THE
WIRELESS
ENGINEER
AND
EXPERIMENTAL WIRELESS

Vol. XII. MAY, 1935 No. 140

Editorial

The Glow Discharge Potential Divider

IN October a paper was read before the Elektrotechnischer Verein in Berlin, on an interesting type of potential divider which has been specially developed to supply suitable voltages to the various stages of a wireless receiver, but which has many other applications. In addition to providing two or three alternative voltages it acts as a voltage regulator, giving a very constant output voltage, although the supply voltage may be fluctuating. It is stated that the output voltage does not vary more than ± 0.2 per cent. when the supply voltage varies as much as ± 10 per cent., and that it falls about 1 or 2 per cent. as the load is increased from zero to full load. It thus has some of the advantages of a battery of accumulators as a source of supply without the disadvantage of the fall of voltage during discharge. The name " stabilisator " which has been given to the device suggests its voltage regulating properties rather than its potential dividing capabilities. It consists of a number of glow-discharge gaps in series across the supply voltage, which in most cases will be the output of a rectifier and smoothing unit. The gaps are mounted in a glass tube, which contains gas at a pressure of a few centimetres of mercury. The electrodes are of iron, which is coated with some special material. Each intermediate electrode serves as the cathode of one gap and the anode of the next.

Once the striking p.d. has been reached the current which flows is mainly due to ionisation of the gas molecules by collision with the accelerating electrons, and this current, being thus a cumulative effect, is very sensitive to small changes in the accelerating p.d. This is shown by the characteristic curve in Fig. 1. On the p.d. reaching the value OA the current commences to flow and the p.d. falls to OB; the curve which gives the p.d. necessary to maintain various currents through the gap, has a small slope, and except for small currents is approximately a straight line which, if produced backwards, cuts the zero ordinate at the point C. The ordinate OC may be regarded as a back e.m.f. and the p.d. across the gap is given by the formula $V = E + Ir$, where E is the back e.m.f. and r is the a.c. resistance of the gap.

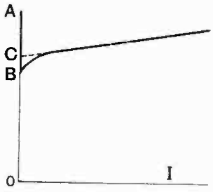


Fig. 1.

This a.c. resistance lies between 10 and 50 ohms, but increases with the frequency so that it reaches double its initial value at a frequency of about 3,000 cycles per second. By connecting condensers of 2 or 3 μF across the gaps, however, the impedance can be kept down to about 50 ohms at all frequencies.

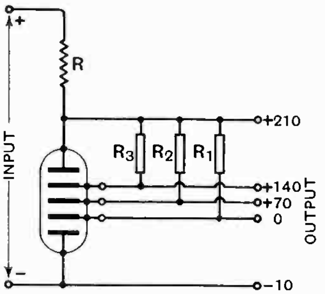


Fig. 2.

Fig. 2 shows a stabilisator containg 4 gaps in series, and Fig. 3 shows the equivalent circuit diagram in which each gap is replaced by a back e.m.f. and a resistance. A series ballast resistance R is essential to prevent the destruction of the tube and the drop of voltage across it must be at least a third of the total supply voltage when carrying the full-load current, including that taken by the tube itself, which is about 10 to 15 mA.

The slope of the characteristic is shown exaggerated in Fig. 1; in reality a destructively large current would flow before the ordinate of the characteristic reached a value equal to the striking voltage OA. If the supply voltage goes up, the current through the ballast resistance and the tube increases, causing an increased drop of voltage across R, but, as Fig. 1 shows, a very small increase of voltage across the tube. In fact, the fluctuation across the tube, or across any section of the tube, is equal to that across the ballast resistance reduced in the ratio r/R, where r refers to the part considered. To the apparatus being fed from the tube it functions as a source of low a.c. resistance. The high resistances R_1, R_2, R_3 in Fig. 2 are striking resistances. On switching on the supply voltage, the full p.d. is applied *via* R_1 to the bottom gap, and then when it breaks down, *via* R_2 to the next gap, and so on. The disadvantage of having the loss of a third or more of the supply voltage across the ballast resistance can be reduced in the same way as was done in the case of the Nernst lamp, viz., by using an iron wire run at a high temperature in a tube containing hydrogen. Up to a certain temperature the resistance increases slowly and the curve of p.d. plotted against the current shows a gradual rise approximating to a straight line through the origin. When the temperature reaches the critical point the iron undergoes a change and any further increase of the current causes a rapid increase of the resistance and p.d., so that the p.d. is trebled for a relatively small increase of the current, as shown in Fig. 4. If the normal working current is taken as that of the mid-point of this narrow range, the p.d. can be varied ± 50 per cent. for a current variation of ± 8 per cent. The use of such a resistance in place of an ordinary resistance not only allows the same stability to be obtained with a smaller loss of voltage, but also adds greatly to the elimination of voltage fluctuations in the output. As, however, the action of the ballast resistance depends on temperature changes, there will be a thermal lag which would cause it to be less effective against rapid fluctuations, but these should be eliminated by the ordinary smoothing devices.

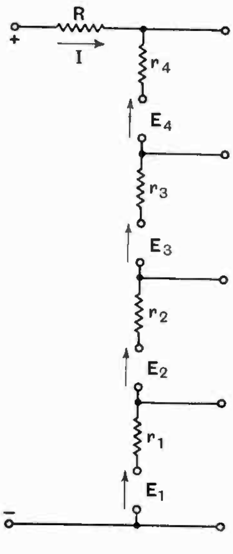


Fig. 3.

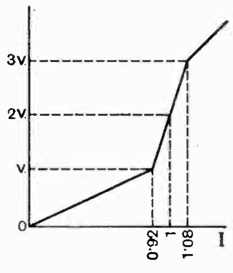


Fig. 4.

Where very great constancy of voltage is required, two stabilisators can be used, the output from the first feeding into the second through a second ballast resistance. A small voltage of great constancy can be obtained from a single tube by using a part of it as the first stabilisator, and another part of it as the second, as shown in Fig. 5, where the upper three gaps form the first element, the output from which is supplied through the ballast resistance BR_2 to the bottom electrode which forms the anode of the second element which consists of the bottom gap alone.

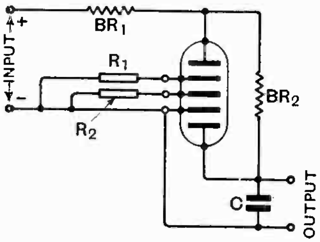


Fig. 5.

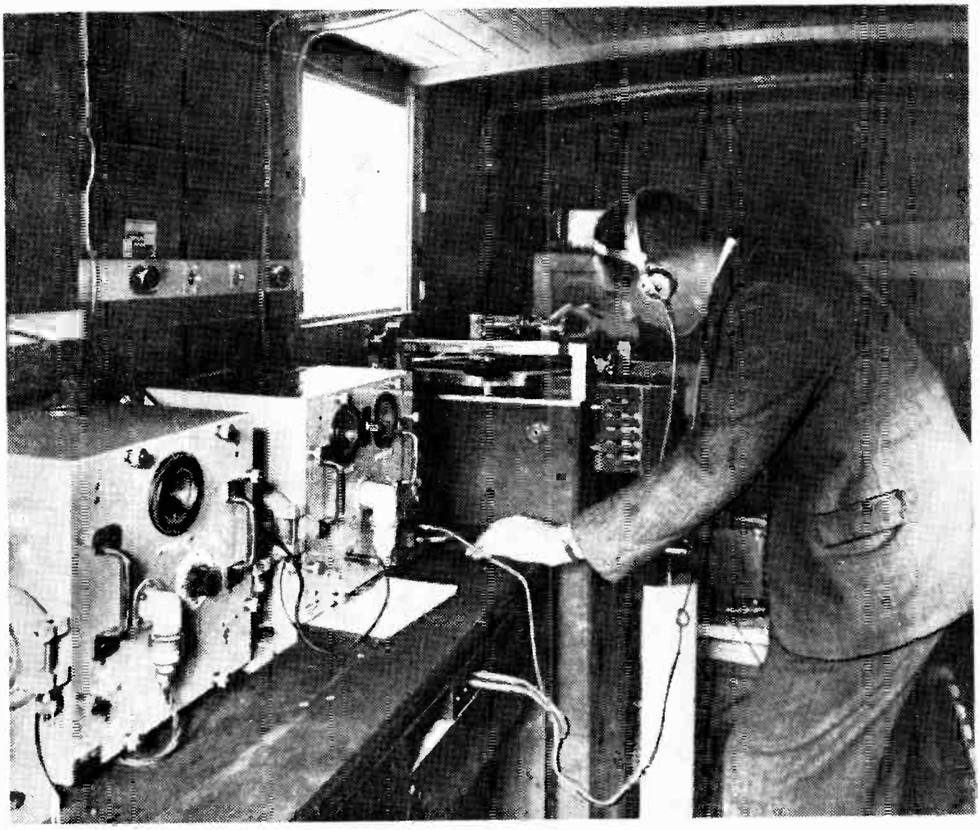
This device has many obvious applications where a moderate or small supply of power is required at a very constant voltage, such, for example, as in the case of the master oscillator of a transmitting station.

G. W. O. H.

The Damping of Ultra-short Waves

IN the April Editorial it was stated that the field strength had to be multiplied by a factor $e^{-\alpha d_1}$, where d_1 is the amount by which the total distance d exceeds the visible distance. It should have been stated that in this formula d_1 is in *kilometres*, whereas in the other formulae which were given the distances are expressed in metres.

G. W. O. H.



A view in the B.B.C.'s new recording van. Records are taken of ceremonial and sporting events for subsequent broadcasting in the news bulletins or dramatic programmes.

Incremental Magnetisation*

Experiments upon Stalloy

By L. G. A. Sims, Ph.D., M.I.E.E., and D. L. Clay, B.Sc., Hons.

Introduction

THE evolution of a satisfactory method of measuring the properties of iron when subjected to combined D.C. and A.C. excitation had received attention in the Electrical Department of the University of Birmingham for several years. Following a number of experiments using different methods of measurement, the inherent difficulties (not the least of which is waveform error) were appreciated and a logical line of attack was formulated. Attention was first devoted to the part played by harmonics and eddy currents and their effects were studied with A.C. excitation alone. A series of careful experiments was made the results of which have already been published.† Based upon the experience gained, a solution to the more difficult problem of measurements with excitation by combined D.C. and A.C. was decided upon and the lines of reasoning by which this solution was separated out as superior to others were published recently‡ in conjunction with a short paper upon the analysis of the harmonics of incremental magnetisation.§ The present authors then began a series of precision experiments upon a sample of Stalloy magnetised by combined A.C. and D.C. These experiments were primarily intended to test thoroughly the method of measurement which had been evolved, but, at the same time, information upon the Stalloy sample was automatically obtained. The results set forth below have, therefore, a double purpose.

Before describing the results, a brief *résumé* of the reasons for adopting the method of measurement concerned will be of assistance. It is necessary to recall that however pure the source of power may be, the process of magnetising iron cyclically produces in general appreciable distortion of waveform and therefore appreciable harmonics. Further, if polarisation of the iron occurs (but only under this condition), even as well as odd harmonics are produced.|| Again, if true (as distinct from simulated) A.C. excitation is present then eddy currents are produced, the effects of which are not entirely negligible.¶ A precise method of measurement must take full account of these facts, in addition to dealing flexibly with the circuit problems which follow from the presence of the combined A.C. and D.C.

Ballistic Methods of Measurement.—Results can be obtained by the use of the ballistic galvanometer or fluxmeter. But the A.C. cycle has to be simulated. This appreciably restricts the scope of measurement and its type. For instance, it is difficult to arrange for given increments of flux density although given increments of magnetising force (if not too small in comparison with the steady polarising force), can be produced. This method is most easily applied to tests in which a sinusoidal alternating current is to be simulated.

The method neglects the effects of eddy currents and provides no information concerning losses.

But, despite its disadvantages, it must be accepted as of practical value and some tests employing it are described in the present paper.

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* MS. accepted by the Editor, January, 1935.

† See "On the Theory and Measurement of the Magnetic Properties of Iron," Gall and Sims, *J.I.E.E.*, Vol. 74, No. 449.

‡ See "Incremental Permeability and Inductance: the Rôle of Wave-form in Measurement," Sims, *Wireless Engineer*, Vol. XII, Nos. 136 and 137 (Jan. and Feb., 1935).

§ See "Analysis of Waveforms: Half-period Contact with Waveforms containing Even Harmonics," Sims, *Wireless Engineer*, Vol. XI, No. 131, (Aug., 1934).

|| See "Incremental Permeability and Inductance," *loc. cit.*

¶ See *J.I.E.E.*, *loc. cit.*

Bridge Methods.—Measurements upon incremental magnetisation using the A.C. bridge have been much employed. But the method is inflexible and it fails to provide complete information when waveform distortion is present. Further, it gives no information upon losses.

Rectifying Commutator and D.C. Instrument

Experiments have been described in which the inherent sensitivity of the D.C. moving-coil instrument can be employed by the use of a rectifying commutator. There are grounds for commending this principle but, due to the presence of even harmonics, the commutator should be of special design whereby both variable contact time and variable contact phase are provided.*

Valve Voltmeter Methods

The high input impedance and sensitivity of the valve voltmeter, together with its ability, if suitably designed, to ignore an unwanted steady voltage, are advantages which have special value in this work. But the instrument is susceptible to waveform error and cannot be justifiably adopted when the excitation amplitudes are such as to produce appreciable distortion.

Use of Ammeter, Voltmeter and Wattmeter, as in Epstein Square Test

If the D.C. is introduced in the primary or exciting winding of the test specimen, it must pass through the R.M.S. instruments in that circuit. The A.C. component has therefore to be separated by calculation which becomes inaccurate if the A.C. is small as compared with the D.C. Furthermore, if the sample is small, corrections become necessary for the losses in the instruments and the accuracy of the result is necessarily not of the first order.

An alternative is to employ A.C. only in one exciting winding, polarising the core by means of D.C. introduced into a secondary winding. Two difficulties arise here. The secondary winding has, by transformer action, an A.C. voltage induced within it, and if this is permitted to drive A.C. into the D.C. exciting circuit, corrections must be made. Alternatively, the secondary winding can be so loaded with resistance that the A.C. it produces is negligibly small. This then, calls for correspondingly high D.C. voltage to drive the required D.C. into the secondary winding and the voltage may be so high as to present a serious problem.

From early experiments upon this method it can be stated that it is fraught with difficulty if accuracy is to be secured.†

Nevertheless, if information is needed upon R.M.S. conditions, one of the above alternatives must be adopted.

Requirements to be Fulfilled

It is desirable that the apparatus adopted should conform with the following requirements:

(*a*) Measure accurately both A.C. and D.C. quantities in the exciting circuit.

(*b*) Take account of waveform distortion.

(*c*) Measure loss, including eddy current loss.

(*d*) Be very flexible.

(*e*) Provide information upon R.M.S. values.

(*f*) Preferably provide information upon harmonics.

(*g*) Enable a sinusoidal voltage to be maintained at the terminals of the test coil: alternatively enable a sinusoidal current to be maintained within the coil.

Desideratum (*g*) is necessary in order to avoid the introduction of harmonic losses in the test iron.

Conditions (*a*), (*c*), (*d*) and (*g*) can best be met by a potentiometer suitable for use with D.C. and A.C. This type of instrument is not only extremely flexible so that current may be measured (indirectly by means of the voltage developed across a shunt) with the least possible disturbance of waveform but it also measures phase angle and therefore losses. But to measure without delay both A.C. and D.C. quantities requires a potentiometer of great versatility. The Gall

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* See "Incremental Permeability and Inductance," *loc. cit.*

† If chokes are used instead of resistance to limit the A.C. without raising the circuit resistance appreciably, there are fresh difficulties due to the lowering of the choke inductances by the D.C. and corrections are needed for the iron loss in the chokes. The latter uncertainty is a very undesirable factor.

co-ordinate A.C. and double D.C. potentiometer was adopted for the work.

Conditions (*b*) and (*f*) require the use of a Joubert disc and harmonic analyser, and it was decided to apply an analyser developed by Messrs. H. Tinsley & Co. since this included the required combination of synchronously driven contacts.

Condition (*e*) was met by the inclusion of a substandard indicating multi-range dynamometer ammeter in the exciting circuit. A substandard multi-range moving-coil ammeter was also included for measurement of the direct current, but its readings were only employed for preliminary adjustments, final D.C. measurements being made upon the potentiometer.

Description of Apparatus and Circuit

A simple schematic diagram of the apparatus is shown in Fig. 1. The test ring and search coil are shown as L_{Δ}. This ring was fed with A.C. from a multi-tapped auto-transformer (not shown) which was fed from a 25-kW. alternator. This machine was selected, after tests of its waveform, as being most suitable from the points of view of good wave shape and large output rating, the latter being desirable in order that the waveform should be disturbed as little as possible by changes in the D.C. and A.C. supplies to the test ring. With this machine the maximum demand for the tests was a very small fraction of its rated output. Its waveform was monitored from time to time by oscillograph and its frequency maintained constant.

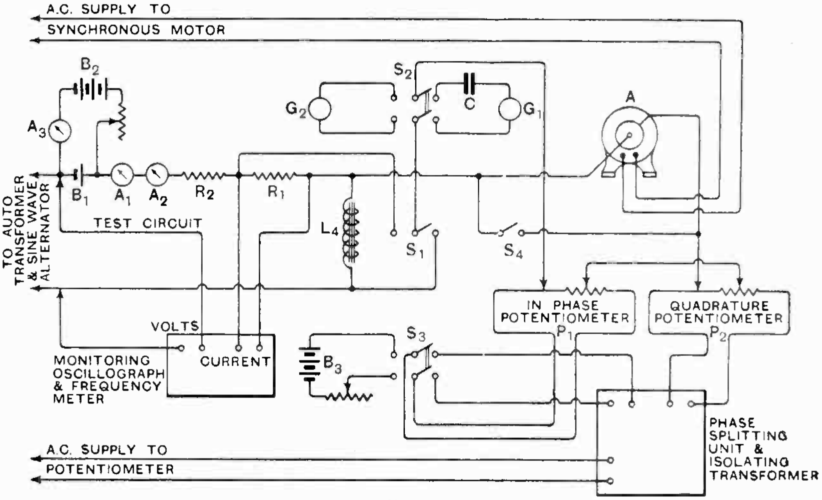

Fig. 1.

Change of A.C. voltage at the test ring terminals was made by altering the tappings upon the auto-transformer in conjunction, if necessary, with small changes in alternator excitation. In no case was variable series resistance employed in the test circuit for this purpose since such a method of control is bound to disturb the waveform at the test ring due to the distorted current taken by the latter. For the same reason armature reaction in the alternator was prevented from disturbing its waveform. This was accomplished not only by the choice of the large alternator already mentioned, but also by maintaining the excitation of the machine at or near to its maximum value.

A certain very small amount of series resistance in the test circuit was inevitable due to the winding resistances of the dynamometer and moving-coil ammeters A_1 and A_2 and the shunt R_1. The voltage across the latter provided the means of measuring by potentiometer the A.C. and D.C. entering the test ring. As changes in the ranges of the meters A_1 and A_2 would have caused comparatively important changes in this low resistance circuit, a compensating resistance of low value (R_2) was included and altered when necessary.

The direct current was fed to the test coil by a low voltage battery B_1. Although the demand upon this was slight yet its fall of voltage during discharge was sufficient to disturb the potentiometer measurements. This effect was counteracted by the provision of a charging circuit $A_3\,B_2$, the charging current being so adjusted that constant D.C., to potentiometer accuracy, flowed in the test circuit.

Before leaving the description of the supplies it is of importance to note the variety of A.C. voltages required in this or any similar circuit lay-out, since this is one of the practical difficulties which precise measurements entail. From the same A.C. source are required the following different supplies :

(1) A variable voltage source for the test ring.

(2) A fixed voltage for the A.C. potentiometer.

(3) A different fixed voltage for the synchronous motor of the harmonic analyser.

(4) A different fixed voltage for the synchronous motor of the oscillograph.

For these purposes a versatile transformer is needed to follow the alternator.

Turning to the measurements, the A.C.-D.C. potentiometer is fed either from A.C. drawn from its own isolating transformers or from D.C. drawn from a battery B_3, change-over being effected by the double-pole switch S_3.

When measuring A.C. components, balance is indicated by a vibration galvanometer G_1, but the inevitable D.C. voltage across the current measuring shunt R_1 would cause a lateral displacement of the elements of this galvanometer unless a condenser C were included in the galvanometer circuit. When measuring D.C. quantities, a moving-coil galvanometer G_2 is brought into use by means of the double-pole switch S_2. Since this galvanometer when in balance for D.C. in R_1 is affected by the A.C. component across R_1 it may be necessary to include a choke in its circuit. But the authors found that this was not necessary with the galvanometer they employed and the choke was omitted after preliminary tests.

Further details regarding the operation of the potentiometer will be given later, but it may be stated here that the switch S_1 enabled either volts or current (A.C. or D.C.) to be measured by the potentiometer. Actually a double-pole switch was used since the test coil A.C. induction was measured by means of a search coil. The switch S_4 enabled the harmonic analyser disc to be short-circuited during these measurements.

The harmonic analyser A (which will be described in more detail later) enabled the full amplitude of the distorted exciting current of the test ring to be measured, as well as enabling its harmonics to be analysed. Preliminary phase adjustments were made by means of a moving-coil voltmeter connected with the analyser disc (the voltmeter is not shown in Fig. 1) but the final measurements were made upon the potentiometer, the latter being excited by D.C. for this purpose.

The Co-ordinate A.C. and Double D.C. Potentiometer

Although this instrument is well known to most measurement engineers, a brief description of its operation may be desirable particularly as its application in incremental measurements is unique to the present investigation so far as is known.

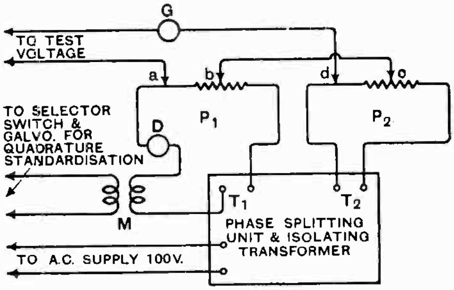

Fig. 2.

Considering Fig. 2, the potentiometer has two complete elements P_1 and P_2. These are fed from a pair of transformers, indicated by T_1 and T_2. Considering the potentiometer P_1, the correct current for exciting the slide wire is indicated by a reflecting dynamometer D. If desired, the dynamometer itself can be checked by feeding the wire through the dynamometer from a D.C. instead of an A.C. source, when a standard cell voltage should balance against the appropriate length of slide wire. Whilst this process serves to check the dynamometer it will be seen that it also provides the means of using P_1 for D.C. measurements. This principle was adopted in the present case.

The potentiometer P_1 when excited by A.C. is known as the " in phase " potentiometer.

The " quadrature " potentiometer P_2 is fed from an isolating transformer T_2, the phase of the current being turned through 90° by means of a network of resistance and capacity in the secondary circuit of T_2. The exact quadrature phase shift is indicated when the secondary voltage of a specially designed standard mutual inductance M balances against the appropriate length of slide wire of P_2. Since the primary of M is in series with the feed to the "in phase" potentiometer P_1 it will be seen that balance between P_2 and the secondary voltage of M infers phase quadrature between the currents in P_1 and P_2.

By means of a selector switch the quadrature standardisation can be checked against M.

The magnitude and phase of an unknown voltage can now be determined. The unknown voltage is tapped across portions of P_1 and P_2 in series, and a vibration galvanometer G indicates the degree of unbalance. By adjusting the tapping points *abcd*, a vector combination (always consisting of two components in quadrature) can be selected from P_1 and P_2 to balance the unknown. (The phase of either component can be reversed by a switch embodied in the potentiometer.) The resultant vector can thus be given any desired phase and any magnitude within the range of the potentiometer voltage. Thus the unknown voltage can be balanced in phase and magnitude.

Then, if the incremental magnetisation of a test specimen results from an A.C. component of exciting current I_0 and the search coil voltage be E_2, the potentiometer readings will yield results in the form

$$E_2 = a_2 + jb_2$$
$$I_0 = -a_0 + jb_0$$

whence, if the exciting turns are N_1 and the search coil turns N_2, it follows that the applied voltage E_1 which is concerned with producing the A.C. component of induction in the specimen will be given (free of ohmic drop) by

$$E_1 = -\frac{N_1}{N_2}[a_2 + jb_2]$$

and the iron loss watts P will be

$$P = \frac{N_1}{N_2}[b_0 b_2 + a_0 a_2]$$

It is to be noted that although the power P will be correct if either E_2 or I_0 is a sinusoid, yet the potentiometer alone will not yield complete information concerning the distorted quantity. Thus, supposing that E_2 is sinusoidal and I_0 is distorted, the value of I_0 read by the potentiometer will be the fundamental component of this quantity, harmonics being ignored by the sharply tuned vibration galvanometer detector.

The D.C. component in the exciting circuit is measured by the potentiometer after the necessary switching has been performed.

Reverting to the A.C. component of exciting current I_0, there remains the measurement of its full amplitude, as distinct from the value of its fundamental, and the separation of its harmonics if desired.

The operation of the combined Joubert contact and analyser used for this part of the work is as follows. The apparatus consists of a disc driven by a synchronous motor. The disc has a number of concentric tracks to any of which contact can be made at any desired phase by a small brush. Considering the measurement of exciting current amplitude, and referring to Fig. 1, the switch S_1 is opened, thus bringing the synchronous disc in series with the voltage developed by the current flowing in R_1 (switch S_1 being in the left-hand position during the measurement). The Joubert track on the analyser will deliver voltage pulses of constant amplitude depending upon the phase of the collector brush. By adjusting the phase of the latter until the pulse is a maximum and balancing this pulse by the D.C. potentiometer, the positive peak of the current wave is determined. Similarly, the negative peak can be measured and thus the full amplitude of the complex current wave and thus of the magneto-motive force is determined.

For the measurement of harmonics the same process is followed, but the appropriate harmonic track of the synchronous disc is used. These harmonic tracks have segments equal in number to the order of the harmonic to be measured. Thus the track for measuring the second harmonic will contain two segments, and so on. Contacts are therefore made at harmonic frequency. The pulses of voltage delivered from such a track will have a mean value depending upon the harmonic under measurement and upon certain of its multiples, but not upon harmonics of other orders.

If short segments were used upon these tracks, similar for instance, to the Joubert segment, the error due to harmonics which are multiples of the desired harmonic would necessarily be included fully in the measurement, but by using longer segments this error can be largely eliminated. The best segment length for this purpose is determinable mathematically. If only odd harmonics are present (as in magnetisation by A.C. alone) a segment length equal to one-third of the period of the desired harmonic is correct.* This form of segment has been adopted in the analyser marketed by H. Tinsley & Co. and used in the present experiments. Although correct for the purpose contemplated by the makers (namely, for measurements upon iron excited by A.C. alone) the segment lengths are not ideal when even harmonics are present, half-period segments then being advantageous.† Thus the experimental results given later for the harmonics of incremental magnetisation are susceptible of some error of measurement (probably small) and further work upon this aspect of the problem is contemplated.

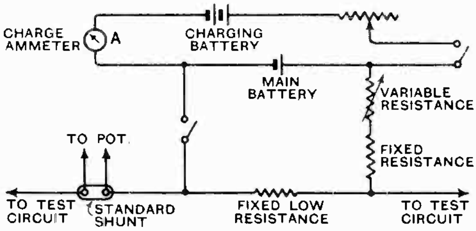

Fig. 3.

Before proceeding to a description of the results, some explanation must be given of the means adopted for varying the direct current in the test circuit. It has already been explained that, in order to maintain as nearly as possible a sinusoid of induction in the test specimen, the resistance of the exciting circuit was kept as low as possible, series resistance for control purposes being avoided. Since the lowest D.C. voltage available from secondary cells is of the order 2.0 volts it will be clear that, if the D.C. is introduced in series with the A.C. in a single exciting circuit of low resistance, some difficulty will be encountered in reducing the D.C. to low values and in avoiding a large jump in the excitation when, for instance, two cells are used instead of one. The difficulty was met by the device shown in Fig. 3, the cell voltage being reduced by a potentiometer arrangement which left the main circuit resistance practically undisturbed. The test specimen consisted of a half-gross of standard Stalloy 16 mil. ring stampings, weighing 1233 grams. The dimensions were 15,24 cms. inside diameter and 17,78 cms. outside diameter (6in. × 7in.) giving a ratio of radial thickness to mean diameter of 1/13. This ratio was chosen to compromise between error due to non-uniform flux distribution‡ on the one hand, and error due to punching stresses in the ring edges, on the other hand. The ring shape has advantages which need not be pointed out.

The effective cross section of the sample was determined by averaging the results of a large number of micrometer measurements upon individual rings, insulation being scraped away but not scale. The measurements must therefore be taken as applying to this condition.

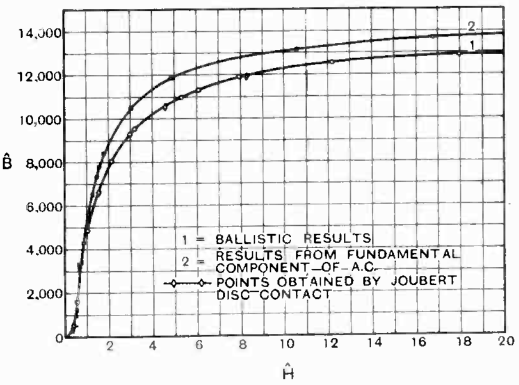

Fig. 4.—"*Reversals*" *B-H curves.*

The search coil was wound next to the iron in a small gap left in the exciting

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* See B. G. Gates, *Journal of Scientific Instruments*, Vol. ix, No. 12.

† See Sims, *Wireless Engineer, loc. cit.*

‡ See Hughes, *J.I.E.E.*, Vol. 65, No. 370, October, 1927.

winding. Both windings were counted with special care.

Check Tests

In order to be satisfied that conditions throughout the measurement circuits were reliable to the degree of precision required it was desirable to carry out a test under A.C. excitation alone as, owing to the paucity of published experimental information upon carefully controlled incremental measurements upon Stalloy, the investigation was original in nature, whereas a measurement with A.C. alone could be compared with many other similar tests. Accordingly the complete circuit of Fig. 1 was used but without D.C. feed from the battery B_1 and a pair of B-H curves was obtained from the readings of the co-ordinate potentiometer and the analyser (Joubert contact). The readings so obtained also provided a loss curve. A third B-H curve was then obtained by a ballistic method. The B-H results are plotted in Fig. 4. Curve 1 shows the ballistic results and three of the Joubert contact readings are plotted as diamonds beside this curve. The Joubert readings indicate slightly larger H valves than the ballistic readings for the same inductions. This small divergence is due to the presence of eddy currents during the A.C. test. Curve 2 is plotted from the co-ordinate potentiometer readings and here, for densities above about 5,000 per sq. cm. the H values become appreciably smaller than the corresponding ballistic values for given densities. Below about 5,000 lines per sq. cm. the curves are in agreement. The divergence at high densities is due to waveform distortion which the potentiometer ignores. This distortion is taken into account by both the ballistic and analyser measurements. These results are in agreement with theory and with previous experimental work,* moreover, the actual values agree with the known behaviour of Stalloy. The corresponding permeability curves are shown in Fig. 5. The loss curves, shown per pound and per kilogramme in Fig. 6, were calculated (in the manner shown earlier), from the magnitudes and phases given by the co-ordinate potentiometer. The values here were again in agreement with the known behaviour of Stalloy under A.C. excitation.

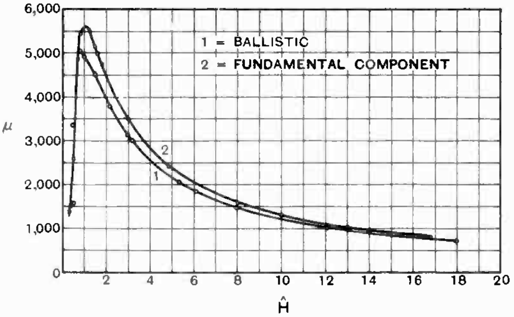

Fig. 5.

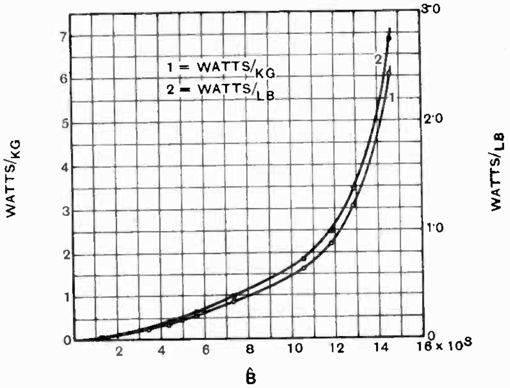

Fig. 6.

These tests assured the authors that the incremental measurements would most probably be reliable as it was necessary only to bring the D.C. battery voltage into circuit for incremental conditions to apply. It will be clear from Figs. 1 and 3 that this involved

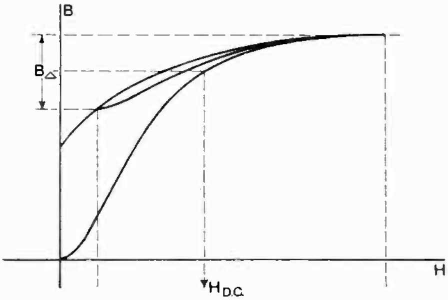

Fig. 7.

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* See Gall and Sims, *J.I.E.E., loc. cit.*

no disturbance of the main circuit components.

Tests were begun with an arbitrary value of direct current giving a steady value of magnetising force $H = 11.2$, the specimen having been demagnetised by allowing the alternator voltage to die down from a high value.

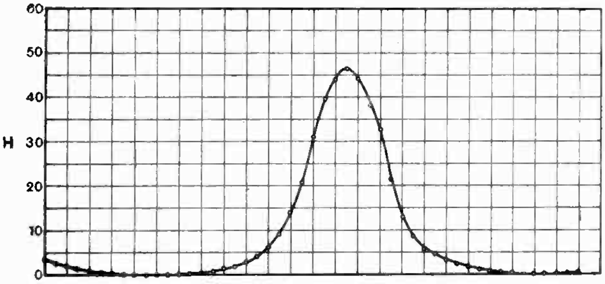

Fig. 8.—*Current waveform by Joubert disc.*

In Fig. 7 is shown a combined excitation figure based upon the assumption that the A.C. is switched on after the D.C. There is necessarily some uncertainty regarding the A.C. cycle, but it is at least clear that a sinusoidal induction variation must produce an unsymmetrical cycle of H.

A current wave trace is shown in Fig. 8 as obtained by the Joubert contact of the harmonic analyser. This wave was analysed mathematically, using 36 ordinates per cycle and the results compared with harmonic values obtained from the analyser. The results to the 3rd harmonic were as below :—

The differences are not entirely negligible but they were in the direction to be expected with type of segment employed.* The authors judged the results to justify the employment of the analyser and tests were therefore put finally in hand.

—	By Fourier Analysis.	By Harmonic Analyser and D.C. Potentiometer.
Steady component of H	11.1	11.2
Fundamental of A.C. in terms of H . .	17·5	17·9
2nd harmonic . .	9·45	10.84
3rd harmonic	5·05	5·56

(*To be concluded.*)

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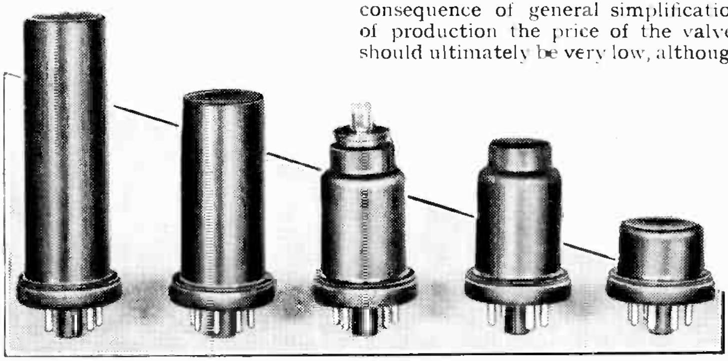
* See " Analysis of Waveforms," *loc. cit.*

New All-metal Valves

An American Innovation

THE General Electric Company of America has created a stir by the sudden release of first samples of new all-metal types of receiving valves. The only glass content is small beads of glass used in sealing the leads to the electrodes from the valve pins to the valve base, which is of metal.

The valves are smaller than the standard glass types and the construction permits of much closer spacing of the electrodes and shorter connections. After construction the valve is exhausted through a metal tube which is pinched and welded when the right degree of vacuum has been attained. The photograph shows a selection of the new types, the height of the largest being little over 3 inches.



It is stated that this method of construction enables manufacture in quantity to be carried out within much finer limits than formerly, and that in consequence of general simplification of production the price of the valves should ultimately be very low, although at first prices will not be below those of equivalent glass types.

The Amplification of Transients*

By Geoffrey Builder, Ph.D., F.Inst.P.

(Research Physicist, Radio Research Board of the Commonwealth Council of Scientific and Industrial Research)

IN a paper in the *Wireless Engineer*, C. H. Smith† has discussed the amplification of transients and concluded that " . . .the response of a low-frequency amplifier to exponentially damped sine waves differs from the response to steady tones. The decrement of the damped sine wave is unchanged, but the amplification obtained is greater for the damped wave train than the undamped, particularly for those frequencies at which, due to the presence of reactances in the coupling units, a reduction in the amplification of steady tones occurs."

This result is very surprising from a fundamental point of view. The importance of the general problem is considerable and further investigation is essential. In this paper it will be shown that the statement is altogether misleading, and, moreover, that the conclusions which are arrived at are not justified by the analysis given.

Before discussing the more detailed problem it is necessary to make some remarks on the general assumptions underlying the analysis. Smith states, in the introduction to his paper, " that the modulation of a transmitter is rarely sufficiently periodic to permit of the exact application of Fourier Analysis." He then says: " If, therefore, we make what may be considered an extension of Fourier's theorem and postulate that any transmitted programme may be resolved, at least theoretically, into a finite number of exponentially damped sine waves of fixed frequency, decrement and initial amplitude, we have a concept which is much more general and probably more accurate in practice than the present one of resolving into pure tones, and which gives a result still capable of mathematical analysis."

The point of view suggested in these statements is rather difficult to understand. The author is presumably referring to analysis in terms of Fourier series; such analysis is probably not applicable to speech and music. He has, however, apparently ignored the Fourier Integral method, although it is this which is usually considered when discussing any irregular and transient wave forms, and although the Fourier Integral gives an expression for any wave form, within certain very broad limits, in terms of pure sinoids. There is, therefore, no need to postulate an analysis of programme modulation in terms of damped sine waves, and it might be somewhat difficult to apply and to justify the process in general. On the other hand, the mathematical technique required in Fourier Integral analysis has been very well developed. In fact, to investigate mathematically the effect of a circuit on a damped sinoid applied suddenly to the circuit, the analysis will usually be based ultimately on Fourier Integral methods.

If the transients being discussed can in fact be represented by a Fourier Integral, the steady-state properties of the circuit determine the amplification of the sinoidal e.m.f.'s implied in the Fourier Integral formulation. The amplification of the component frequencies of the transient being determined by the steady-state characteristics of the circuit, the amplification of the transients must, as far as magnitude is concerned, be expressed by the response curve of the circuit. In discussing the amplification of a pure sinoid of fixed frequency it is usually immaterial whether the circuits are distortionless or not. Thus it is not generally feasible to compare the degree of amplification of a transient with that of a pure sustained sinoid. Briefly, it may be said that the circuit which has a response dependent on frequency does not distort a pure sustained sinoid, and the amplitude of the sinoid in the output of the circuit can be used to define the magnification of the circuit for that frequency, while a transient is distorted, and the output amplitude is closely associated with the distortion and is a function of the behaviour of the circuit at all frequencies.

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* MS. accepted by the Editor October, 1934.

† C. H. Smith: *Wireless Engineer*, X, 296 (June, 1933).

In the analysis of the response of a circuit to any arbitrarily defined transient it is generally most convenient to find first the *indicial response* of the circuit. That is to say, one finds an expression $A(t)$ for the response to a unit e.m.f. suddenly applied at time $t = 0$. Then, if any transient expressed by the function $e(t)$ is applied to the circuit at $t = 0$, the superposition theorem* gives the response $B(t)$ by the equation

$$B(t) = e(0)\,A(t) + \int_0^t A(t-\lambda)\,e'(\lambda)\,d\lambda \quad (1)$$

where $e(0)$ is the value of $e(t)$ at $t = 0$,
$e'(t)$ is equal to $de(t)/dt$,

and $A(t-\lambda)$ is obtained by substituting $(t-\lambda)$ for t

wherever it occurs in $A(t)$. It is therefore clear that, to obtain a general idea of the behaviour of a circuit when transient e.m.f.'s are applied to it, the most useful expression of this behaviour is the indicial response. At the same time, it is probably the simplest explicit analytical expression of the transient properties of the circuit.

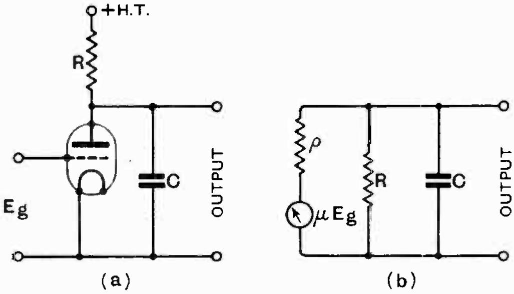

Fig. 1.

Smith has discussed low-frequency amplifiers of the resistance, resistance-capacity and choke coupled forms. Consider the first of these, as given in Fig. 1(a). C includes stray capacities, the anode-cathode capacity of the valve and the input capacity of the next valve. μ and ρ are the amplification factor and internal resistance of the valve. Fig. 1(b) is the equivalent circuit. The indicial response can readily be found by simple theory, or by using the operational calculus, and is

$$A_1(t) = M_{10}(1 - \epsilon^{-K_1 t}) \quad \ldots \quad \ldots \quad (2)$$

where $K_1 = \dfrac{\rho + R}{\rho R C}$

$$M_{10} = \mu\frac{R}{R+\rho}$$

The response of the amplifier to a sustained e.m.f. of angular frequency p is such as to result in an amplification

$$M_{1p} = M_{10}\sqrt{\frac{K_1^2}{K_1^2 + p^2}} \quad \ldots \quad \ldots \quad (3)$$

Using equation (1), the response to a transient $\epsilon^{-at}\sin pt$ is given by

$$B_1(t) = M_{10}\int_0^t (1 - \epsilon^{-K_1\overline{t-\lambda}})\,(p\cos p\lambda - a\sin p\lambda)\,\epsilon^{-a\lambda}d\lambda$$

since $e(0) = 0$. Therefore integrating,

$$B_1(t) = M_{10}\sqrt{\frac{K_1^2}{(K_1 - a)^2 + p^2}}\left[\frac{p\epsilon^{-K_1 t}}{\sqrt{[(K_1 - a)^2 + p^2]}} + \epsilon^{-at}\sin\overline{pt - \phi}\right] \quad \ldots \quad (4)$$

where $\tan\phi = p/(K_1 - a)$.

The corresponding equation in Smith's paper is

$$E_0 = M_{10}\sqrt{\frac{K_1^2}{(K_1 - a)^2 + p^2}}\,.\,\epsilon^{-at}\sin\overline{pt - \phi} \quad (5)$$

and was obtained by neglecting the aperiodic term containing $\epsilon^{-K_1 t}$. The author therefore concluded that the amplification of the transient $\epsilon^{-at}\sin pt$ is given by the factor

$$M_{1T} = M_{10}\sqrt{\frac{K_1^2}{(K_1 - a)^2 + p^2}}$$

as compared with the value of M_{1p} given by equation (3) for steady-state sinoidal e.m.f.'s. M_1 is clearly greater than M_{1p} on account of the term containing a.

There are two serious objections to this conclusion. In the first place, as the author points out, M_{1T} has a maximum value at $a = K_1$. Imposing this condition in equation (5), we have $E_0 = M_{10}(K_1/p)\epsilon^{-at}\cos pt$, since ϕ is equal to $\pi/2$. The character of the transient has therefore changed entirely, so that, even if something has been gained in amplitude, a great deal has been lost in fidelity of reproduction. Secondly, if numerical values are considered, it is seen that a could not be equal to K_1 for any reasonable practical conditions. K_1 could scarcely be

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* V. Bush: "Operational Circuit Analysis" (Wiley and Sons), 1929, page 62.

as small as 10^5. Suppose a is equal to this. If $p = 10^4$, the decrement per cycle would be 20π and would still be 2π for $p = 10^5$. The transient would therefore be practically a uni-directional pulse and the change in character noted above would be important.

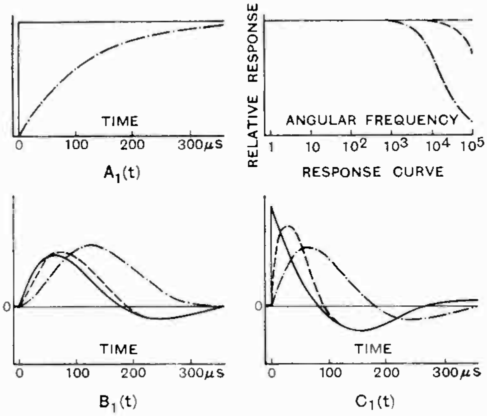


Fig. 2.—*Characteristics of resistance-coupled amplifier of Fig.* 1.

———— $K_1 = \infty$
— — — — $K_1 = 10^5$
— · — · — · $K_1 = 10^4$
$a = 10^4$ $p = 2 \times 10^4$

It is to be noted also that, in such a case, the time constant of the term in $\epsilon^{-K_1 t}$, neglected in deriving (5), is of the same magnitude as that of the required transient and so cannot be ignored. That these criticisms are justified is shown by the numerical cases to be given.

What actually happens is stated implicitly by equation (4) taken with equations (3) and (2), and it is worth while illustrating these equations graphically. At the same time the response of the circuit to the transient $\epsilon^{-at}\cos pt$ should be considered, to give a more general representation. The response of the circuit of Fig. 1 to a transient $\epsilon^{-at}\cos pt$ is

$$C_1(t) = M_{10}\sqrt{\frac{K_1^2}{(K_1-a)^2+p^2}}$$
$$\left[\epsilon^{-at}\cos\overline{pt-\phi} - \frac{K_1-a}{\sqrt{[(K_1-a)^2+p^2]}}\,\epsilon^{-K_1}\right] \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

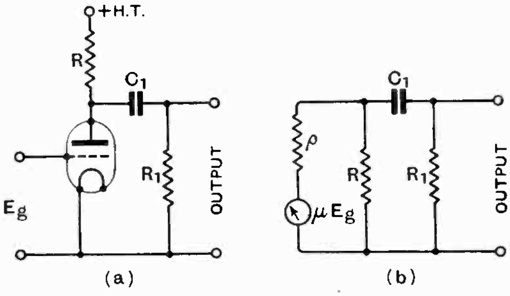
where, as before, $\tan\phi = p/(K_1 - a)$.

In practice, one finds that for well-designed equipment the transient is well reproduced by resistance-coupled amplifiers. For example, K_1 may be as high as 10^7 and should not be less than 10^6. The transient $\epsilon^{-at}\begin{matrix}\cos\\ \sin\end{matrix} pt$ may perhaps have values somewhat greater than 10^4. For the sake of illustration we take two cases, which could readily be reproduced experimentally,

(i) $a = 10^4$ $p = 2 \times 10^4$ $K_1 = 10^4$
(ii) $a = 10^4$ $p = 2 \times 10^4$ $K_1 = 10^5$

In Fig. 2 are plotted the frequency-response curves, the indicial response curves and the responses of the circuit to $\epsilon^{-at}\sin pt$ and $\epsilon^{-at}\cos pt$, given by $B_1(t)$ and $C_1(t)$ respectively, for values of K_1 of 10^4 and 10^5, corresponding to cases (i) and (ii) above and for a distortionless circuit ($C = 0$) having $K_1 = \infty$.

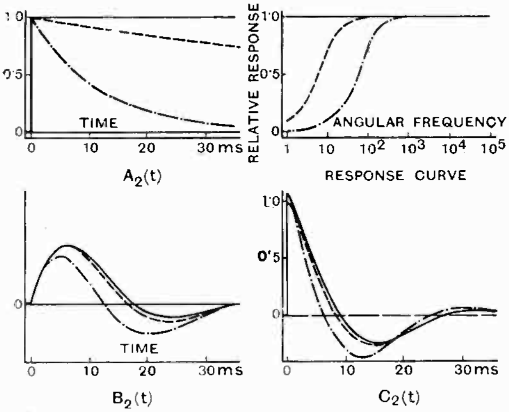
The curves for $A_1(t)$, showing the response to unit e.m.f. applied at time $t = 0$, require no further explanation. The full-line curves, drawn for $K_1 = \infty$, show the form of the original transient, since the amplifier is distortionless in this case. The curves for $B_1(t)$ and $C_1(t)$ give a fairly clear picture of what is happening. Smith, in effect, contends that from the steady-state characteristics one could specify an amplification factor M_{1p} (from equation (3) for the appropriate value of K_1) for the frequency p for undamped sinoids; that this amplification factor is too small in dealing with transients, presumably in that the maximum amplitude of the transient in the amplifier output circuit is greater than that to be expected from the value of M_{1p}. To illustrate the irrelevance of this argument the scales of ordinates for the curves $B_1(t)$ and $C_1(t)$ have been chosen thus; the full-line curve gives the applied transient in amplitude and form; the broken-line curves for the output transients for $K_1 = 10^5$ and $K_1 = 10^4$ have



(a) (b)

Fig. 3.

been obtained by dividing the voltages at the amplifier output by the factor M_{1p} calculated for the appropriate value of K_1 in each case. Considering the curves for $B_1(t)$, it is observed that there is a marked relative gain in amplitude in Smith's sense, when $K_1 = 10^4 = a$. The distortion is at least equally marked. The response to $\epsilon^{-at} \cos pt$, as given by $C_1(t)$, is even more noteworthy in that, not only is the distortion marked, but there is a considerable relative loss of amplitude in Smith's sense.



$A_2(t)$ RESPONSE CURVE

$B_2(t)$ $C_2(t)$

Fig. 4.—*Characteristics of resistance-capacity coupled amplifier of Fig. 3.*

—————— $K_2 = 0$

— — — — $K_2 = 10$

— · — · — · $K_2 = 100$

$a = 100$ $p = 200$

Similar conclusions are reached when the resistance-capacity coupled amplifier of Fig. 3 is considered. For simplicity, the anode-cathode capacity of the valve and other stray capacities are neglected. The equivalent circuit is shown in Fig. 3(b). In the same way as before, we obtain

$$A_2(t) = M_{2\infty}\,\epsilon^{-K_2 t}$$

$$B_2(t) = M_{2\infty} \sqrt{\frac{a^2 + p^2}{p^2 + (K_2 - a)^2}} \cdot \epsilon^{-at} \sin \overline{pt + \theta} - M_{2\infty} \frac{pK_2}{p^2 + (K_2 - a)^2} \cdot \epsilon^{-K_2 t} \quad \ldots (7)$$

$$C_2(t) = M_{2\infty} \cdot \frac{K_2^2 - aK_2}{p^2 + (K_2 - a)^2} \cdot \epsilon^{-K_2 t} + M_{2\infty} \sqrt{\frac{p^2 + a^2}{p^2 + (K_2 - a)^2}}\, \epsilon^{-at} \cos \overline{pt + \theta} \quad \ldots \quad \ldots (8)$$

where $\tan \theta = pK_2/(p^2 + a^2 - aK_2)$

$$M_{2\infty} = \frac{\mu RR_1}{\rho R + \rho R_1 + RR_1}$$

$$K_2 = \frac{1}{C_1[R_1 + \rho R/(\rho + R)]}$$

and $$M_{2p} = M_{2\infty} \sqrt{\frac{p^2}{K_2^2 + p^2}}$$

gives the variation with frequency of the response to steady-state sinoids.

Considering the coefficients of the damped sinoidal terms of (7) and (8), and neglecting the terms in $\epsilon^{-K_2 t}$, Smith again concluded that the transient amplification is greater than the corresponding amplification of a steady-state sinoid of frequency p. That this is not so is seen by the curves of Fig. 4. These have been plotted in the same way as was done for the resistance-coupled amplifier, and using values of $K_2 = 0$, corresponding to the distortionless amplifier ($C_1 = \infty$), and $K_2 = 10$ and $K_2 = 100$, corresponding to cases repeatedly met with in practice. p is taken equal to 2×10^2 and a as 10^2, so that the form of the applied transients is as before, but the time scale is different. The curves for frequency response and indicial response require no further comment. The relative amplitudes and forms taken by $B_2(t)$ and $C_2(t)$ again show considerable distortion for $a = K_2 = 10^2$, in the first case the amplitude being relatively less, and in the second relatively greater than that obtained by distortionless amplification by a factor determined by the steady-state response of the circuit to a sinoid of frequency $p = 2 \times 10^4$.

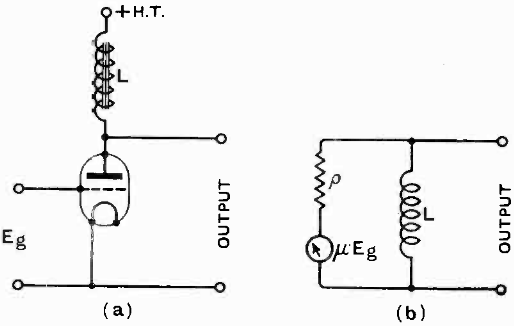


Fig. 5.

A choke-coupled amplifier, as shown in Fig. 5, gives exactly similar results since the indicial response may be written

$$A_3(t) = M_{3\infty}\epsilon^{-K_3 t} \text{ where } K_3 = \rho/L.$$

The cases of resistance-capacity coupling taking stray and interelectrode capacities into account, choke-capacity coupling, parallel-fed transformer coupling, and so on, are rather more complicated and will be discussed elsewhere.

To summarise, we may conclude that the amplification of a transient by any circuit can only be stated in terms of the overall characteristic as a function of frequency, and cannot therefore be compared with the amplification factor of the circuit for a sustained sinoid of any particular frequency. Further, if there is in this sense sometimes a relative gain of transient output amplitude it is necessarily accompanied by a corresponding amount of distortion and is therefore of no value in the reproduction of programme e.m.f's. Nor does this gain in amplitude occur in all cases. It may be noted that these conclusions can be derived from the general theory of "equivalence" and have a wide range of validity beyond that which could be claimed for the illustrations given in this paper.

This work has been carried out as a subsidiary part of the programme of the Radio Research Board of the Commonwealth Council of Scientific and Industrial Research, and is published with the permission of the Board. The author is indebted to Dr. H. C. Webster for his careful checking of the work, and to Professor J. P. V. Madsen, Chairman of the Board, for his continued interest and encouragement.

Book Review

The Superheterodyne Receiver.

By Alfred T. Witts, A.M.I.E.E. 125 pages. Sir Isaac Pitman and Sons, Ltd, Parker Street, Kingsway, London, W.C.2. Price 3s. 6d.

The popularity of the superheterodyne is of such recent growth that this receiver finds but scanty mention in most text-books. A new book devoted primarily to it may, therefore, be expected to supply a want. The book under review covers the whole ground of the modern superheterodyne as used for broadcast reception, but is concerned more with the methods employed than with the reasons for them. It does not enter into theoretical questions more than superficially.

The two first chapters are devoted to the early history of the superheterodyne and the circuits of such early single-valve frequency-changers as Houck's harmonic changer and the Tropodyne are given. The third chapter explains the process of frequency-changing, and is followed by one dealing with practical difficulties such as ganging and the elimination of the various forms of whistle which may occur under certain circumstances. Chapters are devoted to a description of the various modern single-valve frequency-changers, such as the heptode and triode-pentode, and to A.V.C. systems. It concludes with a description of a number of modern superheterodynes of which complete circuit diagrams are given. The single-span modification of the superheterodyne is included and a brief description is given of its mode of operation and particular advantages.

The book is up-to-date, and the references are all to British, American, and German current practice. It does not cater for the needs of designers of receivers, but as the author states in his preface "there must be many amateurs, students, and radio servicemen who have desired more complete and up-to-date information on the working of the superheterodyne than that available in the wireless books so far published." The book should fill the needs of this section of the wireless fraternity, for it is not only clearly written but unusually free from errors.

W. T. C.

Elements of Loud Speaker Practice

By N. W. McLachlan, D.Sc., M.I.E.E. 160 pages, 92 illustrations, 6 diagrams. Oxford University Press, Warwick Square, London, E.C.4. 5s.

The requirements of research workers and those engaged in the design of loud speakers, has been adequately met by the authors book "Loud Speakers" previously reviewed.* The present volume forms an admirable introduction to the subject and is just the type of book one would recommend a friend of an engineering turn of mind whose interest in broadcast reception lies a little deeper than the mere acceptance of programmes in return for depressing a switch.

All known types of driving mechanism are described and special attention has been given to the behaviour of the moving coil loud speaker and conical diaphragms in general. Mathematical analysis has been avoided, but the author has not hesitated to give quantitative data where this will help in giving a clearer understanding of the physical significance of the phenomena under consideration.

The treatment is not confined to the loud speaker unit itself, but embraces the surrounding medium and shows the influence of baffles and the room characteristics on the performance.

The concluding chapter on recent developments includes among other things, references to the piezo-electric drive, twin-cone diaphragms and the use of groups of reproducers to give auditory perspective.

F. L. D.

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* *The Wireless Engineer*, June, 1934, p. 304.

The Transient Aspect of Wide-band Amplifiers*

Examination with the Cathode Ray Oscillograph

By O. S. Puckle

A MEANS of examining the behaviour of wide-band amplifiers when supplied with transient input waves is described and results obtained with a particular resistance-capacity coupled television amplifier are given.

A plea for a change of method in describing the gain-frequency characteristic of television amplifiers is made.

The amplifiers used in television transmission are, for the most part, preceded by a photo-cell which is usually mounted so as to form an integral part of the amplifier. Such an amplifying system must be constructed to pass a very wide band of frequencies and, in the opinion of the author, it is more convenient to measure the behaviour of such a system in terms of time constants rather than in terms of a gain-frequency characteristic.

A normal television amplifier having a level characteristic may to a first approximation, have its performance specified in the form of two time constants, one describing the performance at the low frequency end and one that at the high frequency end of the gamut.

The details of the method about to be described were very briefly touched upon, in a paper read before the Institution of Electrical Engineers on Feb. 7th, 1934, by L. H. Bedford and the author,† although the subject was fully discussed from the mathematical point of view.

The use of a cathode ray tube to make visible the wave form of the signal obtained from the output of the amplifier when a square wave light pulse is applied to the photo-cell, is an obvious method of carrying out transient tests. The use of another

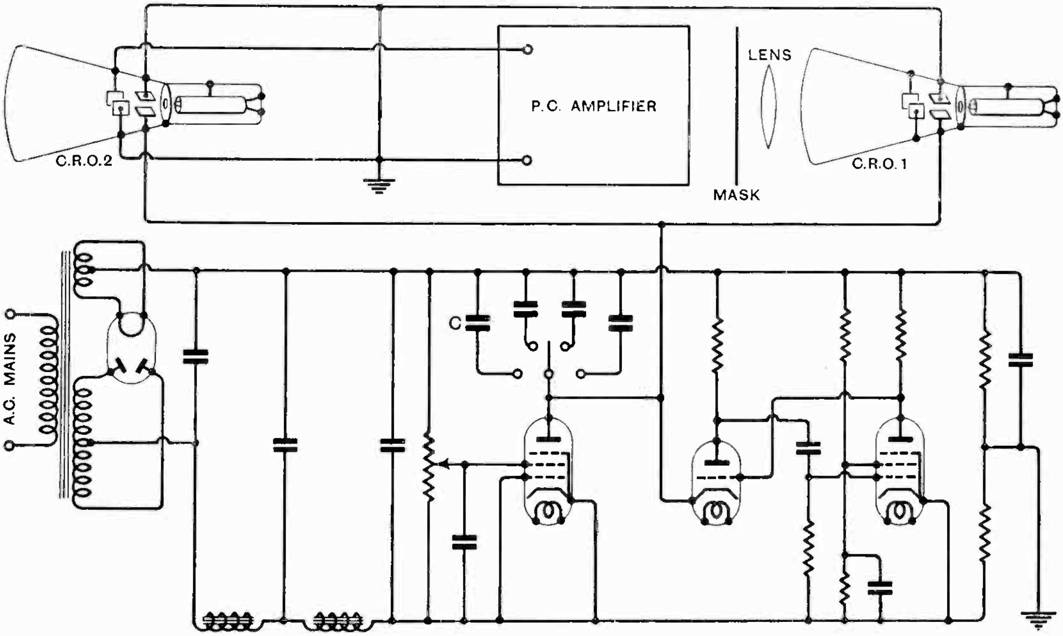

Fig. 1.

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* MS. accepted by the Editor April, 1935.

† "A Velocity Modulation Television System," L. H. Bedford and O. S. Puckle, *Journ. I.E.E.*, Vol. 75, No. 451, July, 1934, p. 63.

oscillograph as a source of light pulses, although perhaps less obvious, is a valuable application, as it allows of great flexibility in the choice of amplitude, frequency and time duration of the input light signal. The suggestion to apply the signal in this way is due to Bedford.

The light pulse is most conveniently applied to the photo-cell by deflecting the cathode ray beam of the oscillograph mounted in front of it (*CRO* 1) by means of a saw-tooth wave-form time base, and by masking off all but the required portion of the sweep line. It is important to ensure that the mask is of a thin material, preferably one having a matt black surface, and that the edges are smoothly cut. By varying the width of the unmasked part of the line the pulse duration may be varied. Alteration of the sweep velocity alters the pulse frequency and duration, while alteration of the current in the cathode ray beam varies the light intensity and hence the amplitude of the pulse.

In order to obtain sharp sides to the input light pulse, it is advisable to focus the light from the tube on to the mask by means of a suitable lens. Finally, the cathode ray beam must be well focused on the fluorescent screen.

Having now arranged the input light signalling device it remains to apply the same time base deflection sweep to the receiving oscillograph (*CRO* 2) so that the input and output signals may be examined along the same base. In this way the delay time of the amplifier may also be measured. The circuit arrangement is shown in Fig. 1.

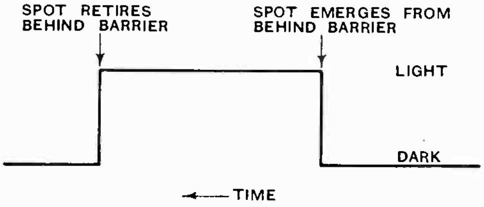


Fig. 2.

With regard to the time base, the sweep traverse must, of course, be reasonably linear and arrangements must be made for measuring the charging current and the capacity of the condenser, or condensers, C. Then the velocity u of the time base sweep, expressed in volts per second, is equal to $\frac{I}{C}$

where I = charging current in amperes
C = capacity in farads.

The time duration of the sweep must now be measured. This, of course, is $\frac{V}{u}$ where V = total voltage sweep.

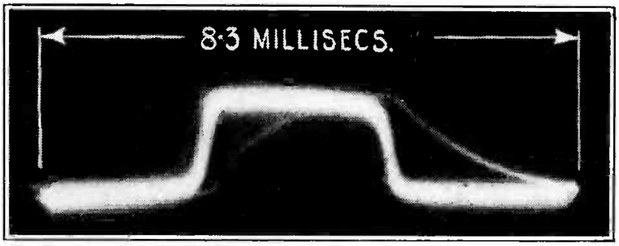


Fig. 3.

The value of V may be measured by marking the ends of the sweep line on the tube and by applying a sinusoidal voltage and calculating the peak value.

The sweep time having been calibrated, it is now possible to examine the amplifier characteristics. The actual amplifier, the tests on which are about to be described, has its last valve arranged without fixed bias (the grid condenser and leak having a relatively small time constant), so that the valve biases itself by the action of its grid current.

The high frequency condition of the amplifier will be considered first.

Fig. 2 shows a pulse as applied to the photo-cell amplifier with a falling frequency characteristic, while Fig. 3 shows the resulting output. In all these figures the sweep time increases from right to left, and the horizontal lines appearing in all the photographs except Figs. 3 and 6 are *not* zero lines. It should be noted that the upper part of each pulse corresponds to light on the photo-cell, the lower line representing darkness.

A pulse is sent through the amplifier as the spot sweeps over the surface of the cell and a much shorter one (in time) occurs during the fly-back sweep. Inspection of the figure shows the sweep travelling from right to left in 8.3 milliseconds and the fly-back occurring much more rapidly. It will be seen that, owing to the lower frequencies involved, the amplifier can handle the pulse due to the sweep, while in the case of the more rapid fly-back, the pulse is deformed due to the presence of shunt capacities.

If the velocity of the pulse through the amplifier be increased as shown in Fig. 4 in which the time of traverse of the sweep is 512 microseconds, it will be seen that, although the pulse is the same as before, the resultant pulse at the output of the amplifier is quite different. This is due to the attenuation and phase displacement of the high frequency components of the pulse, which are caused by capacity shunts across the coupling resistances, etc. Since the pulse is made to occur more rapidly by increasing the time base velocity, the value of the highest frequency required to provide a faithful copy of the input pulse is increased, and unless due precautions are taken the amplifier will attenuate these frequencies and so produce distortion. Fig. 5 shows this effect carried one stage further, the sweep time being 195 microseconds.

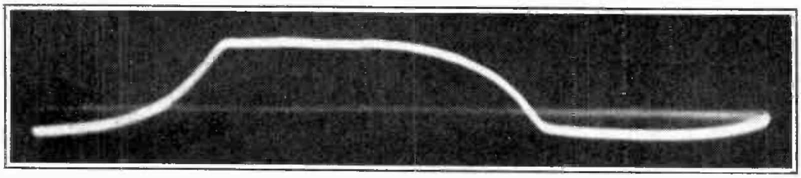
If, now, the amplifier be compensated to make up for the attenuation of these high frequencies, the distortion may be remedied, or very nearly so, as shown in Fig. 6, where the time is still 195 microseconds. It will be noticed that the commencement and end of the pulse is not vertical. This lack of verticality is principally due to the existence of aperture distortion.

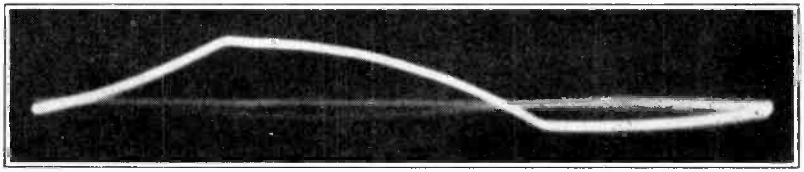
Fig. 7 shows the same time sweep but with the compensation carried out to excess. In this figure the excess of compensation appears as an excess of amplitude at the beginning and end of the pulse.

The photographs shown in Figs. 4, 5, 6 and 7 do not give entirely true results since the signal applied to the photo-cell is already distorted by aperture distortion and by afterglow of the fluorescent screen of the transmitting cathode ray tube (*CRO1*).

Aperture distortion which is due to the fact that the spot is not infinitely small, has been discussed by many authors and the effect is well known. If the spot traverse time is reduced to a velocity well within the capability of the amplifier, and if the afterglow is negligible, the remaining lack of verticality is due to aperture distortion. In this way the aperture distortion may be measured in terms of microseconds.

Since the spot on the screen of the oscillograph in front of the photo-cell does not reach maximum brilliance instantaneously and remains glowing for a minute fraction of a second after the bombardment of the screen ceases, an effect analogous to another time constant is added. These effects are known as excitation time delay and after-glow. This time was measured and was found to be less than 5 microseconds with the calcium tungstate screen which was used for the experiments.





(Above) Fig. 4.

(Right) Fig. 5.

Figs. 6 and 7 show an effect similar to that seen in Fig. 3 in which distortion occurs in the fly-back due to high frequency attenuation and phase displacement, but in addition it is seen that, on the flyback stroke (left to right), the amplitude does not reach a maximum until some time after the spot has passed behind the barrier. This effect is partly due to the fluorescent excitation-time delay, and to screen afterglow.

Figs. 6 and 7 also show irregularities in screen illumination during the period when the light shines on the photo-cell.

Similar measurements of the low frequency characteristics of a photo-cell amplifier may be made with the circuit arranged as before:

the time base may be set to run very slowly, say about ten traverses in one second. Then with a pulse form as in Fig. 2, the low frequency characteristics of the amplifier will be exhibited on the receiving oscillograph tube (*CRO* 2).

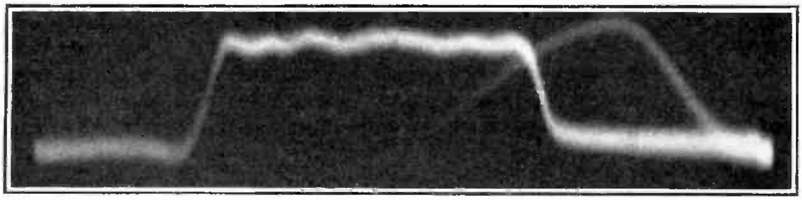
Fig. 8 shows a test carried out on the same amplifier as in the previous high frequency tests, and in which the sweep traverse time is .115 seconds. It will be seen that after a certain time the pulse decays to zero and a small negative pulse is actually introduced. Due to the insufficiently long time constant of the amplifier, the original pulse falls to zero, and the resistance and capacity components in the amplifier are such as to give a small negative pulse before the spot retires behind the barrier. The actual state of affairs which exists is, that in the later stages of decay of the pulse, the final drop to zero for the last stage is not amplified, while those of the previous stages are amplified, and, indeed, several of these reversals of polarity of the pulse are possible in a multi-stage amplifier (*vide Journal I.E.E.*, Vol. 75, No. 451, July, 1934, page 76, Fig. 11). As the spot passes behind the barrier a pulse is produced which, since the amplitude of the received pulse has fallen to zero, must necessarily pass into the region of " darker than dark " where grid current flows in the last valve. When this occurs the grid condenser becomes charged once more and a quasi-exponential return to " dark " takes place.

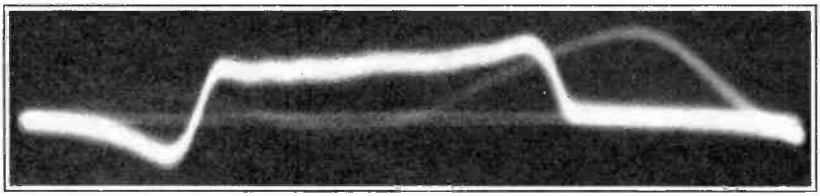
The uneven nature of the top of the curve is due, chiefly, to irregularities in the screen material of the sending oscillograph (*CRO* 1) as a result of which the illumination, and consequently the amplitude, of the transmitted pulse varies slightly in different parts of the screen,. although the beam current is constant. The regularity of the screen coating has received attention and is now improved.

The shape of the pulse obtained during the fly-back period is just discernible in Figs. 9, 10 and 11.

Fig. 9 shows the same shape of pulse, but with a traverse time of .0455 secs. It should be noticed that the signal does not now fall to zero since the amplifier time constant is sufficiently good to prevent this but it is not yet good enough. By adding low-frequency compensation this state of affairs may be remedied, and Fig. 10 shows this carried out to excess, for the amplitude of the pulse actually rises to a small extent. The excess of L.F. compensation explains why the return pulse to the condition of darkness does not, in fact, quite reach that condition until some time after the spot has passed the barrier.

Fig. 11 shows a slightly higher frequency, the traverse time being .015 seconds. All the





(Above) Fig. 6.

(Right) Fig. 7.

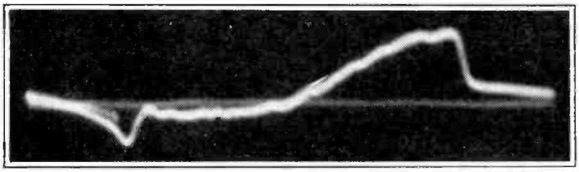
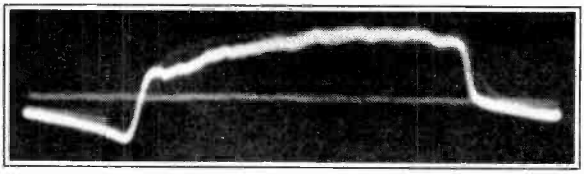


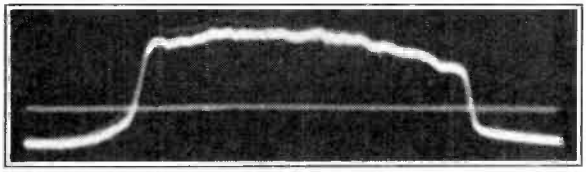
Fig. 8.

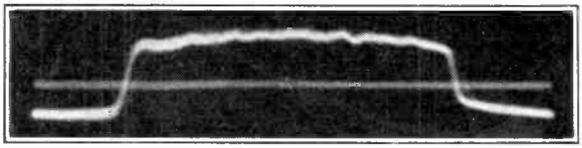
low-frequency curves (Figs. 8 to 11 inclusive) show screen irregularities.

Finally, at these low frequencies, the commencement and conclusion of the pulse should provide a vertical rise and fall, any departure from this condition being caused, as stated earlier in this article, by aperture distortion, the amplifier and screen afterglow time constants being too short to appear at this frequency.

The amount of attenuation and phase displacement of the high-frequency components in a received pulse determines the steepness of the wave front, while the attenuation and phase displacement of the low-frequency components determines the constancy of the amplitude of the pulse.







(Above) Fig. 9.

(Right) Fig. 10.

(Below) Fig. 11.

If the high- and low-frequency compensating circuits are varied during the tests, they may be used to measure the time constants of the amplifier for any particular condition. For instance, suppose that complete high-frequency compensation is inconvenient, the compensation may be adjusted, so that the amplifier has a time constant of, say, one microsecond, and the remainder of a television transmitting-receiving system of which the amplifier may form a part can be designed to compensate for the greater part of this amount. Similarly, the low-frequency compensation may, if carried to completion, cause the amplifier to " motorboat," and here, again, the remaining time constant may be compensated elsewhere in the system.

It must be pointed out here that if each stage, save one, is almost critically compensated at high frequencies, the amplifier may be said to have a single resultant high-frequency time constant, viz., that of the uncompensated stage.

The time constant method of describing the overall performance characteristic of a television system is of great value, since it enables the necessary compensation to be inserted in all receivers. A strong plea that the time constants of all future television transmitters shall be fixed and declared beforehand is therefore urged, in order that receivers may be capable of providing good definition whether they are constructed for sale and use in London, Manchester or elsewhere. It is obviously unsatisfactory that it should be necessary to manufacture receivers with different time constants for different localities. It must be appreciated that the eye is a much more delicate instrument than the ear, and that phase relationship is of the utmost importance for successful television reception. Moreover, poor high-frequency compensation leads either to poor definition or to harsh boundaries which are extremely objectionable, while poor low-frequency compensation provides another very deleterious effect, namely, that of extension of the whites and blacks either in the scanning direction or in the picture direction.

The amplifier delay time may be measured by shifting the position of the sweep line on the oscillograph (*CRO* 1) until the commencement of the pulse is at the extreme end of the sweep. The delay time is then found by measuring the distance from the end of the sweep to the commencement of the pulse on the receiving oscillograph (*CRO* 2). The knowledge of the sweep time then enables the time delay through the amplifier to be calculated. It is, cf course, necessary to run the time base sweep at high velocity to make the delay time a measurable quantity.

Since carrying out these tests the author has seen a very excellent book on the subject of Cathode Ray Oscillographs* by Manfred von Ardenne in which there is described on pp. 363 and 364 a very similar measurement for detecting the existence of aperture distortion and screen inertia, *i.e.*, screen afterglow and excitation time delay. An English translation of Von Ardenne's book is shortly to appear.

The author's thanks are due to Mr. L. H. Bedford for much valuable assistance and advice and to Mr. R. Pollock for taking the photographs.

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* "Die Kathodenstrahlröhre und ihre Anwendung in der Schwachstromtechnik," von Manfred von Ardenne, Berlin, *Verlag von Julius Springer*, 1933.

The Non-Linear Theory of the Maintenance of Oscillations

The April meeting of the Wireless Section I.E.E was devoted to a lecture on the above subject by Dr. F. Le Corbellier of the French Post Office.

In opening his remarks, the lecturer referred to the importance of a knowledge of oscillations and to the inadequacy of the classical theory to deal with many cases which now existed in different practical forms. Amongst such practical things to which analogous reference could be made were the new problems of cross-modulation and interaction of radio waves, as well as mechanical problems such as those of the internal combustion engine.

Of all these problems that of the generator was the most fundamental. The classical theory was already familiar and the lecturer proceeded to review this in the well-known form of the usual differential equation in which the "negative resistance" effect of the valve is regarded as equating to the positive resistance of the circuit. This was open to several obvious physical objections, notably the difficulty of the negative resistance being exactly equal to the positive resistance and of explaining the limitation of oscillations when the "negative resistance" was greater than the (positive) resistance of the circuit.

The energy for the maintenance of oscillations was derived from the h.t. battery and, since this was of d.c. or zero frequency, the most appropriate conception of the generator was that of a frequency transformer. In this field physical experiment was actually ahead of mathematical theory.

Originally the sinusoidal oscillator was considered of most importance, but this was no longer the case, the "saw tooth" wave-form of cathode ray and television practice being quoted as an example. The non-linear theory was not new, but dated back to 1883, when Lord Rayleigh used the conventional differential equation but showed the importance of a non-linear term which he introduced into it.

The lecturer then turned to the familiar neon lamp circuit as a typical source of "relaxation oscillations," showing the well-known conditions in which these oscillations could be maintained and illustrating the wave-form on a cathode ray oscillograph. From this he derived the appropriate curve showing a *régime* of negative resistance, operating over which oscillations could be maintained. The curve thus satisfied the conditions of negative-resistance characteristic and the lecturer proceeded to show that while the algebraical analysis of such cases might be extremely difficult the performance could adequately be analysed by graphical methods. These were illustrated in detail, from which, also, it was shown that the shape of the resultant oscillations was determined by the length of the negative resistance region used in the operating conditions. The different wave-forms that could be derived according to whether the voltage was taken across the capacity, resistance or inductance of a series-tuned circuit were illustrated, and the lecturer also showed the gradual transition of wave-form from the sinusoidal to some of the forms of relaxation oscillation obtained in practice. It was important to realise that the sinusoidal form could never be perfectly attained.

From the neon lamp the lecturer then turned to the case of the dynatron oscillator, where the requisite conditions of a negative resistance *régime* could again be secured. The oscillatory circuit was then parallel-tuned instead of series-tuned as with the neon lamp oscillator. The wave-form from this oscillator was shown on the cathode ray tube. From this the lecturer finally turned to the triode coupled-circuit oscillator, where, he stated, the same general conditions prevailed if the tuned circuit was associated with the grid of the valve.

In the concluding section of the lecture, the speaker developed in greater detail the conception of a frequency transformer.

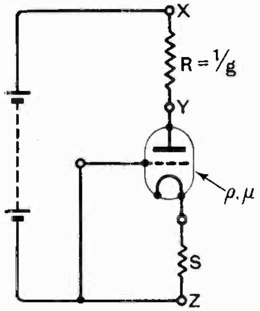
Correspondence

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

Anode Potential Measurements with a Voltmeter

To the Editor, The Wireless Engineer

SIR,—I would like to give an alternative and, I think, simpler proof of the correctness of Mr. Cosen's interesting artifice for measuring the anode potential of a valve,* and to draw attention to another method of making this measurement.



Dealing first with Mr. Cosen's method, the valve and the "automatic bias" resistance S are replaced by a resistance in series with an E.M.F., thus: $e_g = Si_a$ and

$$i_a = \frac{v_a + \mu e_g + k}{\rho}$$

(where k is a constant)

$$\therefore i_a\left(1 - \frac{\mu}{\rho}S\right) = \frac{v_a + k}{\rho}$$

or $i_a = \dfrac{v_a + k}{\rho - \mu S}$

So that the circuit between Y and Z can be replaced by an E.M.F. k and a resistance $(\rho - \mu S)$. The network now consists of ohmic resistances and E.M.F.s; we can therefore apply Thévenin's Theorem† which can be stated in the following form: If the impedance looking into a circuit between two points be z, the potential difference existing between these points will be reduced in the ratio $T/(T + z)$ when an impedance T is connected across these points.

Apply the voltmeter to XY. The impedance looking in at XY is $\dfrac{RA}{R + A}$ where $A = \rho - \mu S$; the p.d. across R was $V_{XZ} - e$, therefore the voltmeter will read $(V_{XZ} - e)\dfrac{T}{T + \dfrac{RA}{R + A}} = V_{XY}$.

T being the resistance of the voltmeter.

Now apply the voltmeter to YZ. The impedance looking in at YZ is $\dfrac{RA}{R + A}$ (the same as before): the p.d. across YZ was e. The voltmeter will read

$$e\frac{T}{T + \dfrac{RA}{R + A}} = V_{YZ}.$$

From these two equations $\dfrac{V_{XZ} - e}{e} = \dfrac{V_{XY}}{V_{YZ}}$

or $\quad e = \dfrac{V_{XZ}}{V_{XY} + V_{YZ}} \cdot V_{YZ}$

which is the expression obtained by Mr. Cosens.

A simpler method for finding e (always assuming the linearity of the valve characteristics over the relevant portion) will now be given.

Let the resistance of the circuit looking in at YZ be z. Connect the voltmeter to YZ. Then, if V_1 be its reading, $V_1 = e\dfrac{T}{T + z}$.

Now repeat the measurement with a resistance mT in series with the voltmeter, and let V_2 be its reading.

Then $\quad V_2 = e\dfrac{T}{T + m\,T + z}$.

Eliminating T and z we have $e = m\dfrac{V_1 V_2}{V_1 - V_2}$.

If $m = 1$ (*i.e.*, the added resistance is equal to the voltmeter resistance) $e = \dfrac{V_1 V_2}{V_1 - V_2}$. The expression is due to Dr. P. G. Agnew,‡ and is discussed by Dr. Wenner (*loc. cit.*). This expression will give the result; if, however, the correctness of the "linearity assumption" is in doubt, the procedure can be repeated with a different value of m, and the consistency or otherwise of the two values obtained for e will serve as an indication of the reliance to be placed on the method. This method is absolutely general in application to linear networks containing sources of direct or alternating E.M.F.

Datchet. L. BAINBRIDGE-BELL.

The Tellegen Effect

To the Editor, The Wireless Engineer.

SIR,—Your editorial on the "Tellegen Effect" in the February issue comments on the wonder which laymen often express in that radio messages do not get mixed up. May I suggest that a large per cent. of the physicists are somewhat hazy on this question.

The sixty-five-year-old Helmholtz-Koenig Side-band-Combinational tone controversy is a case in point. Hazel (*Philosophical Magazine*, January, 1935, p. 103) has shown that the controversy was due to the fact that for some reason there was a failure of the participants to grasp the fundamentals of the question.

In Helmholtz's siren we can assume that the output was due to the air pressure in the wind box or cavity of the siren. The pressure at either orifice is modified by the other opening. Thus

the pressure $P = P_0 + P_1 \sin wt$ and

the output is $(P_0 + P_1 \sin w_1 t) \sin w_2 t$

which, by well-known mathematics, can be shown to consist of four frequencies, the parent frequencies and the combinational frequencies.

Helmholtz was right when he said that he found combinational frequencies.

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* *W.E. and E.W.*, Feb., 1935, p. 84.

† This is discussed at length, with examples of its use, by Dr. F. Wenner, *Proc. Phys. Soc.*, Vol. 39, p. 124. See also Transmission Circuits, by Johnson, Chapter VIII, and Transmission Networks, by Shea, p. 55.

‡ *Trans. Amer. Inst. E.E.*, 39, p. 541 (1920).

Koenig tried to add the two frequencies of his forks and failed to find the combinational frequencies. No mathematical process will give more than the parent frequencies in straight addition of frequencies.

Koenig was right when he said he found no combinational frequencies. However, if the two frequencies are added through some non-linear device such as a modulating tube the combinational tones appear.

This general haziness was brought out in the "Side Band Controversy" which raged rather heatedly at times in your journal during 1928–1931. One of the most convincing arguments against side bands seemed to be: "If there are side bands why do we need the first detector in the superheterodyne receiver?" The difference between addition and modulation (or multiplication) was not grasped.

To get combinational tones or sidebands there must be a "product term" in the analysis, or process. Straight addition does not supply the "product term." The two frequencies are added through the first detector tube and the "product term" is supplied.

In the "Tellegen Effect" the medium at some place must be non-linear.

This suggests the question, "Is there such an effect with light?" It seems that a non-linear medium is all that is necessary.

Bloomington, Indiana, U.S.A.

R. R. Ramsey,
Professor of Physics,
Indiana University.

Mixing Valves

To the Editor, The Wireless Engineer

Sir,—Referring to Mr. R. J. Wey's letter in your April issue, commenting on my article "Mixing Valves," it is satisfactory that his results agree generally so well with mine. However, I should like to point out that I cannot entirely agree with the values quoted by him in his table. Comparing the three mixing valves: 2A7 of R.C.A., 41 MPG of Cossor, Ltd., and FC 4 (octode) of Mullard, the most important values, in my opinion, should run as in the table below.

The values in the first two columns are those quoted by Mr. Wey. As regards the column FC 4, data from the valve makers are taken. The data in Mr. Wey's column 2A7 do not coincide with those published by the R.C.A. The latter values are cited in a column marked "publ." As published valve data are generally the outcome of tests on a great number of valves, I suggest, that Mr. Wey would also find them by extending his measurements to a considerable number of valves and then taking mean values.

In my article $S_{\max.}$ is taken at 3 volts pos. on the first grid of the octode and not zero, as Mr. Wey states.

Eindhoven, April 2. M. Strutt.

Bessel Functions for Engineers

To the Editor, The Wireless Engineer

Sir,—I am particularly interested in some of the statements made in the excellent review of my book in *The Wireless Engineer*, p. 193, April, 1935. Your reviewer seems to have interpreted my views with unerring accuracy. I should like to amplify his remarks on the probable reactions of the pure mathematician when he reads the text. As your reviewer says, in effect, the degree of rigour was determined by the exigencies of the situation. The mathematician does not understand the engineer's outlook, and it is difficult for him to do so without some practical experience and a little sympathy. Modern economic conditions do not permit the engineer to spend his time on rigorous proofs, however willing he may be to do so, and his duty to his employer is to produce satisfactory results in the minimum of time. Even if the methods of attack were absolutely rigorous, the accuracy of the results in engineering practice would seldom be high enough to warrant such procedure. But there are different degrees of rigour, and one feels that whilst the mathematician demands rigour of the highest degree, there is no reason for the engineer to go to the opposite extreme and make rigour evanescent. As in all matters of this nature, a *via media* is the proper procedure, so the mathematician and the engineer should meet each other half way. Little good comes of mathematicians wasting valuable space in journals exercising their plenary powers of sarcasm and invective. Let the mathematician reflect that, however low the rigour of the engineer may sink in his opinion, the engineer provides him with many amenities in life. In not a few cases it is only after the engineer has conducted costly experiments and obtained experimental data, that an analytical exposition is possible. Heaviside was a butt for the ridicule of the mathematician, because he used his operators without formal proof of validity of the processes involved. Would it not have been far better if the mathematician had exercised his faculties in an attempt to discover the *modus operandi* of the operators,

	2A7.	41 MPG.	FC 4.	2A7 (publ.).
(1) Anode volts	200	250	200	250
(2) Screen volts	150	100	85	100
(3) Input grid bias	−2.8	−1.5	−1.5	−3
(4) Mean anode current	3.4	3.9	2.0	3.5 I_a mA.
(5) Conversion conductance	0.29	0.96	0.7	0.52 S_c mA/V.
(6) $\sqrt{I_a/S_c}$	6.5	2.05	2.02	3.6
(7) Oscillator volts eff.	7.1	4.1	5	26
(8) Eff. intern. resistance	—	—	1.5	0.36 megohms.

instead of preaching from the text "*rigor mortis*"? But this type of ding-dong controversy goes on between any two sections of the human race who have "creeds." It is in reality such a waste of useful energy. We cannot prove that two and two make four, but they always have made four, so we take the practical result and stick to it, despite the philosophers.

There is another aspect of "rigour." If in teaching mathematics to engineers we insist upon too much rigour, there will be a psychological reaction regarding the inventive faculties. The engineer knows that any device can, at best, be only an approximation to the ideal. Frequently the approximation is crude in practice, although it may be fairly close in the laboratory. If, therefore, his soul is seared with rigour, the engineer will hesitate to evolve apparatus unless it works with a high degree of precision. In this way the world might lose its great inventions.

The omission of contour integrals from my book was deliberate—as the reviewer implied. I wonder how many of those who read these lines know what is meant by contour integrals? By their aid Bessel function theory can be formulated in quite a small compass. But I do not think that it would have been right to introduce them, for the time is not ripe. In reading books on pure mathematics the engineer tries to get either a geometrical or a physical picture of the analysis. Frequently the nomenclature adopted by the mathematician is so inept that one is puzzled as to its origin, so the "picture" does not materialise. As an illustration, take the following: Contour integration relates to functions where the independent variable is a complex number, e.g., $w = 1/(z - z_1)$, where z is of the form $x + iy$, x and y being variable, and z_1 is constant. When $z = z_1$ the value of w is infinite and the mathematician says that the function has a "pole." By contour integration he finds that the "residue" at the pole is unity. To an engineer who likes to call a spade by the same name, the terms "pole" and "residue" do not seem to be appropriate. But I solved the riddle a short time ago! In the *Mathematical Gazette* for Feb. 1935 is reported a charming address, entitled "The Food of the Gods," delivered by Prof. E. H. Neville to the Mathematical Association. This gave me food for thought and invention! As the "pole" is approached the value of the function steadily increases and ultimately tends to infinity. We conceive, therefore, a plane upon which, in imagination, we erect a tapered pole, of circular or other cross-section, and let it stretch as far as the finiteness of space permits. Enthroned as "gods" upon the pinnacle sit the pure mathematicians partaking of their "food." The "residue" consists of the crumbs, which fall as manna to the poor engineers and physicists, seated at the foot of the polar throne, like Lazarus the beggar. I hope this little figment of imagination will show that if engineers are not particular as to rigour of deduction, mathematicians are just as lax in their nomenclature. Another example is given on p. x of the B.F. book.

Finally, I would express my great appreciation of the reviewer's remarks upon the relatively low standard of mathematical knowledge amongst engineers in this country. It was mainly for this reason that the B.F. book was written. Since the book is usable by anyone whose mathematical equipment is up to engineering degree standard, I hope that it will not only be read, but thoroughly digested by engineers, whether they require Bessel Functions or not. I trust that the "bogy," that these functions are impossible for engineers to handle, has now been demolished. The elementary part of B.F. is just as simple as trigonometry, when one is equally familiar with both.

London. N. W. McLachlan.

The Industry

THE recently introduced Kolster-Brandes car radio receiver is of the two-unit type, remotely controlled. One unit comprises the receiver chassis and speaker, while the power equipment, including a rotary HT generator is housed in a second container.

The well-known gold-film fuses made by Microfuses, Ltd., of 4, Charterhouse Buildings, Goswell Road, London, E.C.1. are now in regular commercial production, in ratings as low as 1, 2 and 3 mA. These are, of course, mainly used for the protection of delicate measuring instruments.

Ekco communication engineering equipment was exhibited—and demonstrated for the first time—at the recent Physics Exhibition, held in conjunction with the conference on Industrial Physics at Manchester University. Pamphlets describing various pieces of apparatus are now available.

Contribution à la Bibliographie de la Radioéletricité, 1922-1932.

Étienne Chiron, Paris: 125 pp.

L'Onde Électrique, well-known to our readers as an important French journal devoted to radio-electricity in all its various applications, was started in 1922, when the "Société des Amis de la T.S.F.," of which it is the official organ, was founded. Between then and the end of 1932 it had published close on 500 original articles and more than 1,500 abstracts of papers from all over the world. The present little book, in the form of an extra-fat issue of the journal itself, is a complete Index to all these articles and abstracts, and needs, therefore, to be used in conjunction with the volumes of the journal from 1922 to 1932 inclusive. Original articles and abstracts are kept separate, and the useful authors' index is so arranged that it serves for both without confusion. If any criticism may be made of such a commendable and laborious accomplishment, it may perhaps be regretted that the whole period is covered in two parts, 1922–27 and 1928–1932, each with a separate index. It would have been more convenient if the two had been merged, so that there might be only one subject index and one authors' index. And the plan of printing "Articles" or "Abstracts," as the case may be, at the top of the pages—as carried out in the second part—should have been adopted throughout.

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PROPAGATION OF WAVES

1312. The Characteristics of Downcoming Radio Waves [Effect of Lateral Deviation: New Method of Measurement of Angle of Incidence].—D. F. Martyn and A. L. Green. (*Proc. Roy. Soc.*, Series A, 1st Jan. 1935, Vol. 148, No. 863, pp. 104–120.)

This paper examines and measures the lateral deviation observed by Cherry and Martyn (1933 Abstracts, p. 385 and back references). Three independent aerial systems were used to receive and record simultaneously the interference fringes between ground and sky wave (due to fading or the frequency-change method). Simultaneous reception on three aerial systems is developed as the basis of a method of angle of incidence measurement. The theory of the simultaneous reception on loop and aerial of one laterally deviated downcoming wave is given and the phase difference between fringes recorded on two such systems is found. The simultaneous reception of two downcoming waves in the plane of propagation is then discussed and it is concluded that Cherry and Martyn's results cannot be explained on this hypothesis. Photographic records of simultaneous loop-aerial fringes are shown and a correlation found between the sine of the angle of incidence and the loop-aerial phase correspondence. The case of simultaneous reception on two loops and aerial of one laterally deviated downcoming wave is next dealt with; the wave characteristics and the position of the ionospheric reflecting centre are determined theoretically and practical values are obtained by reduction of records. A ground plan of ionospheric reflecting centres for one series of observations is given. It is found that a considerable amount of lateral deviation of the reflected ray is normally present. Its polarisation is normally right-handed and approximately circular [in Australia] but marked deviations from the circular form occur. These appear to be correlated with the angle made by the reflected ray with the earth's magnetic field.

1313. Further Investigation of the Amplitude Variations of Downcoming Wireless Waves.—J. L. Pawsey. (*Proc. Camb. Phil. Soc.*, January, 1935, Vol. 31, Part I, pp. 125–144.)

An account of experiments made with the object of checking previous work on lateral deviation of downcoming waves (Ratcliffe and Pawsey, 1933 Abstracts, p. 384). Observations with spaced receivers having vertical aerials were made with $\lambda = 290$ m, using the frequency-change method. Pulses with $\lambda = 170$ m were also used, with circularly polarised aerials at the spaced receivers. An aerial system arranged to suppress vertically incident waves is described, and figures are given showing the calculated ratio of the "suppressed" to the "unsuppressed" signal as a function of the angle of incidence, for a perfectly and also an imperfectly conducting earth and both magneto-ionic components. Records of spaced reception for a greater wavelength and greater transmission distance are given; there is also a diagram of amplitude distribution for the reflected wave, as observed and as calculated from the theory of random scattering.

The greatest lateral deviation observed, 20° or more, was that due to *e* region, and the least, about 0.5°, was due to normal E region for a distant transmitter. Random scattering at the ionosphere gives a consistent explanation of the time variation of amplitude of a reflected wave. Ionospheric winds are found to be a very important cause of fading.

1314. Field-Strength and Fading Measurements in the Broadcast Band at the Summit of the Zugspitze [9 700 Feet].—A. Agricola. (*Hochf:tech. u. Elek:akus.*, January, 1935, Vol. 45, No. 1, pp. 28–31: long summary only.)

The measurements here described were undertaken with the main object of discovering any existing connections between propagation phenomena on medium wavelengths and the weather. The summit of the Zugspitze was a particularly suitable place for reception, as there are often almost immobile atmospheric strata between it and emitting stations on the plain below. Records were taken during the years 1931/32 of the field strength from München (Munich: $\lambda = 533$ m, distance $d = 92$ km) and Beromünster ($\lambda = 459$ m, $d = 240$ km). The apparatus registered 30 points per hour; these were divided into groups of constant field strength and constant deviation from the mean, and counted. A measure for the unsteadiness of the field strength was obtained by finding the average deviation from the mean and expressing it as a percentage of the mean value: it amounted to 7–9% by day, 30–45% by night.

At noon and in the evening a current recorder was also used to obtain fine-structure field-strength curves of München, Rome ($\lambda = 441$ m) Beromünster and Nuremberg ($\lambda = 239$m). The fading curves thus obtained were measured with a planimeter and the *degree of fading* was defined as $\sigma\% = 100 \{1 - (\text{mean value of record})/(\text{maximum value})\}$. σ is usually small during the day, may rise to 70% shortly after sunrise, and decreases again during the night. σ for noon fading sometimes reaches values of 10 or 20%.

§ B describes the daily and annual variation of fading and field strength. Fig. 1 shows the mean daily variation of fading and Fig. 2 that of the field strength. Differences in the curves for München and Beromünster are explained by the greater relative value of the ground wave from München; small values of the space wave merely seem to modulate the ground wave and it is only when the night is far advanced that a mean increase of field strength is observed. Fig. 3 shows the mean daily variation for various months of the unsteadiness of the field strength from Beromünster, and Fig. 5 the annual variation in this quantity for München and Beromünster. These show the usual changes and also the sunset recombination of the intermediate ionised region in the stratosphere. Ionic clouds arising sporadically between the earth and the Kennelly-Heaviside layer cause additional absorption.

The annual curves have a maximum in March and a minimum in May. There is a decrease in field strength just before sunset; to this there corresponds an autumnal minimum in the September records for München. Fig. 6 shows the annual curve of field-strength unsteadiness at different times of day, for München.

§ C discusses the results. The influence of three conducting regions in the atmosphere is deducible from the records. (1) *The Kennelly-Heaviside region.* The *common* control of all frequencies by one region is shown in the curve (Fig. 7) for the weekly means of σ over the sunset period for the four stations mentioned above. A connection between the degree of magnetic disturbance and night fading is also suspected.

(2) *The daytime ionisation in the stratosphere*, a diffuse scattering region between the Kennelly-Heaviside region and the earth. This is not completely opaque to high frequencies but smooths out the reflected wave from the ionosphere, so that, though there are few daytime variations, a reflected wave is still present. This is shown by the decrease in the attenuation factor for wave propagation as the distance from the emitter increases, a phenomenon which is quite general and not affected by the composition of the earth's surface. Direct reflection from the ionised region of the stratosphere is excluded by the decrease of field strength during the morning. Stratospheric ionisation is also the cause of the increase of fading during twilight and the similar annual variation in day and night values.

(3) The *lower atmosphere* (*troposphere*), whose influence is identical with that of the weather. The days of maximum field-strength changes occur in January and July, when high strata of mist and thunderstorms are most frequent. There is also an increase of night fading on days when high strata of mist are present, but this does not apply to thunderstorms. This shows that the mist strata are responsible for the increased fading. Fig. 8 shows the connection between atmospheric pressure and night fading for the period January/July, 1932; the maxima of the two occur at the same period of the year. The influence of tropospheric strata is also seen in the afternoon increase in fading. The effects of polar, maritime and continental air can also be distinguished. Strong daytime fading was frequently observed (particularly on Innsbruck and München, also on Rome and Nuremberg) when thunderstorms were near. In one case a thundercloud over the summit of the Zugspitze caused 100% increase in the field strength from Nuremberg, which decreased again as the cloud moved away.

1315. RADIO AND EARTH-POTENTIAL OBSERVATIONS IN NEW ENGLAND [including K.-H. Layer Heights and Support to Meteor Action Hypothesis].—G. W. Kenrick and P. M. Goldberg. (*Trans. Am. Geophys. Union*, June, 1934, Part I, pp. 147–155.)

1316. THE DISCOVERY OF X-RAYS FROM THE SUN [responsible for Production of the E Layer].—E. A. W. Müller. (*Science*, 22nd Feb. 1935, Vol. 81, No. 2095, Supp. p. 8.)

1317. IONOSPHERE MEASUREMENTS DURING THE PARTIAL ECLIPSE OF THE SUN OF FEBRUARY 3, 1935 [Ultra-Violet Light an Ionising Agent].—J. P. Schafer and W. M. Goodall. (*Nature*, 9th March, 1935, Vol. 135, pp. 393–394.)

Critical ionisation frequencies for the E, M and F_2 regions (1933 Abstracts, p. 558) were measured on the day of the above eclipse and a decrease in maximum ionic density of 20–25% was found in all three regions. The minimum ionisation occurred at or very shortly after the eclipse maximum. The results "indicate that ultra-violet light is an important ionising agency in the E, M, F_1 and F_2 regions."

1318. THE INTERACTION OF RADIO WAVES [" Luxembourg Effect " due to Non-Linear Relationships in the Ionosphere].—V. A. Bailey and D. F. Martyn. (*Wireless Engineer*, March, 1935, Vol. 12, No. 138, pp. 122–125.)

For previous papers *see* 1934 Abstracts, p. 606 and back references. The writers end by pointing out a subsidiary consequence of their theory: a station such as Luxembourg, which produces an appreciable disturbance in the ionosphere, must have its own modulation distorted during transmission through the ionosphere. *See* also 1396.

1319. FURTHER STUDIES OF RADIO TRANSMISSION IN GEOPHYSICAL INVESTIGATIONS [Smaller Apparent Propagation Velocity the Nearer the Great Circle lies to Magnetic Pole: etc.].—H. T. Stetson. (*Trans. Am. Geophys. Union*, June, 1934, Part I, pp. 158–160.) For previous papers *see* 1933 Abstracts, p. 615.

1320. Variation with Temperature of the Magnetic Susceptibility of an Electron Gas.—K. F. Niessen. (*Physica*, Oct./Nov. 1934, Vol. 1, No. 10/11, pp. 979–988: in German.)

In a previous paper the variation with field strength was investigated. Author's summary of present paper:—"It is shown that the magnetic susceptibility χ of an electron gas . . . increases with the temperature according to the formula

$$\chi = (n\mu_B{}^2/W_0) \,.\, (1 + \pi^2/12 \,.\, k^2T^2/W_0{}^2),$$

where n = number of electrons per cm³, $\mu_B = eh/4\pi mc$ (Bohr's magneton) and

$$W_0 = (3n/8\pi)^{\frac{2}{3}}h^2/2m$$

(Fermi energy limit for $T = 0$). The whole is based on the assumption of free electrons."

1321. Further Ozone-Measures and the Possible Connection of Ozone with the Sunspot-Cycle [New Data showing Higher Mean Value in spite of Sunspot Minimum, and Smaller Amounts of Ozone at Stations nearer Equator].—F. E. Fowle. (*Trans. Am. Geophys. Union*, June, 1934, Part I, pp. 160–162.) For a previous paper *see* 1933 Abstracts, p. 615.

1322. The Quantitative Determination of the Ozone Content of Air Layers near the Ground, with the Help of the Light Counter Tube.—B. Stoll. (*Helvet. Phys. Acta*, Fasc. 1, Vol. 8, 1935, pp. 3–38.)

1323. The Principal Limit of the Transmission of Solar Radiation by the Earth's Atmosphere in the Far Infrared.—A. Adel and V. M. Slipher. (*Phys. Review*, 1st Feb. 1935, Series 2, Vol. 47, No. 3, p. 251: preliminary letter.)

1324. Light of the Night Sky [Identification of Lines as Goldstein Nitrogen Bands].—J. Kaplan. (*Phys. Review*, 15th Jan. 1935, Series 2, Vol. 47, No. 2, p. 193.)

1325. Propagation of Micro-Radio Waves [Theory in Absence of Atmosphere: Qualitative Agreement with Marconi's Observations].—P. S. Epstein. (*Phys. Review*, 1st Feb. 1935, Series 2, Vol. 47, No. 3, p. 258: short abstract only.) *See* 934 of April.

1326. The Fundamentals of Decimetre Wave Technique [Propagation, Radiation, Generation and Reception of Micro-Waves: Calculation of Beam Concentration and of Energy taken up by Receiving Aerial].—W. Runge. (*Telefunken-Zeit.*, October, 1934, Vol. 15, No. 68, pp. 24–33.) Lecture to the Union for Aviation Research.

1327. Radio Wave Propagation: an Ultra-Short-Wave Demonstration Model [as at Physical Society's Exhibition].—E. C. S. Megaw. (*Wireless Engineer*, November, 1934, Vol. 11, No. 134, pp. 583–586.)

1328. Regular Ultra-Short [5-Metre] Wave Communication over 100 Miles [Hartford/Boston].—Hull. (*See* 1440.)

1329. Broadcasting Sound Pictures on Ultra-Short Waves in Germany.—Scholz. (*See* 1526.)

1330. Lines with Distributed Electromotive Forces, *and* Lines with Distributed Propagating E.M.F. [Application to Receiving Aerials, etc.].—K. Kurokawa. (*Jap. Journ. of Eng. Abstracts*, Vol. 10, 1934, pp. 39 and 40.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

1331. Audio-Frequency Atmospherics [including Their Possible Use in Layer-Height and Electrical Storm Measurements].—E. T. Burton and E. M. Boardman. (*Trans. Am. Geophys. Union*, June, 1934, Part I, pp. 155–158.) For previous papers *see* 958 of April.

1332. Lightning Effects [Description of Radio Set struck by Lightning].—H. E. Adshead. (*Wireless Engineer*, November, 1934, Vol. 11, No. 134, p. 605.)

1333. The Mechanism of the High Velocity of Propagation of Lightning Discharges [Velocity of Discharge Tip greatly exceeds Velocity of Electrons in the Tip].—A. M. Cravath and L. B. Loeb. (*Phys. Review*, 1st Feb. 1935, Series 2, Vol. 47, No. 3, pp. 259–260.)

1334. Lightning Discharges to Grounded Conductors [and Their Frequent Occurrence: Visible Discharges from Trees, Aerials, etc.].—J. C. Jensen. (*Trans. Am. Geophys. Union*, June, 1934, Part I, pp. 133–135.) Contribution to the discussion referred to in 1934 Abstracts, p. 316 (Zeleny).

1335. Spark Breakdown in an Inhomogeneous Field [caused by Space-Charge Instability: Theoretical Considerations].—W. Rogowski. (*Arch. f. Elektrot.*, 11th Feb. 1935, Vol. 29, No. 2, pp. 130–134.)

1336. Photoelectric Effect and Spark Mechanism [Intensities and Absorption Coefficients of Photoelectric Effects produced by Radiation from Electron Currents in Air would explain Sparking Potential].—A. M. Cravath. (*Phys. Review*, 1st Feb. 1935, Series 2, Vol. 47, No. 3, p. 254: abstract only.)

1337. Application of the Wilson Chamber to the Study of Spark Discharge [in Air: Formation and Distribution of Ions].—U. Nakaya and F. Yamasaki. (*Proc. Roy. Soc.*, Series A, 1st Feb. 1935, Vol. 148, No. 864, pp. 446–453.)

Photographs of ion clouds for various conditions of spark discharge are given; the ion cloud from the negative electrode is found to be spindle-shaped and of a diffuse character, while that from the positive electrode is composed of thin streamers of well-defined form.

1338. The Charged and Uncharged Nuclei in the Atmosphere and Their Part in Atmospheric Ionisation.—F. J. Scrase. (*Met. Office, Geophys. Mem.* No. 64, 1935, 15 pp.)

"The mean of the ratio of the numbers of uncharged nuclei and large ions of each sign at Kew was found to be 3.5, but smaller values were obtained when nuclei were very numerous, *i.e.* in conditions of high humidity and poor visibility. The range of vision was found to be roughly inversely proportional to the square of the nucleus content. . . . Estimates of the combination coefficients between small ions and charged and uncharged nuclei have been obtained."

1339. Atmospheric Electrical Condition and Meteorological Elements.—K. Shiratori. (*Mem. Fac. Sci. and Agric.*, Taihoku Imp. Univ., December, 1934, Vol. 10, No. 6, pp. 203–296: in English.)

Among the various conclusions, it is found that "the associations between conductivity and meteorological elements, except wind velocity, are not so simple and apparently seem to differ by season. . . . By the method of partial correlation for finding the effects of single elements it can be known that the principal influence is wind velocity in any season; but only in morning of summer the largest influence is temperature. The effect of rain depends largely on its intensity, and heavy rain causes often abnormal increases of conductivity, though drizzle rain lets it decrease. The wetness of soil after rain affects the emanation content in air and therefore results to reduce conductivity. The conductivity during thunderstorm and typhoon undergoes abnormal variation not only for the $\lambda -$ but also for the $\lambda +$, which may be caused by the polarisation effect of the atmospheric electric field and by the influence of wind and rain."

1340. Radio and Earth-Potential Observations in New England.—Kenrick and Goldberg. (*See* 1315.)

1341. An Analysis of the Diurnal Variation of the Earth's Potential Gradient.—J. G. Brown. (*Phys. Review*, 1st Feb. 1935, Series 2, Vol. 47, No. 3, p. 259: abstract only.)

1342. An Arrangement for Automatic Alteration of the Sensitivity of a Benndorf Recording Electrometer [for Measurement of Atmospheric Electric Disturbances]. —R. Steinmaurer. (*Physik. Zeitschr.*, 1st Feb. 1935, Vol. 36, No. 3, pp. 106–107.)

1343. Atmospheric-Electric Observations at the College-Fairbanks Polar-Year Station [Alaska].—K. L. Sherman. (*Trans. Am. Geophys. Union*, June, 1934, Part I, pp. 141–142.)

1344. The Production of the Auroral Spectrum in the Laboratory.—J. Kaplan. (*Trans. Am. Geophys. Union*, June, 1934, Part I, pp. 162–166.) For other papers *see* 968 of April: *cf.* also 380 of February.

1345. Aurorae and Earth-Currents.—W. J. Rooney. (*Trans. Am. Geophys. Union*, June, 1934, Part I, p. 166: abstract only.)

1346. Preliminary Report on Auroral, Magnetic, and Earth-Current Observations at Chesterfield, North-West Territories, Canada.—J. Patterson. (*Trans. Am. Geophys. Union*, June, 1934, Part I, pp. 166–167.)

1347. Reports on Magnetic and Electric Work of Organisations in N. America during 1933/1934.—(*Trans. Am. Geophys. Union*, June, 1934, Part I, pp. 177–186.)

1348. Some Facts about Secular Variation of the Earth's Magnetism [and the Correlation with Sunspot Numbers].—R. O. Sandoval. (*Trans. Am. Geophys. Union*, June, 1934, Part I, pp. 167–169.)

1349. Apparent Effect of Magnetic Activity upon Secular Variation of the Vertical Component of the Earth's Magnetic Field.—A. G. McNish. (*Trans. Am. Geophys. Union*, June, 1934, Part I, pp. 175–176.)

1350. "Earth, Radio and the Stars" [Book Review].—H. T. Stetson. (*Rad. Engineering*, November, 1934, Vol. 14, No. 11, p. 22.)

1351. [Observed] North-South Asymmetry of the Cosmic Radiation in Mexico, *and* "Shadow" of Earth Explains Cosmic Ray Variation.—T. H. Johnson. (*Phys. Review*, 1st Jan. 1935, Series 2, Vol. 47, No. 1, pp. 91–92: *Sci. News Letter*, 26th Jan. 1935, Vol. 27, No. 720, p. 53.)

1352. The Equatorial Longitude Effect in Cosmic Rays [Dissymmetry in Earth's Magnetic Field extends Far into Space].—R. A. Millikan and H. V. Neher. (*Phys. Review*, 1st Feb. 1935, Series 2, Vol. 47, No. 3, pp. 205–208.)

1353. Production of Induced Radioactivity by the Cosmic Radiation [Occurrence of Double "Stösse"].—J. E. I. Cairns: Alvarez. (*Phys. Review*, 15th Jan. 1935, Series 2, Vol. 47, No. 2, p. 194.) For a reply by Alvarez, asserting that the artificial radioactivity hypothesis is unnecessary, probability laws accounting for the observed number of pairs of bursts, see *ibid.*, 15th Feb. 1935, pp. 320–321.

1354. The Origin of the Hardening of Cosmic Rays in Passing through Matter [Theoretical Explanation assuming Single Energy for Rays entering Atmosphere].—W. F. G. Swann. (*Phys. Review*, 1st Feb. 1935, Series 2, Vol. 47, No. 3, p. 250.)

1355. Cosmic Rays and Nova Herculis [Increase of Cosmic Ray Intensity coincides with Appearance of Nova], *and* Cosmic Rays and Novae [Energy Supply Considerations]. —W. Kolhörster: W. H. McCrea. (*Zeitschr. f. Physik*, No. 5/6, Vol. 93, 1935, pp. 429–431: *Nature*, 9th March, 1935, Vol. 135, pp. 371–372.)

1356. Origin of the Cosmic Rays [High-Speed Particles accelerated by Gravitational Pull of Universe].—E. A. Milne. (*Nature*, 2nd Feb. 1935, Vol. 135, p. 183.)

1357. [Experimental] Evidence for a Positron-Negatron Component of the Primary Cosmic Radiation.—T. H. Johnson. (*Phys. Review*, 15th Feb. 1935, Series 2, Vol. 47, No. 4, pp. 318–319.)

1358. The Different Types of Rays in the Complete Structure of Cosmic Radiation [Primary Radiation is Charged Massive Particles: Classification of Subsidiary Types and New Experiments].—H. Geiger and E. Fünfer. (*Zeitschr. f. Physik*, No. 7/8, Vol. 93, 1935, pp. 543–555.)

1359. Terrestrial Magnetism and Cosmic Rays [" Variations of the Second Kind " partly due to Variations in the Opposite Sense of Horizontal Component of Earth's Magnetic Field].—V. F. Hess and W. Illing. (*Nature*, 19th Jan. 1935, Vol. 135, pp. 97–98.)

1360. Influence of a Circular Equatorial Current on the Cosmic Rays.—de Benedetti and Vigano. (*La Ricerca Scient.*, 15/31 Dec. 1934, 5th Year, Vol. 2, No. 11/12, pp. 422–431.)

1361. Recent Researches on Fluctuations of Cosmic-Ray Ionisation.—J. W. Broxon. (*Trans. Am. Geophys. Union*, June, 1934, Part I, p. 143.)

1362. Absorption of Cosmic Particles in Copper and Lead [No Marked Dependence on Atomic Number of Absorbing Screen].—G. Alocco. (*Nature*, 19th Jan. 1935, Vol. 135, pp. 96–97.)

1363. Apparatus for Transmitting Cosmic-Ray Data from Stratosphere [by Radio Signals controlled by Photocell].—J. M. Benade and R. L. Doan. (*Phys. Review*, 15th Jan. 1935, Series 2, Vol. 47, No. 2, p. 198: abstract only.)

PROPERTIES OF CIRCUITS

1364. On the Stability of a Network with Retroaction.—M. Bayard. (*Ann. des P.T.T.*, February, 1935, Vol. 24, No. 2, pp. 109–115.)

1365. The Frequency Analysis of the Heterodyne Envelope [Coefficients of Fourier Series in terms of Complete Elliptic Integrals].—A. C. Bartlett. (*Wireless Engineer*, September, 1934, Vol. 11, No. 132, pp. 482–483.)

1366. The Graphical Determination of the Efficiency Curve from the Input/Output Power Curve.—A. Grocholski. (*E.T.Z.*, 7th Feb. 1935, Vol. 56, No. 6, pp. 125–126.)

1367. Impedance-Matching Networks [Calculation simplified by Table of Constants].—B. Ephraim. (*Rad. Engineering*, October, 1934, Vol. 14, No. 10, pp. 12–13.) For corrections and criticisms see *ibid.*, February, 1935, p. 26.

1368. Investigations on the Non-Quasi-stationary Current Distribution in Systems of Linear Conductors.—Pfister. (*See* 1430.)

TRANSMISSION

1369. Wide-Band Transmission over Balanced Circuits.—A. B. Clark. (*Bell S. Tech. Journ.*, January, 1935, Vol. 14, No. 1, pp. 1–7.) *See* 1122 of April.

1370. Oscillations in a Split-Anode Magnetron: Mechanism of Generation [particularly of the New " Rotating-Field " Oscillations: the Advantages of the Four-Plate Magnetron].—K. Posthumus. (*Wireless Engineer*, March, 1935, Vol. 12, No. 138, pp. 126–132.)

For the " rotating-field " magnetron oscillations *see* 91 of January. As with the " electronic " type, their preferred frequency depends on the anode potential and the magnetic field strength, but this frequency is *inversely* proportional to the field strength, which is generally very much above the critical cut-off value for the static condition. With the four-plate magnetron an efficiency of more than 50% is often obtained.

1371. The Generation of Oscillations with the Magnetron [Design Theory, and Some Telefunken Two- and Four-Slit Types: the Lack of a Good Modulation System: etc.].—W. Runge. (*Telefunken-Zeit.*, December, 1934, Vol. 15, No. 69, pp. 5–14.)

1372. The Production of Electric [Micro-] Waves of Length less than One Metre.—K. W. Wagner and H. E. Hollmann. (*E.N.T.*, December, 1934, Vol. 11, No. 12, pp. 418–437.)

A comprehensive account of the developments of the last few years, references to which are to be found throughout these Abstracts. The subjects dealt with are reaction oscillators, the Barkhausen retarding-field method, Gill-Morrell oscillations, dwarf waves, working diagrams, specially designed valves: the physical basis of electron motion: and the magnetron with its recent developments. A list of relevant articles is appended. *See* also 1373.

1373. The Production of Ultra-Short [and Micro-] Waves.—G. W. O. H. (*Wireless Engineer*, March, 1935, Vol. 12, No. 138, pp. 119–121.) Prompted by the Kelly-Samuel paper (748 of March) and that of Wagner & Hollmann (*see* 1372).

1374. The Mechanism of Electronic Oscillations [in Brake-Field Triode: Combination of " Swinging Electron " and Current-Voltage Phase-Difference Conceptions].—W. E. Benham. (*Wireless Engineer*, January, 1935, Vol. 12, No. 136, pp. 3–7.)

1375. " Inductive " Amplification in a Valve with Negative Anode, and Its Possible Connection with B.-K. Micro-Wave Oscillations.—Bakker and de Vries. (*See* 1390.)

1376. New Types of [Ultra-] Short-Wave Tuned Circuits.—(*Wireless World*, 22nd March, 1935, Vol. 36, pp. 290–292.)

A résumé of the specialised technique developed for r.f. amplification on ultra-short waves by various workers and published in the *Proceedings of the*

Institute of Radio Engineers, in *Electrical Engineering*, and in the Russian *Journal of Technical Physics*. *See* Abstracts, 1934, p. 556 (Terman); 98 of January (and back reference); and 988 of April.

1377. Practical Communication on the 224-Mc Band: the New Tube and Directive [Yagi] Antennas reveal a World of Possibilities [Ultra-Short-Wave Transmitter and "Acorn" Detector Valve Receiver].—R. A. Hull. (*QST*, November, 1934, Vol. 18, No. 11, pp. 8–11 and 66.)

"It is our impression that the signals on the new band soak into valleys and generally cover the landscape more effectively than our 56 Mc signals have done. . ." Strong signals were received in a motor car over a 50-mile path blocked by 1 200-ft hills.

1378. Stabilising the Ultra-High-Frequency Transmitter: Resonant Short-Line Frequency Control for 2.5 and 5 Metre Oscillations.—R. A. Hull: Terman. (*QST*, February, 1935, Vol. 19, No. 2, pp. 13–15.) Experimental work based on Terman's paper (1934 Abstracts, p. 556.)

1379. The Temperature Coefficient of Inductance, with Special Reference to the Valve Generator [Estimation of Effect of Expansion without and with Deformation].—E. B. Moullin. (*Proc. Inst. Rad. Eng.*, January, 1935, Vol. 23, No. 1, pp. 65–84.)

"It is suggested, in conclusion, that if a valve generator is found to have a temperature coefficient of frequency which is notably greater than half the coefficient of linear expansion of the metal of the coil, then the dominant cause is not change of inductance."

1380. Effect of Temperature on Inductance of Coil controlled by Eddy-Current Surface at suitable Distance and of suitable Shape and Coefficient of Expansion.—Telefunken. (German Pat. 598 724, pub. 16.6.1934.)

1381. Development of the Quartz Control of the Telefunken High-Power Transmitters: Part II.—R. Bechmann. (*Telefunken-Zeit.*, October, 1934, Vol. 15, No. 68, pp. 16–24.)

For Part I *see* Abstracts, 1934, p. 34. The results of the continuous method of temperature control there described are now shown by data of the performance of the Vienna, Mühlacker, and other stations during 1933 and 1934. The frequency fluctuations are seen to lie inside the limits of accuracy of measurement—4×10^{-6}. "Thus the effectiveness of the system described exceeds the present broadcasting requirements." The writer then passes on to the recent development of quartz oscillators with very small temperature coefficients, dealing briefly with the method using a circuit combining quartz crystals of positive and negative coefficients, the method combining two modes, in the same crystal, with opposed coefficients (*e.g.* Lack, 1929, p. 582, and Parkin, 1932, pp. 594–595), and the method using some compensating change in a circuit element such as the quartz holder. He then discusses at greater length the method depending on special orientations of the crystal cut, giving temperature coefficients of any desired value within the limits $\pm 80 \times 10^{-6}$, including the (theoretical) value zero (Bechmann, 1934, p. 47, and 503 of February). With these γ_δ-cut crystals, of which the ordinary γ-cut is only a special case ($\delta = 90°$) it is easy to obtain a temperature coefficient of 1×10^{-6}, and with great care this can be reduced to below 1×10^{-7}. The latest quartz holders are finally described.

1382. The Temperature Coefficient of Quartz Plates for Long Waves [1 000 to 3000 m].—I. Koga. (*E.N.T.*, January, 1935, Vol. 12, No. 1, pp. 1–2.)

The plates are cut parallel to the electric axis and suitably oriented relative to the optical axis (Koga and Takagi, end of 1021 of April: Bechmann, 503 of February). Fig. 1 shows the relation between the angle to the optical axis and the natural frequency, with the temperature coefficients. Figs. 2 and 3 give measurements showing the changes in the temperature coefficients for different temperatures of observation. Figs. 4 and 5 show measurements for another plate. It will probably be possible to design plates with very flat temperature/frequency curves.

1383. High Power from the Crystal Oscillator: a Controlled-Oscillator Circuit in which the Crystal Load is Adjustable ["R" Circuit enabling 100 Watts to be handled in One Stage].—D. E. Ruspoli. (*QST*, November, 1934, Vol. 18, No. 11, pp. 13–16.)

1384. Short Waves in the Service of Reporting [Portable Transmitters at Gliding Competitions, for Running Commentaries, etc.].—(*Telefunken-Zeit.*, October, 1934, Vol. 15, No. 68, pp. 50–53.) *See* also 1001 of April.

1385. Portable 40-Metre Transmitter.—(*Wireless World*, 1st and 15th March, 1935, Vol. 36, pp. 210–212 and 260–262.)

1386. Theory of Anode-Voltage Modulation. Part I.—R. Hofer. (*Telefunken-Zeit.*, October, 1934, Vol. 15, No. 68, pp. 34–42.)

The writer points out that anode-voltage modulation, either by the parallel-valve or the series-valve method, has not hitherto been dealt with thoroughly in the literature. Methods for the experimental determination of the "modulation characteristic" have been described, but such characteristics are often valid only for a very narrow range of notes, because the impedance of various circuit components (condensers, modulating choke, transformer, etc.) may cause a variation with frequency of the a.c. anode voltage transferred to the r.f. valve. Moreover, he shows later that even the resistance of the latter valve, for note frequencies, does not remain unchangedly ohmic for all modulating notes but must take on a distinctly complex value for the higher frequencies, unless the detuning of the carrier-tuned oscillatory circuit with respect to the sidebands is to be neglected.

The present work, therefore, deals with the definition of the three important quantities involved, namely the l.f. resistance of the r.f. valve, the effective sideband e.m.f. acting on this valve, and the valve's internal resistance to these sidebands;

together with the dependence of these three quantities on frequency and on amplitude. The continuation of the paper is announced, but does not appear in No. 69 (December, 1934).

1387. Measurement of the Modulation Percentage of Amplitude-Modulated Oscillations: Comprehensive Survey.—E. Alberti. (*Funktech. Monatshefte*, January, 1935, No. 1, pp. 1-7.)

Theoretical: method using oscillographic recording of oscillation curve (Mauz and Zenneck: von Ardenne): stroboscopic method (Heilmann): frequency spectrum method (Runge): change of aerial current method (Geissler): measurement of effective value of modulation voltage (Kammerloher): measurement of ratio of maximum amplitudes of unmodulated and modulated transmissions (Geissler, Jolliffe): measurement of the ratio of the maximum value of amplitude to effective value of modulated current (Mandelstam and Papalexi): measurement of maximum and minimum amplitudes (van der Pol and Posthumus): measurement of ratio of modulated current to carrier current, taken simultaneously (Geissler): and finally, cross-coil meter methods (Büge, Hallen).

1388. The Design of Class B Amplifiers [L.F. and R.F., by Graphical Method using Sets of Hyperbolae on Transparent Celluloid for use on Valve Characteristic Sheets].—de la Sablonière. (*Wireless Engineer*, March, 1935, Vol. 12, No. 138, pp. 133-141.)

1389. The Dynatron Frequency Doubler.—T. Hayasi. (*Journ. I.E.E. Japan*, July, 1934, Vol. 54 [No. 7], No. 552, p. 801: Japanese only.)

RECEPTION

1390. Amplification of Small Alternating Tensions by an Inductive Action of the Electrons in a Radio Valve with Negative Anode.—C. J. Bakker and G. de Vries. (*Physica*, Oct./Nov. 1934, Vol. 1, No. 10/11, pp. 1045-1054: in English.)

Authors' summary:—"The possibility of amplification is investigated both theoretically and experimentally when the anode is kept negative, so that the electrons in a thermionic valve cannot reach this anode, but approach it sufficiently near to induce considerable charges. The influence of the transit times is taken into account. The agreement of theory and experiment is satisfactory." The writers have constructed a receiver with 3 r.f. stages; inter-stage grid capacities and leaks could be omitted, and the receiver gives very good results for wavelengths 15-50 m. The induction effect here developed "might be of importance for the explanation of the Barkhausen-Kurz oscillations in a triode."

1391. Notes on the Theory of Diode Rectification [assuming Linear Characteristic and Load Resistance shunted by Capacity: the Influence of R/ρ and θ/T].—J. Marique. (*Wireless Engineer*, January, 1935, Vol. 11, No. 136, pp. 17-22.) "This study shows that independently of the improvement of smoothing, the increase of the time constant of the load circuit increases the average rectified voltage, the useful power, and the output." *See* also 717 of March.

1392. The "Acorn" Valve as Detector in an Ultra-Short-Wave Receiver [134 cm].—Hull. (*See* 1377.)

1393. Linear Detector Distortion [due to Modulation over 100%, Sidebands unsymmetrical in Phase owing to Detuning: etc.].—K. W. Jarvis. (*Electronics*, December, 1934, pp. 386-387.)

1394. Beat-Note Change and Frequency "Jump" of an Oscillating Audion as the Tuning of the R.F. Pre-Amplifier Circuit is Varied.—W. Kautter. (*Telefunken-Zeit.*, December, 1934, Vol. 15, No. 69, pp. 26-35.)

In an oscillating-audion receiver with r.f. pre-amplifying stages it is of course desirable that the audion frequency should be controlled simply by the audion-circuit tuning. Actually, however, as the tuning of the r.f. circuit is varied a more or less marked note change is liable to be produced which may develop into a sudden "spring" or (for a close enough coupling) into a setting-up of oscillation in the r.f. stages. The cause lies in some kind of coupling between the audion and r.f. circuits. If there are several r.f. stages in front of the audion, a direct coupling with the first r.f. circuit is naturally the greatest danger. Since, however, screening and the use of choke coils can to a great extent prevent all such external couplings, the practically important coupling is that due to the grid/plate capacity of the r.f. valve. With triodes this capacity is so large that neutralisation is necessary to prevent oscillation, but with screen-grid valves such neutralisation is not necessary and is not generally provided.

The writer gives a quantitative analysis of the influence of the r.f. circuit acting through this capacity, deriving simple formulae by which it can be calculated how far from the "spring" of the audion wave, and from the r.f. oscillation point, the system is being worked. The change of note can, it is true, be prevented by the introduction of a weak coupling between grid and anode circuits; not only, however, is this an undesirable principle but also such a neutralisation is, strictly speaking, only possible for a single frequency (p. 35). In the course of the analysis it is shown that the coupling of grid and anode circuits in a r.f. amplifier, whether through a capacity or through a slight magnetic coupling, is quite different in its action from the ordinary magnetic coupling between two circuits; in particular, negative conductances (*see* 1934 Abstracts, p. 206, r-h col.) occur in the former which are prohibited in the latter by energy considerations. Further, it is seen that the demands of de-coupling become more difficult to fulfil as the amplification per stage increases, and that as a consequence it is quite impossible to use the full "durchgriff" amplification of modern screen-grid valves.

1395. The Grid-Anode Capacity of Valves: Its Effect on the Associated Tuned Circuits.—M. O'C. Horgan. (*Wireless Engineer*, September, 1934, Vol. 11, No. 132, pp. 464-475.)

1396. OBSERVATIONS OF THE "INTERACTION" EFFECT: A NEW DANGER FOR BROADCAST RECEPTION? LUXEMBOURG AND DROITWICH INTERFERE WITH SEVEN OTHER STATIONS.—K. Schmoll. (*Funktech. Monatshefte*, January, 1935, No. 1, pp. 9–12.)

With descriptions of interference by Luxembourg with reception from Leipzig, Munich, Lyons, Stuttgart, Beromünster (and Sottens) and Radio Paris, and by Droitwich with reception from Athlone. Apart from the case of Radio Paris, all the effects were in the 380–540 m band. A special case of interference with the Leipzig transmission, traced to Cologne, is also described: this is another example of the "straight line rule." It is mentioned that when the Luxembourg wave suffers fading the effect does not extend to the interfering modulation, but if fading occurs to the interfered-with station the Luxembourg modulation simultaneously decreases. In bad conditions for distant reception the interaction effect is more pronounced. A specimen form for forwarding observations to the journal is given. *See* also 1318.

1397. WAVE-TRAPS AND SELECTORS [Improved Efficiency by Use of Retroacting Valve].—F. G. Mee. (*Wireless World*, 22nd March, 1935, Vol. 36, pp. 285–286.)

1398. MEASURES FOR THE REDUCTION OF INTERFERENCE BY STRAY CAPACITIVE FIELDS IN AMPLIFIERS.—F. Benz. (*Hochf:tech. u. Elek:akus.*, February, 1935, Vol. 45, No. 2, pp. 61–65.)

"In the following, methods are described which are employed for the reduction of interference, particularly in low-frequency amplifiers. A special point is to investigate how far the interfering fields can be reduced in their effects by screening, envelope shielding ['Hülling,' by cans, etc.] and also by earthing and by a little known measure named by the writer 'Flächenwirkung' [levelling effect]." In his explanation of the last measure the writer points out the receiving-antenna action of the input leads, the effective height of the "aerial" depending on the distance apart of these leads (Fig. 6) and on the metallic parts attached to them. Thus the effect to be aimed at is to make these input leads resemble a feeder rather than an aerial; the same applies also to the output leads, to reduce their "transmitting aerial" action. The general principle therefore is to fix the metallic parts to a cathode-potential plate and to run the "dangerous" leads as close to this as possible. Earthing, well known as an interference-reducing measure in amplifiers, is merely a special case of the "levelling" process.

The writer shows that in many cases the "levelling" method may well replace screening and envelope shielding, both inside an amplifier and in the input and output leads. "The advantage is particularly noticeable at high frequencies, at which the shielding of a lead would produce too great a capacitive shunt." The one lead may run close to the cathode-potential lead or may be twisted round it. Multi-stage amplifiers should be divided into units (pre-, intermediate- and main-) each of 3 or 4 stages at most: the units should be separately screened by metal boxes, and the various stages mounted on a metal plate: the components should be mounted on this plate or on conductors connected to it. The connections should be run as close as possible to this plate or to the connected conductors. The various transformers should have one pole, both on the input and the output side, connected to the cathode, and the iron cores should be similarly connected.

1399. RADIO INTERFERENCE FROM LUMINOUS GAS TUBES, *and* THE SUPPRESSION OF INTERFERENCE IN BADEN-BADEN.—G. W. O. H. (*Wireless Engineer*, August, 1934, Vol. 11, No. 131, pp. 403–404.)

1400. PLAN TO ELIMINATE RADIO INTERFERENCE.—A. N. Goldsmith. (*Electronics*, December, 1934, pp. 370–371.)

1401. DIATHERMY INTERFERENCE: DATA ON THE ELIMINATION OF RADIO INTERFERENCE PRODUCED BY HIGH-FREQUENCY ELECTRO-MEDICAL APPARATUS.—R. L. Haskins. (*Rad. Engineering*, February, 1935, Vol. 15, No. 2, pp. 20–21 and 26.)

1402. THE DETERIORATION OF RUBBER-COVERED IGNITION CABLES.—Haas. (*See* 1632.)

1403. DECOUPLING EFFICIENCY.—R. I. Kinross: Barclay. (*Wireless Engineer*, September, 1934, Vol. 11, No. 132, p. 482.) For previous correspondence *see* 1934 Abstracts, p. 91, l-h column.

1404. SECOND CHANNEL AND HARMONIC RECEPTION IN SUPERHETERODYNES [and the Question of Trouble caused by Back-Coupling between First and Second Detectors].—G. W. O. H. (*Wireless Engineer*, September, 1934, Vol. 11, No. 132, pp. 461–463.)

1405. CONNECTING SEVERAL RECEIVERS TO ONE AERIAL: A NOTE ON THE PROBLEMS INVOLVED.—M. Reed. (*Wireless Engineer*, August, 1934, Vol. 11, No. 131, pp. 428–430.)

1406. RECEIVER PERFORMANCE DATA [Some Difficulties in obtaining Absolute Measurements: Inconsistencies of Standard Signal Generators, etc.].—H. E. Stoakes: Cocking. (*Wireless Engineer*, January, 1935, Vol. 12, No. 136, pp. 22–23.) Prompted by Cocking's articles (114 of January). For a criticism by Scroggie see *ibid.*, March, p. 141.

1407. BROWN MULTI-WAVE TUNER.—(*Wireless World*, 29th March, 1935, Vol. 36, p. 319.)

A description is given of a new system of tuning developed by S. G. Brown, in which inductance and capacity are not lumped together as in ordinary technique, but are distributed. Among the peculiarities of a circuit of this type is the fact that the current is not uniform throughout its length, but may drop to zero at one or more points depending upon its dimensions. At these nodal points the voltage is at a maximum, so that the greatest voltage is obtained for the operation of a valve by tapping off at a current node.

1408. METHODS FOR THE EXTENSION OF THE VOLUME RANGE OF BROADCAST PROGRAMMES, AND PROPOSALS RELATIVE TO THEIR USE AT THE TRANSMITTER AND RECEIVER.—(*Rad. Engineering*, November, 1934, Vol. 14, No. 11, pp. 7–9 and 13.)

1409. An Improved Short-Wave Frequency Changer.—E. J. Alway. (*Wireless World*, 1st March, 1935, Vol. 36, pp. 213–214.)

Difficulties arise when using a heptode frequency changer on short wavelengths owing to the coupling between oscillator and screen-grid portions of the valve. The author describes a method of eliminating this trouble.

1410. Noise introduced in Superheterodynes with Frequency Conversion [and the Superiority of the Pentagrid Converter].—C. A. Hultberg. (*Rad. Engineering*, October, 1934, Vol. 14, No. 10, pp. 22–23.)

1411. Correct and Incorrect Uses of Valves [especially in Automatic Volume Control].—K. Steimel. (*Electronics*, October, 1934, pp. 327–328: summary only.)

1412. The Design of A.V.C. Systems: A Practical Review of the Chief Methods.—W. T. Cocking. (*Wireless Engineer*, August/October, 1934, Vol. 11, Nos. 131, 132 and 133, pp. 406–414, 476–482, and 542–547.) For correspondence see *ibid.*, September, 1934, and February, 1935, pp. 483 and 87.

1413. A Note on Self-Bias Circuits [Reduction of Amplification, and Its Avoidance: a Possible Increase of Amplification].—E. Williams. (*Wireless Engineer*, November, 1934, Vol. 11, No. 134, pp. 600–602.) For a criticism by Hansen see *ibid.*, January, 1935, p. 23.

1414. Prevention of Repeat Points [in Superheterodynes]. — Rechnitzer. (*Electronics*, November, 1934, p. 364.) Long summary of the paper referred to in 728 of March.

1415. Wave-Band Switch Design.—L. L. Manley. (*Rad. Engineering*, December, 1934, Vol. 14, No. 12, pp. 25–26.)

1416. Mechanical Features of the Season's Radio Sets.—(*Electronics*, November, 1934, pp. 344–346.)

1417. Signal-Seeking Circuits to aid Correct Tuning [" Directive Sense " Circuits supplying " Corrector " Circuits].—S. Y. White. (*Electronics*, January, 1935, p. 18.)

1418. Receiver Design Trends [All-Wave Receivers, with Double Doublet or other Horizontal-Polarisation Aerial: Separately Shielded Coils for Each Band: Self-Seeking Circuits for Automatic Tuning Correction: Beat-Oscillator Circuits for Short-Wave Tuning: Dual A.F. Amplifiers: Acoustic Labyrinths: Deflector Plates in front of Loudspeaker: etc.].—(*Rad. Engineering*, February, 1935, Vol. 15, No. 2, pp. 7–11.)

1419. Scanning 1934: a Review of Radio Broadcast Reception during 1934 [with American Statistics].—R. H. Langley. (*Rad. Engineering*, January, 1935, Vol. 15, No. 1, pp. 7–10.) *See* also pp. 13, 20.

1420. Radio Broadcast Receivers: a Review of the Design Considerations involved in the Production of Broadcast Receivers for European Markets.—J. S. Jammer and L. M. Clement. (*Rad. Engineering*, December, 1934, Vol. 14, No. 12, pp. 16–22.) *See* 733 of March.

1421. The Modern Broadcast Receiver—an Electro-Technical Precision Apparatus [Works Methods, Component Testing, etc.]—H. Kalden. (*Funktech. Monatshefte*, September, 1934, No. 9, pp. 375–379.)

1422. Characteristics of German Radio Receivers.—W. E. Schrage. (*Electronics*, October, 1934, pp. 306–307.)

1423. Advancements in A.C.-D.C. Design [Universal Superheterodyne Broadcast Receiver 9 × 4 × 6.5 Inches designed to Special Requirements].—P. Ware. (*Electronics*, January, 1935, pp. 14–15.)

1424. New Superheterodyne Arrangements: the Duplex Superhet [with Double Frequency Change] and the Superhet with Short-Wave Oscillator [*Wireless World* " Single Span "].—Schwandt: Miram. (*Funktech. Monatshefte*, September, 1934, No. 9, pp. 361–364.)

1425. Reflex Knapsack Receiver [using the Special " People's Receiver " Valves KC1 and KL1].—F. Nittura. (*Funktech. Monatshefte*, September, 1934, No. 9, pp. 365–366.)

1426. A Long-Distance Receiver of the Highest Fidelity.—W. Nestel. (*Funktech. Monatshefte*, September, 1934, No. 9, pp. 373–374.)

1427. A New Standard System of Reporting Signals [the " RST " System].—A. M. Braaten. (*QST*, October, 1934, Vol. 18, No. 10, pp. 18–19 and 106, 107.)

1428. The Decibel as a Unit of Receiver Sensitivity.—K. D. Huff. (*Rad. Engineering*, December, 1934, Vol. 14, No. 12, pp. 23 and 26.)

AERIALS AND AERIAL SYSTEMS

1429. On the Regulation of the Velocity of Propagation of Electromagnetic Waves in Aerial Conductors.—M. S. Neumann. (*Journ. of Tech. Phys.* [in Russian], No. 8, Vol. 4, 1934, pp. 1535–1550.)

As is well known, the velocity of propagation of electromagnetic waves in a transmission line is $c/\sqrt{LC}$, where L and C are the inductance and capacity of the line per unit length. For a normal line the product LC is unity and the velocity is therefore equal to c. By altering the values of L and C velocities smaller and greater than c can be obtained (in the latter case these will of course be phase velocities and not the rate at which energy is propagated along the line.) A number of very simple methods are indicated for increasing L and C and for reducing L (it is considered impracticable to reduce C). For instance, L can be increased by inserting a few turns of wire in the line of definite intervals, and decreased by connecting perpendicular conductors between $\lambda/2$ and $\lambda/4$ in length. C can be increased by mounting metal discs of, say, 20 cm diameter for a line of 0.2 cm diameter, etc.

A number of practical applications of these principles are then given under the following headings. (a) *Long-Wave Aerials.* A comparative study is given of an ordinary L type aerial and an aerial of the same dimensions in which the velocity of propagation has been reduced by one half. The following results are obtained :—The inductance of the loading coil required for the second aerial is two fifths of that for the first ; the effective height is increased by 2.4% ; the potential at the far end of the aerial remains practically unchanged and the decrement is increased 1.65 times, a very important feature for high speed telegraphy and for telephony. If the same aerial is arranged so that the velocity of propagation is halved in the horizontal portion and doubled in the downlead, the effective height is increased by 20%, and for the same effective height, therefore, masts 20% lower can be used, representing a saving in the cost of the masts of about 45%.

(b) *Broadcasting Aerials.* By reducing the velocity in the horizontal portion of the aerial the length of this portion can also be reduced, thus not only lowering the cost of the aerial but also diminishing the undesirable radiation from the horizontal portion. By reducing the velocity in both the downlead and horizontal portions the size of the aerial can be considerably decreased and an effective height exceeding the physical height obtained. In some cases it is possible to dispense altogether with the horizontal portion by using a slightly inclined aerial supported by one mast and either reducing the velocity in the whole aerial or reducing it in the upper part and increasing it in the lower part.

(c) *Simple Short-Wave Radiators.* By altering the velocity in a half-wave radiator standing waves are obtained of shorter or greater length than in free space, and the relationship between the physical length of the radiator and the operating wavelength can therefore be varied. A number of polar diagrams are given showing the effect of velocity variation on the directive properties of radiators of various lengths, and a curve is added showing that the radiation resistance of a half-wave radiator increases very rapidly with the increase of velocity.

(d) *Complex Short-Wave Aerials.* By using the above methods the tuning of a complex short-wave aerial can be considerably simplified and the actual size of the conductors and spacing between them made much more flexible. A Telefunken aerial is examined as an example and some indications are given for obtaining the maximum directive effect, (*a*) when the number of radiators is fixed and the size of the aerial can be varied, and (*b*) when the number of radiators can be varied and the size of the aerial is fixed.

1430. INVESTIGATIONS ON THE NON-QUASISTATIONARY CURRENT DISTRIBUTION IN SYSTEMS OF LINEAR CONDUCTORS.—W. Pfister. (*Ann. der Physik*, Series 2, No. 1, Vol. 22, 1935, pp. 31–52.)

The main purpose of this paper is to investigate how the current distribution in systems of linear conductors, without coils or condensers, depends on the frequency used. The theory is first given for a circular ring, using development in Fourier series (not as regards time but as regards geometrical position on the circle) and the method introduced by Pistolkors (1929 Abstracts, p. 329, where the journal year should read 1929), graphs being given (Fig. 2) for the radiation resistance and reactance as functions of the frequency. The case of any closed simple circuit is then discussed in general. Branched systems are next considered ; the general equations are given and an example shows how impedances may be estimated.

Experiments were made in a wavelength range of 7.5 to 19 m, using copper wire 2 mm thick at a height of 1.80 m above the earth. The amplitudes of the currents were measured with hot-wire air thermometers (Fig. 4) connected directly in circuit and calibrated with d.c. The wire was used in the form of a square and a rectangle ; Fig. 5 shows the measured values for various frequencies and inductive coupling to the emitter, in comparison with those calculated for a circle. The main trend of the calculated curves is followed by the measured points. A Lecher parallel-wire system is coupled to the emitter at different points and the curves of Figs. 6 and 7 obtained. Figs. 8–10 show other examples of branched circuits.

1431. A NEW TYPE OF EXPANSION [of Solutions of Wave Equation] IN RADIATION PROBLEMS [including Method applicable to Calculation of Radiation from Given Current Distribution].—W. H. Hansen. (*Phys. Review*, 15th Jan. 1935, Series 2, Vol. 47, No. 2, pp. 139–143.)

1432. CALCULATION OF VERTICAL ANTENNA RADIATION PATTERNS [by Simple Geometry].—E. A. Laport. (*Electronics*, February, 1935, pp. 46–49.)

1433. HORIZONTAL RHOMBIC [" Diamond Shaped "] ANTENNAS [Theoretical Methods of Design and Experimental Confirmation : Coupling Circuits and Resistance Terminations : etc.].—E. Bruce, A. C. Beck, and L. R. Lowry. (*Proc. Inst. Rad. Eng.*, January, 1935, Vol. 23, No. 1, pp. 24–46 : *Bell S. Tech. Journ.*, January, 1935, Vol. 14, No. 1, pp. 135–158.) For the earlier paper on the " diamond-shaped " (now called " rhombic ") receiving aerial *see* 1932 Abstracts, p. 96.

1434. A NEW ANTENNA SYSTEM FOR OPERATING CONTROL OF RADIATION [for Short Waves below 60 m : Vertical-Plane Angle Control to suit Communication Conditions, and Some Control of Polarisation : Saving of Space : etc.].—J. L. Reinartz. (*QST*, February, 1935, Vol. 19, No. 2, pp. 9–12.)

A current-fed dipole with one quarter-wave end sectional horizontal and the other end section bent down, parallel to feeders, carried into operating room and earthed through a tuning system.

1435. THE DIRECTIVE ANTENNA AT KAINA [" Tilted V " Short-Wave Beam Aerial for Amateur Transmission].—D. C. Redgrave. (*QST*, November, 1934, Vol. 18, No. 11, pp. 21–23 and 74.) Elementary form of the RCA Model D aerial (1932 Abstracts, p. 38).

1436. GETTING COÖPERATION IN THE ANTENNA SYSTEM: A PRACTICAL SURVEY OF THE IMPORTANT FEATURES OF DIFFERENT TYPES [of Short-Wave Amateur Aerials].—W. J. Goodell. (*QST*, February, 1935, Vol. 19, No. 2, pp. 16–20 and 22, 70.)

1437. MATCHED-IMPEDANCE COUPLING TO THE ZEPP ANTENNA: A CONVENIENT END-FEED SYSTEM OF HIGH EFFICIENCY.—L. L. Hardin, Jr. (*QST*, February, 1935, Vol. 19, No. 2, pp. 23–24 and 41.)

1438. RECEIVING AERIALS [Dependence of Tuning Inductance on Ratio h_{eff}/λ unless This is Very Small, and on Nearness to Earthing Point: etc.].—E. Siegel. (*Hochf:tech. u. Elek:akus.*, February, 1935, Vol. 45, No. 2, pp. 51–61.)

Author's summary:—By the application of line theory to receiving aerials the current- and potential-distributions in unloaded and loaded aerials are determined and the inductance necessary to bring the aerial into resonance, at any point on the aerial, is calculated. Formulae for the aerial reactance are also derived, and it is shown that the capacity of an aerial, which depends in general on the wavelength of the exciting oscillation, nevertheless as this wavelength increases tends towards a limiting value which is set simply by the dimensions of the aerial and its characteristic impedance. Next, the natural wavelength of an aerial with an inductance inserted at any point is determined by graphical methods, and approximate formulae for the natural wavelengths of unloaded aerials are given.

In sections VII and VIII the current- and voltage-distributions in aperiodic aerials are investigated, and it is shown that such an aerial can be assigned a capacity depending only on its geometrical dimensions.

Finally, formulae for the characteristic impedances of aerials are given; an important point emerging here is that while the characteristic impedance of an aerial of given geometrical form is definitely dependent on the ratio h/λ [h being the length of the aerial] nevertheless for a given h/λ it is independent of the current distribution in the aerial. For aerials which are short compared with the wavelength of the exciting oscillation, the characteristic impedance can with sufficient accuracy be considered as dependent only on the geometrical dimensions; *i.e.* as independent of h/λ [this fact can be used for the simple measurement of the characteristic impedance with a comparatively long wave, where $\lambda \overset{=}{>} 8h$]. All the theoretical results are checked by measurement and essentially confirmed.

1439. THE FUNDAMENTALS OF DECIMETRE WAVE TECHNIQUE [including Beam Concentration and Receiving Aerial Conditions for Micro-Waves].—Runge. (*See* 1326.)

1440. EXTENDING THE RANGE OF ULTRA-HIGH-FREQUENCY AMATEUR STATIONS [Directive Aerials for 5-Metre Waves: Hartford/Boston 100 Mile Regular Communication].—R. A. Hull. (*QST*, October, 1934, Vol. 18, No. 10, pp. 10–13 and 106.) *See* also *ibid.*, November, p. 9: also abstract 660 of February.

1441. THE PROBLEM OF AUTO-RADIO ANTENNAS.—(*Electronics*, February, 1935, pp. 41–43.)

1442. THE CATENARY IN THE LOGARITHMIC CO-ORDINATE SYSTEM [Graphical Method of Calculation for Large Spans].—J. Hak. (*Elektrot. u. Masch:bau*, No. 32, Vol. 52, 1934, pp. 373–375.)

VALVES AND THERMIONICS

1443. DETERMINATION OF THE CONTROL VOLTAGE OF ELECTRONIC VALVES OF CONSTANT AMPLIFICATION FACTOR ALONG THE SYSTEM AXIS.—J. E. Scheel. (*Arch. f. Elektrot.*, 11th Jan. 1935, Vol. 29, No. 1, pp. 47–69.)

The well-known Barkhausen method of regarding phenomena within a valve gives eqns. 1 and 1a for single-grid valves (Figs. 1, 2) but does not consider the effect of space charge. Schottky's method gives eqn. 2. The present writer derives (II) general expressions for the control voltage u_{st} for a valve with cylindrical electrodes. Eqns. 5a and 5b solve the statical problem and include the expressions of Barkhausen and Schottky. When space charge is present, eqn. 7 gives the solution. Two examples are given to illustrate its use. The relations are found between the reciprocal of the anode amplification factor and the dimensions of anode and cathode (eqn. 15). As an example, calculated characteristics are given (Fig. 6) for a cylindrical single-grid valve under various assumptions as to the quantities which may be neglected in the expression for u_{st}. Multiple-grid valves with cylindrical electrodes are next similarly considered, with their equivalent set of capacities, and numerical examples are given. A list of relevant literature is appended.

1444. CALCULATION OF "DURCHGRIFF" THROUGH A CLOSE PARALLEL-WIRE GRID [where the Schottky Formula fails].—F. Ollendorff. (*Elecktrot. u. Masch:bau*, No. 50, Vol. 52, 1934, pp. 585–591.)

The Schottky "durchgriff" formula (equation 2, derived for a plane grid of round parallel wires) holds for thin wires where $\rho_0 \ll \tau$ (ρ_0 being the wire radius and 2τ the distance between axes) provided both the grid/anode and grid/cathode distances are very large compared to τ. But even on this assumption it is easily seen from the formula that it only applies to the region $\pi\rho_0/2\tau < \pi/6$, that is, $\rho_0 < \tau/3$; for if $\rho_0 > \tau/3$ the formula gives a negative "durchgriff." Further, for wires where ρ_0 is only a little less than $\tau/3$ the formula is very inexact—a fact of importance with modern close grids. The writer therefore sets himself to derive a "durchgriff" formula free from this limitation. By means of a more precise version (*see* equations 7 and 8) of the Schottky definition of "durchgriff," and by potential-theory methods, he deals first with the field of a flat-strip grid, obtaining a simple and definite expression for the "durchgriff" (equation 33: for symbols *see* equation 18, O being the "numerical grid aperture" as in equation 8). For a round wire grid, on the other hand, the "durchgriff" depends on the anode/grid distance and also on two quantities (t and δ in equation 55) which are given, as functions of the grid dimensions, in formulae and curves; equations 56, I to IV, give these values in varying approximations. Of these, II, the second approximation, is sufficiently accurate when $z_0 \,.\, 2/\pi \approx 0.4$, *i.e.* when $\rho_0 \approx 0.4r$, so that in this important case the "durchgriff" is given by the comparatively simple equation 57. If $\rho_0 < 0.1r$ the first approximation is sufficient, and yields, in fact, the Schottky formula; this condition may thus be regarded as the limit of validity of the latter formula.

1445. Limits to Amplification.—J. B. Johnson and F. B. Llewellyn. (*Bell S. Tech. Journ.*, January, 1935, Vol. 14, No. 1, pp. 85–96.) *See* 756 of March.

1446. The Grid-Anode Capacity of Valves: Its Effect on the Associated Tuned Circuits.—M. O'C. Horgan. (*Wireless Engineer*, September, 1934, Vol. 11, No. 132, pp. 464–475.)

1447. Theory of Multi-Electrode Vacuum Tubes.—H. A. Pidgeon. (*Bell S. Tech. Journ.*, January, 1935, Vol. 14, No. 1, pp. 44–84.) *See* 752 of March.

1448. Short Cut for Determining Operating Conditions of Power Output Triodes [with the Power Output or Distortion Rule and Conversion Formulae].—(*Rad. Engineering*, September, 1934, Vol. 14, No. 9, pp. 20–21.)

1449. Self-Bias and the Valve Load Diagram.—W. T. Cocking. (*Wireless Engineer*, December, 1934, Vol. 11, No. 135, pp. 655–657.)

1450. The "Condenser Discharge Oscillographic Method" of obtaining Complete Characteristics of Tubes for Class B or Class C Operation, where Ordinary Graphs fail.—Kozanowski and Mouromtseff. (*Rad. Engineering*, January, 1935, Vol. 15, No. 1, pp. 16–18.)

1451. The Cold-Cathode Tube: the Farnsworth Electron-Multiplier and Its Use as an Oscillator.—Lippincott and Metcalf: Farnsworth. (*Rad. Engineering*, November, 1934, Vol. 14, No. 11, pp. 18–19.) *See* also 207, 208 of January: also *Electronics*, January, 1935, p. 22.

1452. Design and Use of "Acorn" Tubes for Ultra-High Frequencies [Experimental Model for Research].—B. Salzberg: Thompson and Rose. (*Electronics*, September, 1934, pp. 282–283 and 293.) *See* 1934 Abstracts, p. 94. The present paper gives constructional details of the triode.

1453. RCA-955 Acorn Type Tube [for Ultra-High Frequencies].—(*Rad. Engineering*, September, 1934, Vol .14, No. 9, p. 21.)

1454. Vacuum Tubes as [Ultra-] High-Frequency Oscillators.—M. J. Kelly and A. L. Samuel. (*Bell S. Tech. Journ.*, January, 1935, Vol. 14, No. 1, pp. 97–134.) *See* 748 of March.

1455. Mixing Valves [Single and Double Grid].—M. J. O. Strutt. (*Wireless Engineer*, February, 1935, Vol. 12, No. 137, pp. 59–64.)

It is shown that the conversion conductance S_c is about 1/5th to 1/4th of the maximum transconductance encountered during oscillator swing. Conditions for best conversion as regards valve noise require $\sqrt{i_a}/S_c$ to be as small as possible, i_a being the d.c. anode current under operating conditions: optimum local-oscillator adjustment is derived from this, but minimum whistling notes lead to a further condition for local-oscillator voltage and a compromise with the noise condition is recommended. *See* also 1934 Abstracts, p. 614.

1456. Frequency-Changer Tubes [including Triode-Hexode (Mixing Hexode) and Octode]. (*Electronics*, January, 1935, pp. 28–29.) Survey based on three recent papers (French and English.)

1457. Recent Developments in Frequency-Changing Valves.—G.W.O.H. (*Wireless Engineer*, November, 1934, Vol. 11, No. 134, pp. 581–582.)

1458. Heptode Frequency Changers [Derivation of Expressions for Conversion Conductance and Effective Stage Gain: Experimental Confirmation].—R. J. Wey. (*Wireless Engineer*, December, 1934, Vol. 11, No. 135, pp. 642–654.)

1459. Features of the New Mixing Tubes [Screen-Grid Mixer-Oscillator, Fading-Mixing Hexode, Octode].—K. Steimel. (*Electronics*, December, 1934, p. 393: summary only.)

1460. A New Output Tetrode [N 40, with Two Narrow Box-Form Anode Plates and Earthed Screens].—Marconiphone Company. (*Electronics*, February, 1935, p. 65.) "It has been demonstrated that the new tetrode can be made with a better 'knee' than a pentode, and the anode current curves are straighter. A noticeable increase in output is then available, with less third harmonic."

1461. Operating Notes on the New Pentodes [Raytheon RK–23 and –25 and RCA 802].—(*QST*, February, 1935, Vol. 19, No. 2, pp. 29–31 and 66.)

1462. An Intermediate Power Pentode, RCA–802 [giving Full Rated Output at 7.5 Metres].—(*Electronics*, February, 1935, p. 68.)

1463. Notes on Screened-Grid Pentode Detectors [Good Sensitivity and Linearity: Special Automatic Biasing System: High Degree of Self A.V.C.].—F. R. W. Strafford. (*Wireless Engineer*, September, 1934, Vol. 11, No. 132, pp. 484–487.)

1464. Relations in the Receiving Tube Family [Chart].—(*Electronics*, November, 1934, p. 343.)

1465. GERMAN DESIGNATIONS OF BROADCAST VALVES.—(*Funktech. Monatshefte*, January, 1935, No. 1, pp. 12–13.)

"Diodes" . . . "octodes" are to be replaced by "zweipolröhre . . . achtpolröhre": the "fading-mischhexode" becomes the "dreipol-sechspolröhre": the "duo-diode" becomes the "doppel-zweipolröhre"; etc. The "technically incorrect" name "fanggitter" (suppressor or collector grid) is being replaced by "bremsgitter" (brake grid). A table of Telefunken, Valvo and Tungsram types is given, showing the new and old designations.

1466. CONTINUOUSLY EVACUATED VALVES AND THEIR ASSOCIATED EQUIPMENT.—C. R. Burch and C. Sykes. (*Wireless Engineer*, March, 1935, Vol. 12, No. 138, pp. 142–144: *Nature*, 16th Feb. 1935, Vol. 135, pp. 262–263.) Summaries of I.E.E. paper.

1467. ALL-METAL VACUUM TUBES [Special Seals, Welding, etc.].—O. W. Pike and G. F. Metcalf. (*Electronics*, October, 1934, pp. 312–313.)

1468. NEW TELEFUNKEN MAGAZINE [*Die Telefunken-Röhre*]. — G. W. O. H. (*Wireless Engineer*, September, 1934, Vol. 11, No. 132, p. 475.)

1469. HEAT LOSSES FROM A TUNGSTEN WIRE IN HELIUM [Accommodation Coefficient Corrected for Etching is 0.069].—W. C. Michels and Gladys White. (*Phys. Review*, 15th Jan. 1935, Series 2, Vol. 47, No. 2, p. 197: abstract only.)

1470. THE EMISSION OF ELECTRONS [from Metal Targets] BY SWIFTLY MOVING MERCURY IONS.—L. H. Linford. (*Phys. Review*, 13th Feb. 1935, Series 2, Vol. 47, No. 4, pp. 279–282.)

DIRECTIONAL WIRELESS

1471. SOME PRINCIPLES UNDERLYING THE DESIGN OF SPACED-AERIAL DIRECTION-FINDERS [and the Prediction of "Standard-Wave Error" and "Pick-Up Factor"].—R. H. Barfield. (*Wireless Engineer*, January, 1935, Vol. 12, No. 136, pp. 24–25.) Summary of I.E.E. paper.

1472. NEW AIDS FOR AIR NAVIGATION.—(*Marconi Review*, Jan./Feb. 1935, No. 52, pp. 29–30.)

1473. DISCUSSION ON "STUDY OF THE MAGNETIC FIELD PRODUCED BY A LOW-FREQUENCY CURRENT CIRCULATING IN A CONDUCTOR IN THE PRESENCE OF THE GROUND."—Bourgonnier. (*Bull. de la Soc. franç. des Élec.*, March, 1935, Series 5, Vol. 5, No. 51, pp. 223–230.) *See* also 152 of January.

ACOUSTICS AND AUDIO-FREQUENCIES

1474. NEW HIGH-VACUUM CATHODE-RAY TUBES FOR SOUND-ON-FILM RECORDING.—M. von Ardenne. (*Filmtechnik*, No. 5, 1935, 4 pp.)

Many points governing the design of this special tube are the same as those discussed for tubes for television and test-room purposes (813 of March), but there are special requirements for sound-recording purposes. Thus not a fluorescent spot, but a fluorescent line uniformly bright throughout its length, is required: this is obtained by electron-optical cylinder lenses. Another difference is that since the ray is not deflected the fluorescent screen can be brought very close to the ray-generating system, and the brightness of the luminous line is really only limited by the saturation and fatigue of the screen material. The tube shown in Fig. 2 gives a modulation of brightness combined with a modulation of line-length. A pure brightness modulation is given by the design of Fig. 3, much more resembling a cylindrical-electrode valve (with, however, a slot in each cylinder) than a cathode-ray tube. A calcium tungstate screen is used, and Fig. 4 shows an un-retouched photograph of the uniformly bright line given by this tube.

1475. ENGRAVED SOUND TRACKS FOR FILM RECORDING: A NEW VARIABLE-WIDTH PROCESS [using Wedge-Shaped Cutting Edge: Immediate "Play-Back," Avoidance of Grain-Size, Halation and Slit-Width Limitations].—J. A. Miller. (*Electronics*, February, 1935, pp. 52–53.)

1476. THE MICRODENSITOMETER AS A LABORATORY MEASURING TOOL [Modified Moll Type for Sound-Picture Investigations].—W. R. Goehner. (*Bell Tel. System Tech. Pub.*, Monograph B-825, 10 pp.)

1477. MUSIC FROM PAPER TAPE [New Selenophone Development]. — (*Wireless World*, 29th March, 1935, Vol. 36, p. 310.)

1478. CALCULATION OF THE ACOUSTIC FIELD OF A CIRCULAR PISTON MEMBRANE.—H. Stenzel. (*E.N.T.*, January, 1935, Vol. 12, No. 1, pp. 16–30.)

The general formula (1) for the acoustic field of a circular membrane in a rigid baffle is discussed for points at a greater distance than the membrane radius, using development of the integrand in spherical harmonics and Bessel functions (II 1), and formulae 25 and 26 are found for the components of the acoustic pressure. The corresponding method is used for points at a smaller distance than the membrane radius (II 2), giving formula 29. Relations between functions occurring in the analysis are then developed (III). Practical examples are given in IV, with different values of the ratios (membrane radius)/(wavelength) and (distance of observation point)/(wavelength). Figures 3–7 show the calculated results and tables 1–9 give numerical data of functions required.

1479. LOW-FREQUENCY DISTORTION IN HORN SPEAKERS DUE TO THE MEDIUM [and the Incorrectness of Rocard's Formula: the Question of Throat Diameter: etc.].—S. Goldstein and N. W. McLachlan. (*Wireless Engineer*, August, 1934, Vol. 11, No. 131, pp. 423–424.) For Rocard's paper *see* Abstracts, 1933, p. 216. For the Wente and Thuras paper *see* 1934, p. 444 (Fletcher and others).

1480. EXTRANEOUS FREQUENCIES GENERATED IN AIR CARRYING INTENSE SOUND WAVES [Application of Non-Linear Theory to Exponential Horn: Experimental Measurement of Second Harmonic and Combination Tones].—Thuras, Jenkins and O'Neil. (*Bell S. Tech. Journ.*, January, 1935, Vol. 14, No. 1, pp. 159–172: *Journ. Acous. Soc. Am.*, January, 1935, Vol. 6, No. 3, pp. 173–180.)

1481. LOUDSPEAKER RESPONSE CURVES.—(*Wireless World*, 29th March, 1935, Vol. 36, pp. 306–310.) Full details of a method of taking loudspeaker response curves, using a microphone suspended in free air: the curves are directly recorded by photographic means.

1482. THE TIME OF RELAXATION IN CRYSTALS OF ROCHELLE SALT [Theory of Action of Mechanical and Electrical Forces: Experiments on Dielectric Constant and Power Loss].—R. D. Schulwas-Sorokin and M. V. Posnov. (*Phys. Review*, 15th Jan. 1935, Series 2, Vol. 47, No. 2, pp. 166–174.)

1483. PROPERTIES OF ROCHELLE SALT [Dielectric, Pyroelectric, Optical and Electro-Optical Measurements: Atomistic Theory correlating Observations].—H. Mueller. (*Phys. Review*, 15th Jan. 1935, Series 2, Vol. 47, No. 2, pp. 175–191.)

1484. "PIEZO-ELECTRICITY: A TECHNICAL TREATISE ON THE APPLICATIONS OF ROCHELLE SALT CRYSTALS TO HIGH-FIDELITY SOUND REPRODUCERS."—Rothermel Company. (At Patent Office Library, London.)

1485. DESIGN TRENDS IN CONNECTION WITH LOUDSPEAKERS. (*See* 1418.)

1486. ACOUSTICAL LABYRINTHS FOR HIGH-FIDELITY REPRODUCTION.—(*Electronics*, January, 1935, p. 28.) *See* also 1485.

1487. THE WESTERN ELECTRIC "BULL HORN" 500-WATT LOUDSPEAKER FOR VOICE BROADCASTING.—(*Rad. Engineering*, October, 1934, Vol. 14, No. 10, pp. 14 and 17.) *See* also 465 of February.

1488. PUBLIC ADDRESS SYSTEM AT THE NATIONAL AIR RACES.—(*Rad. Engineering*, October, 1934, Vol. 14, No. 10, pp. 20–21 and 24.)

1489. A SIMPLE MOVING-COIL MICROPHONE [also serving as Loudspeaker in Loudspeaking Telephone Set].—D. McMillan. (*P.O. Elec. Eng. Journ.*, January, 1935, Vol. 27, Part 4, pp. 284–289.)

1490. THE SENSITIVITY OF CARBON MICROPHONES AT VERY LOW FREQUENCIES [10–200 c/s].—F. Hehlgans and O. Mattiat. (*Hochf:tech. u. Elek:akus.*, February, 1935, Vol. 45, No. 2, pp. 37–42.) Of the microphones tested, only the high-quality types (AEG Reiss and Sell "rod") preserved their sensitivity below 50 c/s.

1491. PRE-AMPLIFIER DESIGN [particularly the Causes and Elimination of Hum in a High-Gain, High-Fidelity A.C. Operated Pre-Amplifier for Condenser and Ribbon Microphones].—H. L. Shortt. (*Rad. Engineering*, October, 1934, Vol. 14, No. 10, pp. 9–11.)

1492. AN ELECTRONIC FADER [Constant Impedance Network replaced by Valves: Infinite Number of Steps, Independence of Type and Condition of Microphone, and other Advantages].—Gunsolley: H. L. Mills. (*Electronics*, February, 1935, p. 58.)

1493. HIGH-EFFICIENCY PUSH-PULL OUTPUT STAGES: A NEW SYSTEM FOR LARGE VOLUME [using Valves with Very Low A.C. Resistance].—K. A. Macfadyen. (*Wireless World*, 15th March, 1935, Vol. 36, pp. 256–258.)

1494. A HIGH-FIDELITY AUDIO-FREQUENCY AMPLIFIER: DESIGN OF A 15-WATT UNIT USING RESISTANCE-COUPLED PUSH-PULL STAGES WITH A PHASE INVERTER [eliminating Interstage Transformers].—H. L. Shortt. (*Rad. Engineering*, January, 1935, Vol. 15, No. 1, pp. 14–15 and 18.)

1495. I.F. TRANSFORMER DESIGN: HIGH FIDELITY: BAND-PASS FILTER DESIGN.—F. H. Scheer. (*Rad. Engineering*, December, 1934, Vol. 14, No. 12, pp. 24–25.)

1496. CLASS B TRANSFORMERS.—N. Partridge. (*Wireless World*, 22nd March, 1935, Vol. 36, pp. 280–282.)

1497. NEW VISTAS IN RADIO [Increased Audio-Frequency Range and Intensity Range required for True Musical Reproduction: Auditory Perspective obtainable by using "Double Circuits."]—L. Stokowski. (*Journ. Franklin Inst.*, February, 1935, Vol. 219, No. 2, p. 166: abstract only from *Atlantic Monthly*, January, 1935.)

1498. NON-LINEAR DISTORTION IN APPLIED ELECTRO-ACOUSTICS [and Its Compensation and Correction].—I. Podliasky. (*Ann. des P.T.T.*, January, 1935, Vol. 24, No. 1, pp. 1–54.)

1499. LOUDNESS, PITCH AND THE TIMBRE OF MUSICAL TONES AND THEIR RELATION TO THE INTENSITY, THE FREQUENCY AND THE OVERTONE STRUCTURE: *and* LOUDNESS AND PITCH [Recent Investigations, including Effect of Intensity and Pitch on Timbre].—Harvey Fletcher. (*Journ. Acoust. Soc. Am.*, October, 1934, Vol. 6, No. 2, pp. 59–69: *Bell Lab. Record*, January, 1935, Vol. 13, No. 5, pp. 130–135.)

1500. RELATION OF PITCH TO INTENSITY.—S. S. Stevens. (*Journ. Acoust. Soc. Am.*, January, 1935, Vol. 6, No. 3, pp. 150–154.)

1501. ON A PHYSIOLOGICAL EFFECT OF SEVERAL SOURCES OF SOUND ON THE EAR AND ITS CONSEQUENCES IN ARCHITECTURAL ACOUSTICS.—Aigner and Strutt. (*Journ. Acoust. Soc. Am.*, January, 1935, Vol. 6, No. 3, pp. 155–159.) *See* 1934 Abstracts, p. 622.

1502. “Distance Effect” in a Radio Studio.—A. V. Rabinovich. (*Journ. of Tech. Phys.* [in Russian], No. 6, Vol. 4, 1934, pp. 1134–1141).

When the distance between the microphone and the source of sound is increased the listener receives the impression that the studio has become larger. The reason for this is that while the sound energy falling directly on the microphone has diminished, the energy of the reflected waves remains practically unchanged; in other words, reverberation appears to have increased. The timbre of the sound is also affected. The author calls this phenomenon “distance effect” and gives an account of experiments carried out with a view to determining the minimum displacement required for this effect to appear for different sources of sound. A theoretical interpretation of these experiments is given and the main conclusions reached are that the effect is more pronounced for large changes in distance, and is less apparent the greater the initial separation.

1503. On the Determination of Optimum Reverberation Conditions for Rooms with Acoustic Coupling.—M. A. Saposchkow. (*Journ. of Tech. Phys.* [in Russian], No. 8, Vol. 4, 1934, pp. 1588–1607.)

The writer begins by introducing and defining a number of reverberation conceptions, of which the most important are “standard reverberation,” defined as the time taken for the sound to drop 60 db in intensity, and “optimum reverberation,” which is that value of standard reverberation which is found to give the most pleasing result to the ear. The necessary requirements are then determined for the obtaining of optimum reverberation conditions for two rooms which are acoustically interdependent. The conditions affecting reverberation are examined in great detail for the two main classes of coupled rooms, *i.e.*, (*a*) those in which the coupling between the rooms operates in one direction only, as in the case of a broadcasting studio and a listener's room, or a film studio and cinema auditorium, and (*b*) those which are directly coupled, as the stage and auditorium of a theatre, or two rooms with an interconnecting doorway.

1504. Remarks on the Theory of Oscillations in One Dimension.—M. A. Sapojkov. (*Journal of Tech. Phys.* [in Russian], No. 6, Vol. 4, 1934, pp. 1109–1130.)

A detailed discussion is given of the acoustic processes which take place when oscillations are propagated in one dimension, as, for instance, along a pipe. The discussion is based on the theory of free oscillations of a system at its natural frequency, and it is indicated that this theory can also be used for determining the acoustic properties of a room.

1505. Attenuation Losses in Strong Acoustic Oscillations in Tubes [in Air and CO_2: 50 c/s].—K. O. Lehmann. (*Ann. der Physik*, Series 5, No. 5, Vol. 21, 1934, pp. 533–552.)

The attenuation constant was determined by measuring the sound pressure amplitudes and difference of phase at the beginning and end of a tube of 6.7 cm diameter. Its value for oscillations of ordinary strength was found to be (at 740 mm Hg and 19°C) 1.32×10^{-4} cm^{-1} in air and 1.28×10^{-4} cm^{-1} in co$_2$. It remained constant up to amplitudes of 30 000 bar and then rose, owing to turbulence. Measurements at higher pressures showed that the attenuation decreased in a manner approximately inversely proportional to the square root of the increased density, in qualitative agreement with the theory of Helmholtz and Kirchhoff. The phase velocity was found to be independent of amplitude and pressure in the range studied.

1506. Sound Absorption Coefficients [Criticism of Paper by R. F. Norris].—V. L. Chrisler. (*Journ. Acoust. Soc. Am.*, October, 1934, Vol. 6, No. 2, p. 115.) *See* 1934 Abstracts, p. 623.

1507. On the Theory of Sound Absorption of Porous Materials.—M. Rettinger: Gemant. (*Journ. Acous. Soc. Am.*, January, 1935, Vol. 6, No. 3, pp. 188–191.) Prompted by the “unreasonably small values for the absorptivity of porous materials at low frequencies” arrived at by Gemant (1934 Abstracts, p. 98).

1508. A Direct-Reading Frequency Meter for High-Speed Recording [for Study of Frequency Variations in Speech or Singing, etc.]—Hunt. (*See* 1566.)

1509. A Precision Heterodyne Oscillator [0–15 500 c/s with Frequency Error less than 0.2% ± 1 c/s].—L. E. Ryall. (*P.O. Elec. Eng. Journ.*, October, 1934, Vol. 27, Part 3, pp. 213–221.)

1510. “Precision Heterodyne Oscillators”: Correspondence.—W. H. F. Griffiths. (*Wireless Engineer*, August, 1934, Vol. 11, No. 131, p. 424.) *See* 1934 Abstracts, p. 387.

1511. A Single-Tube Beat-Frequency Oscillator [using Wunderlich Valve with Two Symmetrical Grids].—Podolsky and McBride. (*Electronics*, November, 1934, pp. 356–357.)

1512. A New Mains-Driven Beat-Note Generator [with Refinements regarding Frequency Constancy, Non-Linear Distortion, etc.].—Siemens & Halske. (*Hochf:tech. u. Elek: akus.*, January, 1935, Vol. 45, No. 1, p. 32.)

1513. Some Applications of Modern Acoustic Apparatus [Automatic Level Recorder, Crystal Analyser, and Acoustic Spectrometer].—S. K. Wolf and W. J. Sette. (*Journ. Acous. Soc. Am.*, January, 1935, Vol. 6, No. 3, pp. 160–168.)

1514. Time Base for Investigation of Magnetic Sound-Recording Systems.—Young. (*See* 1621.)

1515. Screening and the “Levelling” Procedure, particularly in Audio-Frequency Amplifiers.—Benz. (*See* 1398.)

1516. Analysis of Waveforms: Half-Period Contact in Waveforms containing Even Harmonics [with Special Joubert Disc].—L. G. A. Sims. (*Wireless Engineer*, August, 1934, Vol. 11, No. 131, pp. 419–423.)

1517. A Note on Fundamental Suppression in Harmonic Measurements [*e.g.* in Wave-Form Distortion Measurements on Iron-Cored Communications Transformers: a Bridge-Circuit Suppressor].—H. M. Wagner. (*Proc. Inst. Rad. Eng.*, January, 1935, Vol. 23, No. 1, pp. 85–88.)

1518. Inter-Modulation in Audio-Frequency Amplifiers [Non-Mathematical Discussion, and an Experimental Method of Observation forming Valuable Laboratory Tool for Detection of Non-Linearity].—A. C. Bartlett. (*Wireless Engineer*, February, 1935, Vol. 12, No. 137, pp. 70–74.)

1519. Automatic Line-Measuring Equipment of the German Broadcast System [Underground Trunk Cables].—Leonhardt. (*Electronics*, November, 1934, pp. 347–349.)

1520. Plotting Response Curves: Decibels Direct from the Slide Rule.—E. V. Wait. (*Wireless World*, 1st March, 1935, Vol. 36, p. 219.)

1521. The Decibel as a Unit of Receiver Sensitivity.—K. D. Huff. (*Rad. Engineering*, December, 1934, Vol. 14, No. 12, pp. 23 and 26.)

1522. Symbolism in Electro-Acoustics.—N. W. McLachlan. (*Wireless Engineer*, September, 1934, Vol. 11, No. 132, pp. 487–489.) For correspondence see *ibid.*, November, p. 605.

PHOTOTELEGRAPHY AND TELEVISION

1523. Deviation of the Electron Beam and Spot Distortion in the Cathode-Ray Tube [Influence of Boundary Fields].—P. Deserno. (*Arch. f. Elektrot.*, 11th Feb. 1935, Vol. 29, No. 2, pp. 139–148.)

An experimental investigation of the proportionality between deviating field and deflection when the latter is large, as is necessary in television tubes. The arrangement of the tube (a cold-cathode oscillograph with double vacuum) is shown in Fig. 1. Fig. 4 shows the variation of angle of deviation with deflecting voltage, for various exciting voltages (2.6 to 6.5 kv) and Fig. 5 gives the departure from proportionality between voltage and deflection for a curved screen. Fig. 6 shows the effect of unsymmetrical distribution of the deflecting voltage; Figs. 7 and 8 illustrate the blurring of the screen picture which is produced by this unsymmetrical voltage distribution. Fig. 9 demonstrates the fine trace produced by surrounding the deflecting plates with a screening cage, connected to the middle of the deflecting voltage. Magnetic deflection is next considered; Fig. 12 shows how the deflection on a plane screen depends on the deflecting current, for various exciting voltages. The error in this case was small; Fig. 13 illustrates the form of deflecting coil which will minimise it. Simultaneous electrostatic deflection in two directions is illustrated by Figs. 14 and 15; the latter shows the increase of sensitivity as dependent on the sideways deflection of the beam. Fig. 16 suggests a form for the deviating plates which will avoid the distortion shown in Fig. 14.

Spot distortion with electrostatic deflection is illustrated in Fig. 17 and its theoretical value in Fig. 18. Fig. 21 gives a circuit for automatic magnetic post-concentration of the spot. The uniformity of the trace may also be increased by working *ab initio* with a slight under-concentration (Fig. 22, curve b). Fig. 24 gives a comparison of spot distortion with electrostatic and magnetic deviation. The best method of avoiding spot distortion is to keep the beam as narrow as possible while it is in the deflecting field.

1524. On the Calculation of Constants for Television Transmission.—J. A. Riftin. (*Journ. of Tech. Phys.* [in Russian], No. 7, Vol. 4, 1934, pp. 1375–1386.)

The object of the article is to establish a relationship between the requirements for clear reproduction in a television receiver and the operating conditions of the associated transmitter. The points studied and the results obtained are:—

1. *Definition.* This depends on the number of lines (p) of which the picture is built up. 2. *Relationship between* (1) *and transmitter characteristics.* For a given size of object and distance from the transmitter, p is determined by the ratio of the focal length (f) of the lens to the transmitter strip width (d). 3. *Distance of the object from the transmitter.* This is given by the expression

$$A = 1/p \, . \, f/d \, . \, H,$$

where A is the distance and H the height of the object. 4. *Area of the object.* This is determined by the expression $A^2 \, . \, n/(f/d)^2$, where n is the number of picture elements.

5. *Angle of vision of the transmitter.* This angle is equal to $2 \tan^{-1} (Z/2f/d)$, where Z is the total number of lines. 6. *Number of picture elements.* The required number of elements is deduced either from (4), when the determining condition is the area of the object, or from (5), when the determining condition is the angle of vision. In the latter case use is made of the fact that $n = kZ^2$, where k is the ratio of the width to the height of the picture. 7. *Illumination of the object.* Experience shows that the ratio of the intensity of illumination, $B_{\max}$, of the brightest point of the object to that of the darkest point, $B_{\min}$, should not be less than 10.

For this condition two expressions are deduced: (i) for a transmitter of the non-cumulative type, *e.g.* for mechanical scanning,

$$B_{\max} = K \, . \, n/\pi r^2 \epsilon \, . \, (f/d)^2$$

candles/cm², and (ii) for a transmitter of the cumulative type, *e.g.* the Zworykin iconoscope,

$$B_{\max} = K_1 \, . \, 1/\pi r^2 \epsilon \, . \, (f/d)^2$$

candles/cm², where K and K_1 are constants independent of the optical and scanning systems of the transmitter, r is the radius of the lens aperture of the transmitter, and ϵ is the sensitivity of the photo-cell in amps/lumen.

1525. Wide-Band Transmission over Balanced Circuits.—A. B. Clark. (*Bell S. Tech. Journ.*, January, 1935, Vol. 14, No. 1, pp. 1–7.) *See* 1122 of April.

1526. Broadcasting Sound Pictures on Ultra-Short Waves in Germany.—W. Scholz. (*E.N.T.*, January, 1935, Vol. 12, No. 1, pp. 3–16.)

I. *Theoretical Considerations.* Ia : Present state of television communication : the frequency ranges required permit five complete television emitters to operate in the range 7.5 to 5.7 m. Ib : Propagation of ultra-short waves, in flat country (law of decrease in field strength), in hills or mountains (field strength from sender on the Brocken), in large towns (buildings act as antennae : field-strength eqn. 6). Ic : Planning a network of ultra-short-wave television emitters in Germany. Plan of 21 stations and their ranges (Fig. 10). In the North German plain, towers of 100 or 200 m height are needed. Auxiliary senders on wavelengths < 5.5 m may be used to bring up the field strength in towns without a main emitter. It is contemplated that several stations may relay the same programme, being connected by wireless relays on the tone frequency.

II. *Experiments and Measurements* with emitter Berlin-Witzleben. IIa : Reception experiments. Good reception was possible up to a distance of 50 km ; field strengths at various distances are tabulated. IIb : Development of a field-strength measuring apparatus for ultra-short waves. The circuit is shown in Fig. 11. Resonant circuits were used in the i.f. amplifier and the valves had steep characteristics. Fig. 12 gives the resonance curve of the i.f. oscillator ; Fig. 13 shows the relation of the i.f. voltage to the anode current (reaction factor). Fig. 14 gives the calibration curve of the apparatus. IIc : Field strength measurements Fig. 15 shows the measured (field strength)/(distance from Berlin) curve in the surrounding plain ; the reciprocal-distance curve is given for comparison. Good agreement is found. The attenuation factor is calculated. Examples of measurements in a town are given, to indicate the amount of attenuation to be expected. A list of relevant literature is appended.

1527. Television at the Berlin Radio Exhibition, 1934.—E. H. Traub. (*Journ. Television Soc.*, September, 1934, Series 2, Vol. 1, Part II, pp. 341–351.)

1528. High-Definition Television in Germany.—(*Wireless World*, 22nd March, 1935, Vol. 36, pp. 288–289.)

1529. German Government aids Television [Transmitters, Coaxial Cable, Receivers].—(*Electronics*, January, 1935, pp. 10–11 and 30.)

1530. Television—the Transmitter [and Receiver] Problem and Federal Funds.—(*Electronics*, October, 1934, p. 299.)

1531. Mechanical and Cathode-Ray Systems share in Television Advance [including Preiss System with Mirror vibrating about Two Axes at Right Angles, with Mechanical Resonance helping Synchronisation].—(*Electronics*, September, 1934, pp. 272–273.)

1532. Television : a Survey of Present-Day Systems [Philco, RCA-Victor, Farnsworth, Hogan, Preiss, Peck, etc. : Views on Prospects of Commercialisation].—(*Electronics*, October, 1934, pp. 300–305.)

1533. Television Scanning by Cathode Ray [Farnsworth " Image Dissector "].—(*Wireless World*, 1st March, 1935, Vol. 36, pp. 208–209.)

1534. The Government Advisory Committee on Television [and the Questionnaire to the Television Society].—(*Journ. Television Soc.*, September, 1934, Series 2, Vol. 1, Part 11, pp. 375–376.)

1535. The Image in a Television Receiver : Effect of Various Typical Disturbances and Faults.—M. von Ardenne. (*Wireless World*, 15th March, 1935, Vol. 36, pp. 254–255.)

1536. Television Reception [on Ultra-Short Waves] and the Superheterodyne.—(*Wireless World*, 8th March, 1935, Vol. 36, pp. 236–239.)

1537. Teaching by Television.—E. B. Kurtz. (*Journ. Television Soc.*, September, 1934, Series 2, Vol. 1, Part 11, pp. 367–369.)

1538. Associated Press opens Wire-Photo System [10 000-Mile Facsimile System].—(*Electronics*, January, 1935, p. 9 : photos and diagram only.)

1539. Facsimile—The Home Radio Printing-Press [Young " Lawnmower " (Carbon Paper), Hogan " Radio Pen," and New " Fultograph "].—(*Electronics*, November, 1934, pp. 336–339.)

1540. New Facsimile Telegraphy Office in Cologne [Kerr Cell replaced by " Light Tap " on Electrodynamic Oscillograph Loop Principle : Improved Disc Drive : etc.].—(*E.T.Z.*, 7th Feb. 1935, Vol. 56, No. 6, p. 133.)

1541. A High Intensity Discharge Tube [Small but Highly Brilliant Source by Constriction in Positive Column of D.C. Arc].—D. S. Stevens. (*Review Scient. Instr.*, February, 1935, Vol. 6, No. 2, pp. 40–42.)

1542. The Eye as an Integrator of Short Light Flashes [10^{-6} to 10^{-8} Sec.].—J. W. Beams. (*Journ. Opt. Soc. Am.*, January, 1935, Vol. 25, No. 1, p. 48 : summary only.)

1543. A Study, by means of Huygen's Principle, of the Reflection of a Spherical Light Wave from a Moving Plane Mirror.—Galli-Shohat. (*Journ. Opt. Soc. Am.*, January, 1935, Vol. 25, No. 1, pp. 39–41.)

1544. Composite Prism for Rotating a Ray of Light.—L. Lumière. (*Comptes Rendus*, 21st Jan. 1935, Vol. 200, No. 4, pp. 281–283.)

1545. The Secondary Emission Phototube [Sensitivity of Vacuum Tube magnified some Six Times by Auxiliary Cathode bombarded by Photoelectrons : Free from Delay Mechanism associated with Gas Amplification : Many Applications, including Use as Stable Self-Oscillators : etc.].—H. Iams and B. Salzberg. (*Proc. Inst. Rad. Eng.*, January, 1935, Vol. 23, No. 1, pp. 56–64.)

1546. The Formation of a Potassium Film on Silver [Saturation of Photocurrent].—J. J. Brady. (*Phys. Review*, 15th Jan. 1935, Series 2, Vol. 47, No. 2, p. 197.)

Abstract only: for previous work see 1933 Abstracts, p. 107. Current/voltage curves showed that "the photocurrent approaches saturation at lower voltages when examined immediately after deposition than when the film has been standing for some time;" the change is more pronounced with films less than 3 molecular layers than with thicker films. The changes are quicker at room temperature than at that of solid carbon dioxide and are very small at that of liquid air. "The formation of patches is suggested as a likely explanation for the phenomena."

1547. The Production and Properties of Caesium Photocells.—P. V. Kisselev and S. U. Lukianov. (*Journ. of Tech. Phys.* [in Russian], No. 8, Vol. 4, 1934, pp. 1560–1571.)

A photocell is described comprising a neon-filled or vacuum tube containing a thin silver plate covered by a caesium film of atomic thickness (cathode) and a nickel bar or mesh (anode). The manufacturing process consists of the four main stages which are described in detail. The sensitivity of these cells is high; for example, a vacuum cell operated at 100 v is 20% more sensitive that the corresponding German (Pressler) cell. The current/lumen characteristic is linear between 0.001 and 10 lumens and after that bends only very slightly. The spectral sensitivity curve passes through a maximum at wavelengths of the order of 7 500 Å. The sensitivity did not vary by more than 0.5% over 6 months for vacuum cells, or slightly more for the neon-filled type. The latter type were found by practical use in a sound film installation to transmit satisfactorily frequencies up to 10 000 c/s and to be free from the microphonic effects.

1548. The Spectral Photoeffect at Compact Caesium Films [Four Selective Maxima].—W. Kluge. (*Zeitschr. f. Physik*, No. 9/10, Vol. 93, 1935, pp. 636–643.)

The construction of the cell used is described (Fig. 1, §2). The experimental method was the same as that used in previous work (1933 Abstracts, p. 221). Fig. 2 shows the increase in the photocurrent and in the relative importance of a long-wave maximum produced by hydration. Fig. 3 shows the effect of two different caesium sources, one $CsCl + Ca$, the other CsN_3. Fig. 4 gives the variation of photocurrent with wavelength in the case when the caesium film was formed on platinum-iridium foil (in the other cases silver had been used). This figure clearly shows the presence of *four* maxima with wavelengths above 227 $m\mu$. The long-wave maximum occurs at about 500 $m\mu$ and seems to be due to an optical absorption band of adsorbed Cs atoms. The short-wave maxima seem also to be due to optical absorption by Cs.

1549. The Light Absorption of Adsorbed Caesium.—de Boer, Custers and Dippel. (*Physica*, Oct./Nov. 1934, Vol. 1, No. 10/11, pp. 935–944.)

In German. From the English summary:—"At low degrees of occupation the absorption spectra are found to have a character very different from that of the spectra which are measured at high degrees of occupation [at the highest the spectrum is almost the same as that of a thin film of caesium metal] . . . The high photoelectric yield and the corresponding strongly shifted threshold toward longer wavelengths at a low degree of occupation are correlated with the measured absorption spectra. A method is described for lowering the degree of occupation of the caesium layer by means of lead."

1550. Adsorption of Alkali Metals on Metal Surfaces. II. Dipole Moment of Adsorbed Cs-Ions: Adsorption Isotherm.—de Boer and Veenemans. (*Physica*, Oct./Nov. 1934, Vol. 1, No. 10/11, pp. 953–965: in English.)

1551. Theories of the Spectral Selective Photoelectric Effect.—C. Zener. (*Phys. Review*, 1st Jan. 1935, Series 2, Vol. 47, No. 1, pp. 15–16.)

The writer gives diagrams representing the models of three different theories for the interpretation of the spectral selective efficiency of an alkali metal, and discusses their relative efficiencies. Mechanisms in which the metal electrons absorb the light directly can never give high efficiencies, but alkali atoms *outside* a gas layer on the surface may absorb light and then transfer their excitation energy to the metal electrons. The efficiency of this process is comparable with the highest efficiency observed.

1552. Supplement to the Report "On the Investigation of Free Alkali Metals (1930–1933)" [Correction and Addition to Remarks on Photoelectric Properties: Molecular Hydrogen does not affect Photoelectric Effect at K-Surfaces at Room Temperature].—H. Alterthum and R. Rompe. (*Physik. Zeitschr.*, 15th Jan. 1935, Vol. 36, No. 2, p. 69.)

1553. Electrical Resistance of Cadmium Films [Relation of Results to Photoelectric Phenomena].—Edith Townes and D. Roller. (*Phys. Review*, 15th Jan. 1935, Series 2, Vol. 47, No. 2, p. 197: abstract only.)

1554. The [Photoelectric] Work Function of Electrons passing from Metals [K, Pt] into Dielectrics [NaCl: Value 2.28 V for K, Pt, agreeing with Measurements for Ag].—N. Kalabuchow. (*Zeitschr. f. Physik*, No. 9/10, Vol. 93, 1935, pp. 702–703.) For previous work *see* 758 of March.

1555. [Comparison of] Tribo and Photoelectric Effects for Palladium.—P. A. Mainstone. (*Phil. Mag.*, February, 1935, Series 7, Vol. 19, No. 125, pp. 278–290.)

Describing an examination of the frictional and photoelectric isotherms for palladium in air and hydrogen at different pressures. The photosensitivity is much increased by degassing at low pressure for air at 300° C. A marked increase due to occluded hydrogen is found, with a maximum at the saturation point, but there is no diminution on subsequent removal of the occluded gas.

1556. The Action of a Counter [of Cosmic Rays] and a Gas-Filled Photocell.—P. Görlich: Teichmann. (*Physik. Zeitschr.*, 2nd Jan. 1935, Vol. 36, No. 1, p. 36.) Remarks on Teichmann's paper on electrode configuration in the photocell (235 of January). Teichmann replies on p. 37.

1557. Photoelectric Cells of the So-Called "Rectifier" or "Barrier-Layer" Type [and the Non-Rectifying Cell with Low Temperature Variation].—C. Roy-Pochon. (*Bull. de la Soc. franç. des Élec.*, December, 1934, Series 5, Vol. 4, No. 48, pp. 1199–1210.) *See* also 1934 Abstracts, p. 507.

1558. Investigations on Copper Oxide Photo-cells. II. Fatigue Phenomena.—W. Bulian. (*Physik. Zeitschr.*, 2nd Jan. 1935, Vol. 36, No. 1, pp. 33–34.)

For I *see* 1934 Abstracts, pp. 45–46. Curves of the decrease of photocurrent from cells constructed and already described by the writer (*loc. cit.*), and subjected to long continuous illumination, are shown in Fig. 1. Attempts at eliminating the fatigue are described; the method of enclosure in a gas-tight space, already described in I, was found to be the best. Fatigue phenomena are due to optical and chemical changes in the sputtered electrodes.

1559. The External Photoelectric Effect in Cuprous Oxide [Long-Wave Limit, Output, etc., determined in Air and Hydrogen].—E. Wasser. (*Physik. Zeitschr. der Sowjetunion*, No. 4, Vol. 6, 1934, pp. 351–367: in German.)

1560. Notes on Resistances of Selenium Cells deposited in Certain Gases [The Influence of Depositing Temperature: Hard Platinum Grid permits Soldered Joints to Terminals].—Lynn W. Jones. (*Journ. Opt. Soc. Am.*, January, 1935, Vol. 25, No. 1, pp. 1–3.)

1561. Non-Saturated Character of Colouring Matters and the Photovoltaic Phenomenon.—C. Stora. (*Comptes Rendus*, 11th Feb. 1935, Vol. 200, No. 7, pp. 552–554.)

1562. Electrical Breakdown of Illuminated Rocksalt under X-Rays [Increased Concentration of Free Electrons in Photoelectric Effect causes Decrease of Breakdown Voltage].—A. Worobjew. (*Zeitschr. f. Physik*, No. 3/4, Vol. 93, 1935, pp. 269–277.)

1563. Photoelectric Effect and Spark Mechanism.—Cravath. (*See* 1336.)

MEASUREMENTS AND STANDARDS

1564. Short-Wave Measurement [and the New Procedure used by the Radio-Austria A.-G., giving Accuracy within 0.003–0.004%].—M. Benesch. (*Elektrot. u. Masch:bau*, No. 8, Vol. 53, 1935, pp. 90–91.)

The apparatus is outlined and the following example of the procedure is given:—suppose an incoming wave (around 18 000 kc/s) is to be measured. Heterodyned by the precision variable oscillator 2 (in Fig. 2) this wave gives its zero-beat point for an oscillator reading of 48° 40′. Having found this roughly, the signal is switched out and the 100 kc/s standard generator 3, very rich in harmonics, is switched on and the heterodyne oscillator varied till the zones of the beat notes with the two harmonics on either side of the 48° 40′ are found. These zones are roughly at 34° and 58°; the calibration curve shows that they correspond to the 178th and 179th harmonics, with frequencies 17 804.4 and 17 904.4 kc/s. This interval is then subdivided by switching on the 10 kc/s generator 6. The tuning of this frequency to the exact tenth part of the 100 kc/s frequency is quickly checked in the listening circuit 5: no beats should be audible. The heterodyne oscillator is then varied till the beat-regions lying between the main points 34° and 58°, mentioned above, are found roughly: these are at 36, 38, 40, 43, 45, 48, 50, 53 and 56 degrees. Finally, the zero-beat point of the incoming wave is found carefully, together with the beat-note zones above and below it. The reading for the zero-beat is 48° 40′ and for the two beat notes 48° 05′ and 50° 40′. The reading 48° 05′ is six beat zones above the main point 34° and corresponds, therefore, to 17 804.4 + (6 × 10) kc/s, *i.e.* to 17 864.4 kc/s; the other reading corresponds to 17 874.4 kc/s. By interpolation, the value 17 866.7 kc/s is obtained for the incoming wave. The whole process takes only a few minutes. The subdivision of the 100 kc interval between the harmonic beat-zones at 34° and 58°, by means of the 10 kc/s generator as described, eliminates error due to the imperfect linearity of the frequency characteristic of the heterodyne generator (in spite of the greatest care in connection with the edge shape of the condenser plates) and enables an accuracy within 0.003 and 0.004% to be attained in spite of scale-reading inexactitudes.

1565. Notes on the Measurement of Radio Frequencies [and the Sullivan-Griffiths Sub-Standard Dynatron Wavemeter: Interpolation Methods: Crystal and Fork Standards: etc.].—W. H. F. Griffiths. (*Wireless Engineer*, October, 1934, Vol. 11, No. 133, pp. 524–532.)

1566. A Direct-Reading Frequency Meter suitable for High-Speed Recording [Thyratron-Inverter Pulses, controlled by Input Signal Frequency, give Indicating-Instrument Reading Proportional to Frequency].—F. V. Hunt. (*Review Scient. Instr.*, February, 1935, Vol. 6, No. 2, pp. 43–46.)

For use with paper-puncturing spark recorder, oscillograph, etc. For frequency variations in speech or singing: in combination with a counter, for radioactivity decay: by heterodyne methods, for measurement of radio frequencies, its high response speed enabling it to detect frequency modulation: can be given very high sensitivity to small frequency changes, for frequency monitoring or control at commercial, audio- or radio-frequencies: with suitable pick-up, for identifying vibration frequencies in rotating machinery: etc.

1567. The Telefunken Precision Frequency Meter [Five-Unit Equipment, for 14.3 to 57 m Waves, extensible to 6 000 m].—L. Leng. (*Telefunken-Zeit.*, October, 1934, Vol. 15, No. 68, pp. 43–49.)

The absolute error is given by $f = \pm (n \times 10^{-5} + 170)$ c/s, so that for 14.3 m and 57 m waves it amounts to 1.8×10^{-5} and 4.2×10^{-5} respectively; this represents an accuracy at least 2½ times as great as that required by the Madrid Conference.

1568. A Null Method of Frequency Measurement.—K. B. Karandeev. (*Journ. of Tech. Phys.* [in Russian], No. 7, Vol. 4, 1934, pp. 1357–1374.)

A description of a method developed by the author for measuring frequencies within a range of 100 to 10 000 c/s. The method is based on the comparison of currents flowing from the same source of e.m.f. through two parallel branches, of which one is a pure resistance and the other a pure capacity. Two thermocouples are connected in the branches, and two alternative circuits have been used for comparing the currents. In the first, the d.c. output of one couple is fed across a potentiometer, the drop across part of which is balanced against the output from the second couple, using a d.c. galvanometer in series with the latter as an indicator. In the second circuit, the outputs of the two couples are connected directly in opposition, with the galvanometer in circuit, balance being achieved by varying the value of either the resistance or condenser branch. Formulae are derived for each case and an investigation is given of the errors introduced by various simplifying assumptions. The accuracy of the method was also directly checked by the measurement of known frequencies.

A comparison is given between these circuits and the Robinson bridge, which shows that while the accuracy is approximately the same in both cases, the theoretical sensitivity of the former (0.005%) is much higher than that of the latter (0.5%).

1569. Standard-Frequency Radio Emissions [from WWV: Notes on Changes in Schedule].—Nat. Bureau of Standards. (*Journ. Franklin Inst.*, February, 1935, Vol. 219, No. 2, pp. 237–238.)

1570. Electrostatic Pendulum [Maintained by Discharging Condenser with Appropriate Time Constant].—J. A. van den Akker. (*Phys. Review*, 15th Jan. 1935, Series 2, Vol. 47, No. 2, pp. 199–200: abstract only.)

1571. Electrically Maintained Tuning Forks [and the Lorenz Method of Suspension: the Possibility of a Balanced System with Two Forks back-to-back on Common Stalk].—G.W.O.H. (*Wireless Engineer*, January, 1935, Vol. 12, No. 136, pp. 1–2.)

1572. The Temperature Coefficient of Inductance, with Special Reference to the Valve Generator, *and* Effect of Temperature on Inductance of Coil.—Moullin: Telefunken. (*See* 1379 and 1380.)

1573. The Temperature Coefficient of Quartz Plates for Long Waves.—Koga. (*See* 1382.)

1574. Attenuation of Oscillations in Piezo-electric Quartz Crystals.—A. G. Rziankin. (*Journ. of Tech. Phys.* [in Russian], No. 7, Vol. 4, 1934, pp. 1282–1294.)

The possibility of varying the decrement of crystals was investigated in the U.S.S.R. by Chaikin (1930 Abstracts, p. 222: the journal year is as given there, and not as shown in present paper), and in the present paper an account is given of further experiments in this direction. The attenuation was measured by the usual resonance method and also by the direct method developed by Chaikin. In the latter method, oscillations of a definite amplitude are excited in the crystal by a separate oscillator which is then switched off. After a certain time interval, the electrodes of the crystal are connected to a circuit containing a detector and a ballistic galvanometer and the remaining energy of the crystal is measured. A detailed description of the apparatus used in these measurements is given. The results obtained are as follows: (*a*) The decrement is independent of the amplitude of oscillations so long as such phenomena as sparking, luminosity of the crystal, etc., are absent. (*b*) The decrement can be increased by raising the pressure of the surrounding medium (air, CO_2, N_2) on the crystal. (*c*) Continuous variation of the decrement can be obtained by depositing on the crystal a thin layer of some volatile substance such as napthalene. The amount of substance deposited can be regulated by temperature control of the crystal chamber. Logarithmic decrements equal to those of ordinary oscillating circuits (0.027) were obtained by this method.

1575. A [Coloured Spot] Phenomenon presented in Polarised Light by Quartz in Vibration [Useful in detecting Defects in Homogeneity and in Shape: the Existence of Simple Modes of Vibration].—P. T. Kao. (*Comptes Rendus*, 11th Feb. 1935, Vol. 200, No. 7, pp. 563–565.)

1576. An Investigation of the Optical Effects in Electrically Stressed Quartz.—(*Marconi Review*, Jan./Feb. 1935, No. 52, pp. 16–25: to be continued.)

Author's summary:—Quartz, cut in a predetermined manner, is electrically stressed and the optical effects exhibited by particular modifications in the birefringence are observed. The complicated state of vibration of the two components within the crystal is given special attention. To this end, the hypothesis of Gouy is developed and the separate activity of the linear and the circular retardation is studied. The piezo-optical constant is determined for all directions in the plane containing optic and mechanical axes. The relation between the piezo-electric and the piezo-optical constant is given. The photo-elastic constant is also brought in and the possibility of employing the piezo-optical effect commercially is discussed.

1577. X-Ray Extinction in Piezoelectric Crystals [due to Warping of Lattice Planes during Oscillation].—G. W. Fox and W. A. Fraser. (*Phys. Review*, 15th Jan. 1935, Series 2, Vol. 47, No. 2, p. 200: abstract only.)

1578. Oscillations of a Hollow Quartz Cylinder [Transverse Radial, Transverse Circular, Longitudinal, and Rotating Modes: Suitability for Piezoelectric Oscillators].—Ny Tsi-Ze and T. Ling-Chao. (*Comptes Rendus*, 11th Feb. 1935, Vol. 200, No. 7, pp. 565–567.)

1579. A-Cut Crystals, *and* AT-Cut Crystals Available.—(*QST*, October and November, 1934, Vol. 18, Nos. 10 and 11, pp. 17 and 12, 78.) For these cuts *see* Lack, Willard and Fair, 1934 Abstracts, p. 570.

1580. A Simple Method of Demonstrating the Piezoelectricity of Crystals.—L. Bergmann. (*Physik. Zeitschr.*, 2nd Jan. 1935, Vol. 36, No. 1, pp. 31–32.)

The crystal is placed between two metal electrodes and subjected to periodic pressure changes (produced *e.g.* by a tuning fork). The periodic variations in charge thus produced are rendered audible by amplification. The sensitivity of the method is discussed.

1581. Selectivity Measurements: a Common Source of Error in Measurements of Receiver Selectivity.—Dingley. (*Rad. Engineering*, October, 1934, Vol. 14, No. 10, pp. 7–8 and 24.) A summary was dealt with in 1934 Abstracts, p. 381.

1582. "Visual" Production Alignment [Cathode-Ray Oscillograph as a Curve Tracer in Production Testing].—(*Rad. Engineering*, November, 1934, Vol. 14, No. 11, pp. 20–21.)

1583. Incremental Permeability and Inductance [of Ferromagnetic Materials]: the Rôle of Waveform in Measurement.—L. G. A. Sims. (*Wireless Engineer*, January and February, 1935, Vol. 12, Nos. 136 and 137, pp. 8–16 and 65–69.)

1584. Simplified Signal Generators for Tests on Receivers [Broadcast and Commercial].—L. Brandt. (*Telefunken-Zeit.*, December, 1934, Vol. 15, No. 69, pp. 36–44.)

General considerations: description of a design for 3 000 m–15 m wave-range: of a design for 20 m–3 m wave-range: of an auxiliary unit (3 000 m–50 m) to increase the output voltage from 0.1 v to 100 v, for the imitation of strong interference, investigations close to a transmitting station, etc. The precautions taken as regards screening and "choking," and as regards careful design to obtain reliability, simplicity in operation and economy in construction and in valves, are described.

1585. Single-Sideband Signal Generators [for Precision Analysis of Receiver Performance].—(*Electronics*, January, 1935, p. 31.)

1586. Signal Generator Attenuator Design.—R. F. Shea. (*Rad. Engineering*, January, 1935, Vol. 15, No. 2, pp. 12–15 and 26.)

1587. Heterodyne Capacity Measuring Set [with Visual Beat Indicator].—W. C. Lister. (*Wireless Engineer*, August, 1934, Vol. 11, No. 131, pp. 425–427.)

1588. Precision Condenser Calibration at Radio Frequencies [using Dynatron Oscillator].—E. L. Hall and W. D. George. (*Electronics*, October, 1934, pp. 318–320.)

1589. A Plate-Impedance Bridge [using 60-cycle Mains: Variable Voltage Method].—E. Atkins. (*Rad. Engineering*, February, 1935, Vol. 15, No. 2, pp. 23 and 26.)

1590. On the Measurement of Very Small Capacity Changes.—W. Bünger. (*Zeitschr. f. Physik*, No. 9/10, Vol. 91, 1934, pp. 679–684.)

The measurement is made by an a.c. bridge circuit (Fig. 1) which renders negligible the effect of changes in wavelength and voltage. The construction and calibration (Fig. 2) are described in detail; changes in $\Delta C/C$ of the order of 2×10^{-9} could be measured.

1591. The Measurement of [Very] Small Resistances by the Compensation Apparatus.—H. Freytag. (*E.T.Z.*, 7th Feb. 1935, Vol. 56, No. 6, p. 128.)

1592. A Piezoelectric Peak Voltmeter [Modulated Carrier Waves around 20 000 Volts measured by Cathode-Ray Oscillograph by interposition of Piezoelectric Step-Down Transforming Device].—L. M. Myers. (*Marconi Review*, Nov./Dec. 1934, No. 51, pp. 4–8.)

1593. A Diode-Triode Peak Voltmeter.—A. W. Barber. (*Electronics*, October, 1934, p. 322.)

1594. Anode Potential Measurements [under Undisturbed Working Conditions] with a Voltmeter.—C. R. Cosens. (*Wireless Engineer*, February, 1935, Vol. 12, No. 137, pp. 84–85.)

1595. Direct-Reading Meters for Tube Measurements [Dynamometer Instruments and Special Circuits].—W. P. Koechel. (*Electronics*, December, 1934, pp. 381–383.)

1596. Use and Construction of Choke Coils for the Measurement of Very Small Direct Voltages [10^{-8} V] with Amplifiers.—R. Colberg. (*Zeitschr. f. Physik*, No. 7/8, Vol. 93, 1935, pp. 507–527.)

The principle of the method of measurement here developed is that the unknown voltage and a compensating voltage send a weak direct current through a choke coil. The current is suddenly broken by opening a switch and the magnetic energy in the choke is discharged as a damped oscillation across the capacity in the grid circuit of a valve and the coil capacity (circuit Fig. 2). The variations in grid voltage are heard as crackling sounds. The compensating voltage is then adjusted until these can be no longer heard, *i.e.* no current flows through the choke, and the value of the direct voltage is known. The method is investigated theoretically and the practical construction of the choke coil, switch and compensating arrangement is described (pp. 508–513). The disturbances and necessary screening, with the effect of thermal voltages and slow magnetic variations, are then dealt with (pp. 513–515). Part II discusses the theoretical design of choke coils with a high amplification factor: the latter is proportional to the linear dimensions, for geometrically similar coils and matched impedances, so that it can be increased as much as is desired. Part III discusses increase in sensitivity of the whole arrangement and comparison with other instruments.

1597. A MAINS-DRIVEN VALVE VOLTMETER OF VERY HIGH SENSITIVITY [using a Two-Stage Anode-Voltage Stabilisation by a Reflex Connection of One Glow-Discharge Stabilising Tube].—O. Limann. (*Hochf:tech. u. Elek:akus.*, February, 1935, Vol. 45, No. 2, pp. 66–67.)

Preliminary tests were made with an indirectly heated valve as an anode-bend voltmeter, with its heating current controlled by an iron-wire barretter and its anode and grid-bias voltages by a "Stabilisator" tube in the straightforward connection, the voltmeter sensitivity being increased by repose-current compensation by a bridge connection. The results were disappointing, a deliberate mains-voltage change from 220 v to 240 v causing the indicating instrument to alter by 40% of its full-scale value, while the natural mains fluctuations produced current swings which rendered accurate compensation impossible. This trouble was found to be due chiefly to the heating conditions involved in the use of an indirectly heated valve. A directly heated valve was therefore employed, its filament voltage being stabilised in the ordinary way by the glow-discharge tube. For the anode voltage a double (reflex) stabilisation was devised (Fig. 2), the 210 v stabilised voltage given by three gaps of the tube being taken through a series resistance to the fourth gap, which was thus loaded in the opposite sense. The working voltage thus obtained was found to be some 20 v higher than that ordinarily obtained. This doubly stabilised voltage was used as the anode voltage of a valve voltmeter in the leaky-grid (audion) connection. The complete circuit, with repose-current compensation, is shown in Fig. 3: the deliberate mains-voltage variation mentioned above produced only a change of 2% instead of 40%. and the swings of current completely disappeared. This increased stability was accompanied by a great increase of sensitivity: moreover, the waiting time involved in the use of an indirectly heated valve, before the sensitive indicating instrument could be connected, was eliminated.

1598. ELECTROSTATIC VOLTMETER WITH POINTER READING, FOR FREQUENCIES 0 TO 10^7 c/s AND VOLTAGES UP TO 220 V.—F. Maske. (*Physik. Zeitschr.*, 2nd Jan. 1935, Vol. 36, No. 1, pp. 29–31.)

The instrument acts by the attraction of condenser plates of which one, the "needle," is suspended by a very thin thread. A damping disc is placed under the "needle," to bring it to rest more quickly. Some typical measurements and curves are given, to show that the instrument really does fulfil the claims made in the title. The use at very high frequencies is limited by the power consumption.

1599. ZERO-POINT DISPLACEMENT IN DOUBLE-COIL INSTRUMENTS [Use of Auxiliary Current].—W. Geyger. (*Arch. f. Elektrot.*, 11th Feb. 1935, Vol. 29, No. 2, pp. 134–139.)

The circuit of the double-coil instrument connected in a bridge is shown in Fig. 1 and in a potentiometer arrangement in Fig. 3. In the latter an auxiliary current is employed to adjust the zero so that the whole scale of the instrument may be used.

1600. CAMBRIDGE VERSATILE GALVANOMETER: WITH SOME ATTACHMENTS FOR USE IN THE WIRELESS LABORATORY.—C. R. Cosens. (*Wireless Engineer*, November, 1934, Vol. 11, No. 134, pp. 587–595.)

1601. SURGE [Resistance-Capacity] BRIDGE FOR THE INVESTIGATION OF [High-Voltage] ELECTRICAL FIELDS.—S. Szpor. (*Arch. f. Elektrot.*, 12th Dec. 1934, Vol. 28, No. 12, pp. 783–789.)

This bridge will measure wave amplitudes up to 300 kv. The circuit is shown in Fig. 1. A glow-discharge lamp is used as the indicator. The equilibrium conditions are described in §2 and the sensitivity and dark regions of the lamp are worked out in §3. The accuracy is discussed in §4, numerical data are given in §5, and §§6 and 7 describe investigations without and with glow discharges respectively. In the latter case, only qualitative investigations can be made.

1602. A NEW METHOD OF DETERMINATION OF THE MAGNETIC CONSTANTS OF SMALL SPECIMENS IN ALTERNATING FIELDS.—R. Jaanus. (*Tech. Phys. of U.S.S.R.*, No. 1, Vol. 1, 1934, pp. 57–63: in English.)

1603. A PRECISION MAGNETIC FIELD STANDARD [Design of Solenoid].—F. G. Dunnington. (*Phys. Review*, 1st Feb. 1935, Series 2, Vol. 47, No. 3, pp. 257–258: abstract only.)

1604. SIMPLIFIED INDUCTANCE-COIL CALCULATIONS [Chart derived from Nagaoka Single-Layer Formula].—A. R. Rumble. (*Electronics*, October, 1934, p. 315.)

SUBSIDIARY APPARATUS AND MATERIALS

1605. A DISCHARGE-TUBE LIGHT SOURCE WITH CONTROL CHARACTERISTICS SIMILAR TO THOSE OF A THYRATRON [for Stroboscopic and Recording Purposes: Very Intense and Concentrated Source].—D. C. Rose. (*Canadian Journ. of Res.*, December, 1934, Vol. 11, No. 6, pp. 780–786.)

1606. A SOURCE OF LIGHT OF EXCEPTIONAL INTENSITY AND SHORT DURATION [Millions of Candle Power lasting less than 5 Millionths of a Second].—Michel-Lévy and Muraour. (*Comptes Rendus*, 11th Feb. 1935, Vol. 200, No. 7, pp. 543–545.)

1607. Measurements of the Light Output in the Positive Discharge Column of Neon.—Klarfeld and Taraskov. (*Tech. Phys. of U.S.S.R.*, No. 1, Vol. 1, 1934, pp. 21–29: in English.)

1608. Neon-Tube Condenser Tester.—Browning. (*Electronics*, January, 1935, p. 22.)

1609. A Highly Luminous Glow Discharge Tube for the Spectroscopic Investigation of Small Quantities of Material.—H. Schüler and H. Gollnow. (*Zeitschr. f. Physik*, No. 9/10, Vol. 93, 1935, pp. 611–619.)

1610. A Simple [Triode] Arrangement for the Recording of Very Short Potential Impulses.—Rossi. (*La Ricerca Scient.*, No. 9/10, Vol. 2, 5th Year, 1934, pp. 377–379.)

1611. Design of Constant Resistance Attenuators.—Rangachari. (*Wireless Engineer*, November, 1934, Vol. 11, No. 134, pp. 596–599.)

1612. A Simple Method of Selecting an Inductometer Scale [and a Simple Reciprocal Property leading to an Improvement in Mechanical Design].—Astbury. (*Journ. Scient. Instr.*, October, 1934, Vol. 11, No. 10, pp. 319–320.)

1613. "Siebschaltungen: Nachtrag" (Filter Circuits: Supplement).—Cauer. (*Zeitschr. V.D.I.*, 9th March, 1935, Vol. 79, No. 10, p. 338.) Notice of a 3-page supplement to the book referred to in 1932 Abstracts, p. 537 (at end of abstract.)

1614. Metal Discharge Tubes [Intensity and Energy of Cathode Beam in Cold-Cathode Oscillograph: Dimensions of Tubes, Use of Pre-Concentration, State of Cathode Surface, Emission from Cathode with Crater].—J. M. Dodds. (*Arch. f. Elektrot.*, 11th Jan. 1935, Vol. 29, No. 1, pp. 69–78.)

Experiments with metal discharge tubes and external recording were made, in order to find the design which would give the greatest energy density in the beam with the highest cathode voltages. Figs. 1, 2a, 2b show various tubes; the energy yield is given in Figs. 3 and 4. Fig. 7 shows the efficiency of the tube in Fig. 2b. The energy yield from a tube with Wehnelt cylinder is shown in Fig. 8. §5 describes, with photographs, electron-microscopic investigations of current density for different types of cathode; a cathode with an artificial crater (Fig. 16) gives auto-pre-concentration and very constant emission but small energy density. To attain very high recording velocities it is best to use a new cathode.

1615. Elimination of Distortion in Cathode-Ray Tubes.—Du Mont. (*Electronics*, January, 1935, pp. 16–17.)

Methods of eliminating distortion due to change in beam velocity caused by the deflecting voltages; change in internal resistance as these voltages are varied; threshold effect in gas-concentrated tubes; and varying length of beam path through deflection plates.

1616. Deviation of the Electron Beam and Spot Distortion in the Cathode-Ray Tube.—Deserno. (*See* 1523.)

1617. Fundamentals of Applied Geometrical Electron Optics [General Introduction: Action of Lenses, Cathode-Ray Tube and Electron Microscope].—Brüche. (*Arch. f. Elektrot.*, 11th Feb. 1935, Vol. 29, No. 2, pp. 79–107.)

1618. New High-Vacuum Cathode-Ray Tubes for Sound-on-Film Recording.—von Ardenne. (*See* 1474.)

1619. New RCA Cathode-Ray Tubes [High-Vacuum Types 907 and 908], *and* New Sylvania Cathode-Ray Tube [Type H7–2].—(*Rad. Engineering*, January, 1935, Vol. 15, No. 1, pp. 11–12 and 20: pp. 19–20.)

1620. Cathode-Ray Tube Electrode-Support Design giving Ruggedness combined with Great Screen/Deflecting-Plates Distance in Shortest Possible Tube.—Du Mont. (*Rad. Engineering*, January, 1935, Vol. 15, No. 1, p. 23.)

1621. A Single-Stroke Time Base [synchronised with Camera Control in Cathode-Ray Oscillograph Equipment, particularly for recording Amplifier and Tape Noise in Magnetic Recording Systems].—Young. (*Marconi Review*, Jan./Feb. 1935, No. 52, pp. 26–27.)

1622. "The Cathode-Ray Oscillograph" [Book Review].—Stekolnikoff. (*Elektrot. u. Masch: bau*, No. 3, Vol. 53, 1935, p. 36.) The book is in Russian.

1623. Luminescence of Thorium Oxide Activated by Rare Earths. Optimum Concentration for Different Sources of Excitation [Cathode Rays, Ultra-Violet Light and Hydrogen Flame require Different Concentrations, Cathode Rays requiring Least].—Wick and Throop. (*Journ. Opt. Soc. Am.*, February, 1935, Vol. 25, No. 2, pp. 57–62.)

1624. Quantitative Determination of the Definition given by Intensifying Foils [in X-Ray Photography].—Wiest. (*Zeitschr. f. tech. Phys.*, No. 2, Vol. 16, 1935, pp. 53–56.)

1625. A Home-made Oscillograph [embodying the Micromesh Tunograph Tube].—C. C. Inglis. (*Wireless World*, 22nd March, 1935, Vol. 36, pp. 283–284.)

1626. Sturdy Metal-to-Glass Seals [using "Fernico"].—(*Electronics*, November, 1934, p. 365.)

1627. "Metal Skin" Leads fused into Ceramic Containers: Fused Joints between Steatit T2 and Lead Glass: etc. [Leipzig Fair].—(*E.T.Z.*, 28th Feb. 1935, Vol. 56, No. 9, pp. 244–245.)

1628. Comment on "New Methods of Leading-In to Vacuum Containers."—Handrek: Selényi. (*Zeitschr. f. tech. Phys.*, No. 2, Vol. 16, 1935, p. 57.)

Referring to Handrek's paper (539 of February)

Selényi points out that the German patent 604 107 describes a process which bears the same relation to Handrek's as welding does to soldering.

1629. Ceramic Insulating Materials for High Frequencies [Survey, with Examples of Application].—Handrek. (*Zeitschr. V.D.I.*, 15th Dec. 1934, Vol. 78, No. 50, pp. 1441–1449.)

1630. An Advance in the Composition of Ceramic Dielectrics [for Low H.F. Loss and Small Temperature Coefficient: "Diacond"].—Albers-Schönberg, Soyck and Ungewiss. (*E.T.Z.*, 28th Feb. 1935, Vol. 56, No. 9, p. 226.)

1631. Transparent Synthetic Resin ["Leukon": nearly as good as Amber as regards Insulation].—(*Journ. Scient. Instr.*, March, 1935, Vol. 12, No. 3, p. 97.)

1632 The Mechanism of the Destruction of the Insulation of Rubber-Insulated Lines and Cables [including Ignition Cables] by Glow-Discharge Phenomena [in Air-Filled Spaces].—Haas. (*Elektrot. u. Masch:bau*, No. 37, Vol. 52, 1934, pp. 429–434.)

1633 New Flexible Rubber Insulation ["Laytex"].—(*Electronics*, November, 1934, p. 365.) *See* also 307 of January.

1634 "Theory of Dielectrics."—A. Schwaiger. (Translated by Sorensen: available at Patent Office Library, London.)

1635. Chemical Applications of Recent Dielectric Constant Theory [with Reference to Mechanisms describing Dielectric Behaviour of Insulating Materials].—J. W. Williams. (*Journ. Franklin Inst.*, February, 1935, Vol. 219, No. 2, pp. 211–235.) Concluded from the January issue.

1636. Discontinuities in Electrification Changes [in Dielectrics: Electrical Breakdown of Air near Electrodes].—H. Schönfeld. (*Ann. de Physik*, Series 2, No. 1, Vol. 22, 1935, pp. 53–64.)

1637 The Ageing of Insulation in High Tension Cables, *and* The Ageing of Electrical Insulating Materials.—Inge and Walter: Goldman and Vul. (*Tech. Phys. of U.S.S.R.*, No. 1, Vol. 1, 1934, pp. 30–41 and 42–56: in English.) For the second paper *see* 549 of February.

1638. Cellophane-Wrapped Wire [for Magnets: "Celenamel"].—(*Electronics*, October, 1934, p. 329.)

1639. A New Hook-up Wire with Non-Absorbent Highly Insulating Covering: "Lenzite."—(*Electronics*, October, 1934, p. 329.)

1640. New Transmitting By-Pass Condensers [Non-Inductively Wound with Oil-Impregnated Paper].—(*QST*, November, 1934, Vol. 18, No. 11, p. 80.)

1641. Dielectric Properties of Cellulose Paper.—Whitehead and Greenfield. (*Elec. Engineering*, October and November, 1934, Vol. 53, Nos. 10 and 11, pp. 1389–1396 and 1498–1503.)

1642. The Motion of the Ion Lattice in Insulators [Oxide Films on Al and Ta] with Extreme Electric Field-Strengths [9.5 to 10 MV/cm].—A. Güntherschulze and H. Betz. (*Zeitschr. f. Physik*, No. 5/6, Vol. 92, 1934, pp. 367–374.) Continuation of the work referred to in 338 of January.

1643. Dielectric Losses in Crystals.—N. Bogoroditsky and V. Malishev. (*Journ. of Tech. Phys.* [in Russian], No. 7, Vol 4, 1934, pp. 1306–1317.)

An account of measurements of dielectric losses in certain types of crystal (quartz, talc, gypsum, rock salt and mica). Measurements were carried out at various temperatures and frequencies, and the main conclusion reached is that these losses are mainly due to resistance. The results obtained are shown in a number of tables and curves.

1644. Surface-Force Theory of Crystal Rectification [in Symmetrical Crystals: Surface Ions give Unbalanced Electrostatic Force].—Khastgir. (*Nature*, 26th Jan. 1935, Vol. 135, p. 148.)

1645. Rectifying Effect in Chrome Cast Iron.—L. G. Hall. (*Phys. Review*, 15th Dec. 1934, Series 2, Vol. 46, No. 12, p. 1109.)

1646. The Deterioration of Copper Oxide Rectifiers due to Temperature Rise.—Suzuki. (*Journ. I.E.E. Japan*, October, 1934, Vol. 54 [No. 10], No. 555, pp. 1035–1038: English summary p. 118.)

1647. On Some Electron Properties of Tellurium and Wilson's Mechanism of Semi-Conductivity.—Cartwright and Haberfeld-Schwarz. (*Proc. Roy. Soc.*, Series A, 15th Feb. 1935, Vol. 148, No. 865, pp. 648–664.)

1648. The Electrical Piercing of Thin Layers of Aluminium Oxide in an Electrolyte [Breakdown Voltage as a Function of Ion Concentration and Temperature: Discharge introduced by Cold Emission from Negative Electrode].—van Geel. (*Physica*, Oct./Nov. 1934, Vol. 1, No. 10/11, pp. 989–995: in French.)

1649. Polarised-Grid Mercury-Vapour Rectifiers for High-Power Broadcasting Transmitters.—Danz: Brown-Boveri Company. (*Génie Civil*, 2nd March, 1935, Vol. 106, No. 9, pp. 219–220: summary only.)

1650. Theory of Half-Wave Rectification [and Experimental Investigation of Single-Phase Mercury Rectifier].—Gotô. (*Rep. of Rad. Res. in Japan*, July, 1934, Vol. 4, No. 2, Abstracts pp. 36–37: summary only, in English.)

1651. The "Ignitron" Type of Inverter.—Wagner and Ludwig. (*Elec. Engineering*, October, 1934, Vol. 53, No. 10, pp. 1384–1388.)

1652. New Methods of Controlling [from Outside, instead of by a Grid] the Arc Ignition for Hot-Cathode Rectifiers.—Watanabe and Takano. (*Journ. I.E.E. Japan*, November, 1934, Vol. 54 [No. 11], No. 556, pp. 1159–1163: English summary pp. 131–133.)

1653. Diminishing Effect of Voltage Ripples by the Parallel Running of Rectifiers.—Matuura. (*Journ. I.E.E. Japan*, October, 1934, Vol. 54 [No. 10], No. 555, pp. 1087–1096: English summary pp. 124–126.)

1654. Rectified Currents and the Characteristics of Exploring Electrodes in Mercury Arcs, *and* The Ionic Currents in Exploring Electrode Characteristics.—Kovalenko, Roshanski and Sena. (*Journ. of Tech. Phys.* [in Russian], Nos. 7 and 9, Vol. 4, 1934, pp. 1271–1281 and 1688–1697.)

1655. The Influence of an Axial Magnetic Field on the Discharge Density in Mercury Vapour at Low Pressures.—Mirlas. (*Journ. of Tech. Phys.* [in Russian], No. 8, Vol. 4, 1934, pp. 1522–1534.)

1656. Liberation of Electrons from Molybdenum Surfaces by Positive Mercury Ions.—Gvosdover. (*Physik. Zeitschr. der Sowietunion*, No. 4, Vol. 6, 1934, pp. 415–423.)

1657. Magnetic Control of Thyratrons.—McArthur. (*Electronics*, January, 1935, pp. 12–13 and 26.)

1658. The Starting Potential of the Glow Discharge in Neon-Argon Mixtures between Large Parallel Plates. I and II.—Penning and Addink: Penning. (*Physica*, Oct./Nov. 1934, Vol. 1, No. 10/11, pp. 1007–1027 and 1028–1044: in English.)

1659. Elastic and Magnetic Properties of Metals [and the Possible Use of Oriented Strains in creation of Permanent Magnets].—F. Bitter. (*Science*, 22nd Feb. 1935, Vol. 81, No. 2095, Supp. p. 9.)

1660. Nickel Steels for Permanent Magnets [including Honda's New "N.S.K" Steel].—(*E.T.Z.*, 6th Dec. 1934, Vol. 55, No. 49, pp. 1210–1211: summary only.)

1661. Ferrocart and Its Applications [in America].—Fill. (*Electronics*, November, 1934, pp. 358–359.)

1662. Transformer Design.—Kelley. (*Rad. Engineering*, December, 1934, and February, 1935, pp. 7–11 and 16–19.)

1663. Use and Construction of Choke Coils for the Measurement of Very Small Direct Voltages.—Colberg. (*See* 1596.)

1664. The Time-Decrease of Permeability at Low Magnetising Forces [Distinct from Ordinary Ageing: Effect on Inductance Constancy of Iron-Cored Coils: etc.].—Webb and Ford. (*Journ. I.E.E.*, December, 1934, Vol. 75, No. 456, pp. 787–797.)

1665. Drift of Magnetic Permeability at Low Inductions after Demagnetisation.—Sanford. (*Journ. of Res. of Nat. Bur. of Stds.*, September, 1934, Vol. 13, No. 3, pp. 371–376.)

1666. Economical Design for Radio Set Transformers.—C. A. Hultberg. (*Electronics*, September and October, 1934, pp. 286–287 and 310–311.)

1667. Wide-Range Variable Condenser for Special "Laws": a New Instrument Especially Suitable for the Frequency Adjustment of Heterodyne Oscillators.—Griffiths. (*Wireless Engineer*, August, 1934, Vol. 11, No. 131, pp. 415-418.)

1668. Flexible Shafts for Radio.—(*Electronics*, October, 1934, p. 329.)

1669. Electrode Disintegration in Relay Contacts [Particle Migration due to Arc or Glow Discharge: Application to Design of Contacts].—Holm. (*Zeitschr. f. tech. Phys.*, No. 11, Vol. 15, 1934, pp. 483–487.)

1670. Electromagnetic Forces set up between Current-Carrying Conductors during Short-Circuit.—G. L. E. Metz. (*Journ. I.E.E.*, October, 1934, Vol. 75, No. 454, pp. 527–541.)

1671. Advantages and Disadvantages of Aluminium for Cables.—(*E.T.Z.*, 11th Oct. 1934, Vol. 55, No. 41, pp. 1008–1009.)

1672. A Method of Soldering Molybdenum to Copper.—Müller and Clay. (*Journ. Scient. Instr.*, December, 1934, Vol. 11, No. 12, p. 405.)

1673. "Electronic Regulator for A.C. Generators": Discussion and Author's Closure.—Gulliksen. (*Elec. Engineering*, November, 1934, Vol. 53, No. 11, pp. 1530–1531.) *See* 1934 Abstracts, p. 453, l-h column.

1674. More on Gaseous Voltage Regulators for Receiver "B" Supplies.—H. A. Robinson. (*QST*, January, 1935, Vol. 19, No. 1, pp. 29–30 and 84, 86.)

1675. D.C. Voltage Stabilisation [Rectifier-Filter Combination stabilised by Single Triode].—Kohler. (*Electronics*, December, 1934, pp. 388–389.)

1676. The "Thyratron" Motor [Commutator replaced by Thyratron Unit: Advantages—Automatic and Remote Control, Reliability, etc.].—Alexanderson and Mittag. (*Elec. Engineering*, November, 1934, Vol. 53, No. 11, pp. 1517–1523.)

1677. The Compensated Rotor-Fed Triphase Motor as Ideal Synchronous Motor.—Kramer. (*E.T.Z.*, 4th Oct. 1934, Vol. 55, No. 40, pp. 975–978.)

1678. The Inherent Instability of Synchronous Machinery.—J. C. Prescott and J. E. Richardson. (*Journ. I.E.E.*, October, 1934, Vol. 75, No. 454, pp. 497–511.)

1679. "Castle" Sine-Wave Alternator Sets [for Testing Meters, etc.].—(*World Power*, December, 1934, Vol. 22, No. 132, pp. 283–284.)

1680. Electrostatic Generators [with "Residual Discharge" Excitation].—Jolivet. (*Rev. Gén. de l'Élec.*, 17th Nov. 1934, Vol. 36, No. 20, pp. 698–701.) *See* also Abstracts, 1934, p. 53: for Chaumat's work *see* 1932, p. 242.

STATIONS, DESIGN AND OPERATION

1681. The Operation of Several Transmitters on the Same Wavelength [Common-Wave Broadcasting].—G.W.O.H.: L. B. Turner. (*Wireless Engineer*, December, 1934, Vol. 11, No. 135, pp. 639–641.) For Turner's comments on the interpretation of the Lorenz Company's "variation of 1 in 10^9" and the coercive action of the mechanism see *ibid.*, January, 1935, p. 23, and for a correction, February, p. 87.

1682. Transmitters on the Same Wavelength [Common-Wave Broadcasting: B.B.C. Experience from 1926 to Present Day: Advantage of Line Driving].—Kirke. (*Wireless Engineer*, February, 1935, Vol. 12, No. 137, pp. 85–87.)

1683. Wired Broadcasting [Reasons for Its Future Use in Germany: the German P.O. Tests].—Gladenbeck. (*E.T.Z.*, 7th Feb. 1935, Vol. 56, No. 6, pp. 121–122.)

These tests are now being carried out in Berlin: three carrier waves, between 1 000 and 2 000 m (the Deutschlandsender's wavelength being avoided) are used. During 1935–1936 a large-scale test will be made in the Dresden-Löbau district: if this also is satisfactory, wired broadcasting will be introduced for the whole of Germany. *See* also 1684.

1684. Wired Broadcasting Tests in Berlin.—(*Funktech. Monatshefte*, January, 1935, No. 1, p. 8.) *See* also 1683.

1685. "Re-Diffusion" Broadcasting in Europe: How Wire Distribution Circuits serve Listeners in England and Holland.—(*Electronics*, February, 1935, pp. 44–45.)

1686. Cable for "Central Broadcasting Establishments" [for Radiodiffusion Services]. (*E.T.Z.*, 14th Feb. 1935, Vol. 56, No. 7, p. 172.)

1687. KYW: Directional Aerial, Complete A.C. Operation, Nitrogen-Filled Condensers among Features of New [Philadelphia] Station.—(*Electronics*, January, 1935, pp. 6–7.) *See* also 1212 of April.

1688. The New WOR: Unique Radiation System is Outstanding Feature of New 50 kW Transmitter at Cartaret, N.J.—(*Electronics*, February, 1935, pp. 38–40.)

1689. The Lakihegy (Budapest) High-Power Broadcasting Station.—(*Elektrot. u. Masch:bau*, No. 35, Vol. 52, 1934, pp. 413–414.)

1690. Broadcast Transmitter Characteristics: a Survey of 36 Stations.—A. S. Clarke and L. A. Schuttig. (*Electronics*, December, 1934, pp. 378–380 and 392.)

1691. Type-Printing Telegraphy for Wireless Communication [Siemens-Verdan Multiplex System as on Berlin/Moscow Service].—Wüsteney and Hennig. (*Telefunken-Zeit.*, December, 1934, Vol. 15, No. 69, pp. 15–26.)

1692. What are the Costs for Police Radio Systems?—Fink. (*Electronics*, December, 1934, pp. 372–374.)

1693. Thirty Years Ago: [Military] Wireless in German South-West Africa.—H. Neumann. (*Telefunken-Zeit.*, December, 1934, Vol. 15, No. 69, pp. 44–49.)

GENERAL PHYSICAL ARTICLES

1694. Fundamental Dimensions of μ_0 and K_0 in Electrical Science [Electrostatic System disappears when Electromagnetic Dimensions are used].—J. B. Henderson. (*Nature*, 19th Jan. 1935, Vol. 135, pp. 105–106.) For comments by Wilberforce see *ibid.*, 16th February, p. 270.

1695. The Result of the Inclusion of Electrostatic Phenomena in the Mathematical Structure.—Andronescu. (*Rev. Gén. de l'Élec.*, 26th Jan. 1935, Vol. 37, No. 4, p. 121: long summary only.)

1696. A [Fruitless] Search for a Photomagnetic Effect.—R. M. Emberson and R. T. Dufford. (*Phys. Review*, 15th Jan. 1935, Series 2, Vol. 47, No. 2, p. 202: abstract only.)

1697. Mean Kinetic Energy and Mean Energy Spent in Excitation by Electrons Drifting through Dense Gases [in Electric Field].—Null. (*Phys. Review*, 15th Feb. 1935, Series 2, Vol. 47, No. 4, pp. 301–305.)

1698. On the Angular Distribution of the Light Emission from a Directed Stream of Electrons in a Gas [60-Volt Beam in Helium].—J. A. Smit. (*Physica*, February, 1935, Vol. 2, No. 2, pp. 104–110: in English.)

1699. Electronic and Ionic Current in Characteristics of Collectors [and the Upper Limit of Temperature of Positive Ions].—Kovalenko and others. (*Tech. Phys. of U.S.S.R.*, No. 1, Vol. 1, 1934, pp. 9–20: in English.)

1700. Remarks on Two Earlier Papers on Electron Diffusion.—M. J. Druyvesteyn. (*Physica*, Oct./Nov. 1934, Vol. 1, No. 10/11, pp. 1003–1006: in German.)

1701. The Intensity of the High-Frequency Electrodeless Discharge [in Hydrogen] as Conditioned by Power Control of the Generator.—O. Stuhlman, Jr., and M. S. McCay. (*Journ. Franklin Inst.*, January, 1935, Vol. 219, No. 1, pp. 37–46.)

1702. Superficial Effect (Skin Effect) in the Positive Column of a Na/Ne Discharge.—Uyterhoeven and Verburg. (*Comptes Rendus*, 11th Feb. 1935, Vol. 200, No. 7, pp. 536–539.)

1703. Extinction of the Corona Discharge by Particles in Suspension in the Electric Field.—M. Pauthenier and M. Moreau-Hanot. (*Comptes Rendus*, 26th Nov. 1934, Vol. 199, No. 22, pp. 1193–1195.) For recent papers by Pauthenier *see* Abstracts, 1933, p. 150; 1934, pp. 261, 632.

1704. Hysteresis Phenomenon in the Dynamic Characteristic of the Flash Discharge.—Valle and Gawehn. (*La Ricerca Scient.*, No. 7/8, Vol. 2, 5th Year, 1934, pp. 281–282.)

MISCELLANEOUS

1705. Properties of the Scale Co-ordinate [and Types of Measurement Codification: Difference Equations in Scale Co-ordinates illustrate Selection Principles in Formalisation of Measurement Operations].—W. Bender. (*Journ. Franklin Inst.*, February, 1935, Vol. 219, No. 2, pp. 187–210.) *See* also 1933 Abstracts, p. 54, r-h column.

1706. On Observations of Points connected by a Linear Relation.—Beryl M. Dent. (*Proc. Phys. Soc.*, 1st Jan. 1935, Vol. 47, Part I, No. 258, pp. 92–106: Discussion pp. 106–108.)

1707. Note on the Location of the Critical Points of Harmonic Functions.—J. L. Walsh. (*Proc. Nat. Acad. Sci.*, October, 1934, Vol. 20, No. 10, pp. 551–554.)

1708. The Computation of the Integrals required in Mutual-Inductance Calculations [Complete Elliptic Integrals of Third Kind].—N. F. Astbury. (*Proc. Phys. Soc.*, 1st Jan. 1935, Vol. 47, Part I, No. 258, pp. 86–91.)

1709. The Accuracy of Least Squares Solutions. Part II: The Standard Deviation of the Errors of Linear Equations of Condition.—Sterne. (*Proc. Nat. Acad. Sci.*, 15th Dec. 1934, Vol. 20, No. 12, pp. 601–603.) For Part I *see* 603 of February.

1710. "Higher Mathematics for Engineers and Physicists" [Book Review].—I. S. and E. S. Sokolnikoff. (*Electronics*, January, 1935, p. 26.)

1711. "Bessel Functions for Engineers" [Book Review].—McLachlan. (*Wireless Engineer*, April, 1935, Vol. 12, No. 139, p. 193.)

1712. A Proposed Reformulation of the Electromagnetic Equations and Revision of Units.—L. Page and N. I. Adams. (*Journ. Franklin Inst.*, November, 1934, Vol. 218, No. 5, pp. 517–531.)

1713. Marconi's Place in History.—Dowsett. (*Marconi Review*, Nov./Dec. 1934, No. 51, pp. 1–3.)

1714. The Physical Society's Exhibition [including Magnetostrictive Apparatus for Mechanical Stress, Valve Microphonicity Test, etc.].—(*Engineer*, 11th Jan. 1935, Vol. 159, No. 4122, pp. 40–42.)

1715. The Physical Society's Twenty-Fifth Annual Exhibition: Descriptions of the Exhibits.—(*Journ. Scient. Instr.*, February, 1935, Vol. 12, No. 2, pp. 45–67.)

1716. Radio at the Leipzig Fair.—(*E.T.Z.*, 28th Feb. 1935, Vol. 56, No. 9, pp. 252–253.)

1717. Discussion on "On the Effects of Electromagnetic Induction between Power and Communication Lines."—Fallou. (*Bull. de la Soc. franç. des Élec.*, March, 1935, Series 5, Vol. 5, pp. 231–243.) *See* 1934 Abstracts, p. 339.

1718. A Modern Coupling Condenser for High-Frequency Telephony over Power Lines.—(*E.T.Z.*, 14th Feb. 1935, Vol. 56, No. 7, p. 183.)

1719. Electrical Transmission to a Distance of Indicator Positions by Reaction-Free Alternating Current Instruments [Addition of Suitable Condenser in Moving Coil Circuit of Induction Dynamometer: Circuit, Theory and Properties].—W. Geyger. (*Arch. f. Elektrot.*, 10th Nov. 1934, Vol. 28, No. 11, pp. 689–694.)

1720. Telemetering System using Over-Biased Triodes [working over 50 Miles of Telephone Line].—(*Electronics*, October, 1934, p. 322.)

1721. Ultra-High Frequencies in Therapeutic Research [Description of 2.3 to 8.5 m Transmitter using Magnetron Oscillator].—Ladner. (*Marconi Review*, Nov./Dec. 1934, No. 51, pp. 9–13.)

1722. The Application of High [and Ultra-High] Frequency Currents in Medicine and Surgery [Survey of Biological Principles, Description of Marconi Apparatus, etc.].—A. W. Lay. (*Marconi Review*, Nov./Dec. 1934 and Jan./Feb. 1935, Nos. 51 and 52, pp. 14–19 and 1–15.)

1723. Short-Wave [12-Megacycle] Treatment of Bursitis.—Whitney. (*Gen. Elec. Review*, February, 1935, Vol. 38, No. 2, pp. 70–76.)

1724. "Die physikalisch-technischen Methoden der Elektromedizin und ihre Apparaturen" [Book Review].—Schirmann. (*Elektrot. u. Masch:bau*, No. 3, Vol. 53, 1935, p. 36.)

1725. Four-Ounce Amplifier for Heartbeats [Portable Electrical Stethoscope].—(*Electronics*, January, 1935, p. 23.)

1726. "Applications of Röntgen and Electron Rays, with Special Attention to Organic-Chemical Problems."—Eggert and Schiebold. (At Patent Office Library, London: in German.)

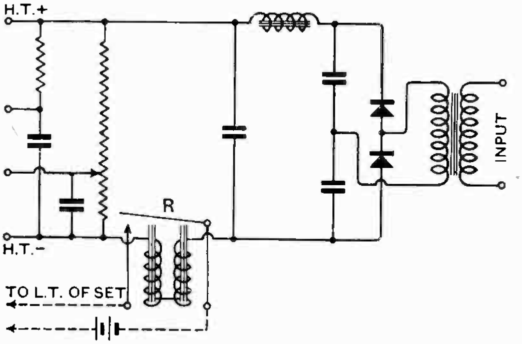
Some Recent Patents

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.

SWITCHING ARRANGEMENTS

Application date March 27th, 1933. *No.* 417061.

Where H.T. is supplied through a mains eliminator, and L.T. current from an accumulator, a single switch in the H.T. lead is arranged to control both sources of supply. The magnetic relay *R* is inserted in the negative H.T. lead, as shown, and its armature is made close to the L.T. Circuit. The initial surge of current taken by the smoothing condensers operates the relay momentarily, until the current through the valves grows sufficiently to hold the armature permanently in position. When the H.T. circuit is broken the armature falls away and shuts off the L.T. supply.



No. 417061.

Patent issued to A. J. Mombrum.

TELEVISION TRANSMITTERS

Application date 28th March, 1933. *No.* 417181.

The invention is designed to allow of a rapid change-over from one item to the next in a television broadcast programme based upon the use of cinematographic films. Two films are arranged about a common scanning disc or drum, each being provided with separate sets of lamps for producing the line and picture frequencies respectively, and for illuminating the film. If necessary there may be an additional lamp for scanning the sound trace where the programme includes both sight and sound.

The duplicate sets of lamps and associated scanning-gear are so arranged that the operation of a single throw-over switch, when one film is completed, cuts that film out of the transmission circuit, and simultaneously starts televising the second film.

Patent issued to Electrical and Musical Industries, Ltd., and C. O. Browne.

MULTI-ELECTRODE VALVES

Convention date (Germany) 22nd February, 1933. *No.* 417027.

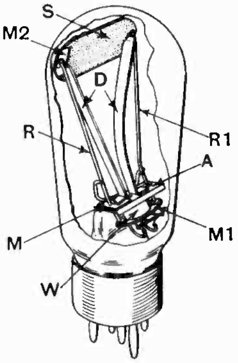
In a valve containing electrodes which serve as rectifiers for the purpose of providing A.V.C. bias, as in a double-choke triode, the cathode is made of standard length, but is rectangular in shape. The emission from the end face supplies the electron stream for the diodes; it flows at right-angles to the main emission, which comes from the long side of the cathode and is therefore wholly available for amplification, etc. By restricting the length of the cathode, heating current is cut down and any tendency to produce microphonic noise is minimised.

Patent issued to Telefunken Ges für drahtlose Telegraphie m.b.h.

CATHODE RAY TUBES

Application date, 29th March. 1933. *No.* 417182.

The fluorescent screen S is of metal and is supported by a pair of rods R, R 1 from the "gun" part of the tube, which consists of the usual pierced anode A and focusing cylinder W. The pair of deflecting plates D are shaped as shown, and extend from the cathode to the screen so as to increase the effect of the control voltage. The screen is sloped to enable the spot to be clearly seen. Mica insulation is used at M, M1, M2. The tube is designed to be operated by a comparatively low anode voltage, so that it is suitable for use as a visual tuning indicator. The use of a metal fluorescent screen affords the electron stream an easy return path to the anode, and so avoids the necessity for gas focusing.



No. 417182.

Patent issued to Standard Telephones and Cables, Ltd., W. T. Gibson, and D. H. Black.

THERMIONIC VALVES

Application date, 31st March, 1933. *No.* 417192.

The glass bulb is painted with a layer of carbon prepared by mixing gum tragacanth with graphite. When dry this is overlaid with an insulating and protective coating of non-conductive material.

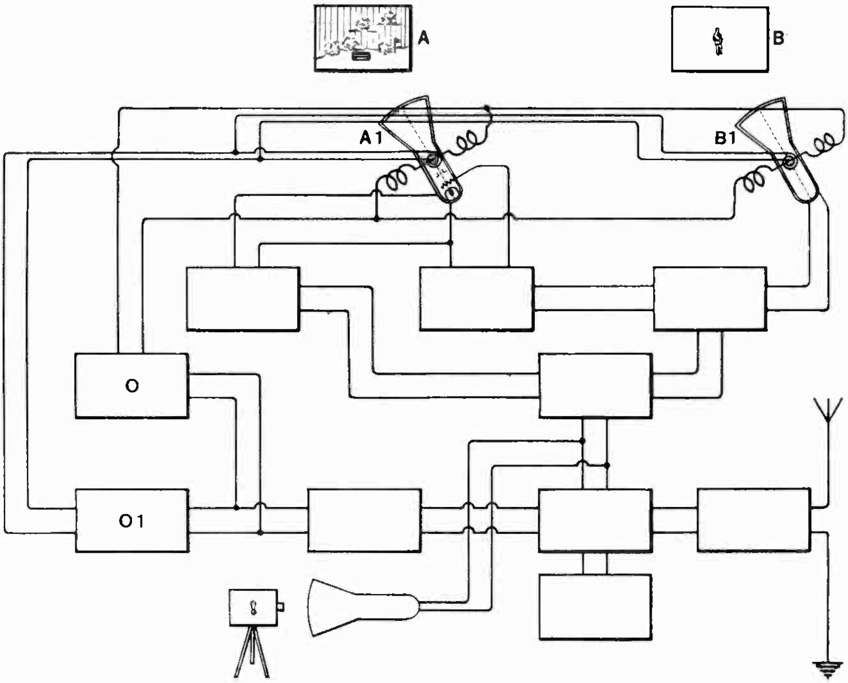
The inner carbon film is sufficiently conducting to act as a screen, and is connected in the usual way to the negative side of the cathode.

Patent issued to North London Valve and B.U.R.T.S., Ltd., and A. E. F. Thomas.

SCANNING SYSTEMS

Convention date (U.S.A.), 1st November, 1932.
No. 417282.

For the sake of economy or convenience, the background of a televised picture is prepared and transmitted separately from the moving actors. Certain kinds of backgrounds, for instance, may be difficult or impossible to set up in the studio, where the dramatic action takes place. Accordingly, as shown in the figure, the background film A which has already been prepared, is scanned by one cathode-ray tube A1, whilst the foreground B which may be in the studio, is simultaneously scanned by a second cathode-ray tube B1, both tubes being controlled by common saw-toothed oscillators O, O1. The studio performer B moves against a "black" background, which serves to apply an automatic cut-out bias to the tube B1 so that only the moving figure is recorded. In this way no "ghost" effect is produced when the two scenes are combined in transmission.



No. 417282.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.

DIRECTION-FINDING SYSTEMS

Application date, 31st March, 1933. No. 417196.

The direction and identity of a given beacon station is televised to the navigating officer, who need therefore have no knowledge of the Morse code. The beacon transmitted consists of two continually-rotating loop aerials, set at right-angles to each other. One of the loops radiates the television signals and a synchronising frequency, whilst the other radiates the synchronising frequency alone. The latter signal is therefore omni-directional. The result is that a non-directional set at the receiving end is kept constantly synchronised, though the beacon's identity mark is shown on the indicator only when the rotating-beam reaches a given point in its sweep.

Patent issued to Marconi's Wireless Telegraph Co., Ltd., H. M. Dowsett, and L. E. Q. Walker.

TUNING DIALS

Convention date (Germany), 24th January, 1933.
No. 417293.

Tuning dials which incorporate the names of the various European broadcasting stations are usually too large to be effectively illuminated by a single lamp. To overcome this difficulty a cylindrical lamp of the "coffit" type is made to serve as a tuning indicator, the various names being either painted on the glass surface or printed on a strip of semi-transparent paper stuck spirally around the glass surface. The lamp is mounted on a pair of trunnion electrodes so that it can be rotated bodily.

Patent issued to Ideal Werke Akt für drahtlose Telephonie.

TRANSMITTING AERIALS

Convention date (Germany), 26th January, 1933.
No. 417296.

A series of radiating aerials are arranged about a common centre so as to lie on a surface of revolution, preferably a cone. This gives a radiation field with a small vertical component, suitable for broadcasting. The maximum diameter of the cone should be greater than one-fourth of the working wavelength. Two or more similar series may be arranged one above the other, and each radiator may be earthed, or alternatively may function as a dipole.

Patent issued to Telefunken ges für drahtlose Telegraphie m.b.h.

VARIABLE INDUCTANCES

Application dates, 1st February and 3rd April, 1933. No. 417378

The iron core of a high-frequency tuning-coil is made in two parts, which may be rotated relatively to each other to alter the gap between them and so increase or diminish the reluctance of the magnetic circuit. In one form the core is cylindrical, but is divided into two halves by a cut inclined to the axis. Rotation of the upper half relatively to the lower then opens the intervening gap, and so alters the overall inductance. The adjustment can conveniently be made even when the coil is enclosed in a screening case.

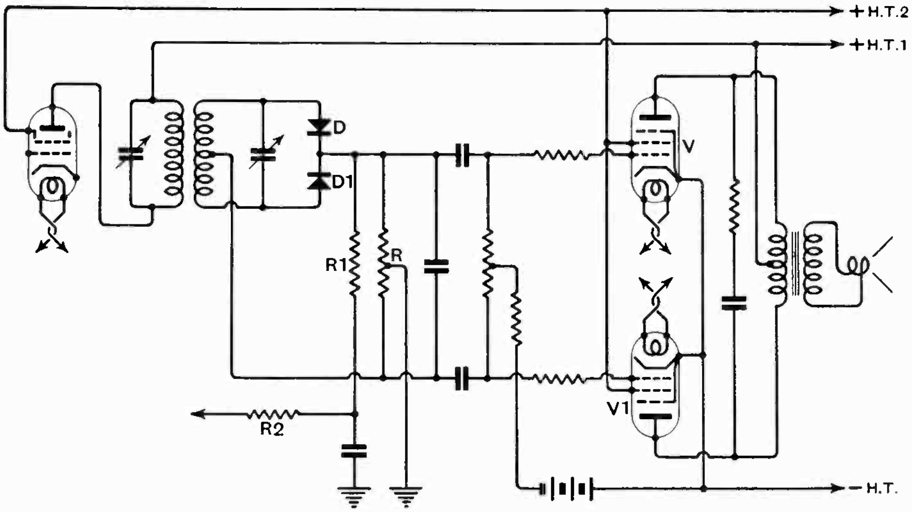
Patent issued to General Electric Co., Ltd., H. C. Turner, G. R. Polgreen, C. G. Smith, and C. N. Smyth.

PUSH-PULL AMPLIFIERS

Application dates, 30th March and 10th June, 1933. No. 417384

Instead of using a transformer input to a pair of push-pull pentodes V, $V1$, the output from a full-wave pair of metal rectifiers D, $D1$ is fed to a resistance R, the ends of which are connected to the control grids of the pentodes, and the centre-point to earth. The resistances $R1$, $R2$ provide automatic gain-control bias for a preceding stage of amplification.

Patent issued to E. K. Cole, Ltd., and G. Bradfield.



No. 417384.

CATHODE-RAY TUBES

Convention date (U.S.A.), 29th April, 1933. No. 417435

If an attempt is made to enlarge the picture produced on the fluorescent screen of a cathode-ray tube by projecting it through a magnifying lens, a considerable amount of the available light suffers total internal reflection at the external surface of the glass bulb. In order to avoid this loss, a semi-spherical lens is supported by a collar formed at the end of the cathode-ray tube, and the space between the inner end of the lens and outer end of the tube is filled with oil or other suitable fluid having an index of refraction equal to that of the glass forming the bulb of the tube.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.

THERMIONIC VALVES

Convention date (Germany), 6th February, 1933. No. 417498

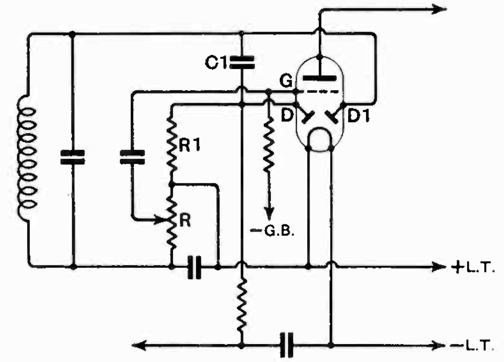
The overall efficiency or "slope" of a valve largely depends upon the close-spacing of the electrodes, and in order to bring the anode and grid into as close proximity as possible it has been proposed to accommodate the supporting members for the grid inside recesses or bulges formed in the periphery of the anode. According to this invention, the supporting wires both for the anode and grid are located in two side recesses formed in the sides of the anode, the remaining surface of the latter being brought close to the wires of the grid. The arrangement is particularly advantageous in the case of a valve containing several grids.

Patent issued to Telefunken ges für drahtlose Telegraphie m.b.h.

AUTOMATIC VOLUME CONTROL

Application date, 3rd April, 1933. *No.* 417515

The modulated signal is applied to the two rectifying anodes *D*, D_1 of a double-diode-triode amplifier, the anode *D* being connected through a condenser C_1 to the high-potential side of the input and to the positive side of the L.T. supply. The other anode D_1 is connected to negative L.T. and to the same side of the input, so that when the signal voltage reaches a certain value full-wave rectification takes place. The rectified signals are fed back to the control grid *G* from a resistance *R*, whilst the voltage across the resistance R_1 is used for automatic volume control. Since the anode *D* is normally at the same potential as the positive limb of the cathode, it does not produce a biasing voltage until the signal amplitude reaches a value sufficient to offset the normal fall in voltage across the cathode. This is utilised to apply delayed A.V.C. to the preceding amplifiers.



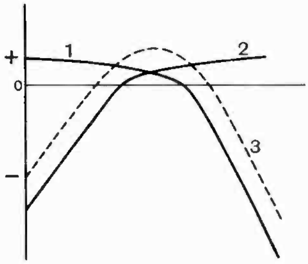
No. 417515.

Patent issued to A. L. McR. Sowerby and A. C. Cossor, Ltd.

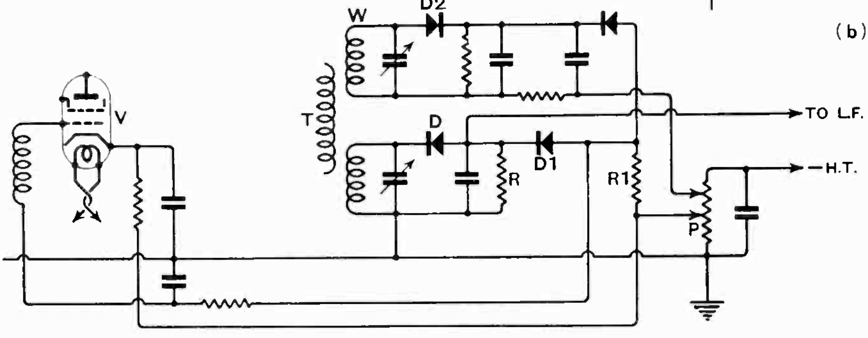
Application date, 8th April, 1933. *No.* 417608

Delayed automatic volume control is ensured by the combined action of two rectifiers arranged to be traversed by the resulting current from two opposed voltages, one voltage being proportional to the strength of the received current whilst the other voltage is fixed. As shown in Fig. (*a*), the input transformer *T* feeds a rectifier *D* having a load resistance *R*, which feeds A.V.C. bias to a L.F. stage and is also included in the circuit of a rectifier D_1, resistance R_1, and a potentiometer *P*. The voltage across R_1 is fed back to the grid of the valve *V*. In the absence of signals, this bias will be slightly positive, but as signals appear, the rectifier *D* produces an opposing potential, and as they increase in strength the grid of the valve *V* becomes negative, as shown by the curve 1, in Fig. (*b*). The input transformer *T* also energises a second winding *W* associated with a reversed rectifier D_2, so that the resulting voltage curve takes the form shown at 2, Fig. (*b*). The dotted-line curve 3 shows the resulting change of grid bias on the valve *V* with increasing signal strength.

Patent issued to L. E. Thompson and The Westinghouse Brake and Saxby Signal Co., Ltd.



(b)



(a)

No. 417608.

THERMIONIC VALVES

Application date, 11th April, 1933. *No.* 417789

A choke coil is wound in recesses formed in the outer surface of the base or cap of the valve, whilst a condenser is permanently fitted in the interior hollow of the cap. A grid leak may also be housed in a recess in the under-surface of the same part of the valve. The several components are connected to corresponding pins on the valve-base, so that they are automatically brought into circuit when the valve is plugged into its holder. The arrangement helps to simplify the wiring of a set.

Patent issued to H. W. Adey.