSES AND THEIR APPLICATION IN PRACTICE [Survey].—Koch & Zeller. (*Zeitschr. V.D.I.*, 28th Nov. 1936, Vol. 80, No. 48, pp. 1440–1446.) Including the Rentlinger electro-magnetic vibrometer and the Teleos equipment with " spark " recorder.

803. PIEZOELECTRIC VIBRATION-METER AND ITS USE FOR THE DETECTION OF BEARING VIBRATION [in testing Turbo-Generator Rotors].—Mason & Ray. (*Electrician*, 6th Nov. 1936, Vol. 117, pp. 565–567.)

804. VIBRATION INVESTIGATIONS ON ROLLER-GRINDING MACHINES [using the Temme Electro-Magnetic Vibrometer].—Emicke & Benad. (*Zeitschr. V.D.I.*, 19th Sept. 1936, Vol. 80, pp. 1159–1162.)

805. NEW METHOD FOR MEASUREMENT OF SLIP [depending on Beats between Alternating Currents connected to Slipping Systems].—Schmieder. (*E.T.Z.*, 15th Oct. 1936, Vol. 57, No. 42, pp. 1201–1204.)

806. UNUSUAL APPLICATIONS OF THE CATHODE-RAY TUBE.—Reyner. (*Wireless World*, 2nd Oct. 1936, Vol. 39, pp. 356–358.)

807. IN OTHER FIELDS [Use of Valves and Gas-Filled Relays in Non-Radio Branches of Science and Industry].—Henderson. (*Wireless World*, 20th & 27th Nov. 1936, Vol. 39, pp. 525–527 & 582–583.)

808. WELDING WITH THYRATRON CONTROL.—Carter. (*Wireless World*, 9th Oct. 1936, Vol. 39, p. 391.)

809. APPLICATION OF WIRELESS RECEPTION MEASUREMENT BY THE ABSORPTION METHOD [to Geological Investigations in Caverns, Mines, &c.].—V. Fritsch. (*E.T.Z.*, 15th Oct. 1936, Vol. 57, No. 42, pp. 1204–1205.)

For previous work *see* 4271/3 of 1936. A short description is here given of the determination of the constitution of caverns, mines, etc. from measurements of the frequency variation of the extinction coefficient.

810. DOWSING FOR CABLE [with Exploring Coil and Headphone Amplifier].—Crisfield. (*Bell Lab. Record*, Aug. 1936, Vol. 14, No. 12, pp. 383–386.)

811. INDICATORS FOR HIGH-SPEED INTERNAL-COMBUSTION MOTORS [Survey].—Meurer. (*Zeitschr. V.D.I.*, 28th Nov. 1936, Vol. 80, No. 48, pp. 1447–1454.)

812. THE DEVELOPMENT OF MEASURING PROCESSES IN METALLURGY.—Scheil. (*Zeitschr. V.D.I.*, 28th Nov. 1936, Vol. 80, No. 48, pp. 1466–1468.)

813. To test Prison Bars [Soft Steel with Inserts of Hardened Steel] by their Magnetic Behaviour.—Sanford. (*Sci. News Letter*, 21st Nov. 1936, p. 329.)

814. Investigations using the Magneto-Optical Kerr Effect [Investigations on Magnetite, Polycrystalline Nickel, Samples of Technical and Elastically Deformed Iron and Nickel, etc.).—Zapf. (*Ann. der Physik*, Series 5, No. 6, Vol. 27, 1936, pp. 477–506.)

815. Twin Microphones quickly test Accuracy of Watches.—Tamm. (*Sci. News Letter*, 21st Nov. 1936, p. 329.) *See* also 2142 & 3748 of 1935.

816. "The Electron-Beam Sectrometer for Potentiometric Titrations."—Smith & Sullivan. (At Patent Office Library, London: Cat. No. 76 851 : 40 pp.)

817. Uniformity as the Gauge of Quality [*e.g.* in Valves and Photocells].—Paterson. (*Journ. I.E.E.*, Dec. 1936, Vol. 79, No. 480, pp. 655–666.)

818. Portable Photoelectric Daylight-Factor Meter.—Barnard. (*Journ. Scient. Instr.*, Dec. 1936, Vol. 13, No. 12, pp. 392–403.) Developed at the N.P.L.

819. Radiation Measurements in the Ultra-Violet with the [Selenium] Barrier-Layer Cell [and the Use of Glass and Liquid Filters in a Practical Apparatus].—Krefft & Rössler. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 17, 1936, pp. 479–481.)

820. A Photoelectric Spectrophotometer of High Accuracy.—J. S. Preston & F. W. Cuckow. (*Proc. Phys. Soc.*, 1st Nov. 1936, Vol. 48, Part 6, No. 269, pp. 869–880.)

821. A New Spectrophotometer and Some of Its Applications [Precision Instrument for Industrial Uses].—Michaelson & Liebhafsky. (*Gen. Elec. Review*, Sept. 1936, Vol. 39, No. 9, pp. 445–450.)

822. A Contouring Density Comparator, *and* The Measurement of Non-Uniform Brightness by Photographic Photometry.—Waldram : Bloch. (*Journ. Scient. Instr.*, Nov. 1936, Vol. 13, No. 11, pp. 352–357 : pp. 358–364.)

823. Photocells Type L.M.T. and Their Applications in Photometry.—(*Génie Civil*, 12th Sept. 1936, Vol. 109, pp. 229–230.)

824. The Barrier-Layer Photoelectric Cell in Photoelectric Photometry [and the Errors depending on Direction of Electric Vector with respect to Plane of Incidence].—Smith & others. (*Review Scient. Instr.*, Nov. 1936, Vol. 7, No. 11, pp. 433–434.)

825. The Photo-Relay and Counter of the Leningrad Section of the Institute of Telemechanics and Communications.—Vlodavsky & Bajda. (*Izvestiya Elektroprom. Slab. Toka*, No. 8/9, 1936, pp. 56–65.)

826. Chemical Applications of Photocells [Description of Various Types: Photocells not always Best Solution to Industrial Problems].—Walters. (*Electronics*, Sept. 1936, Vol. 9, No. 9, p. 74 : summary only.)

827. Determining Probability Curves by Photoelectric Integration of Light Impulses [for Textile Yarn Analysis, etc.].—Saxl. (*Review Scient. Instr.*, Nov. 1936, Vol. 7, No. 11, pp. 429–432.)

828. "Phénomènes Photoélectriques et Leurs Applications" [Book Review].—Boutry. (*Review Scient. Instr.*, Oct. 1936, Vol. 7, No. 10, pp. 378–379.)

829. Photoelectric Cells [particularly for Industrial Purposes: Amplification, Trigger, and Other Circuits: Various Applications].—Walker. (*G.E.C. Journ.*, Nov. 1936, Vol. 7, No. 4, pp. 249–261.) Including level control in coffee packing, escalator speed regulation, and billet handling in rolling mills.

830. The Photocell "Aligning Equipment" of the Kincardine-on-Forth Bridge.—Emms & Rogerson. (*G.E.C. Journ.*, Nov. 1936, Vol. 7, No. 4, pp. 245–247.)

831. Photocell Correction Filter ["Viscor" Filter, giving Weston "Photronic" Cell a Sensitivity Curve almost Identical with Average Eye].—(*Journ. Scient. Instr.*, Oct. 1936, Vol. 13, No. 10, pp. 338–339.) It also tends to retard the heating of the cell.

832. "Nervous System" [Photocell with Zworykin Electron Multiplier] guides Eye of Telescope.—Whitford & Kron. (*Sci. News Letter*, 28th Nov. 1936, p. 343.)

833. Patent for Automatic "Electric Eye" Camera granted to Dr. Albert Einstein. (*Science*, 4th Dec. 1936, Supp. p. 8.)

834. The Photoelectric Pyrometer.—King. (*Gen. Elec. Review*, Nov. 1936, Vol. 39, No. 11, pp. 526–533.)

835. Variation of the Dielectric Constant of Silver Bromide under Illumination.—Martens. (*See* 611.)

836. The Present Position in Telemetering.—Pflier. (*Zeitschr. V.D.I.*, 28th Nov. 1936, Vol. 80, No. 48, pp. 1461–1465.)

837. Measurements at a Distance [Survey of Telemetering].—Garkusha. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1936, pp. 56–67.) Concluded from Nos. 2 & 3, 1936.

838. Carrier Telephony on Long-Distance Lines [Advantages of Carrier Suppression: Equipment of New System Type SMT-35].—Jegorov & others. (*Izvestiya Elektroprom. Slab. Toka*, No. 10, 1936, pp. 36–55.)

839. A New Application of Piezoelectricity: Piezoelectric Recording Manometers and Accelerometers.—Gondet & Beaudouin. (*Génie Civil*, 19th & 26th Dec. 1936, Vol. 109, Nos. 25 & 26, pp. 552–554 & 574–577.)

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. A selection of abstracts from patents issued in the U.S.A. is also included, and these bear a seven-figure serial number.

AERIALS AND AERIAL SYSTEMS

452 791.—Directional aerial systems of the kind in which alternate half-waves are "suppressed" along the radiating element.

A. D. Blumlein. Application date 28th February, 1935.

TRANSMISSION CIRCUITS AND APPARATUS

450 810.—Automatic "repeater" stations for relaying short-wave signals.

Standard Telephones & Cables (assignees of A. B. Crawford). Convention date (U.S.A.) 24th May, 1935.

450 863.—Method of determining the number of loud speakers connected at any given time to a wired-wireless service-line.

British Thomson-Houston Co.; G. S. C. Lucas; and E. S. Hall. Application date 24th January, 1935.

451 237.—Transmitting system in which the mean amplitude of the radiated carrier is determined by the strength of the applied speech and *syllable* voltages.

Standard Telephones and Cables; C. E. Strong and F. C. McLean. Application date 1st February, 1935.

453 501.—Modulator in which the mean carrier-wave amplitude is kept constant in spite of fluctuations in the applied signal strength.

Marconi's W.T. Co. and W. T. Ditcham. Application date 11th March, 1935.

453 732.—Modulating system in which the intensity of the carrier wave is varied in accordance with the intensity of the applied L.F. signals.

British Thomson-Houston Co. Convention date (U.S.A.) 4th October, 1934.

453 922.—Valve circuit for producing oscillations of any frequency within a predetermined range, and for measuring the frequency of oscillations produced by an external source.

British Thomson-Houston Co. Convention date (U.S.A.) 24th March, 1934.

2 030 125.—Producing frequency-modulated signals by means of two LINE-controlled oscillation-generators operated in push-pull on opposite sides of a mean frequency.

G. L. Usselman (assignor to Radio Corporation of America).

2 034 735.—Short-wave oscillation generators with means for preventing frequency "drift."

B. J. Witt and C. S. Franklin (assignors to Radio Corporation of America).

2 034 899.—Transmitter in which modulation is effected by the "series" method, with low internal capacity and high amplification.

W. T. Ditcham (assignor to Radio Corporation of America).

RECEPTION CIRCUITS AND APPARATUS

450 520.—Feed-line for the remote tuning-control of broadcast receivers.

Marconi's W.T. Co. and N. M. Rust. Application date 25th January, 1935.

451 223.—Remote tuning control system with a magnetic braking device for wireless receivers.

A. H. Cooper. Application date 30th January, 1935.

451 227.—Variable selectivity circuit which is controlled by the relative strengths of the desired signal and adjacent interference.

General Electric Co.; N. R. Bligh; and C. N. Smyth. Application date 31st January, 1935.

451 301.—Band-pass input circuit designed to balance-out local interference.

E. K. Cole and G. Bradfield. Application date 26th April, 1935.

451 346.—Means for simplifying the tuning of a receiver fitted with a "noise suppressing" circuit, applicable also for remote control.

Marconi's W.T. Co. (assignees of L. E. Barton). Convention dates (U.S.A.) 1st December, 1933, *and 28th February,* 1934.

451 661.—Thermionic amplifier in which a dynatron effect is utilised to secure a straight-line relation between input and output.

Standard Telephones and Cables. W. T. Gibson, D. H. Black, and W. Lawrence. Application date 8th February, 1935.

452 107.—Suppressor circuit for eliminating local interference from broadcast receivers.

N. V. Philips' Co. Convention date (Germany) 14th May, 1935.

452 585.—Wireless receiver with automatic tuning control which is restrained from coming into operation except within narrow limits.

Marconi's W.T. Co. (assignees of G. L. Beers). Convention date (U.S.A) 23rd February, 1934.

453 140.—Tuning indicator for wireless receivers comprising a carriage which runs along a track with provision for rough and fine adjustment.

General Electric Co.; S. G. Hunter; and W. H. Peters. Application date 5th March, 1935.

2 034 013.—Pentode valve used as a combined oscillator and modulator or "mixer" valve.

H. A. Wheeler (assignor to Hazeltine Corporation.)

2 034 974.—Superheterodyne circuit adapted to receive a wider frequency range than usual.

W. F. Cotter and M. E. Bond (assignors to United American Bosch Corporation).

VALVES AND THERMIONICS

451 974.—Magnetron short-wave generator of the split-anode type.
N. V. Philips' Co. Convention date (Netherlands) 7th July, 1934.

452 343.—Electrode assembly for a multigrid valve designed to operate with a constant characteristic over a long working life.
Standard Telephones and Cables (assignees of C. Depew and V. L. Ronci). Convention date (U.S.A.) 7th September, 1934.

452 355.—Magnetron valve of the split-anode type with a control electrode located outside the discharge path between cathode and anode.
Telefunken Co. Convention date (Germany) 30th November, 1934.

452 490.—Short-wave valve characterised by the provision of a closed resonance space around the electrodes to enhance the amplification effect.
N. V. "Meaf." Convention date (Germany) 1st March, 1934.

452 541.—Electrode construction for valves having a variable-mu characteristic.
N. V. Philips' Co. Convention date (Holland) 12th December, 1934.

453 167.—Method of testing the emission from the cathode of a thermionic valve.
E. R. Sawyer. Application date 11th March, 1935.

453 243.—Split-anode magnetron valve for transmitting or receiving micro-waves.
Marconi's W.T. Co. (assignees of E. G. Linder). Convention date (U.S.A.) 2nd July, 1934.

455 351.—Form of equi-potential cathode which produces no external magnetic field.
Ferranti and M. K. Taylor. Application date 16th April, 1935.

DIRECTIONAL WIRELESS

452 235.—Method of ascertaining the distance of location of a distant wireless transmitter by measuring the relative phase displacement of the radiated signals.
E. A. H. Honore. Convention date (France) 12th August, 1934.

454 955.—Direction finding system based on the use of a spaced aerial of the Adcock type.
Marconi's W.T. Co. and S. B. Smith. Application date 10th April, 1935.

ACOUSTICS AND AUDIO FREQUENCY CIRCUITS AND APPARATUS

2 029 523.—Tone-compensated volume control designed to reduce the middle and higher frequencies.
L. F. Curtis (assignor to United American Bosch Corporation).

TELEVISION AND PHOTOTELEGRAPHY

451 132.—Television scanning system in which cylindrical lenses sweep the image first over a high-speed rotating mirror-drum and then over a low-speed framing drum.
Scophony and G. W. Walton. Application date 25th April, 1935.

451 451.—Construction of cathode-ray tube designed to facilitate the uniform distribution of fluorescent material on the viewing screen.
Marconi's W.T. Co. (assignees of R. T. Orth). Convention date (U.S.A.) 2nd June, 1934.

451 590.—Means for preventing the formation of static charges on the fluorescent screen of a cathode-ray tube.
Telefunken Co. Convention date (Germany) 2nd February, 1934.

451 663.—Television system in which the amplitude of the transmitted signal remains substantially constant in spite of changes in the general illumination.
J. C. Wilson and Baird Television. Application date 8th February, 1935.

451 670.—Combined sound and television system having a specified frequency spacing between the respective carrier-waves.
Radio-Akt. D. S. Loewe. Convention date (Germany) 9th February and 28th April, 1934.

452 012.—Focusing the beam on a cathode-ray television receiver.
F. H. Nicoll. Application date 13th February, 1935.

452 148.—Method of enlarging the picture produced on the screen of a cathode-ray television receiver.
Marconi's W. T. Co., H. M. Dowsett, and R. Cadzow. Application date 16th January, 1935.

452 368.—Cathode-ray television receiver in which the picture is reproduced by heating the screen to incandescence instead of by using a purely fluorescent effect.
F. S. Turner. Application date 15th February, 1935.

452 583.—Multi-vibrator circuit designed to generate pulses of sharp, narrow wave-form.
Marconi's W.T. Co. and G. M. Wright. Application date 25th February, 1935.

452 844.—Electrode arrangement in a cathode-ray television receiver.
Radio-Akt. D. S. Loewe. Convention date (Germany) 27th November, 1933.

453 043.—Lens arrangement for magnifying the picture reproduced by a cathode-ray television receiver.
Telefunken Co. Convention date (Germany) 30th January, 1935.

453 135.—Television receiver in which the accompanying sound programme is separated out in a circuit of the super-regenerative type.
Marconi's W. T. Co. and A. A. Linsell. Application date 4th March, 1935.

453 499.—Television receiver in which the cathode-ray tube is also used as a tuning indicator.
Marconi's W.T. Co. and A. A. Linsell. Application date 11th March, 1935.

454 937.—Method of forming the photo-sensitive "mosaic" screen or electrode used in certain types of cathode-ray tubes for television.
C. J. Whilems. Application date 8th April, 1935.

455 084.—Electrode system for focusing the electron stream on a cathode-ray tube.
Radio-Akt. D. S. Loewe. Convention date (Germany) 12th January, 1934.

455 375.—Circuit for deriving and controlling the intervals and phase-relation of the frame and line scanning impulses used in receiving television.
E. C. Cork, M. Bowman-Manifold, and C. L. Faudel. Application dates 15th January and 16th August, 1935.

455 555.—Applying signal and synchronising frequencies to a cathode-ray television transmitter of the mosaic-cell type.
J. E. Keyston and L. F. Broadway. Application date 17th April, 1935.

2 032 526.—Television system in which the scanning spot is produced by the intersection of two or more slots in rotating cylinders, set coaxially.
A. J. Cawley.

2 037 711.—Scanning apparatus in which the electronic stream is swept over a large aperture containing a smaller aperture.
P. T. Farnsworth (assignor to Television Laboratories).

2 048 094.—Television receiver in which X-rays produced inside a cathode-ray tube are projected through an external scanning disc on to a large screen.
D. Applebaum.

SUBSIDIARY APPARATUS AND MATERIALS

449 392.—Fluorescent screens for cathode-ray tubes.
A. Carpmael (communicated by the Telefunken Co.). Application date 19th December, 1934.

449 706.—Valve-holder having sockets provided with connecting tags so arranged that the valve can be inserted either from the front or back of the holder.
General Electric Co. and H. C. Hannam-Clark. Application date 20th March, 1935.

449 742.—Interference-suppressing unit for electrical apparatus.
P. A. Sporing and The Telegraph Condenser Co. Application date 23rd December, 1935.

450 278.—Interference-suppressor for the small motors used on domestic labour-saving appliances.
Electrolux (assignees of Akt Elektrolux). Convention date (Germany) 3rd June, 1934.

450 463.—Construction of Kerr Cell of the type in which the electrodes are interleaved.
Marconi's W.T. Co.; R. J. Kemp; and J. J. Mason. Application date 16th January, 1935.

450 549.—Ball-controlled variable resistance suitable for wireless sets.
Marconi's W.T. Co. and W. J. Byrne. Application date 18th January, 1935.

451 178.—Single loud-speaker designed to reproduce the same effect as the usual dual combination.
G. Birkbeck. Application date 29th January, 1935.

451 876.—Kerr cell utilising both the ordinary and extra-ordinary rays in combination with a non-linear polariscope for receiving television.
Marconi's W. T. Co. and L. M. Myers. Application date 26th April, 1935.

451 984.—Moving-coil speaker fitted with dust-proof cover at the junction of the diaphragm and driving coil.
E. K. Cole and A. E. Falcus. Application date 19th June, 1935.

452 016.—Adjustable condenser of the kind comprising two cylindrical arenate members.
Murphy Radio and A. Shackell. Application date 14th February, 1934.

452 188.—High-frequency tuning-coil with means for varying the gap between the ends of an annular powdered-iron core.
E. Michaelis. Convention date (Germany) 28th December, 1934.

453 068.—Microphone construction, particularly suitable for public-address systems.
A. Graham & Co. and C. H. Vaughan. Application date 7th May, 1935.

454 873.—High-frequency coupling device comprising two differently-tuned circuits with an adjustable core of finely-powdered particles.
Johnson Laboratories Inc. (assignees of H. E. Meinema). Convention date (U.S.A.) 10th April, 1934.

455 208.—Moving-coil loud speaker fitted with several diaphragms of different sizes arranged on a common axis but separately driven.
J. Sharp and J. F. McGrath. Application date 15th January, 1935.

455 267.—AC mains supply unit particularly adapted for use with cathode-ray tubes.
Radio-Akt. D. S. Loewe. Convention date (Germany) 19th May, 1934.

2 029 729.—Piezo-electric crystal which is cut so that the electric axis is equal to one other axis but unequal to the third axis so as to reduce the number of fundamental frequencies.
R. Lucas (assignor to Cie Generale de T.S.F.).

2 030 235.—Optical valve comprising a doubly-refracting prism suitable for use in television.
G. W. Walton.

MISCELLANEOUS

452 236.—Cutting piezo-electric crystal oscillators so that their temperature coefficient is substantially zero.
Telefunken Co. Convention date (Germany) 10th August, 1934.

452 779.—Construction of air-spaced cables for transmitting wide frequency-bands.
Standard Telephones and Cables, W. K. Weston, D. Nunn, and M. C. Field. Application date 27th February, 1935.

454 826.—Dry-surface rectifier unit designed to take the place of a thermionic valve.
N. V. Philips' Co. Convention date (Germany) 9th March, 1935.

455 497.—Generating relaxation oscillations under the control of an applied frequency.
E. L. C. White. Application date 21st March, 1935.

455 899.—Photo-sensitive surfaces suitable for light cells and for the sensitive electrodes of cathode-ray tubes.
W. Heimann.