THE

WIRELESS ENGINEER

NUMBER 148 VOLUME XIII JANUARY 1936

A JOURNAL OF

RADIO RESEARCH

AND

PROGRESS

2/6 NET

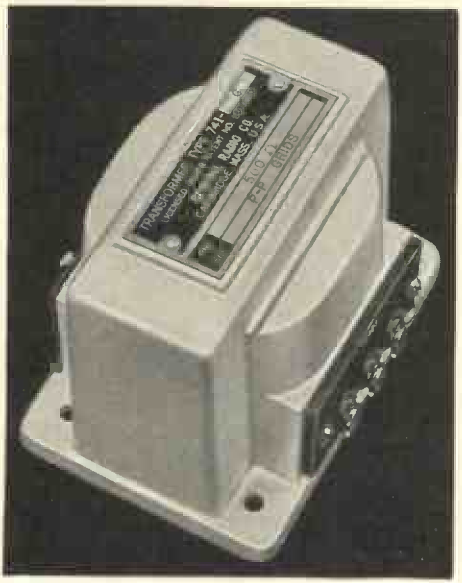
PUBLISHED BY

ILIFFE & SONS LTD.

DORSET HOUSE STAMFORD STREET LONDON S.E.1.

NEW INSTRUMENTS

This is our Record for 1935:



Introduced by us July, 1935.

WIDE-RANGE TRANSFORMERS

These Transformers are offered in three types. They have almost unbelievable frequency characteristics. Prices are quite modest.

741-G. (Line-to-Grid) 500–600-ohm line to push-pull grids. Weight 2½ lbs. Flat response within 2 db. from 35 cps. to 225,000 cps.

741-J. (Interstage) Push-pull plates to push-pull grids. Weight 2½ lbs. Flat response within 2 db. from 70 cps. to slightly over 200,000 cps.

741-P. (Tube-to-Line) Push-pull anodes to 500–600-ohm line. Flat response within less than 2 db. from 20 cps. to 200,000 cps. Weight also 2½ lbs.

Uses: with a CRO Tube as an accurate Oscillograph, Voltmeter or Ammeter for the H.F. ranges. In highest-possible-quality reproduction circuits. In experimental television applications, a truly acceptable picture being possible when transmitted over a 200,000-cycle band-width.

DURING 1935 we had the pleasure of introducing a great deal of excellent new apparatus. This apparatus was designed principally for service in the Electrical, Radio, Communications and Cables, Telephone Engineering, "Talkie", Acoustical Research and allied fields. However, many instruments have useful applications in many other widely differing industries, whilst a small proportion of the instruments have been evolved for specific purposes which lie well outside our usual sphere of activity.

WE MAIL EVERY MONTH a gratis journal devoted to our new developments. Apart from keeping you up to date this journal also contains regularly descriptive papers of an invaluable and absolutely authoritative nature.

If you are not yet on our monthly mailing list, a request on your business heading will ensure it. Such a request will also automatically bring you, from time to time, new Catalogues of great interest. But *please* mention "THE WIRELESS ENGINEER."

A very brief summary of the more important new apparatus introduced by us during 1935 will be found on the opposite page.

CLAUDE LYONS, LTD.

AS

The

WIRELESS ENGINEER

A Journal of Radio Research & Progress

Editor
HUGH S. POCOCK

Technical Editor
Prof. G. W. O. HOWE, D.Sc., M.I.E.E.

VOL. XIII. No. 148

JANUARY 1936

CONTENTS

Published Monthly on the first of each Month

SUBSCRIPTIONS Home and Abroad: One Year, 32/-, 6 Months, 16/-. Single Copies, 2/8 post free

Editorial, Advertising and Publishing Offices

DORSET HOUSE, STAMFORD STREET, LONDON, S.E.1

Telegrams: "Experiwyr Sedist London" Telephone: Waterloo 3333 (50 lines)

Branch Offices

COVENTRY
19 Hertford Street
Telegrams: "Autocar, Coventry"
Telephone: 5210 Coventry

BIRMINGHAM
Guildhall Bldgs., Navigation St., 2
Telegrams: "Autopress, Birmingham"
Telephone: Midland 2971 (4 lines)

MANCHESTER
260 Deansgate, 3
Telegrams: "Iliffe, Manchester"
Telephone: Blackfriars 4412 (4 lines)

GLASGOW
26B Renfield Street, C.2
Telegrams: "Iliffe, Glasgow"
Telephone: Central 4587

The Editor invites the submission of articles with a view to publication. Contributions which are not exclusive should be so described when submitted. MSS. should be addressed to the Editor, "The Wireless Engineer," Dorset House, Stamford Street, London, S.E.1. Especial care should be taken as to the legibility of MSS. including mathematical work.

THE

WIRELESS ENGINEER

Vol. XIII. JANUARY, 1936 No. 148

Editorial

The Nature of Atmospherics

THE pioneer work in the application of the cathode-ray oscillograph to the determination of the wave form of the transient electric field which constitutes an atmospheric disturbance was done by Appleton, Watt and Herd more than twelve years ago. It was one of the first researches undertaken by the Radio Research Board. It was generally agreed at the time that the wave forms obtained could not account for the observed effects of atmospherics on wireless receivers ; the periods were too long and the changes too gradual to be regarded as the cause of the crashing and grinding sounds associated with atmospheric disturbance. Great developments have taken place in recent years in the technique of the cathode-ray oscillograph and no one has done more in the development and application of this technique to the experimental investigation of lightning than H. Norinder, of Upsala, who, with R. Nordell, has recently published an account of their researches.*

For many months they made systematic records, not by the older method of visual observation, but by photographic recording on film. They found that a very wrong impression of the character of the wave form was obtained by visual observation, an apparently smooth curve giving, on development, a curve with a very pronounced high-frequency disturbance superimposed upon it. They express surprise at the magnitude which this high-frequency disturbance can have without revealing itself to visual observation.

Two aerials were employed, both 100 metres long, one 23 metres high and the other 8 metres high. The oscillographs employed were of the type developed by Norinder for his lightning researches ; the vacuum is very high, the D.C. voltage is 50,000 and the film is placed inside the tube which is arranged vertically with the film lying horizontally at the bottom. A beam capable of giving a photographic record of the rapid transients of a lightning discharge is not easily deflected, and such a tube requires about 20 volts to give 1 mm. deflection. The electric field due to a very distant lightning discharge is weak, and it is necessary to use a carefully designed resistance-coupled amplifier between the aerial and the deflecting plates of the tube. The amplifier employed was usually a 2-valve one with an amplification of 800.

There are two methods which may be employed for converting the e.m.f. Eh induced in the aerial into a potential difference v across the deflecting plates. If the voltage v is the drop across a resistance R inserted between the aerial and earth, then $v = iR$ at every moment, and if this resist-

* *Elektrische Nachrichten-Technik,* XII. p. 305. October, 1935.

ance and the effective damping resistance are small, the voltage between the aerial and earth will be equal to the induced e.m.f. Eh, where E is the field strength in volts per metre and h is the effective aerial height in metres. If C be the capacitance of the aerial, $i = dq/dt = ChdE/dt$ and $v = hRCdE/dt$. Under these conditions therefore the trace obtained is not of E but of dE/dt and the curve has to be integrated in order to obtain the curve of E, a laborious procedure when one is dealing with thousands of records. If the changes of E are small or slow so that dE/dt is small, it becomes necessary to use a larger value of R, and the above formula no longer holds without a correction. To avoid misunderstanding, however, it should be pointed out that a resistance of 10,000 ohms is to be regarded as small.

The other method requires the aerial to be so carefully insulated from earth that its potential is at every moment equal to Eh, and a known fraction of this voltage can then be measured by means of a capacitive potential divider. The smaller the capacitance C of the aerial, and the longer the period of the disturbance to be measured, the higher must be the insulation resistance if the recorded voltage v is to maintain a given degree of approximation to the curve of E. It will be seen that both methods have serious limitations and that great care is necessary in the interpretation of the photographic records. The authors installed duplicate oscillographs and made many simultaneous records of atmospherics by the two methods. In view of the experimental difficulties the agreement obtained was very satisfactory and gives one confidence in the records, by whichever method they were obtained. The records can be divided roughly into two classes according to their duration. Those of short duration last from 100 to 400 microseconds and consist of from 0.5 to 2 cycles of an irregular damped oscillation. This is sometimes entirely on one side of the base line, sometimes entirely on the other side and sometimes crossing the base line. The frequency is usually between 2,500 and 10,000, corresponding to wavelengths between 30 and 120 km. The atmospherics of longer duration are of the type recorded twelve years ago by the Radio Research Board workers; their duration is generally between 2 and 6 milliseconds. They are far less frequent than the short duration disturbances; the authors estimate that there are about 40 times as many short as long disturbances. These long duration atmospherics consist very often of about one cycle lasting about 4 milliseconds and corresponding therefore to a frequency of about 250. If they were nothing more than this they would not cause any trouble in a distant radio receiver, but unfortunately the photographic records show high-frequency disturbances superimposed on the low-frequency one. In some cases the disturbance commences with several cycles of high-frequency oscillation of large amplitude, the frequency being about 5,000 to 10,000, and then continues as a slow oscillation with irregular high-frequency ripples superimposed upon it, the whole lasting several milliseconds.

The authors carefully refrain from attempting any discussion of the causes of these phenomena until they have more data—they took 19,000 oscillograms in connection with the work recorded in this paper !—but the work already done marks a great step forward in our knowledge of the nature of atmospherics.

G. W. O. H.

The Physical Society's Exhibition

THE Twenty-sixth Annual Exhibition of Scientific Instruments and Apparatus arranged by the Physical Society will be held this year on January 7th, 8th and 9th, at the Imperial College of Science, South Kensington.

Tickets can be obtained from the Secretaries of Institutions and Scientific Societies, or from the Exhibition Secretary, 1, Lowther Gardens, S.W.7.

The importance of this Exhibition grows from year to year, but, as we have suggested on previous occasions, we feel that the accommodation which is provided is unsatisfactory, and we again express the hope that the organisers will find it possible to acquire for future exhibitions some hall where the exhibits can be displayed to better advantage, and where it would be possible to accommodate larger numbers of the public and so extend still further the usefulness of this annual event.

Polarisation Errors in Direction Finders*

By R. A. Watson Watt

(National Physical Laboratory)

ABSTRACT.—The paper describes a comparison of the experimental performance of three systems of Adcock spaced-aerial direction-finder, carried out by co-operation between Marconi's Wireless Telegraph Company and the Radio Research Board. The work covers the carrying out of several thousand observations partly at Chelmsford and partly at Slough, and the results obtained are expressed in terms of the relative standard-wave errors of the three systems.

THE particular direction-finder devised by Adcock was one of a considerable variety of spaced-aerial direction-finders which may be used in the mitigation of abnormal-polarisation error. Of the whole possible series of spaced-aerial direction-finders it is appropriate, and has become customary, to describe as Adcock systems those utilising spaced vertical aerials, however coupled, since they all follow very directly from the general principle so clearly and early recognised by Adcock. It will probably be found equally convenient to restrict the term "Adcock system" to vertical-aerial systems, and to refer to the many other possible combinations by the more general term "spaced-aerial direction-finder." Barfield has, in a recent paper,† discussed some general principles in spaced-aerial direction-finding, and has reported on performance tests which depended on factors wholly within the control of the investigator. In the present state of our knowledge of the propagation of radio waves it cannot be asserted, nor was it assumed, that such measurements would suffice for full prediction of the performance of a direction-finder in practice, since propagation factors determine the degree of abnormal polarisation with which the instrument is, at any moment, called upon to deal.

The paper did, however, establish a technique for the prediction of the relative performance of different Adcock systems when acted on by a known degree of abnormal polarisation at a known angle of incidence, and for the intercomparison of Adcock systems and loop direction-finders. Barfield's introduction of the "standard-wave error" as a single figure of merit—a necessary though not a sufficient measure of probable performance—has led to a great clarification of issues in Adcock direction-finding, but misunderstanding of the meaning of "standard-wave error" has already led to some confusion, and it cannot be too strongly emphasised that the standard-wave error is, by definition, a quantity which states only the performance for one known angle of linear polarisation, 45°, and one known angle of incidence, 45°, in the absence of other disturbing factors such as lateral deviation of the received wave. From this single figure can be deduced the performance for other states of the received wave, but the utility of the deduction is governed by the accuracy of knowledge, or fore-knowledge, of the instantaneous state. Moreover, the degree of immunity from abnormal-polarisation error, whether measured by the standard-wave error or by statistical evaluation from sampling observations, is a function of many variables, especially of dimensions in relation to wavelength. It depends also on the accuracy of approximation to idealised conditions; it depends—in different degree for different systems—on ground conductivity, and so on. Considerable care and critical judgment are, therefore, required before the results of experiment on one embodiment of any type of Adcock system can safely be utilised in forecasting the performance of another embodiment of the same type.

Barfield's paper cited computed and measured values of the standard-wave error for a number of Adcock systems, comparing them with the standard-wave error of a loop aerial, which is known to be 35°. It was clearly very desirable to determine, by direct observation on received waves, how far the standard-wave error, an invaluable

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

† R. H. Barfield, "Some Principles Underlying the Design of Spaced-Aerial Direction-Finders." *Journ. Inst. Elect. Eng.* Vol. 76, No. 460, April, 1935, pp. 423–447.

partial measure of the progress made towards the perfect Adcock system, was useful in predicting the relative value of imperfect systems in everyday direction-finding. In particular it was desired to compare the results of a long series of observations on loop direction-finders, screened-U,* unbalanced-coupled and balanced-coupled Adcock systems with the performance figures suggested by the standard-wave error. Of the types mentioned, the screened-U and the balanced-coupled types were selected for close study.

S. B. Smith* has discussed the results of a series of nearly simultaneous observations of abnormal-polarisation error or "night effect" on a loop aerial and on a screened-U Adcock installation.

By arrangement between the Department of Scientific and Industrial Research (on the advice of its Radio Research Board) and the Marconi Company, similar methods were applied in a comparison between a balanced-coupled Adcock installation and the same loop aerial system. The experiments described by Smith were carried out at Chelmsford in 1934, 4,500 night observations being made on the broadcast signals from Kalundborg (820 km. distant) on a frequency of 238 kc/s (wavelength 1,261 metres).

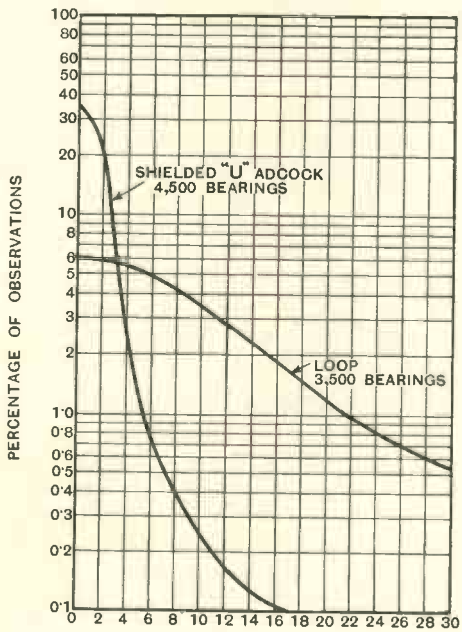


Fig. 1.—*Curves showing results of simultaneous observations at Chelmsford with a loop and with U-Adcock on Kalundborg* ($\lambda = 1261$ *m.*).

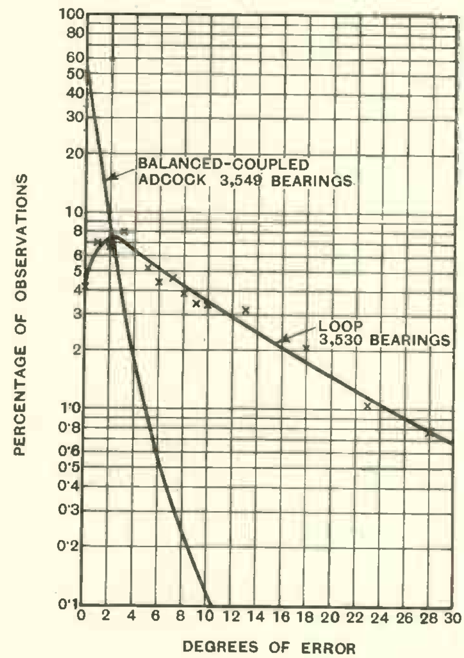


Fig. 2.—*Curves showing results of simultaneous observations at Slough with a loop and with balanced-coupled Adcock on Kalundborg* ($\lambda = 1261$ *m.*).

The second series of experiments was carried out by Smith and Barfield at the Slough Radio Research Station of the National Physical Laboratory in February/March, 1935, 3,500 night observations being made on the signals from Kalundborg (895 km. distant).

The results of both series are sufficiently summarised in Figs. 1 and 2, representing the first and second series respectively. In each figure any ordinate represents that percentage of the whole number of observations in which the departure, in degrees from the mean bearing given by all observations in the series, was equal to that given by the corresponding abscissa.

The fact that the two series of observations were made at different dates leaves room for doubt as to the substantial identity in

* S. B. Smith, "The Night Performance of the Marconi-Adcock Direction Finder Type D.F.G.8." *Marconi Review*, No. 50, Sept.–Oct., 1934, pp. 1–5.

value of each of the two main factors in abnormal-polarisation error, viz. state of polarisation and angle of incidence, even although the same sender was observed and the plan path was sensibly identical. A measure of this difference is given by the loop observations, also plotted in Figs. 1 and 2.

The statistical reduction of the data yields the results shown in Table I, in which the standard deviation (the root mean square departure from the mean value for the series), for each series, is tabulated. If the rough assumption be made that the nature of the incident waves can be restored to comparability by applying a linear factor sufficient to bring the standard deviations for the loop observations to equality in the two cases, the comparable standard deviations for the screened-U and the balanced-coupled system would be 2.37° and 1.54° respectively, as against 2.37° and 1.05° before this rough compensation is effected.

TABLE I.

	Standard Deviation.	
Shielded "U"	2.37°	Chelmsford 4,000 bearings.
Loop	12.35°	
Balanced-Coupled	1.05°	Slough 3,500 bearings.
Loop	8.36°	
Balanced-Coupled	1.54°	Slough results related to Chelmsford observations.
Loop	12.35°	

The "goodness ratio" in respect of total residual non-systematic error would therefore appear to lie between 1.54° (after reduction to equal standard deviation on loop) and 2.27° (without reduction), both in favour of the balanced-coupled system.

On the unjustifiable assumption that the whole error is abnormal-polarisation error, it may be inferred from the nearly simultaneous loop observations—for which a standard-wave error of 35° may be assumed—that the standard-wave error of the Adcock systems tested (including the unbalanced-coupled system, on which a shorter series of about 2,500 observations was made) were approximately :—

Balanced-coupled	4°
Unbalanced-coupled	4°
Screened-U	7°

The corresponding figures for these types, as computed from formulae given in Barfield's paper, are :—

Balanced-coupled	1°
Unbalanced-coupled	3°
Screened-U	6°

The values predicted from theory, and confirmed by experiments not involving propagational uncertainties, may now be compared with those obtained by direction-finding on signals from a moderate distance. The agreement in the case of the screened-U system is very close, that for the unbalanced-coupled system close, that for the balanced-coupled system poor, the observed value being slightly higher than the computed in the case of the unbalanced, and very notably higher in the case of the balanced system. Thus the agreement falls off steeply in passing from systems for which theory suggests a moderate performance to those whose theoretical performance should be very high.

The possible reasons for this discrepancy include :—

(1) Imperfections in balancing.
(2) Effect of metallic stay systems.
(3) Lateral deviation or scattering of the waves from the distant source.

The coupled-system installation used in the test had been designed for use on frequencies of the order of 1,000 kc/sec., and adapted for the 250 kc/sec. band, but since there is no obvious theoretical reason for a change of balance with wavelength, factor (1) does not seem likely to be a dominant one. The effect of the stay system in this installation, which had survived from a stage at which the standard-wave error was much larger, was examined theoretically, and considered likely to give an effect *just* too small to be important. The simplifying assumptions made in this examination are, however, likely to have been incompletely justified, so that factor (2) may be of some importance.

There is, however, nothing in these results or in the general knowledge of propagation of waves incompatible with a working hypothesis that the incoming waves from moderate distances may have suffered lateral deviations of such magnitude as to be negligible relative to abnormal-polarisation error in a system of 6° standard wave-error, sensible in a system of 3° standard-wave error and predominantly important in a system so good, in respect of abnormal-polarisation error, as to have a standard-wave error of 1° or less.

The discussion of the facts set down in this note cannot usefully be carried beyond this point until the vitally important problem of the lateral deviation and scattering of waves from moderate and long distances has been subjected to experimental examination. Spaced-loop systems, despite possible inconveniences in practical direction-finding, are likely to have extremely low standard-wave error and to provide immediately available means for the investigation of lateral deviation. A visual direction-finder of this type, with substantial advantages in practical application, has been disclosed by Barfield in British Patent Application No. 5308, dated February, 1935, while a system for the study of lateral deviation has been described by Eckersley.* It is hoped that one or both of these systems may be applied to the study of the lateral deviations of long waves at an early date.

The work briefly reported in this note was undertaken by the Marconi Company and the Radio Department of the National Physical Laboratory, as a part of the direction-finding research work undertaken, hitherto independently, under the auspices of the Company on the one hand and of the Radio Research Board on the other. The writer may be allowed to express his sense of the cordiality of the co-operation and of the value of the results, a value which would not readily have been attained without the pooling of resources and experience.

* T. L. Eckersley, "Scattering, Polarisation Errors, and the Accuracy of Short-Wave Direction Finding," *Marconi Review*, No. 53, March–April, 1935, pp. 1–8.

Standard Signal Generator

All-Wave A.C. Operated Test Set

THE standard signal generator, type TF. 144/A, made by E. K. Cole, Ltd., operates from the standard 50 cycle power supply, and covers the whole range of radio frequencies from 90 kc/s to 20 mc/s by means of internal coils selected by a panel control.

The radio frequency output voltage is continuously variable from one microvolt to one volt; a step attenuator and a constant impedance slide wire being employed. This is noise free and very robust, and has a logarithmic scale. The output impedance, even at 1 volt, is low, and the indicated H.F. voltage may be relied upon to within ± 10 per cent. at all settings up to 15 mc/s.

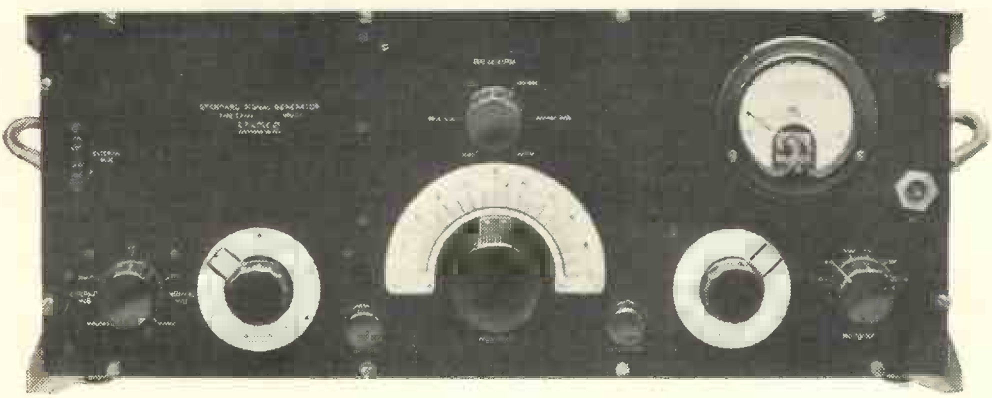
The problem of measuring accurately the modulation depth has been solved by the adoption of an absolute method, the indication of which is independent of the H.F. oscillator plate swing and of the frequency characteristic of the modulation system. The modulation depth is read directly from a control, calibrated continuously from 5 to 80 per cent. modulation.

Internal modulation is at 400 c/s, but external modulation can be used and the output of a normal gramophone pickup is sufficient to provide modulation of a depth comparable with that of a modern broadcasting station. Frequency modulation (less than 50 c/s over the greater part of the range) is such that the errors introduced from this source when testing broadcast receivers are negligible.

The triple screening employed is completely effective in preventing radiation both directly and *via* the power line, so that even at 20 mc/s a receiver having a sensitivity of 1 microvolt per metre may be operated alongside the generator and from the same power supply without any difficulty.

The generator is supplied complete with two dummy aerials, one for broadcast and the other for the short waves, screened cable, calibration charts and mains lead. The price is £95.

The instrument is finished in black crackle lacquer and grey cellulose enamel standardised by E. K. Cole, Ltd., for their precision apparatus.



A.C. operated all-wave signal generator made by E. K. Cole, Ltd.

The Design of Iron-Cored Inductance Coils and Transformers to carry D.C.*

By W. Baggally

SUMMARY.—The following method enables the number of turns, optimum gap length, and core sectional area to be calculated with sufficient accuracy for practical purposes, having given the desired inductance and resistance of the coil, the value of the direct current, the size and shape of core stampings which it is proposed to use, together with a curve connecting the incremental permeability of the core material with the D.C. magnetising force, and a knowledge of the D.C. permeability.

It is assumed that the core consists of the conventional laminations so that the area of cross section may be altered by adjusting the number of stampings used.

All units used in the theoretical work are C.G.S. electromagnetic units, a summary of equations used in practical design and using practical units being given at the end of the paper. The following symbols will be used.

H = D.C. magnetising force in iron.
L = A.C. inductance of coil.
R = D.C. resistance of coil.
I = direct current.
N = number of turns.
W = winding space area.
l_t = length of mean turn.
A = cross-sectional area of core.
l_c = length of mean path through core.
l_g = length of air gap.
μ = D.C. permeability.
μ' = incremental permeability
d = diameter of conductor.
ρ = specific resistance of conductor.
s = wire space factor $= \dfrac{d^2}{(\text{outside diameter})^2}$

It has been found that the formula

$$\mu' = \frac{1}{a + bH} \quad \ldots \quad \ldots \quad (1)$$

wherein a and b are constants, can be made to fit the measured curve of μ' against H over the working range in a satisfactory manner by a proper selection of a and b. Equation (1) will therefore be taken to represent the functional dependence of μ upon H in the following analysis.

We have

$$H = \frac{4\pi NI}{l_c + \mu l_g} \quad \ldots \quad \ldots \quad (2)$$

also

$$L = \frac{4\pi N^2 A}{l_g + l_c/\mu'} \quad \ldots \quad \ldots \quad (3)$$

which on substitution from (1) and (2) leads to

$$L = \frac{4\pi N^2 A}{l_g + l_c\left\{a + \dfrac{4\pi NIb}{l_c + \mu l_g}\right\}} \quad \ldots \quad (4)$$

To find the optimum gap length we differentiate (4) to l_g and equate to zero. Doing so and simplifying, we find

$$l_g = \sqrt{\frac{4\pi NIbl_c}{\mu}} - \frac{l_c}{\mu} \quad \ldots \quad \ldots \quad (5)$$

All the quantities in this expression for l_g are supposed known with the exception of N; we proceed to find N as a function of the required resistance R and we have at once

$$R = \frac{Nl_t\rho}{\pi d^2/4} \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

and $$N = Ws/d^2 \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

and on combining and transposing these last two we find

$$N = \sqrt{\frac{\pi RWs}{4l_t\rho}} \quad \ldots \quad \ldots \quad (8)$$

By transposing equation (4) we obtain

$$A = \frac{L}{N^2}\left\{\frac{l_g + al_c}{4\pi} + \frac{NIbl_c}{l_c + \mu l_g}\right\} \quad \ldots \quad (9)$$

and from equation (7),

$$d = \sqrt{\frac{Ws}{N}} \quad \ldots \quad \ldots \quad \ldots \quad (10)$$

Equations (5), (8), (9), and (10) enable us completely to determine the unknown factors

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

of the design from the given data, as is to be presently explained; but before this can be done it is necessary to determine a and b from the given $\mu' - H$ curve; this is quite readily done as follows.

Equation (1), containing as it does two arbitrary constants, may be caused to coincide with the given curve at two points, the choice of which is at our disposal.

Calling these points (μ_1', H_1), (μ_2', H_2), we have by (1)

$$\mu_1' = \frac{1}{a + bH_1} \quad \ldots \quad (11)$$

$$\mu_2' = \frac{1}{a + bH_2} \quad \ldots \quad (12)$$

and by solving these last for a and b we find

$$a = \frac{\mu_2'H_2 - \mu_1'H_1}{\mu_1'\mu_2'(H_2 - H_1)} \quad \ldots \quad (13)$$

$$b = \frac{\mu_1' - \mu_2'}{\mu_1'\mu_2'(H_2 - H_1)} \quad \ldots \quad (14)$$

Now if l_t were a fixed quantity we could determine N from equation (8) since the other quantities in this equation are assumed known.

Actually l_t depends to some extent on A, since if we use a thicker pile of stampings the mean turn is somewhat lengthened, but in all cases which are likely to be met with in practice we may, keeping everything else unchanged, cause A to vary widely without producing large changes in the magnitude of l_t.

For example, in the case of a coil having a mean turn of perimeter 12 cm. and a square section core of 2.25 sq. cm. cross sectional area, the effect of doubling the core area by doubling the number of stampings is to produce but a 25 per cent. increase in the perimeter of the mean turn.

Thus for simplicity we will assume l_t constant, and in those cases where it is necessary to know the resistance of the finished coil with great accuracy it may be computed without difficulty from the physical dimensions and number of turns.

In practical design it is convenient to use practical units, and the required equations are grouped below. In these the constants have been introduced where necessary to enable practical units to be used; *i.e.* I is in amperes, R in ohms, L in henries, and all lengths in centimetres.

$$a = \frac{\mu_2'H_2 - \mu_1'H_1}{\mu_1'\mu_2'(H_2 - H_1)} \quad \ldots \quad (A)$$

$$b = \frac{\mu_1' - \mu_2'}{\mu_1'\mu_2'(H_2 - H_1)} \quad \ldots \quad (B)$$

$$N = \sqrt{\frac{\pi R W s}{4 l_t \rho}} \quad \ldots \quad (C)$$

$$g = \sqrt{\frac{4\pi N I b l_c}{10 \cdot \mu}} \quad \ldots \quad (D)$$

$$A = \frac{10^9 L}{N^2}\left\{\frac{l_g + a l_c}{4\pi} + \frac{N I b l_c}{10(l_c + \mu l_g)}\right\} \quad (E)$$

$$d = \sqrt{\frac{Ws}{N}} \quad \ldots \quad (F)$$

The method of procedure in designing a coil to meet given requirements is therefore as follows.

Determine a and b from equations (A) and (B) and the given $\mu' - H$ curve. In some cases the data available will consist of an $\mu' - B$ curve, but we may readily plot the $\mu' - H$ curve from this latter together with the static B — H curve.

We assume a square section core in order to calculate l_t, and having decided on a likely size of stamping, N is found from equation (C). With ordinary covered wires s will be of the order of 0.8.

Now selecting a mean value of μ and using the value of N found above, we substitute in (D) to find the gap length l_g.

Having found N and l_g we substitute in (E) to find A.

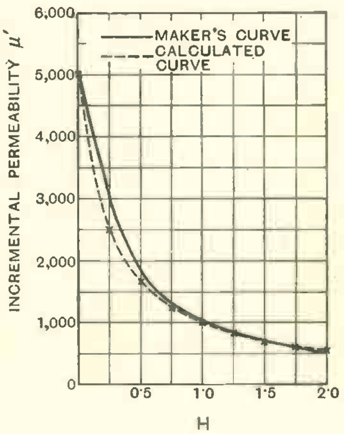
The wire diameter d is found from (F).

In a case where A comes out absurdly large or small as judged by the other core dimensions, it simply means that the proposed stampings are too small or large respectively and we try again.

Some typical values of a, b, and μ are shown in the table, which was prepared from data furnished by the suppliers of the alloys; the Telegraph Construction and Maintenance Co., Ltd. of London in the case of "Radiometal," and Messrs. Adams Bros. and Burnley Ltd. in the case of "Trans" and Dyne."

The way in which equation (1) may be made to approximate to the $\mu' - H$ curve of the iron is illustrated in the accompanying graph for the case of "Radiometal." It will be seen that the approximation is sufficiently good to meet the requirements of practical design work.

As an example, we take the case of a transformer for coupling a transverse-current carbon microphone to the grid circuit of a valve.



Telcon Radiometal. A.C. field = 0.4 *gauss.*

The microphone current is about 30 milliamperes and a primary inductance of 4 henries is required, the primary D.C. resistance being not greater than about 70 ohms.

It was decided to try Telcon Nos. 3 and 3c stampings in "Radiometal." This is an *E* and *I* pair having the following dimensions: Window area = 2.4 sq. cm., l_t = 11.4 cm. for a square section core, l_c = 10.5 cm.

Material	a	b	μ Average
Radiometal δH = 0.4	2×10^{-4}	8×10^{-4}	
Radiometal δH = 0.05	5×10^{-4}	5×10^{-4}	
Radiometal mean value	3.5×10^{-4}	6.5×10^{-4}	7,240
Trans .. δH_4 = 0.6	5.7×10^{-4}	2.82×10^{-4}	
Trans .. δH → 0	2.85×10^{-3}	6.32×10^{-4}	
Trans .. mean value	1.71×10^{-3}	4.57×10^{-4}	2,930
Dyne .. δH_4 = 0.6	9.55×10^{-4}	8×10^{-4}	
Dyne .. δH → 0	4×10^{-3}	2.815×10^{-3}	
Dyne .. mean value	2.48×10^{-3}	1.81×10^{-3}	4,500

Assuming that primary and secondary each occupy one-half of the available winding space and that three-quarters of the total space will be filled by the windings themselves, we find for the primary, W = 0.9 sq. cm.

Taking R=60 ohms, s=0.8, $\rho = 1.78 \times 10^{-6}$ ohms per c.c., we find N = 1,310 from (C) and d = 0.0238 cm. from (F); therefore we decide to use 1,310 turns of No. 36 S.W.G. enamelled wire for the primary, which will allow plenty of room for uneven winding, etc.

In the case of a microphone transformer, the A.C. will be very small, and accordingly we take the values corresponding to δH = 0.05 from the table, which are $a = 5 \times 10^{-4}$, $b = 5 \times 10^{-4}$, μ = 7,240.

Using these values in (D) we find l_g = 0.00455 cm., and since there are two gaps in series, the thickness of foil used to space the gap will be 0.00227 cm.

To find the cross sectional area of core required to give L = 4 henries we substitute in (E) and find A = 3.1 sq. cm. Thus the design of the core and primary winding is completed.

Measurements made on two sample transformers made up to this specification by two different firms gave L = 3.46 henries and L = 5.34 henries, the mean value being 4.4 henries, a D.C. of 27 milliamperes flowing in the primary in each case.

The writer wishes to thank Nuvolion Ltd., on whose behalf the work was undertaken, for their permission to publish this paper.

Correspondence

Modifications of the Push-Pull Output Stage

To the Editor, The Wireless Engineer

SIR,—K. A. Macfadyen, in the above paper (p. 642) describes the "Cathode Load Circuit" and points out that it has similar properties to the Grid Compensation circuit described by me in *The Wireless Engineer*, February, 1933.

The reason for the similarity is that the equivalent circuits of the two arrangements are identical.

In my circuit the cathode of the driver valve is earthed, whilst in Macfadyen's arrangement it is the anode of this valve which is earthed (to A.C. potentials); the action is, however, identical in both cases.

Brighton. W. BAGGALLY.

The Advantage of Inclining the Deflecting Plates in a Cathode-Ray Oscillograph

By W. E. Benham

If the deflecting plates in a cathode ray tube are parallel to one another the maximum deflection that can be obtained on the fluorescent screen is given by the expression

$$Y = \frac{V}{2V_1} \cdot \frac{Ll}{d} \quad . . . (L >> l) \quad .. \quad (1)$$

where V = deflecting voltage.
V_1 = gun voltage.
L = distance of screen from deflector plates.
l = length of deflector plate.
d = separation of deflector plates.

Since in deriving equation (1) no account was taken of cathode ray diameter the value of Y there given must be regarded as an upper limit.

Now V cannot exceed a certain value otherwise the cathode ray beam will be intercepted by the deflector plates. To find the maximum value of V we note that the displacement y of the axis of the cathode ray beam from its mean position cannot exceed $d/2$ without cutting the deflector plates. In addition it must be borne in mind that the beam section is finite. The above condition may then be expressed:

$$\frac{l^2 V}{4V_1 d} < \frac{d}{2} \quad \text{or} \quad V < \frac{2d^2}{l^2} \cdot V_1$$

Combining with equation (1) we obtain

$$Y < \frac{Ld}{l}$$

For $d = 0.5$ cm., $l = 2$ cm., $L = 30$ cm., we obtain

$$Y \leqslant 7.5 \text{ cm.}$$

It is to be noted that it is the ratio $\frac{d}{l}$ which determines the maximum values of V and Y, and not d and l separately.

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

In order to permit of larger deflections the deflector plates may be inclined to one another. If β be the inclination of each deflector plate to the initial direction of the beam, then measuring x along the beam the equation of motion at right angles to the plates for small values of β is approximately the following:

$$m\frac{d^2y}{dt^2} = \frac{eV}{d + 2x \tan \beta}$$

The above assumes that the lines of force are parallel to the y axis. Since $x = ut$ and u is sensibly constant, the above becomes:

$$\frac{d^2y}{dx^2} = \frac{eV}{mu^2} \cdot \frac{1}{d + 2x \tan \beta}$$

The inclination of the beam to the axis is obtained by integration with respect to x subject to $\frac{dy}{dx} = 0$ when $x = 0$; writing $mu^2 = 2eV_1$, we have

$$\frac{dy}{dx} = \frac{V}{2V_1 d} \cdot \frac{d}{2 \tan \beta} \log\left(1 + \frac{2x}{d} \tan \beta\right)$$

$$= \frac{V}{4V_1 \tan \beta} \log\left(1 + 2\frac{x}{d} \tan \beta\right) \quad .. \quad (3)$$

In order to obtain the deflection on the fluorescent screen we multiply the above by L and place $x = l$. Thus

$$Y = \frac{LV}{4V_1 \tan \beta} \log\left(1 + 2\frac{l}{d} \tan \beta\right) \quad .. \quad (3a)$$

The deflection sensitivity is given by

$$\frac{Y}{V} = \frac{L}{4V_1 \tan \beta} \log\left(1 + 2\frac{l}{d} \tan \beta\right) \quad .. \quad (3b)$$

In order to keep the deflection sensitivity constant as the plates are tilted let us seek the value of l/d necessary to keep $Y/V = Ll/2V_1 d$ as β is increased from 0 to $5\frac{3}{4}$ deg. ($\tan \beta = 0.1$). We have, if the suffix 0 refer to values when $\beta = 0$:—

$$(Y/V)_\beta / (Y/V)_0 = \frac{d_0}{2l_0 \tan \beta} \log\left(1 + \frac{2l \tan \beta}{d}\right),$$

We require the ratio on the left-hand side to be unity. Thus we must have :—

$$1 = \frac{5d_0}{l_0}\log_e\left(1 + \frac{l}{5d}\right)$$

From the above we find that if the ratio of deflector plate length to separation was 4 before tilting $\left(\frac{l_0}{d_0} = 4\right)$ the value after tilting $(2\beta = 11\frac{1}{2}°)$ must be increased to 6.135 $\left(\frac{l}{d} = 6.135\right)$ if no loss in deflection sensitivity is to occur. Speaking roughly, therefore, we may say that an increase of 50 per cent. in the ratio $\frac{l}{d}$ keeps the deflection sensitivity constant as the deflector plates are turned each through 5 deg. about the edge nearest the gun of the cathode ray tube.

Equation (3*a*) is seen to reduce to equation (1) for $\beta = 0$. As before V cannot exceed a certain value otherwise the beam will be intercepted by the deflector plates. In order to find the maximum value of V we require to know y, which is obtained by a further integration of equation (3) with respect to x, subject to $y = 0$ when $x = 0$. This yields :

$$y = \frac{V}{4V_1\tan\beta}\left[\left(x + \frac{d}{2\tan\beta}\right)\log\left(1 + \frac{2x}{d}\right)\tan\beta - x\right]$$

The maximum value of y cannot exceed (neglecting here the finite beam section) :

$$\frac{d}{2} + l\tan\beta$$

so that we have as a condition on V

$$V \not> 4V_1\tan\beta\left[\frac{\tan\beta}{\log\left(1 + \frac{2l}{d}\tan\beta\right) - \left(\frac{2l}{2l + d\cot\beta}\right)}\right]$$

(3*a*) thus gives for the maximum value of Y

$$Y = \frac{L\tan\beta\log\left(1 + 2\frac{l}{d}\tan\beta\right)}{\log\left(1 + \frac{2l}{d}\tan\beta\right) - \left(1 + \frac{d}{2l}\cot\beta\right)^{-1}}$$

The following table shows that the sensitivity continuously decreases as β increases.

TABLE I.

$\tan\beta$.	a_1 $(= 1 + 8\tan\beta)$.	$\log_e a_1$.	a_2 $(= 1 + .125\cot\beta)$.	a_2^{-1}	$\frac{Y}{L}$	$V_{max.}$	$30\frac{Y}{LV}$
0	—	—	—	—	.25	75	.1
.1	1.8	.5878	2.25	.444	.402	167	.072
.2	2.6	.9555	1.625	.6155	.562	282	.060
.3	3.4	1.2238	1.417	.706	.708	417	.051
.4	4.2	1.435	1.312	.762	.852	569	.045
.5	5.0	1.609	1.25	.8	.995	740	.041

This, however, would be expected since the value of $(d + x\tan\beta)$, which represents the mean plate separation, is continually increasing. The sharp rise in $V_{max.}$ as β changes from zero to 0.1 is to be noted.

Constants assumed are $V_1 = 600$ volts, $l/d = 4$.

The deflection, sensitivity, and maximum deflecting volts are shown on Fig. 1. The marked falling off in sensitivity as β increases is to be noted.

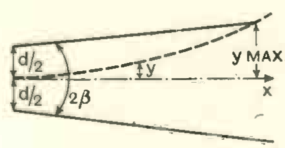


Fig. 1.

If instead of measuring d at point where beam enters the deflector plates d is reckoned at centre line and tilt is obtained by swivelling each plate through an angle β about its centre line, the equation of motion remains unchanged, *e.g.* :

$$m\frac{d^2y}{dt^2} = \frac{eV}{d + 2x\tan\beta}$$

but now x varies between $-\frac{l}{2}$ and $+\frac{l}{2}$

The above equation may be written

$$\frac{d^2y}{dx^2} = \frac{V}{2V_1}\cdot\frac{1}{d + 2x\tan\beta}$$

Integrating subject to $\frac{dy}{dx} = 0$ when

$x = -\frac{l}{2}$ we obtain, after multiplication by $\frac{2 \tan \beta}{d}$:—

$$\frac{2}{d} \tan \beta \cdot \frac{dy}{dx}$$

$$= \frac{V}{2V_1 d}\left[\log\left(1 + \frac{2x}{d}\tan\beta\right) - \log\left(1 - \frac{l}{d}\tan\beta\right)\right]$$

$$\text{and } Y = L\frac{dy}{dx} = \frac{VL}{4V_1 \tan\beta}\log\left(\frac{1 + l/d \tan\beta}{1 - l/d \tan\beta}\right)$$

To obtain y, $\frac{dy}{dx}$ is integrated with respect to x subject to $y = 0$ when $x = l/2$. Writing $x = \xi - l/2$ we have

$$\frac{dy}{dx} = \frac{V}{4V_1 \tan\beta}\left[\log\left\{\left(1 - \frac{l}{d}\tan\beta\right) + \frac{2\xi}{d}\tan\beta\right\} - \log\left(1 - \frac{l}{d}\tan\beta\right)\right]$$

$$= \frac{V}{4V_1 \tan\beta}\log\left(1 + \frac{2\tan\beta}{d - l\tan\beta}\right)$$

$$y = \frac{V}{4V_1 \tan\beta}\left[\left(\xi + \frac{d - l\tan\beta}{2\tan\beta}\right)\mu - \xi\right]$$

$$\text{where} \quad \mu = \log\left(1 + \frac{2\tan\beta}{d - l\tan\beta}\xi\right)$$

The maximum deflection is then given by

$$Y_{max.} = \frac{L\lambda \tan\beta}{\lambda - \left(\dfrac{2}{1 + \frac{d}{l}\cot\beta}\right)} = \frac{L\lambda\left(\tan\beta + \frac{d}{l}\right)}{\lambda\left(1 + \frac{d}{l}\cot\beta\right) - 2}$$

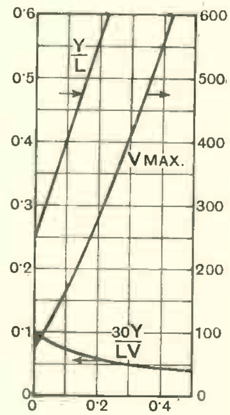


Fig. 2.

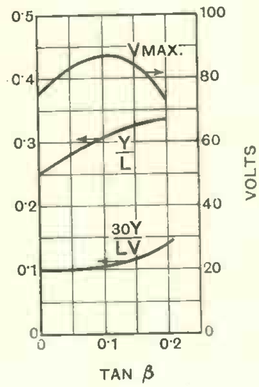


Fig. 3.

The deflection sensitivity $30\frac{Y}{LV}$ in cms. per volt for a 30 cm. beam, $\frac{Y_{max.}}{L}$, and the

TABLE II.

$\frac{l}{d} = 4$ $V_1 = 600$ volts.

$\tan\beta$	$1 + \frac{l}{d}\tan\beta$	$1 - \frac{l}{d}\tan\beta$	λ	$\frac{2}{1 + \frac{d}{l}\cot\beta}$	(Max. Deflecting Voltage) $V_{max.}$	$\frac{Y_{max.}}{L}$	(Deflection Sensitivity) $\left(\frac{30 Y_{max.}}{L V_{max.}}\right)$ mm/volt
0	—	—	—	—	75	.25	1.00
.05	1.2	0.8	.4055	·3333	83.1	.281	1.01
.1	1.4	0.6	.8473	·5714	87	.307	1.06
.15	1.6	0.4	1.3863	·7500	84.8	·327	1.16
.2	1.8	0.2	2.1972	.8888	73.2	·336	1.38

The maximum value of V is obtained as before, and may be written

$$V_{max.} = \frac{4V_1 \tan^2\beta(d + l\tan\beta)}{\lambda(d + l\tan\beta) - 2l\tan\beta}$$

$$\text{where} \quad \lambda = \log\left(\frac{1 + \frac{l}{d}\tan\beta}{1 - \frac{l}{d}\tan\beta}\right)$$

maximum deflection voltage $V_{max.}$ are plotted in Fig. 2 for values of tan β up to 0.2, which represents the maximum permissible tilt which would allow entry of a beam 1 mm. diameter.

The deflection sensitivity is seen to increase moderately over the permissible range of tilt, the maximum deflection $Y_{max.}$ rather more markedly, while $V_{max.}$ passes through a maximum at tan $\beta = 0.1$. As

$\tan \beta = 0.15$ probably represents the practical upper limit of β (distance apart of plates at nearest point = 2 mm. for $d = 5$ mm.) the plates should not be tilted more than about 8½ deg. each about their centres. A 5¾ deg. tilt would increase the *maximum* angular deflection by some 23 per cent. and would, therefore, be a valuable alteration if there is any tendency with parallel plates for the beam to be intercepted or distorted by the plates. A 5¾ deg. tilt is recommended for most purposes: the angle between the two deflector plates would then be 11½ deg. This condition corresponds to the optimum value of $V_{max.}$ as indicated on Fig. 3.

For other values of l and d tables and curves similar to those given above may readily be prepared. In view of the approximate nature of the treatment for large values of β it is considered that nothing would be gained in considering the equations in very great detail.

It is probable that for values of $\tan \beta$ in excess of 0.2 optimum deflector plate shape is curved rather than straight. The electrostatics of a curved plate pair would be more difficult to handle. The component of velocity would be altered in, as well as at right angles to, the direction of motion to an extent which might prove to be of importance as affecting focusing.

Correction for Finite Beam Section. It is readily calculated that electrons on the surface of a cylindrical beam will be intercepted by the deflector plates between which a deflection voltage greater than $V_{max.}\left(1 - \frac{D_B}{D}\right)$ exists. Here $V_{max.}$ is the maximum deflecting voltage for axial electrons, as plotted on Figs. 2 and 3, D_B is the beam diameter and D is the plate separation at the point where the beam leaves the deflector plates. For plates swivelled about their centre lines, $D = d + l \tan \beta$.

As an example, let the beam diameter be 4 mm. and let $D = 16$ mm. The correction factor to the ordinates of all curves on Figs. 2 and 3 will be $1 - \frac{4}{16} = 0.75$. If it is desired to make up for the loss in permissible deflection brought about by the existence of a large beam diameter, l should be increased, and if $d - l \tan \beta$ then becomes too small to admit of entry of the beam into the space between the deflector plates, d will have to be increased also.

Measurements in Radio Engineering

By F. E. Terman, ScD. 400 pages 210 illustrations. Published by McGraw-Hill Publishing Co., Ltd., Aldwych House, London, W.C.2. Price 24s.

In this book the whole field of laboratory measurement is well surveyed, and although it is more suited to the needs of the student than to those of the engineer, the latter will find in it much of value. The scope of the book is wide: the first chapter deals with the measurement of voltage, current and power, and includes an adequate description of all common types of A.C. and D.C. meters. The second chapter is particularly useful in that it contains a discussion of low-frequency methods of measurement and that particular stress is laid upon A.C. bridges, all the chief types being given with their equations for balance. Following chapters deal with high-frequency measurements, resistance devices, frequency, waveform, valve characteristics, overall receiver measurements, among many other related subjects.

The chapter on the measurement of valve characteristics is of especial interest in that the author points out the limitations of the ordinary valve bridge and suggests an alternative arrangement. The section dealing with the H.F. resistance of coils is, however, open to criticism. The author favours a method based on the dynatron but he deals also with other systems, including the resistance substitution method. He rather overlooks the importance of the input resistance of the valve voltmeter, however, for he contents himself with saying that "when very precise results are required, or when the measurements are made at very high frequencies, the vacuum-tube voltmeter losses must be determined and allowed for." In the reviewer's experience, the input resistance of an ordinary valve voltmeter may be as low as 0.5 megohm at frequencies of the order of 1 mc/s, and it is essential to allow for it if the results are to be even reasonably accurate.

Compared with the merits of the book, however, this is a minor point. It will undoubtedly prove of great service to all those engaged in receiver and component design, but perhaps its most valuable feature is the detail which is given of laboratory apparatus. In many cases, these are sufficient to enable apparatus to be readily constructed; H.F. and L.F. oscillators, valve testing gear, dynatron resistance measuring gear, and standard signal generators all come in for discussion in this way. The importance of this feature of the book can hardly be overstressed, for there is all too little published data on the practical aspect of laboratory apparatus.

The book is well printed and bound, and is remarkably free from errors. W. T. C.

Some Measurements on Iron Cored Tuning Coils*

By K. Kaschke

SUMMARY.—The difficulties which have so far handicapped the extensive use of iron cored tuning coils in this country are discussed, and it is anticipated that these difficulties will be removed by the coils described. From various measurements it is shown that the iron cored tuning coil developed by Hans Vogt with a multi-layer winding concentrated in a small space is not only smaller, cheaper and more suitable for production than larger, single layer iron cored coils but, by using a particular design, even produces better magnification, contrary to former views on this subject.

This particular design is discussed with the aid of various measurements; the influence of the core shape to the magnification and the screening losses is shown. It is seen that the "pot" type core produces highest magnification and lowest screening losses.

It is shown that the highly efficient small iron cored coil calls for the use of insulators of low losses throughout the oscillatory circuit to make it fully effective.

THE iron cored tuning coils when first making their appearance in this country in the form of the Ferrocart-coils, developed by Hans Vogt, aroused considerable interest in expert circles, and it was expected that they would displace the air coils previously used due to their superiority in regard to smaller size, smaller stray field and lower losses. However, so far as this country is concerned, the development did not quite come up to these expectations and iron cored coils have found only a relatively limited application in this country. This is contrary to most other countries; for instance, almost all German receivers, shown at the Berlin Radio Show 1935, were fitted with iron cored coils, and a similar development has taken place in other continental countries. Also in the U.S. there are strong tendencies in favour of iron cored coils.

There are probably several reasons for the particular situation in this country. First, most of the British sets in the past were superhets with an intermediate frequency in the order of 110 kc/s. At this frequency, sufficient selectivity can be attained with relatively small and cheap air coils and there is no need of any improvement. In Germany, on the other hand, superhets with 465 kc/s and straight sets were preferably used which, in order to get high selectivity, call for the very best coils which can possibly be made. Intermediate frequencies of 465 kc/s and even 1 600 kc/s are, however, becoming popular in this country too, thus raising here the problem of better coils.

Also the price question was more critical in this than in other countries, while on the other hand due to various reasons, the difference in material and labour cost between iron cored and air coils was greater here than, for instance, in Germany, and did not seem to outweigh the advantages obtainable. Technical development meanwhile went in the direction of lowering the cost of the iron cored coils so that highly efficient iron cored coils can now be produced in which the additional cost of the core is practically compensated by the savings in copper, screening can and space.

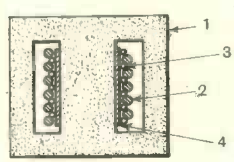


Fig. 1.—*Sectional view of an iron cored coil form according to Fig. 6 of British patent specification No. 366 475 of Polydoroff, of 1929—suggesting single layer space wound arrangement.*

The core material completely encloses the winding, keeping considerable distance between iron and copper. 1 = pot shaped magnetic core, 2 = winding. 3 = intermediate threads for spacing the turns of wire. 4 = intermediate layer between core and winding.

The third and perhaps fundamental reason from a technical point of view is the fact that the effective improvement in the over-

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

all efficiency of the set due to using iron cored coils over air coils is very doubtful and will not justify their use *unless the low loss iron core material is combined with a particular structural arrangement.*

The following is a survey of the features which lead to an optimum combination of material and design. The measurements, which have been carried out, will show that the ideal design of highly efficient iron cored tuning coils differs from the rules which are generally applied to the design of tuning coils to get maximum efficiency and which were believed to be generally true.

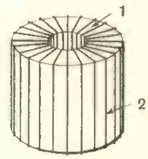


Fig. 2.—*Diagrammatic view of a toroidal coil with a core of laminated Ferrocart of* 1932, *single layer space wound.* 1 = *magnetic core,* 2 = *winding.*

To obtain tuning coils of very low losses formerly the winding was arranged on an insulating cylinder of very large diameter in a single layer, using very thick litz wire of many strands and with thick insulation to get sufficient distance between the windings (see coil No. 1 in Fig. 5). Size, thickness of litz wire and efficiency went hand in hand, the larger the coil and the more copper used, the higher was its efficiency.

This generally accepted rule for attaining highly efficient coils was transferred to the design of iron cored coils as well. An attempt in this direction is illustrated in Fig. 1, from British patent specification No. 366 475 of Polydoroff, of 1929 (Fig. 6 of specification). The winding is of the single layer space wound type, the space being kept by intermediate filaments 3. Much free space is also provided on all sides between winding and core material; the arrangement is very spacious. To make a tuning coil of 160 000 cm inductance a core weight of about $9\frac{1}{2}$ oz. at an external diameter of about $1\frac{9}{16}$in. and a height of about $2\frac{7}{16}$in. is necessary. A coil of this kind would cost a multiple of an equivalent air coil and therefore could not have been used even if at that time a core material of small high frequency losses had been available.

Such a core material was made available in 1932 by the introduction of Ferrocart. When using the Ferrocart material, the radio industry started from the same old principles of spacious arrangement of the coil. Fig. 2 will show the structure of a toroid coil made in 1932. Note the typical arrangement of the single layer space-wound coil. The coils had a diameter of $1\frac{3}{4}$in. and a height of $1\frac{7}{16}$in. or $\frac{1}{2}$in. respectively and a core weight of $5\frac{1}{4}$ oz. or $1\frac{3}{4}$ oz. respectively. In view of the great expenditure of special magnetic material and the elaborate winding method the cost of such single layer iron cored coils was about five times that of an equivalent air coil. The advantage of smaller volume and stray field of such iron cored coils compared to equivalent air coils did not outweigh the great increase in cost, at least as far as industrial sets were concerned. Accordingly the iron core principle could be used for home constructor coils only. The progress envisaged when developing the Ferrocart material thus seemed to be handicapped by commercial considerations. A further reduction of the size, weight and price of iron cored coils appeared quite impossible in view of the existing experiences and theoretical considerations according to which the efficiency goes down in proportion to reduction of size. Experiments confirmed this too, for instance the smaller toroidal coil (No. 4 in Fig. 5) shows a drop of efficiency of 22 per cent. at 1 440 kc/s compared with the larger toroidal coil (No. 3 in Fig. 5).

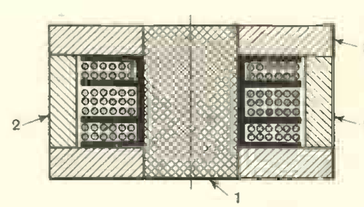


Fig. 3.—*Diagrammatic view of the new iron-cored tuning coil with a multi-layer litz winding concentrated to small space, low capacity winding (low loss sectionalised coil former of Trolitul) with approximately square shaped winding cross section.* 1 = *rod core,* 1 + 3 = *H-core (or, if parts* 3 *are round discs, spool type core),* 1 + 2 + 3 = *E-I-core or if circular: pot core.*

By making experiments on a broad line with a view to creating a new constructional form, which should, by proper combination of a low loss magnetic material with a high efficient design, represent an optimum in regard to highest magnification, smallest stray field and small expenditure in material and labour, Hans Vogt has removed these objections. In fact, by elaborate investigations and researches he has succeeded in

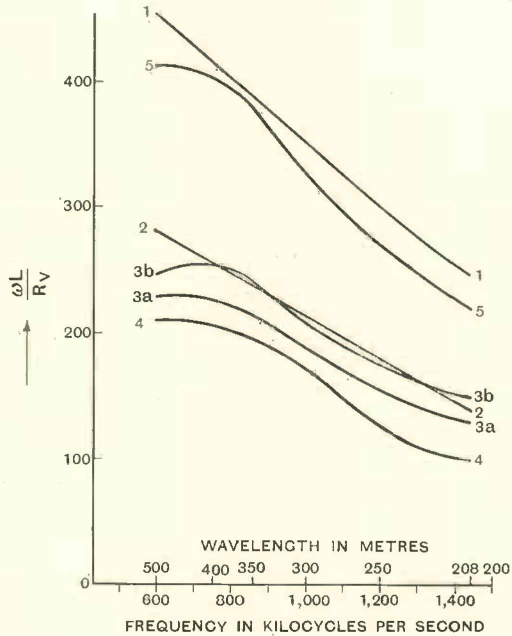


Fig. 4.—*The magnification of various constructional forms of coils, illustrated in Fig.* 5 (*L* = 160 000 *cm*), *curve* 1, *cylindrical air coil, single layer litz wire* 60 *strands of S.W.G.No.* 45, *diameter* 2*in., length of winding* 3⅛*in. Curve* 2, *iron cored tuning coil having a constructional arrangement as per Fig.* 1 (*Fig.* 6 *of Brit. Patent No.* 366 475), *single layer space wound, but with an iron core, litz wire* 20 *strands of S.W.G. No.* 45, *core weight* 9½ *oz., winding diameter* 1*in., winding length ca.* 2*in., exterior dia. of core* 1 9/16*in. Curve* 3, *toroidal coil having a core of laminated Ferrocart, single layer space wound as per Fig.* 2, *core weight* 5¼ *oz.,* (*a*) *solid wire S.W.G. No.* 29, (*b*) *litz wire* 30 *strands of S.W.G. No.* 47. *Core dia. int.* ¾*in., ext.* 1⅝*in., height of core* 1 7/16*in. Curve* 4, *toroidal coil same as No.* 3 *but flatter core of* ½*in. height only and* 1¾ *oz. weight, solid wire S.W.G. No.* 29. *Curve* 5, *up-to-date iron cored coil with a moulded iron core and winding and core concentrated to smallest space* (*section, see Fig.* 3). *Core of pot shape. Litz wire* 20 *strands of S.W.G. No.* 47 *on a sectionalised coil former of Trolitul, winding dia. int.* ⅜*in., winding length* ¼*in., ext. dia. of core* 13/16*in., core weight* ½ *oz.*

finding a form, which meets at the same time the electrical, technological and commercial requirements. This constructional form is shown in section in Fig. 3. By means of semi-automatic winding machines a relatively thin and cheap litz wire is spooled upon a small sectionalised coil former of Trolitul, so that a multi-layer winding concentrated in the smallest possible space is obtained. The core is a small automatically compressed moulded one of about ⅓ oz. to ⅔ oz. weight and a permeability of about 13 (calculated at the toroidal core) and preferably so shaped that it tightly encloses the winding on all sides, although open or semi-closed types may also be used with the same fundamental form of winding.

Volume, core weight and cost of the coils so obtained amount to less than a quarter of the toroidal coils. In spite of this enormous reduction in size and cost the coil is shown by curve 5 in Fig. 4* to be about 72 per cent. better at 1 440 kc/s than the single layer coil No. 3. Accordingly the road which, if existing views had been accepted, appeared to offer no prospects has led to full success.

In fact, the constructional form thus created with the copper winding concentrated in small space and a small moulded magnetic core contradicted the existing views. It is to be noted, however, that it requires quite a particular design to get such superior efficiency with small concentrated coils. Fig. 6 shows a comparison of the efficiency of air and iron cored coils with spacious and with concentrated winding, as illustrated in Fig. 7, No. 1 is a conventional cylindrical air coil with thick multi-strand litz wire, single layer space wound, while No. 2 is an air coil using the same litz wire, but with a concentrated winding (low capacity wave wound coil); No. 3 is an iron cored coil, otherwise with the same arrangement as coil No. 1, single layer spacious form; (a = litz wire about 60 strands of S.W.G. No. 45; b = litz wire about 20 strands of S.W.G. No. 47; c = solid wire S.W.G. No. 29). No. 4 is an iron cored coil corresponding in its arrangement to coil No. 2 *i.e.*, multi-layer concentrated winding of low capacity (sectionalised arrangement) *i.e.*, first with the same thick litz wire as coil No. 1 (curve 4a), secondly with thinner litz wire 20 strands of S.W.G.

* All measuring data in this paper are based on relative measurements by the Dynatron method. The inductance is the same for all compared coils and amounts to about 160 000 cm.

No. 47 (curve 4b) and thirdly with solid wire S.W.G. No. 29 (curve 4c).

To eliminate the influence of the core shape, rod cores were used for the coils Nos. 3 and 4. The result of this investigation is a very striking one: The air coil has deteriorated due to the concentration of winding by 65 per cent. at 1 440 kc/s. A similar deterioration is shown with the iron cored coil (which is concentrated and reduced in approximately the same proportion compared with coil No. 3) when using the same thick litz as coil No. 3a (deterioration 21.5 per cent. at 1 440 kc/s) and with solid wire (deterioration 40 per cent. at 1 440 kc/s). When using 20 strands of S.W.G. No. 47 litz wire, however, an *improvement of* 26.5 *per cent.* is attained at 1 440 kc/s over the single layer iron cored coil with thick litz wire No. 3a, although a considerable saving is effected in the required copper, iron and space. The drop in efficiency of coil No. 4b over 3a towards the lower frequency is absolutely desirable with a

Table of volumes, core weight and magnification at 350 m of the iron cored coils shown in Fig. 5.

Coil No.	*Total volume. cub. ins.*	*Core weight. oz.*	*Magnification. $\omega L/R_v$.*
2	$4\frac{4}{5}$	$9\frac{1}{2}$	236
3	$4\frac{1}{3}$	$5\frac{1}{4}$	214
4	2	$1\frac{3}{4}$	232
5	$\frac{2}{5}$	$\frac{1}{2}$	400

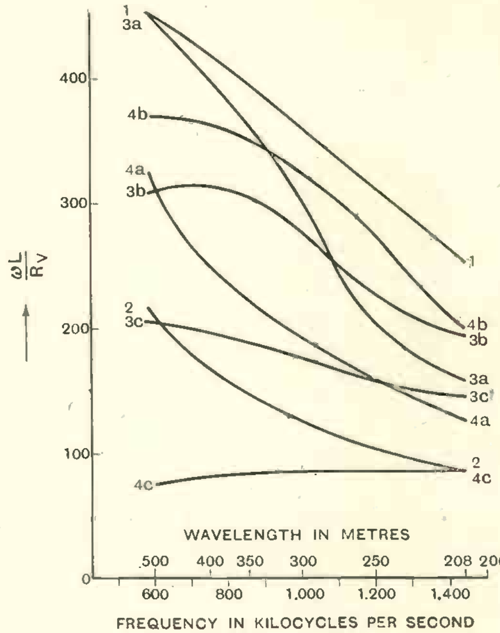


Fig. 6.—*A comparison of the magnification of air and iron cored coils with spaced and with concentrated winding (see Fig. 7). Curve 1, cylindrical air coil, single layer, litz wire 60 strands of S.W.G. No. 45, dia. 2in., winding lengths $3\frac{1}{8}$in. Curve 2, air coil with same litz wire but multi-layer concentrated low capacity winding (wave wound winding). int. dia. 1in., winding length ca. $\frac{5}{16}$in. Curve 3, cylindrical iron cored coil, winding same as coil No. 1, single layer wound, with the same litz wire, core dia. ca. $1\frac{3}{16}$in., winding length $1\frac{3}{4}$in. (a) with same litz as coil No. 1, (b) with litz wire 20 strands of S.W.G. No. 47, (c) with solid wire S.W.G. No. 29. Curve 4, iron cored coil with winding arrangement same as coil No. 2, with concentrated multi-layer low capacity winding (sectionalised coil), core dia. $\frac{9}{16}$in., winding length $\frac{5}{16}$in. (a) with same litz wire as coil No. 1, (b) with litz wire 20 strands of S.W.G. No. 47, (c) with solid wire S.W.G. No. 29.*

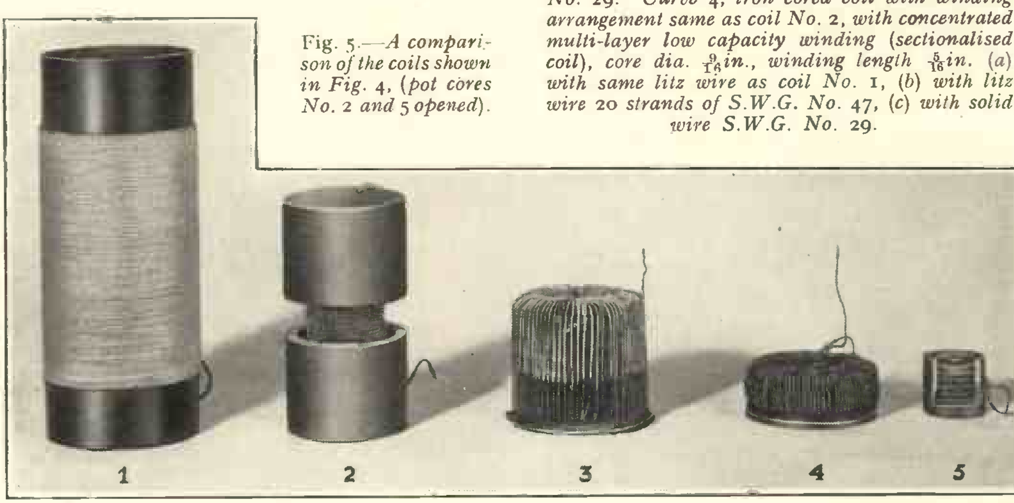


Fig. 5.—*A comparison of the coils shown in Fig. 4, (pot cores No. 2 and 5 opened).*

view to uniform amplification. For an i.f. of 465 kc/s the same or even superior magnification can be attained as with the coil 3a by using 30 strands S.W.G. No. 47 litz wire.

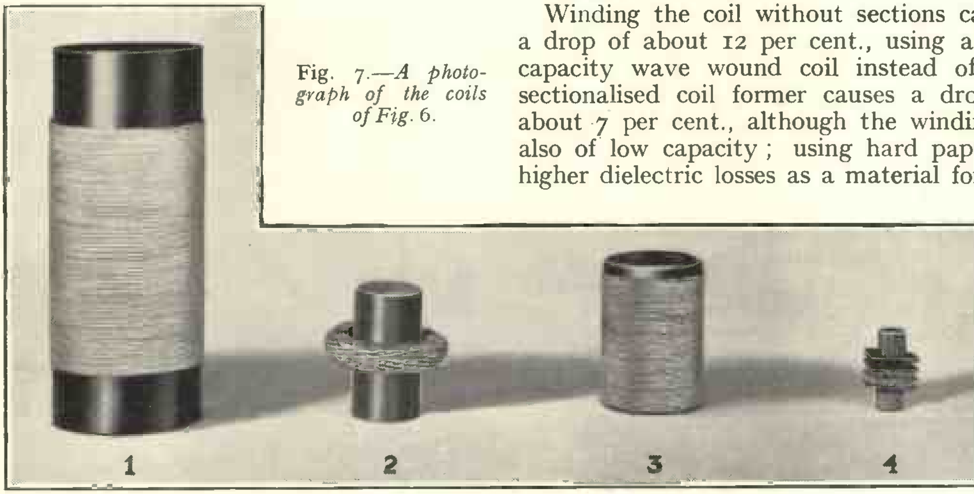


Fig. 7.—*A photograph of the coils of Fig.* 6.

Compared with the single layer coil No. 3b with the same litz wire 20 strands S.W.G. No. 47 the multi-layer coil 4b is superior over the whole range 500 to 1 500 kc/s.

A striking fact in this diagram is particularly the enormous improvement of efficiency attained by litz wire 20 strands of S.W.G. No. 47 over solid wire S.W.G. No. 29 (curve 4c) with the multi-layer coil. The improvement is 130 per cent. at 1 440 kc/s, compared with 35 per cent. corresponding improvement in the single layer iron cored coil (see curve 3c and 3b). This will show how critical the conditions are in such coils having concentrated copper mass.

Still further conditions must be fulfilled with the constructional arrangement of the coil in order to get the outlined success. This will be clear from Fig. 8, showing the magnification of the pot coil (curve 1) illustrated in Fig. 3 and from curve 2 to 6 showing the magnification of the same coil, varying only one feature at a time. The result is as follows:

Winding the coil without sections causes a drop of about 12 per cent., using a low capacity wave wound coil instead of the sectionalised coil former causes a drop of about 7 per cent., although the winding is also of low capacity; using hard paper of higher dielectric losses as a material for the coil former instead of Trolitul gives a drop of 16 per cent. Also the insulation of the litz wire is of considerable influence. Using a litz wire of same structure but an insulation of higher losses causes 31 per cent. drop of efficiency—(all these values being calculated at a frequency of 1 440 kc/s).

This investigation will make it clear, that

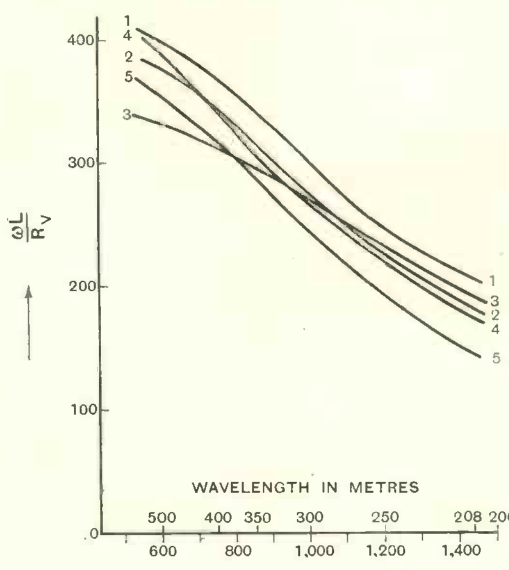


Fig. 8.—*The influence of various factors on the efficiency of iron cored coils with concentrated winding (pot coil as per Fig. 3). Curve No. 1, optimum conditions: Litz wire 30 strands of S.W.G. No. 47, low loss insulation, coil former in 3 sections of Trolitul. The following curves were obtained by changing each one of these features maintaining all others, i.e., curve No. 2 coil former without sections. Curve 3, wave wound coil instead of sectionalised coil. Curve 4, coil former of hard paper instead of Trolitul. Curve 5, same litz wire but with insulation of higher dielectric losses.*

a number of factors must cooperate to get a miniature iron cored coil of an optimum magnification notably better than that of the conventional large single layer iron cored coil.

Further fundamental investigations had to be made to find the most favourable shape of core when combined with the fundamental form of coil outlined above.

Starting from the plain rod core and maintaining the fundamental form of coil already described the different shapes were investigated up to the pot core which completely encloses the winding. Joining yokes 3 to the plain rod core 1 (criss-cross hatching) in Fig. 3, an *H*-core results, from which by closing the remaining openings by exterior legs 2 the three-leg *E-I*-core is obtained. Using circular yoke plates 3 we get a spool type core which by further adding a hollow cylinder 2 gives the pot core completely enclosing the winding. As shown in Fig. 9, the coil, especially in working condition, *i.e.*, measured with the screening cover, is improved in the degree that the flux is enabled to flow through magnetic material without passing through air.

Accordingly the entirely closed pot core is superior, particularly when measured in a small screening can. The *E-I* core has relatively small screening losses, while the semi-closed shapes—*H*-core, spool type core—already produce considerable screening losses and the open rod core shows a very serious fall in efficiency. With other frequencies, for instance, i.f. of 465 kc/s, the conditions are further changed in favour of the pot core, as the screening losses are increased with lower frequency.

It would exceed the scope of this paper to discuss the physical explanations for the strange fact that the highest magnification is attainable just with the smallest concentrated type of iron cored coil, giving values superior to those of larger iron cored coils with greater expenditure of low loss magnetic material and with thick spacious litz wire winding. As a matter of fact, this type of coil has found a very ready acceptance in the radio industry of those countries where iron cored coils had been generally adopted, thus stamping with their approval the way pioneered by Hans Vogt. It must be realised, also, that apart from the small size and improved efficiency, this form of coil offers considerable advantages from a manufacturing point of view: The core weight is reduced to about one-tenth of that of single layer coils; due to the miniature size of the cores they can be produced by direct moulding in automatic machines getting very hard material while the former toroidal cores had to be made by winding upon a mandrel insulating layers covered with the magnetic substance (laminated material) to get uniform structure and low losses of such large cores. Instead of the elaborate single layer space winding the wire is spooled upon a little coil former by a winding machine. One chamber of the sectional coil former may be left empty for the coupling windings. Relatively thin and cheap litz wire may or even must be used and a fraction only of

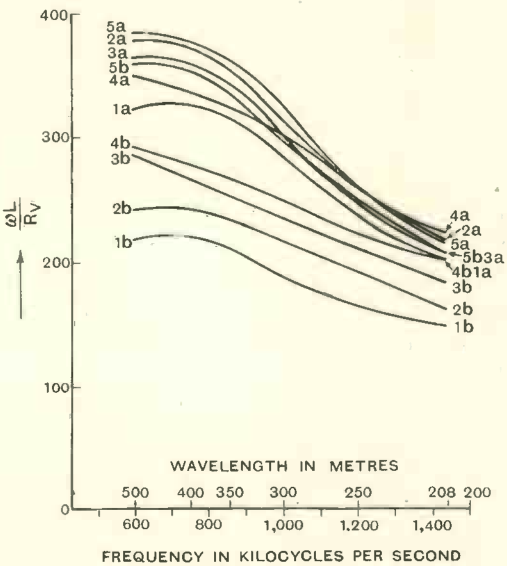


Fig. 9.—*The influence of the core shape on the magnification and screening losses. Curve* 1, *rod core,* 21/64 . 21/64 (=8.5 . 8.5*mm.*), *and* $1\frac{1}{16}$*in. length. Curve* 2, *H-core. Curve* 3, *spool type core. Curve* 4, *E-I-core. Curve* 5, *pot core,* (*a*) *unscreened,* (*b*) *screened in a copper shield can, about* $1\frac{9}{16}$*in. dia.,* $1\frac{9}{16}$*in. height.*

the length of wire needed with air coils or single layer iron cored coils is required. The whole coil forms a compact self-contained unit, the wire is mechanically protected and cannot be damaged or displaced, thus causing undesirable inductance change. Due to the small size and compactness of this coil form it is easily possible to make the inductance value adjustable, for instance by changing the magnetic resistance by an air gap in the core or by adjusting a magnetic part, the adjustment so obtained being free from additional losses, which is a particular advantage of the up-to-date iron cored coil over the earlier types of coils.

It will be clear from the above why most of the iron cored coils so far used in this country, did not come up to expectations. The small compact iron cored coil will not produce the high efficiency it is able to produce unless very special care is taken to adapt its constructional form to the particular electrical conditions prevailing in such compact coil arrangement, particularly using special litz wire and insulating material of low dielectric losses. As shown above, the electrical conditions of such miniature coils are much more critical than with large and spacious coils so that relatively small mistakes in the construction will affect the coil considerably. Also the dielectric losses of the insulating material used for supporting the coil and fixing the soldering tags, and of the material used for the switches are of a considerable influence on the goodness of the whole oscillatory circuit. These losses, while less important with inefficient coils of high losses, become of a definite importance as the share of the coil losses in the total losses of the circuit is reduced. Accordingly it can be stated that to develop their full efficiency iron cored coils should be combined with loss-free insulating material for the coil and throughout the circuit, such as Trolitul, Amenit or low loss ceramic dielectric materials instead of the conventional insulators.

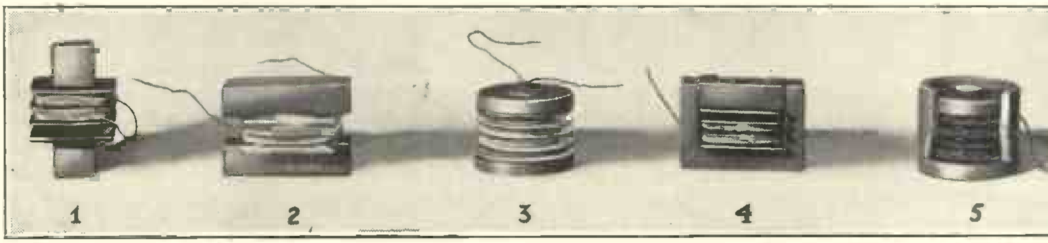


Fig. 10.—*Some up-to-date iron cored coils, built on the same constructional principles with concentrated multi-layer sectionalised winding as per Fig.* 3, *but of different core shape as stated in Fig.* 9 (*pot core No.* 5 *opened*).

Applying the Cathode-Ray Tube to Servicing

The Cathode-Ray Tube at Work

By John F. Rider. 322 pages + IX. 440 illustrations. Published by John F. Rider, 1440, Broadway, New York City, U.S.A. Price $2.50.

The aim of this book is primarily to show how the cathode-ray tube may be applied to the servicing of wireless receivers, and as the author rightly believes that full advantage cannot be taken of any apparatus unless its mode of operation be thoroughly understood, the early chapters are devoted to a description of the cathode-ray tube, its operating principles, and time-base systems. One chapter is given up to describing current commercial cathode-ray gear of American manufacture.

The applications of the tube to servicing are treated in detail, and it is shown how it may be used for the measurement of current and voltage, the comparison of frequencies, and for the study of waveform. The location of distortion with its aid is treated with particular reference to amplitude and phase distortion. An important section is that devoted to the cathode-ray tube in relation to tuned circuits. This is probably the most valuable application of the tube to service work and no fewer than 54 pages are devoted to a description of the principles involved, commercially available gear, and practical difficulties. Transmitting problems and the use of the tube in their solution are briefly touched upon.

The author is obviously convinced of the value of the cathode-ray tube as an aid to servicing. While there is no doubt that it can be of enormous help in certain aspects of wireless, it is a debatable point whether it can be of such great assistance to the service man as the author believes.

The book should, however, prove of inestimable value to all those interested in the application of the cathode-ray tube to receiver testing, as well as to those who wish to obtain an insight into its uses and limitations. It is well printed and bound, and copiously illustrated with photographs of oscillographs. W. T. C.

Phase Distortion in Television*

By R. G. Shiffenbauer

THIS article represents a part of the material resulting from studies on television picture distortions due to the transmission channels. The work was undertaken in 1933 and 1934 in the V.E.I. (All Union Electrical Institute).

The transmission of any image can be regarded, as is known, as the transmission of oscillations of different frequencies which have at every given moment a definite phase and amplitude ratio.

It is obvious that when this ratio is destroyed distortion takes place in the picture received.

This article deals exclusively with the results of studies of the so-called phase distortions of the lowest frequencies that enter the spectrum of the television picture.

THE violation of the phase ratio does not always produce a distortion of the picture. Let us discuss this question in detail. The voltage curve in the photo-current amplifier input when transmitting a picture can be expressed as follows:

$$F(t) = A_0 + \Sigma A_n \cos (n\omega t + \phi_n).$$

Where A_0 — constant component, A_n — amplitude of the nth harmonic. If the angle ϕ_n changes after the signal passes through some part of the circuit, distortion of the curve takes place only when this change is not proportional to the frequency. We will try to prove this. Let us assume that the phase of every harmonic oscillation has changed by a value B_n, where $B_n = \pm mn\omega$, where m is a constant value, and the sign before m is the same for the entire band of frequencies.

Then

$$F'(t) = A_0 + \Sigma A_n \cos (n\omega t + \phi_n \pm mn\omega)$$
$$= A_0 + \Sigma A_n \cos [(t \pm m)n\omega + \phi_n]$$
$$= A_0 + \Sigma A_n \cos (n\omega t' + \phi_n)$$

Where $t' = t \pm m$.

It is obvious that the shape of the curve $F'(t)$ will be the same as that of the curve $F(t)$, *i.e.*, the picture will not be distorted; it will only be displaced by an interval corresponding to time m in the direction of the scanning or opposite to it depending upon the sign before m.

In this case the phase characteristic of the part of the circuit in question will be rectilinear and its equation will be $B = m\omega$. But in cases when the phase characteristic of the transmission channel is not rectilinear, *i.e.*, when m is not constant, all the harmonic components will be displaced by different time intervals, which will inevitably involve the distortion of the $F(t)$ curve, and consequently of the picture transmitted. What will then determine the degree of the phase distortions?

According to some published articles† the presence of phase distortions is measured by

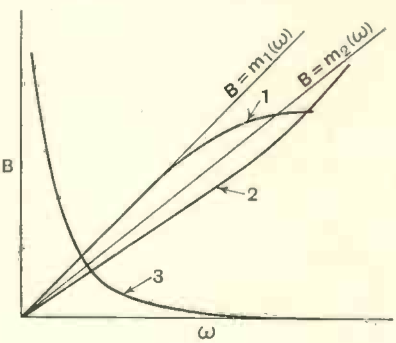


Fig. 1.

the deviation of $\frac{B}{\omega}$ or $\frac{dB}{d\omega}$ from a constant value.

However, it is not difficult to see that, taking any equation $B = f(\omega)$, such as curve 1 in Fig. 1, the deviation of $\frac{B}{\omega}$ from the constant value will be different, depending upon whether we compare curve 1 with the straight line $B = m_1(\omega)$ or with $B = m_2(\omega)$.

Y. C. Steinberg‡ gives a more definite suggestion, he considers that the presence of phase distortion at frequency f is indicated by the value

$$\left(\frac{dB}{d\omega}\right)_f - \left(\frac{dB}{d\omega}\right)_{\text{min.}}$$

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

† *See* bibliography (1) (2).

‡ *See* bibliography (6).

As $\frac{B}{\omega}$ is more significant than $\frac{dB}{d\omega}$ we will assume that the degree of phase distortion at frequency f is determined by the difference $\left(\frac{B}{\omega}\right)_f - \left(\frac{B}{\omega}\right)_{min.}$ in the case of curves similar to curve 2 in Fig. 1 and the difference

$$\left(\frac{B}{\omega}\right)_{max.} - \left(\frac{B}{\omega}\right)_f$$

in the case of curves similar to curve 1*.

$$\left(\frac{B}{\omega}\right)_f - \left(\frac{B}{\omega}\right)_{mean.}$$

In future the values B will be called "additional displacement" and the values $\left(\frac{B}{\omega}\right)_{max.} - \left(\frac{B}{\omega}\right)_f$ and $\left(\frac{B}{\omega}\right)_f - \left(\frac{B}{\omega}\right)_{min.}$ — "relative time displacements."

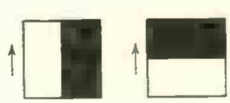
Consequently the distortions, produced in this case in the picture received, corresponding to the curve $F'(t)$, will depend, first upon the value $\left(\frac{B}{\omega}\right)_f - \left(\frac{B}{\omega}\right)_{\substack{max.\\min.}}$, secondly upon the type and behaviour of the modulated source of light used, and thirdly upon the character of the picture. The first statement is clear without further evidence, and the second one can be proved in the following way. If the shape of the voltage curve at the modulated source of light differs from that of the voltage curve at the photo-current amplifier input as a result of "relative time displacements" created at various frequencies in the transmission channel, then the distortion will be observable on the picture only when it extends beyond the limits of "the respective gradation of the modulated source of light."

For instance, if the distortion of the voltage curve is such that dark spots may appear on the light background they will only be noticeable if the difference between the two voltages—corresponding to the light background and to the darker spots suffices to call forth a visible difference in the brightness of the modulated source of light.

In many articles† in the American literature dealing with the calculation of television transmission, the authors apply the so-called limits for relative time displacement allowed in the transmission channels and for the variations of the attenuation with frequency within the frequency range required.

In some of the articles‡ only figures are quoted, in others§ it is shown how they are obtained. Owing to the fact that our points of view on some items concerning the determination of the above-mentioned limits differ greatly from those of the authors of these articles, we shall give a summary of their argument.

First of all, when determining the limits, not one of them mentions that they depend on the behaviour and type of the modulated source of light used. Secondly, the limits cited are given for the deviations of $\frac{dB}{d\omega}$ from the constant value and not those of $\frac{B}{\omega}$, while it is obvious that the image will not be distorted even at very high values of $\left(\frac{dB}{d\omega}\right)_f - \left(\frac{dB}{d\omega}\right)_{\substack{min.\\max.}}$ as long as $\left(\frac{B}{\omega}\right)_f - \left(\frac{B}{\omega}\right)_{\substack{min.\\max.}}$ is low. Thirdly, when determining in the previously mentioned article|| the deviation of $\left(\frac{dB}{d\omega}\right)$ from the constant value for the lowest frequencies of the transmission band the authors make a wrong start. We will give their argument. They analyse the transmission of a simple picture: half black and half white (Fig. 2) placed as in Fig. 2a (the arrow shows the direction of the scanning). The voltage at the amplifier input will contain a strong "picture frequency" and weaker harmonics. Further, the authors assume, that the phase shift at the fundamental frequency ("picture frequency") relative to the higher frequencies will blur the boundary between the white and black fields. Assuming that in the case of a blurred region of n strips, the distortion can be still considered admissible, the authors naturally draw a conclusion that the admissible relative time displacement at the picture frequency will be $t = \frac{n}{800}$; strip



(a) (b)

Fig. 2.

* In some particular kinds of phase characteristic it is convenient to take the difference

† *See* bibliography from (1) to (7).

‡ *See* bibliography (3), (4), (5), (6) and (7).

§ *See* bibliography (1), (2).

|| *See* bibliography (2).

frequency 800, number of strips = 50, number of pictures = 16.

If the scanning of the same picture is made as in Fig. 2*b*, the voltage at the amplifier input will in the main contain "the strip frequency" and its harmonics. In this case with the same width of the blurred region the time corresponding to it will be equal not to the time required for tracing *n* strips, but to that needed for passing *n* elements, *i.e.*, the admissible time displacement for the strip frequencies will be

$t = \frac{n}{50.800}$ (number of elements in a strip = 50).

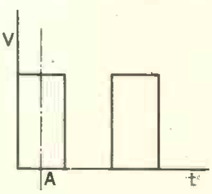


Fig. 3.

Hence the admissible relative displacement, at low frequencies is 50 times more than at frequencies of the strips.

Finally we quote the limits accepted by the authors of the above articles.

For transmitting images consisting of 2.500 elements in 16 pictures per second.

(1) Admissible deviations of $\frac{dB}{d\omega}$ from the constant value for frequencies from 400 p/s to 20.000 p/s were determined experimentally as $= \pm$ 10–20 μS.

(2) In view of the above arguments the values for frequencies from 10 to 400 p/s were 50 times as large, *i.e.*, $\pm$ 500–1,000 μS. We consider that there is no reason for using the values of admissible time displacements obtained for the picture frequency for frequencies that are much higher.

Among other articles in which limits are mentioned we can point out Mr. T. H. Bridgewater's* article. In this article the author says that he found in practice that the presence of relative phase shift below 6° at a low frequency does not cause picture distortion. The type of the picture was not mentioned.

We will pass now to the description of our method of determining the same limits.

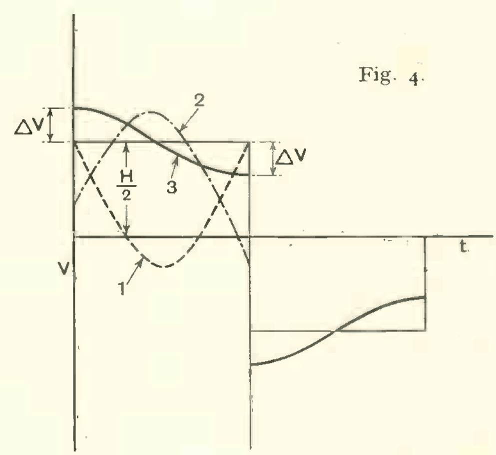
Lowest frequency part of the Band passed.—Let us examine the transmission of the picture discussed in the above article, *i.e.*, as at Fig. 2. In this case the voltage at the amplifier input has the shape shown in Fig. 3. It is known that such a curve can be analysed into harmonic oscillations having amplitudes $A_0 = 0.5H$; $A_1 = 0.636H$; $A_2 = 0$; $A_3 = 0.212H$; the amplitudes of the remaining harmonics will be very small. When scanning as in Fig. 2*a* the picture frequency will be the fundamental, and when scanning as in Fig. 2*b* the strip frequency will be the fundamental. In this case it is very easy to find out what kind of distortions should arise in the picture, if the transmission channel shifts the phase of the fundamental by some angle. We assume, as an example, that the fundamental is shifted in the transmission by 15°. Let us plot, for this case, the shape of the voltage curve at the transmission channel output. The curve is plotted as follows (Fig. 4). We deduct the fundamental from the rectangular curve of the input voltage (without the constant component), then we add to the remaining curve 1 the fundamental 2, shifted by 15°. The resulting curve is 3. In order to simplify the consideration of this question we assume that the amplification factor is equal to 1.

$$\triangle V = A_1 \sin \phi = 0.636H \sin \phi$$

$\triangle V$ at comparatively small values of ϕ is approximately equal to the maximum difference of the ordinates of the distorted and distortionless curves.

From the curve obtained it is clear that, contrary to the statements of the authors

Fig. 4.



of the above articles†, the sharp division between the white and black fields is not broken, only the even ground of the white

* *See* bibliography (10).

† *See* bibliography (2).

as well as of the black field is violated. In order to obtain a distortionless picture it is necessary that the value $2\triangle V$ should not extend beyond the limits corresponding to one gradation of the brightness of the modulated source of light. As for the sake of simplicity we were using in our experiments a mechanical receiving-transmitting television apparatus with a neon lamp as a modulated source of light—all the calculations are based on the characteristics of the neon lamp. From the expression for $\triangle V$ we obtain

$$\text{Sin.}\,\phi_{max.} = \frac{\triangle V_{max.}}{0.636} H_{max.}$$

Consequently, in order to determine the maximum admissible phase shift $\phi_{max.}$ it is necessary to know the maximum value of the admissible voltage fluctuation of $\triangle V_{max.}$ and the difference between the maximum and minimum running voltage of the modulated source of light—H. It is known that differences in illumination that have the same absolute value are more noticeable under the conditions of a weak general illumination. Consequently it suffices to determine the admissible value of $\triangle V_{max.}$ for the weakest illuminations.

The values of H and $\triangle V$ were determined experimentally for a number of neon lamps with different slopes of characteristics.

The experiment was carried out in the following way. A low direct voltage was impressed on a lamp which had run for 1½–2 hours under a normal current, then alternating voltage was applied, the amplitude of which could be changed. By observing the lamp through the disc apertures it was possible to determine the minimum value of the alternating voltage, which produced strips on the even ground of the lamp. The values of $\triangle V$ were thus determined; H was determined in the following way. To a lamp through which a normal direct current was passing an alternating voltage was impressed the amplitude of which was increased up to the moment when an over-modulation occurred. The amplitude of the voltage at which the lamp is on the verge of over-modulation is the maximum amplitude, *i.e.*, $\frac{H}{2}$. In this case the observation was carried out by means of a Nipkow disc and a cathode ray oscillograph simultaneously. H can be determined to a high degree of accuracy, but $\triangle V$ only approximately. The results obtained can vary under the influence of the following factors.

I. The individual eyesight of the observer.

II. What is considered to be the starting point of a distortion, whether the moment when in adding the alternating voltage to the direct the strips are hardly noticeable, and cannot be regarded as a defect, or the moment when the strips become noticeable to such an extent that a distortion of the uniformity of the ground actually takes place.

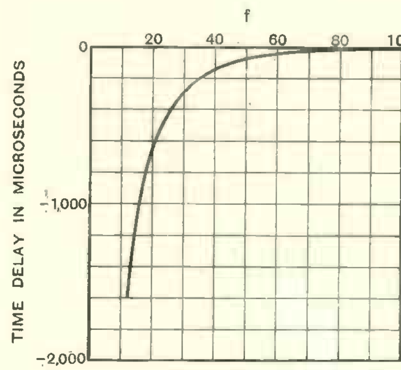


Fig. 5.

III. The behaviour of the lamp.

The foregoing has induced us to use three observers instead of one for determining $\triangle V$. The determination was carried out for two different behaviours of the lamp and for two different kinds of observation.

1. Intense observation.
2. Simple observation.

The experimental check up of the influence of distortions under the actual transmission was carried out in the same cases. The results were in close agreement.

Intense observation depending upon the behaviour of the lamp gave the following data

$$\phi_{crit.} = 1.5^\circ - 2^\circ$$

under simple observation

$$\phi_{crit.} = 4.5^\circ - 6^\circ.$$

Observation has shown that for lamps with different slopes of characteristic the ratio $\frac{\triangle V}{H}$ is practically the same under equal current values, *i.e.*, under analogous behaviour of the lamps. It is quite clear from the above statements, that the admissible relative phase displacements depend not only on the character of the picture, but also on the behaviour and type of the modulated source of light. In the 7-stage amplifier, which we have been using, the phase shift between the input and output voltages without correction went up to 60° at the frequency of 12.5 per/sec. The displacements in the upper harmonics of this frequency were much lower. In Fig. 5 are given the experimentally measured time-delays at different frequencies in one stage of our amplifier. The amplifier did not produce other distortions; therefore we can tell beforehand that when transmitting a picture as at Fig. 2*a*, with 12.5 pictures per sec. all the distortions of the picture produced by the amplifier should be basically due to the phase distortion at the picture frequency.

In order to have the possibility of comparing the theoretically obtained picture with the experimental data we shall draw a curve of resulting output voltage for the phase shift of 60° at 12.5 cycles per sec.

This curve is given at Fig. 6. The rectangular curve denotes the voltage at the

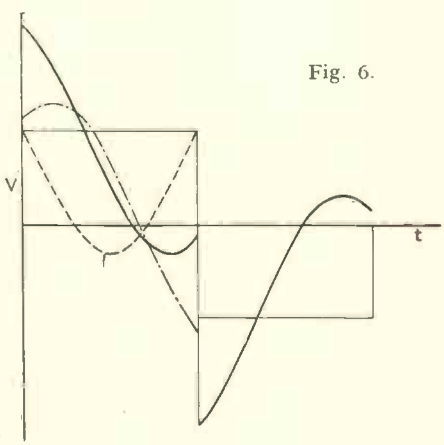


Fig. 6.

amplifier input, the full line curve denotes the voltage at the output. Let us assume the amplification factor = 1. The curve of the output voltage indicates that the border line between the white and the black fields should be of a normal sharpness. As to the white and black fields they should have the following character: on the edge of the white field there should be a brightly illuminated band, that this illumination should grow weaker towards the border line between both fields; immediately beyond the border line there should be a dense dark field gradually growing lighter towards the edge. The experiments have fully confirmed our expectations, *see* Fig. 7. This photograph was taken by scanning it to 1,200 elements—at 12.5 pictures and $\phi 12.5 \approx 60°$. The scanning was carried out as in Fig. 2*a*.

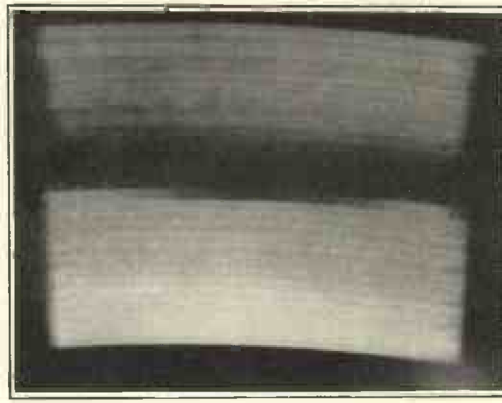


Fig. 7.

Fig. 8 shows the received picture corresponding to Fig. 2*b*. In this case the fundamental frequency is the strip frequency the phase shift of which is zero in our amplifier. As might have been expected, no distortion in this case could be observed. Even such significant phase distortions at the low frequency as took place in our amplifier might be very slightly felt in some pictures—namely, those in which the picture frequency is weakly expressed. When transmitting a picture of a face contrastly lighted the distortions will take place, as in this case the picture frequency is well defined.

Of course, it would be desirable to check experimentally the theoretical results. For this purpose it is necessary to have a set free from phase distortion, but, as already mentioned, our amplifier produces very significant phase shifts at all low frequencies. In connection with this the author suggested a method of compensating phase shifts in resistance-coupled amplifiers, based on the fact that the phase shifts created in the anode circuit in the presence of "decoupling" capacity and resistance have signs opposite to those of the displacements created in the grid circuits by the coupling capacity and by the leak resistance.

Fig. 9 shows an image received after the phase distortions in the amplifier were eliminated. The phase distortions were removed by the method suggested by the author.

When the number of pictures and strips is small the limits determined above can be used for all frequencies up to strip frequency.*

The important thing is that the limits should be determined for the least favourable case; the least favourable case for a given frequency is when the picture contains black and white bands, which in scanning produce rectangular impulses repeated with this frequency, *i.e.*, the same case as we examined in determining limits for the frequency of pictures. But the amplifier, which is the main source of phase displacements in the low frequency range of the passed band of frequencies, produces the displacements in such a way that an increase in the frequency lowers the values of the additional displacements; consequently the admissible dis-

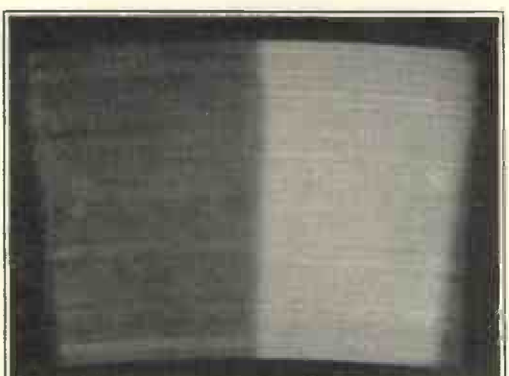


Fig. 8.

placements at the fundamental frequency may be determined by the same method which is applied for the frequency of the pictures. The same may be said about the possibility of using the admissible amplitude distortion (as previously determined) for the average frequencies.

A special article will be dedicated to determining the limits for the highest

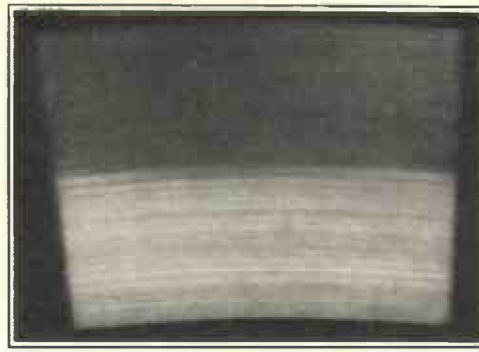


Fig. 9.

frequencies that are used in picture transmission.

Conclusion

In our experiments we did not aim at working out universal limits for phase distortions in television. All that we wanted was, first—to throw additional light on the problem of the influence on the image of phase distortions created in the transmission channels and, secondly, to give a method of determining limits for each individual case according to the characteristics of the modulated source of light.

BIBLIOGRAPHY

(1) "The Production and Utilisation of Television Signals." By Frank Gray, J. W. Horton and R. C. Mathes, *The Bell Syst. Techn. Journ.*, 1927, p. 560.

(2) "Wire Transmission System for Television." By B. K. Gannet and E. J. Green (the same Journ., 1927, p. 616).

(3) "Radio Transmission System for Television." By Edward L. Nelson (same Journ., 1927, p. 633).

(4) "Phase Distortion in Telephone Apparatus." By E. E. Lane (same Journ., 1930, p. 193).

(5) "Phase Distortion and Phase Distortion Correction." By Salle Pero Mead (same Journ., April, 1928).

(6) J. C. Steinberg, "Effects of Phase Distortion on Telephone Quality," (same Journ., 1930).

(7) "Distortion Correction in Electrical Circuits with Constant Resistance Recurrent Networks," Otto J. Zobel (the same Journ., July, 1928).

(8) "Abbildung und Verstärkung beim Fernsehen," Fritz Schröter, E.N.T. H. 11, S.439, 1929.

(9) "Phase displacement in resistance coupled amplifiers and their compensation," R. G. Shiffenbauer. (News on the electro-industry of low-current.)

(10) "Some Aspects of Television," T. H. Bridgewater, *Journal of the Television Society*, December, 1932.

* The admissible values of relative time displacement will not be always the same in this case, as is assumed by the American authors, but inversely proportional to the frequency.

Abstracts and References

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

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

PROPAGATION OF WAVES

1. MAGNETIC STORMS AND UPPER-ATMOSPHERIC IONISATION [Frequent Reduction in Electronic Content of F_2 Region during Magnetic Storms: Possible Explanation by Thermal Expansion of Upper Atmosphere due to Storm-Producing Agency].—E. V. Appleton and L. J. Ingram. (*Nature*, 5th Oct. 1935, Vol. 136, pp. 548–549.)

An examination of measurements of midnight ionisation density in region F_2 of the ionosphere, together with the daily magnetic character figures shows that, when magnetic activity is small, the ionisation is above normal but that the maximum electron content is reduced when the activity is more severe. This reduction may be due to heating of the upper atmosphere by the agency responsible for magnetic disturbances, and consequent expansion. The noon values of maximum ionisation in regions F_1 and F_2 may either increase or decrease during large storms.

2. A NEW RADIO TRANSMISSION PHENOMENON [Sudden Complete Disappearance of Radio Signals over Illuminated Half of Earth during 15-Minute Period at Intervals of 54 Days].—J. H. Dellinger. (*Phys. Review*, 15th Oct. 1935, Series 2, Vol. 48, No. 8, p. 705.)

This sudden disappearance has occurred four times between March and August (inclusive), 1935, at intervals of twice the rotation period of the sun. It seems to depend on some solar emanation lasting only a few minutes. Close observance of wireless and other phenomena at the next interval recurrences is suggested; communications from those interested are invited.

3. ASPECTS OF THE [Overhead] CURRENT SYSTEM PRODUCING MAGNETIC DISTURBANCE.—J. M. Stagg. (*Proc. Roy. Soc.*, Series A, 1st Nov. 1935, Vol. 152, No. 876, pp. 277–298.)

Examination of the vector forces added to the earth's field during magnetic disturbances at seven observatories shows that "the overhead current system producing the regular diurnal disturbing field in moderately high latitudes is primarily concentrated in a narrow zone asymmetrically encircling the magnetic axis pole and at about 23° from it." The disturbing system is always diffuse and complex. The direction of the current flow and its daily change, with the seasonal variation of the current flow, are studied.

4. ON THE CORRELATION OF RADIO TRANSMISSION WITH SOLAR PHENOMENA [Short-Wave Transatlantic Telephone Data show Positive Correlation with Terrestrial Magnetism and Earth Current Data: Long-Range Prediction Method based on 27-Day Recurrence Tendency and 11-Year Solar Cycle: etc.].—A. M. Skellett. (*Proc. Inst. Rad. Eng.*, November, 1935, Vol. 23, No. 11, pp. 1361–1369.)

5. SOLAR MAGNETISM [with Law of Sunspot Polarity: Short Résumé].—G. E. Hale. (*Nature*, 2nd Nov. 1935, Vol. 136, pp. 703–705.)

6. NEW DATA FOR THE STUDY OF PERIODICITY [No Obvious Connection between Sunspot and Climatological Curves].—J. Legrand. (*Comptes Rendus*, 16th Sept. 1935, Vol. 201, No. 12, pp. 509–511.)

7. ECLIPSE EFFECTS IN THE IONOSPHERE [Solar Eclipses of Feb. 1935 and Aug. 1932].—J. P. Schafer and W. M. Goodall. (*Proc. Inst. Rad. Eng.*, November, 1935, Vol. 23, No. 11, pp. 1356–1360.)

For preliminary communications *see* 1317 and 2162 of 1935. The paper ends with a footnote: "while ultra-violet light is probably the ionising agency responsible for the effects noted, any other solar emanation which travels substantially at the velocity of light should not be precluded from consideration," such as Müller's suggestion of X-ray-type radiation (940 and 1316 of 1935).

8. Radio Observations during the Solar Eclipse, August, 1932 [on 400 m Broadcast Carrier at 50 Mile Range: Corpuscular Effect indicated].—J. C. Wilson. (*Brit. Rad. Annual*, 1934/5, pp. 91–96.)

9. Scattering, Polarisation Errors, and Accuracy of Short-Wave Direction Finding.—Eckersley. (*See* 175.)

10. The Thermal Stability of the Lower Atmosphere [Theory of Turbulence shows that Super-Adiabatic Lapse-Rates are possible in Limited Regions: (Possible Relevance to Ultra-Short-Wave Propagation)].—A. L. Hales. (*Proc. Roy Soc.*, Series A, 1st Oct. 1935, Vol. 151, No. 874, pp. 624–640.)

11. Ten-Metre Long-Distance Transmission [Amateur Results in Agreement with Research Values of Minimum Wavelength reflected at Vertical Incidence].—E. V. Appleton. (*World-Radio*, 8th Nov. 1935, p. 20.)

12. Discussion on "Echoes of Radio Waves" [Theory based on Misinterpretation of Magneto-Ionic Theory, due to Neglect of Exact Significance of Accepted Definition of Sense of Rotation of Elliptically Polarised Wave: a New Definition Desirable?].—G. Builder: Janco. (*Proc. Inst. Rad. Eng.*, November, 1935, Vol. 23, No. 11, pp. 1405–1406.) For Janco's theory of long-delay echoes, here criticised, *see* 1934 Abstracts, p. 553.

13. Notes on Magneto-Optics [Description of Effects by Refractive Tensor: Scattering of Light from Magnetised Sphere: Magnetic Field inside Matter: Refractive Tensor of General Medium: Test of Kerr Effect].—C. G. Darwin. (*Proc. Roy. Soc.*, Series A, 1st Oct. 1935, Vol. 151, No. 874, pp. 512–539.)

14. Dielectric Constant of Ionised Air [Experimental Verification of Eccles-Larmor Theory of Decrease of Dielectric Constant below Unity: Lecher Wire System with Ionised Air between Wires excited by Ultra-Short-Wave Oscillator: Wavelength in Air measured on Wires].—S. K. Mitra and S. S. Banerjee. (*Nature*, 28th Sept. 1935, Vol. 136, p. 512.)

15. Search for Interaction of Matter and Radiation as Explanation of Nebular Red-Shift [Possibility of Effect of Free Electrons in Highly Ionised Gas on Frequency of Light Traversing It: Null Result].—R. J. Kennedy and W. H. Barkas. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, p. 483: abstract only.)

16. The Connection between the State of the Ionosphere and the Phenomena of Propagation of Electric Waves.—W. Dieminger. (*Hochf:tech. u. Elek:akus.*, October, 1935, Vol. 46, No. 4, pp. 109–119.)

Experiments are described in which simultaneous continuous records were taken of (1) the state of the ionosphere by means of echoes at vertical incidence, and (2) the field strength received from an emitter at a distance of about 200 km. The apparatus for recording the echoes at vertical incidence has already been described (Goubau and Zenneck, 1933 Abstracts, p. 320); improvements in it are here reported, chief among them being the use of a linear instead of a sinusoidal time-base (circuit Fig. 1). The apparatus for field-strength registration is described in §2 (emitter circuit Fig. 4, receiver circuit Fig. 6, registration device Fig. 7). Three wavelengths, 40, 80 and 160 m, were chosen for the experiment and were all obtained from one quartz-controlled oscillator. The receiver consisted of three non-oscillating audion circuits, tuned to the three wavelengths, and one separate quartz-controlled beat oscillator.

The experiments were carried out during the period 23rd April to 30th Aug. 1934; it was found that the skip distance for 40 m waves was normally greater than 200 km. Reception on 80 m was normally possible; Fig. 8 shows an example of the field-strength record obtained by day, and Fig. 9 the connection between the onset of multiple reflections at vertical incidence and the sunset rise in amplitude on that wavelength. The connection between the disappearance of multiple reflections and the decrease of field-strength after sunrise was not so clear. Reception on 160 m was only possible during the night. Fig. 10 shows the daily variation of field strength on the three wavelengths. A number of observations which deviated from the normal course of events showed reception and/or echoes on 40 m with "evening concentration" of ionisation or abnormal ionisations in E region. The latter seem to occur uniformly over a region of at least 100 km diameter. Echoes on 80 m sometimes disappeared and field-strength fell during the night, owing to electron limitation; poor reception occurring by day is attributed to high ionisation and absorption. Local ionospheric disturbances appeared to have little influence on reception. The writer concludes that the same frequency band can be used for communication over 200 km as that which gives echoes at vertical incidence; the short-wave portion of the band will be the more reliable.

17. Negative Attenuation of Electromagnetic Waves and Sommerfeld's Theory of Ground Absorption [Determination of Electromagnetic Constants].—S. R. Khastgir, D. N. Chandhuri and B. Sen Gupta. (*Nature*, 12th Oct. 1935, Vol. 136, pp. 605–606.)

Curves are given of measurements of the attenuation factor of electric field strength as a function of distance, for two directions from an emitter; negative attenuation of the waves is indicated (*see* also Ratcliffe and White, 1930 Abstracts, p. 621) and, using Rolf's graphs (1930 Abstracts, p. 388) and Sommerfeld's formula (*Ann. der Physik*, 1909, Vol. 4, pp. 28, 665), values of the electromagnetic constants of the earth are deduced which agree well with those obtained from direct laboratory measurements. *See* 18.

18. [Apparent] Negative Attenuation of Wireless Waves [observed by Moullin Voltmeter Method may be due to Flow of Grid Current].—J. A. Ratcliffe and F. W. G. White. (*Nature*, 16th Nov. 1935, Vol. 136, p. 794.) *See* 17.

19. Extension of a Previous Formula for Ground Absorption in Wireless Telegraphy.—K. F. Niessen. (*Ann. der Physik*, Series 5, No. 1, Vol. 24, 1935, pp. 31–48.)

See Niessen, 1731 of 1935. The previous formula assumed that the conduction current in the earth was large compared with the displacement current; in the present paper the case is considered when the conduction and displacement currents are of the same order of magnitude. An extended formula (eqn. 15) is found for the fraction of energy absorbed in the earth, and applied, using practical numerical data, to obtain curves as in the previous paper for the permissible height of the vertical dipole above the ground. The present theory is applicable to short-wave emitters as well as to longer waves.

20. Second Communication on the Radio Experiments in Mines at Kotterbach and Preliminary Communication on the Experiments at Ostrov and Macochy.—V. Fritsch. (*Hochf:tech. u. Elek:akus.*, October, 1935, Vol. 46, No. 4, pp. 124–133.)

For previous work *see* 1934 Abstracts, p. 491, and back reference. The relations of the geological nature of the district investigated to its electrical and radio properties are discussed; the latter may be very different from those of samples measured in the laboratory. Measurements were made by the "capacity method" (§ III, Fig. 4). Many experimental curves are given.

21. On the Propagation of High-Frequency [Short] Radio Waves of Long-Distance Transmitting Stations [Polar Year Results].—Nakai. (*See* 176.)

22. An Analysis of Continuous Records of Field Intensity at Broadcast Frequencies.—Norton, Kirby and Lester. (*Proc. Inst. Rad. Eng.*, October, 1935, Vol. 23, No. 10, pp. 1183–1200.) *See* 952 of 1935.

23. Radioelectric Communications: Signal-Strength Variations [on Long, Medium and Short Waves: Their Effects on Commercial Communication: Over-Modulation].—M. de Bellescize. (*L'Onde Élec.*, October, 1935, Vol. 14, No. 166, pp. 651–667.) For previous parts *see* 4100 of 1935.

24. Velocity Distributions for Elastically Colliding Electrons [Energy lost by Elastic Collisions with Atoms: Solution of Equations giving Distribution Functions for Electrons in Uniform Electric Field and Homogeneous Beam shot into Field-Free Space].—P. M. Morse, W. P. Allis and E. S. Lamar. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol 48, No. 5, pp. 412–419.)

25. The Rate of Change of Electron Temperature in the Mercury Afterglow [Connection between Rate of Recombination and Electron Temperature in Plasma containing No New Ions: Sources of Electron Energy].—R. H. Randall and H. W. Webb. (*Phys. Review*, 15th Sept. 1935, Series 2, Vol. 48, No. 6, pp. 544–549.)

26. Hydrogen in the Upper Atmosphere [may possibly be studied by Its Effect on Nitrogen Afterglow].—J. Kaplan. (*Nature*, 5th Oct. 1935, Vol. 136, pp. 549–550.)

27. Further Study of the Vegard-Kaplan Bands [from Metastable Nitrogen Molecules: Technique of Intensity Enhancement].—J. Kaplan. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, p. 482: abstract only.)

28. The Energy of Formation of Negative Ions in Oxygen [Numerical Estimate].—L. B. Loeb. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, p. 484: abstract only.)

29. Spectrophotometric Comparison of the Zodiacal Light and the Light of the Night Sky [Zodiacal Light contains No Radiations characteristic of the Upper Atmospheric Regions: It results from Diffuson of Solar Light by Very Small Particles near the Earth].—J. Cabannes and J. Dufay. (*Comptes Rendus*, 21st Oct. 1935, Vol. 201, No. 17, pp. 696–699.)

30. Helium Content [and Mixing] of the Stratosphere [Increase at Height of 21 km].—F. A. Paneth and E. Glückauf. (*Nature*, 2nd Nov. 1935, Vol. 136, pp. 717–718.)

31. Measurement of the Reduced Thickness of Atmospheric Ozone during the Polar Winter [Nocturnal Measurement from Stellar Spectra: Tabulated Results for Abisko: Origin of Stratospheric Layers characterised by Total Ozone Thickness].—D. Barbier, D. Chalonge and E. Vassy. (*Comptes Rendus*, 28th Oct. 1935, Vol. 201, No. 18, pp. 787–789.)

32. Quantitative Analysis of Atmospheric Ozone [at Ground Level]. Comparison of Spectrographic and Chemical Methods [Measurements at Abisko and Scoresby Sound: Primordial Effect of Local Meteorological Conditions].—A. Dauvillier. (*Comptes Rendus*, 14th Oct. 1935, Vol. 201, No. 16, pp. 679–680.)

33. Ultra-Violet Solar Radiation Intensities [Note on Recent Data].—Bureau of Standards Notes. (*Journ. Franklin Inst.*, September, 1935, Vol. 220, No. 3, pp. 387–389.) *See* 3772 of 1935.

34. The Far Ultra-Violet Absorption Spectrum of Oxygen.—W. C. Price and G. Collins. (*Phys. Review*, 1st Nov. 1935, Series 2, Vol. 48, No. 9, pp. 714–719.)

35. Absorption of Short Wavelengths [in Solar Radiation by Earth's Atmosphere: Possibility of extending Solar Spectrum beyond Present Ultra-Violet Limit].—K. R. Ramanathan and L. A. Ramdas. (*Nature*, 9th Nov. 1935, Vol. 136, p. 764: short note.)

36. The Dynamical Theory of [Diffraction] Gratings [Occurrence of Dark Bands: Effects of Groove Form and Conductivity].—R. M. Langer. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, p. 487: abstract only.)

37. Polarisation Bands [Band Phenomenon produced by Diffraction Grating for Polarisation perpendicular to Grating Ruling].—J. Strong. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, p. 480: abstract only.)

38. A Theorem connecting the Energy/Momentum Tensor with the Velocity of Propagation of Waves.—O. Halpern. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, pp. 431–433.)

39. The Velocity of Light within a Massive Enclosure [does not differ from That in the Open].—G. W. Hammar. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, pp. 462–463.)

40. A Contribution to the Theory of the B.W.K. [Brillouin - Wentzel - Kramers] Method [and the Sommerfeld Phase Integral Quantum Condition: Transmission of Matter Waves through Potential Barriers].—E. C. Kemble. (*Phys. Review*, 15th Sept. 1935, Series 2, Vol. 48, No. 6, pp. 549–561.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

41. A Note on the Source of Interstellar Interference [Thermal Agitation of Charged Particles in Stars or Interstellar Matter ?].—K. G. Jansky. (*Proc. Inst. Rad. Eng.*, October, 1935, Vol. 23, No. 10, pp. 1158–1163.) The full paper, a summary of which was referred to in 2937 of 1935.

42. Nature of Atmospherics [Arrangement of Flashes into Groups giving Rise to Gross and Fine Structure: Explanation of Discrepancies in Average Duration as determined by Various Investigators].—N. S. S. Rao. (*Nature*, 26th Oct. 1935, Vol. 136, p. 683.) *See* Munro & Webster, 378 of 1935 and back references; *also* Appleton & Chapman, 665 of 1935; *and* Appleton, Watson Watt & Herd, *Proc. Roy. Soc.*, Series A, 1923, Vol. 103, pp. 84–102.

43. Intensity Variations in the Channel of the Return Lightning Stroke.—D. J. Malan, B. F. J. Schonland and H. Collens. (*Nature*, 23rd Nov. 1935, Vol. 136, p. 831.)

From photographs of lightning strokes with the Boys camera it is found that the intensity at the ground end of the return-stroke channel fluctuates, indicating a series of component discharges passing upwards. A table of time intervals between successive component discharges is given and the ratios of the intensities of the different components are estimated. "There is some evidence that the second, and sometimes also the third, component is related to the existence of the charge distributed along the branches."

44. Resolution of Surges into Multi-Velocity Components.—L. V. Bewley. (*Elec. Engineering*, November, 1935, Vol. 54, No. 11, pp. 1199–1203.) Based on the author's travelling-wave theory (1934 Abstracts, pp. 262, 315, 555).

45. On the Electric Charge collected by Water-Drops falling through a Cloud of Electrically Charged Particles in a Vertical Electric Field [Experiments agree with Wilson's Theory].—J. P. Gott. (*Proc. Roy. Soc.*, Series A, 1st Oct. 1935, Vol. 151, No. 874, pp. 665–684.)

Continuation of work referred to in 1934 Abstracts, p. 31. The experiments here described dealt with "(1) the production of a cloud and the method of giving the cloud an electric charge either all of one sign or such that there are equal numbers of positively and negatively charged cloud particles. (2) The measurement of the electrical conductivity of the cloud. (3) The measurement of the electric charge collected by a large water drop while falling through the charged cloud." The results were in accordance with Wilson's theory of the mechanism of thunderclouds (*see*, for example, Wilson, 1929 Abstracts, p. 568); they afforded no evidence for the mechanism suggested by Elster and Geitel (*Physik. Zeitschr.*, Vol. 14, 1913, p. 1287).

46. The Existence of Townsend's Coefficient β [of Gaseous Ionisation by Positive Ions] in Gaseous Breakdown at Higher Pressures [β a Function of Current Density: Static Spark preceded by Enormous Field Distortion].—D. Q. Posin. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, p. 483: abstract only.)

47. Notes on a Case of Damage by Lightning.—J. C. Curley: Myers. (*Journ. Inst. Eng. Australia*, September, 1935, Vol. 7, No. 9, pp. v and va.) Prompted by Myers's Note (2940 of 1935).

48. The Local Variation of the Earth's Electric Field [Latitude Groups of 24-Hour Components: Lower Atmospheric Factors rather than Change in Height of Conducting Layer cause 24-Hour Components: Depression Component caused by Vertical Convection].—J. G. Brown. (*Phys. Review*, 1st Sept. 1935, Vol. 48, No. 5, pp. 484–485: abstract only.) *See* Brown, 1341 of 1935.

49. A Theory of the Local Variation of the Earth's Electric Field [Conductivity determined by Number of Condensation Nuclei: Potential Gradient at Surface varies Inversely with Conductivity: Diurnal Variations due to Daily Turbulence Cycle].—J. G. Brown. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, p. 487: abstract only.)

50. Radiometeorography as applied to Unmanned Balloons [Survey of Present Methods: Directions of Future Improvement: etc.].—W. H. Wenstrom. (*Proc. Inst. Rad. Eng.*, November, 1935, Vol. 23, No. 11, pp. 1345–1355.)

51. A PRACTICAL SYSTEM OF AUTOMATIC RADIO SIGNALS FROM A FREE BALLOON [based on Olland Telemeteorograph].—(*Tech. News Bull. Nat. Bur. of Stds.*, October, 1935, No. 222, p. 98.)

52. " VORLESUNGEN ÜBER PHYSIK DER ATMOSPHÄRE " [Book Review].—A. and K. Wegener. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 16, 1935, p. 315.)

PROPERTIES OF CIRCUITS

53. ON THE THEORY OF FILTERS OF W. CAUER [including the Use of the Tchebycheff Approximation Method].—R. Julia. (*Bull. Soc. franc des. Élec.*, October, 1935, Vol. 5, No. 58, pp. 983–1066.)

" Nothing will be found here on practical filter calculation by the Cauer method. The excellent work of E. Glowatski [1934 Abstracts, p. 50 : *see* also p. 381 and back reference] is sufficient for this purpose, and we should have nothing of importance to add to it. We hope simply that the present memoir may allow engineers to understand better the essentials of a method which can render very great services in its applications."

54. NEW METHODS OF DETERMINATION OF CONSTANTS OF SYMMETRICAL NETWORKS WITH THE AID OF IMPEDANCE MEASUREMENTS.—Selach. (*See* 270.)

55. AN ELECTROMECHANICAL REPRESENTATION OF A PIEZOELECTRIC CRYSTAL USED AS A TRANSDUCER.—Mason. (*See* 182.)

56. CURRENT HARMONICS IN NON-LINEAR RESISTANCE CIRCUITS [Semi-Graphical Solution].—T. D. Owens. (*Elec. Engineering*, October, 1935, Vol. 54, No. 10, pp. 1055–1057.)

57. THE STEADY-STATE RESPONSE OF A NETWORK TO A PERIODIC DRIVING FORCE OF ARBITRARY SHAPE, AND APPLICATIONS TO TELEVISION CIRCUITS.—Carnahan. (*See* 230.)

58. NEGATIVE RESISTANCE AND DEVICES FOR OBTAINING IT.—Herold. (*See* 77.)

59. THE APPLICATION OF A MAGNETIC FIELD TO THE FORMATION OF ION-ELECTRON BUNDLES [in Gaseous Discharges : Production of Relaxation Oscillations].—Slutzkin. (*See* 316.)

60. THE REGENERATIVE RECEIVER OPERATING UNDER A " HARD " RÉGIME.—E. Sekerskaia. (*Journ. of Tech. Phys.* [in Russian], No. 2, Vol. 5, 1935, pp. 253–280.)

[*Note :* the characteristic feature of the " hard " régime referred to in this title is the existence of a range of values of the system parameters (particularly the retroaction coupling) for which both a stable equilibrium *and* stable oscillations are possible. In a " soft " régime, on the other hand, either a state of equilibrium *or* one of periodic oscillations is stabilised, according to the value of the back coupling. In practice the two régimes are distinguished by the " abrupt " or the " smooth " onset of oscillation as the back coupling is increased. As is well known, the " soft " régime is obtained in practice by choosing the operating point on the steepest portion of the valve characteristic. In order to study mathematically the main features of " hard " self-excitation, the equation representing the valve characteristic must be of at least the 5th degree, while in the case of a " soft " régime an equation of the 3rd degree is sufficient.]

A theory of a self-excited oscillator operating under a " hard " régime is given and its operation is examined when a harmonic e.m.f. is applied. The following two cases are discussed separately :—(a) when the frequency of the applied e.m.f. does not differ much from the natural frequency of the oscillatory circuit, and (b) when this difference is considerable. The relationships between the amplitude of the periodic oscillations and the amount of de-tuning, together with the conditions for stability of these oscillations, are established in each case. In addition, an analysis is given of quasi-periodic oscillations appearing in case (b). On the basis of the results obtained the operation of the oscillator is considered for various values of the back coupling. Experimental verification has been obtained of certain of the above theoretical conclusions.

61. ON THE QUASI-LINEAR METHOD IN STUDYING GENERATORS OF ALMOST SINUSOIDAL OSCILLATIONS.—J. B. Kobzarev. (*Journ. of Tech. Phys.* [in Russian], No. 2, Vol. 5, 1935, pp. 216–249.)

If the energy dissipated in an oscillatory circuit (with very small damping) is continuously restored by means of a non-linear device such as thermionic valve, the oscillations in the circuit are not strictly sinusoidal. A complete theory of the operation of such an oscillator when a harmonic e.m.f. is applied is developed in this paper, using exclusively the quasi-linear method first proposed by H. G. Möller. In this method use is made of the " average " slope $\bar{S}$ of the valve, which is a function of E_a and E_g and which is calculated on the assumption that oscillations are strictly sinusoidal.

The state of the " fundamental " resonance, for which the frequency of oscillation is the same as, or only very slightly different from, that of the applied e.m.f., is first examined in detail and conditions are established for the stability of oscillation. The formulae derived permit all the necessary data to be obtained from the experimental characteristic of the valve and $\bar{S}$, which is calculated on the basis of this characteristic. General differential equations (the so-called equations " of the first approximation ") are then deduced, by means of which an examination is made of the " quasi-periodic " régimes for which the amplitudes and phases of oscillations are periodically and slowly varying. In deriving these equations account is taken of the " complex " damping introduced into the circuit by the valve and the applied e.m.f. In the case of the " fundamental " resonance this depends on $\bar{S}$ and on the amplitude and phase of the applied e.m.f.

The " multiple " resonance conditions are next examined, for which the ratio of the frequency of oscillations to the frequency of the applied e.m.f. equals m/n, where m and n are small whole numbers, and a conception is introduced of the " complex average slope " $\vec{S}$ which depends not only on the amplitude of oscillations but also on their phase and on the amplitude of the applied e.m.f. Finally, using a conception of the "generalized average slope" $\overline{\overline{S}}$ introduced by the author in a previous work (*ibid.*, Vol. 3, pp. 318–324), a study is made of the "bi-harmonic" régime for which the oscillations in the circuit can be regarded as a result of super-imposition of free and forced oscillations. *See* next abstract.

62. ON THE THEORY OF SUB-HARMONIC RESONANCE.—J. B. Kobzarev. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 5, 1935, pp. 518–529.)

As an illustration of the quasi-linear theory discussed in a previous paper (*see* 61) the operation of an oscillator is examined when an external force having a frequency double the natural frequency is applied to it. The oscillator is assumed to be operating under a "soft" régime. Differential equations "of the first approximation" are deduced and conditions for stable oscillations established for the cases when the retroaction coupling is both above and below its critical value. Simplified equations for the resonance curves are derived and families of the curves are plotted. The effect of the amplitude of the external force on the resultant oscillations is also discussed.

63. THE FREE OSCILLATIONS IN OSCILLATING CIRCUITS WITH PERIODICALLY VARYING SELF-INDUCTANCE [Mathematical Investigation of Self-Excitation Intervals].—A. Erdélyi. (*Hochf:tech.u.Elek:akus.*, September, 1935, Vol. 46, No. 3, pp. 73–77.)

For related work by the writer *see* 1934 Abstracts, p. 436. Here, the approximate limits of the self-excitation intervals are theoretically determined for "slow" and "rapid" (relative to the natural frequency of the circuit) variations in the inductance. The "rapid" variations are considered in more detail, with a numerical example, and compared with the results of Winter-Günther (Abstracts, 1929, p. 630, and 1931, p. 437).

64. ON RESONANCE IN LINEAR SYSTEMS WITH PERIODICALLY VARYING PARAMETERS.—G. Gorelik. (*Journ. of Tech. Phys.* [in Russian], Nos. 2 and 3, Vol. 5, 1935, pp. 195–215 and 489–517.)

Continuing the work dealt with in 2592 of 1935 a detailed mathematical investigation is given of linear systems when these are on the border line between stability and instability. It is shown that when an external force is applied to such systems the following two kinds of resonance may be obtained, according to the character of the force :—(a) resonance of the first order when the amplitude of the forced oscillations is inversely proportional to the decrement of the system, and (b) resonance of the second order when the amplitude is proportional to the square of the decrement. It is also shown that the effect of a sinusoidal force on such systems depends on the phase of the force, so that if, for instance, two stations are transmitting at the same frequency but with a phase displacement of $\pi/2$ the signals can be received separately on two resonators. The resonance curves for such systems are of an entirely different character from those of harmonic resonators and when the external force is slightly detuned the forced oscillations take the form of slow beats.

65. ABBREVIATED FORMULAE FOR THE DETERMINATION OF THE AMPLITUDE AND STABILITY OF FORCED OSCILLATIONS IN A NON-LINEAR SYSTEM WITH ONE DEGREE OF FREEDOM.—A. G. Lubina. (*Journ. of Tech. Phys.* [in Russian], No. 2, Vol. 5, 1935, pp. 250–252.)

Formulae previously obtained by Andronov and Witt are simplified, making it necessary to evaluate only two integrals instead of the original nine.

66. PRINCIPLES OF A SCIENTIFIC ANALYSIS OF MAGNETIC CIRCUITS.—V. I. Kovalenkov and B. S. Sotskov. (*Izvestia Elektroprom. Slab. Toka*, Nos. 7 and 8, 1935, pp. 41–53 and 35–43.)

For previous work *see* 389 of 1935. "Two methods of designing electro-magnetic systems, giving the same results and permitting an accuracy of design within 5–30% to be obtained, are here given." The first is graphico-analytical, based on a large number of experimental investigations and on the possibility of expressing any smooth curve as a certain infinite series : the curve of flux distribution along the magnetic circuit, expressed graphically as a smooth curve, is represented by the relation $\phi_x = \phi_0 - k_1x - k_2x^2 - k_3x^3 \ . \ . \ .$ In the second, purely theoretical, method this relation is derived from the fundamental equations of an active transducer. The determination of the coefficients is dealt with : in most cases, if the magnetic induction B is not greater than 20 000 gauss, sufficient accuracy is obtained if 2 or 3 coefficients are found. *See* also 322.

67. DISCUSSION ON "THE A.C. RESISTANCE OF PARALLEL CONDUCTORS OF CIRCULAR CROSS-SECTION."—Arnold. (*Journ. I.E.E.*, October, 1935, Vol. 77, No. 466, pp. 571–573.) *See* 2960 of 1935.

68. THE WORKING AND COUPLING CAPACITIES BETWEEN A FOUR-WIRE SYSTEM OF CONDUCTORS [Calculations with Finite Thickness of Wires].—H. Kaden. (*Arch. f. Elektrot.*, 10th Sept. 1935, Vol. 29, No. 9, pp. 636–641.)

TRANSMISSION

69. THE ABSORPTION OF DECIMETRE WAVES IN IONISED GASES AND THE QUESTION OF THE PROOF OF ABSORPTION OF LONG WAVES BY EXCITED HYDROGEN ATOMS.—T. Haase. (*Ann. der Physik*, Series 5, No. 7, Vol. 23, 1935, pp. 657–676.)

Long-wave transitions in the energy levels of excited hydrogen atoms correspond numerically to wavelengths between 2.74 and 27.74 cm. This paper describes tests made with the object of demonstrating their existence experimentally (*see* also Betz, Abstracts, 1933, p. 93 ; Klumb, 1932, p. 517) ; measurements were made of the absorption of damped waves transmitted through the excited gas. The oscillators, receiver and wavelength measurements are described ; Fig. 6 shows the arrangement for measuring the absorption. No selective maxima in the absorption curves were found; comparison with theory showed however that the absorption measured corresponded with that to be expected theoretically for the number of electrons and of excited atoms present, which was too small to give any detectable absorption.

70. The Paths of the Electron in the Magnetron, including the Effect of Space Charge. I [Equations of Motion integrated without and with Magnetic Field for Cylindrical Electrodes: Linear Paths without Field: Additional Field produces Superposed Rotation with Angular Velocity *eH/2mc*].—H. Awender, A. Thoma and D. M. Tombs. (*Zeitschr. f. Physik*, No. 3/4, Vol. 97, 1935, pp. 202–210.)

71. The Upper Frequency Limit for Valve Generators with Reaction [Measurement and Calculation of Time of Lag of Electron Movement in Oscillating Valve behind the Oscillations: Theory of Longitudinal Waves of Space-Charge Density: Relative Dimensions of Voltage, Current and Electrodes for Frequency Increase].—W. Kühnhold. (*Hochf:tech. u. Elek:akus.*, September, 1935, Vol. 46, No. 3, pp. 78–81.)

72. Control by Tourmaline Crystals of Ultra-Short Waves produced in Any Circuit.—W. Kühnhold. (*Hochf:tech. u. Elek:akus.*, September, 1935, Vol. 46, No. 3, pp. 82–85.)

The crystal is coupled into the ultra-short-wave generator as a secondary circuit, in place of the condenser between anode and grid (Fig. 1). The crystal impedance depends on the frequency and compensates the other circuit factors which tend to produce frequency variation. Tests of the control under various conditions are described (§ 1); a theoretical investigation (§§ 2, 3) confirms the results. The writer states that crystal control can be applied to arc generators, dynatrons, magnetrons and Barkhausen circuits.

73. Reducing QRM on 56 Mc: Notes on Methods and Equipment used in the Boston Area [Inter-Station Interference on Ultra-Short Waves examined with Highly Selective Receiver: Transmitter Defects traced: Methods for Improved Stability].—C. F. Hadlock. (*QST*, October, 1935, Vol. 19, No. 10, pp. 27–30 and 82.) A "tin-hat" station (1934 Abstracts, p. 378) had low drift and frequency modulation, but was often troubled with frequency flutter, probably due to vibration of the "hats."

74. Rationalising the Resonant-Line Ultra-High-Frequency Oscillator: Improved Construction using Trombone-Tuned Grid and Plate Circuits.—A. W. Friend. (*QST*, November, 1935, Vol. 19, No. 11, pp. 26–28.)

75. A Short-Wave Frequency Doubler [Cathode Ray driven over Circular Path meets Several Targets and multiplies Ultra-Short-Wave Frequency].—(*Wireless World*, 11th Oct. 1935, Vol. 37, p. 398.)

76. The Functioning of Triode Frequency Treblers [for Short-Wave Transmitters: Theory and Experimental Confirmation: Operating Conditions: Optimum Cut-Off Angle for Anode Current: Design Considerations].—M. Meloni. (*Alta Frequenza*, August, 1935, Vol. 4, No. 4, pp. 389–405.)

77. Negative Resistance and Devices for obtaining It [Crisson's Conception: Current-Controlled and Voltage-Controlled Negative Resistances and Their Differences: Known Devices: Applications: the Type 57 Valve: etc.].—E. W. Herold. (*Proc. Inst. Rad. Eng.*, October, 1935, Vol. 23, No. 10, pp. 1201–1223.) There is a bibliography of 55 items. For the use of the type 57 valve for negative resistance *see* also 1815 of 1935.

78. A Fundamental Concept for Oscillators.—R. Usui. (*Nippon Elec. Comm. Engineering*, September, 1935, No. 1, pp. 34–44: in English.)

Introduction: types of sustained oscillations: graphical solution of constant-coefficient differential equations: integration curves when the damping factor is large: graphical solution for negative resistance (or conductance) oscillators: "kippschwingung" or relaxation oscillations: the oscillator frequency and the mechanism of its variations: discrimination between series and parallel oscillating circuits: a uniform concept for various oscillators [dynatron, arc, back-coupled valves, relaying action of buzzers, neon tubes, multivibrators, saw-tooth generators, etc.]: conclusion.

79. On the Quasi-Linear Method in studying Generators of Almost Sinusoidal Oscillations.—Kobzarev. (*See* 61.)

80. Some Remarks on the Intensity of Oscillations at the Oscillation Threshold [Factors not allowed for in Simple Theory: Maximum Current obtained experimentally with Coupling 1.5 to 2 Times as Close as Limiting Coupling: etc.].—J. Marique. (*L'Onde Élec.*, September, 1935, Vol. 14, No. 165, pp. 599–605.)

81. The Frequency Stability of Crystal-Controlled Valve Oscillators.—E. S. Antseliovich. (*Izvestia Elektroprom. Slab. Toka*, No. 9, 1935, pp. 1–9.)

Various factors affecting the frequency stability of crystal oscillators are discussed and tabulated under the following two headings:—(1) the effect on the frequency of circuit and valve constants and (2) the effect on the frequency of temperature conditions. Under (1) the relative importance of the following factors is established:—(a) changes in anode load; (b) changes in the operating conditions of the valve; (c) change of valve, and (d) construction of the crystal holder. Under (2) thermostat control is discussed, and it is pointed out that the development work in this connection should be directed towards a decrease in (a) the temperature coefficient of the crystal, (b) the temperature coefficient of the crystal holder, and (c) the temperature lag of the thermostat. A table is added showing that for a given frequency stability much less stringent requirements are to be met when crystals with a low temperature coefficient are used.

82. THE STABILITY OF INDUCTANCE COILS FOR RADIO FREQUENCIES [Data on Representative Modern Coils: Effect of Temperature-Variation on Self-Capacitance and Configuration: Compensation Methods: an Experimental Coil of High Stability].—H. A. Thomas. (*Journ. I.E.E.*, November, 1935, Vol. 77, No. 467, pp. 702–722.) *See* also Hak, 326.

83. ASYMMETRIC SIDE-BAND BROADCAST TRANSMISSION.—P. P. Eckersley. (*Journ. I.E.E.*, October, 1935, Vol. 77, No. 466, pp. 517–532: Discussion pp. 532–541.) The full paper, summaries of which were referred to in 2975 of 1935.

84. THE RESPONSE OF MODULATORS AT HIGH AUDIO-FREQUENCIES [Improved by Reducing the Ratio of Potential Energy stored in Tuned Circuit to Energy dissipated in It per Second: Case of Modulated Oscillator: Case of Anode-Modulated Driven Valve].—D. A. Bell. (*Wireless Engineer*, October, 1935, Vol. 12, No. 145, pp. 535–539.)

85. HIGH-POWER OUTPHASING MODULATION [as at Radio-Paris: Theory and Practice: Characteristics and Advantages, especially Economic, over Other Systems].—H. Chireix. (*Proc. Inst. Rad. Eng.*, November, 1935, Vol. 23, No. 11, pp. 1370–1392.)

86. GRID MODULATION [Calculation of Power and Efficiency: Advantages over Anode Modulation if Non-Linear Distortion is corrected: Correction by Counter-Retroaction: Experimental Results].—L. Rubin. (*L'Onde Élec.*, September, 1935, Vol. 14, No. 165, pp. 569–585.) For Podliasky's work on the correction of non-linear distortion, here referred to, see 1498 of 1935. *See* also Black, Abstracts, 1934, p. 272, and Bernamont & Lévy, 1934, p. 388.

RECEPTION

87. A NEW RADIO TRANSMISSION PHENOMENON [Sudden Disappearance of Signals during 15-Minute Period at 54-Day Intervals].—Dellinger. (*See* 2.)

88. A NEW RECEIVING SYSTEM FOR THE ULTRA-HIGH FREQUENCIES [the "Superheterodyne-Infradyne-Super-Regenerator"].—R. A. Hull. (*QST*, November, 1935, Vol. 19, No. 11, pp. 10–14 and 100, 102.)

"Selectivity of any desired order combined with extreme sensitivity, wide-range AVC and noise suppression." The u-h-f signal is converted in the first detector (or mixer) to an appropriate low first-intermediate frequency (say 1.5 Mc/s): this permits the immediate establishment of a desirable order of selectivity. The second detector converts the i.f. signal to a very much higher frequency suitable for thoroughly effective super-regenerative detector action. This high intermediate frequency (21–25 Mc/s) is enormously amplified, and its a.f. components made audible, by the super-regenerative third detector: it is then amplified with the conventional a.f. stage. With the exception of the pre-selector, no two successive stages operate on the same frequency. This accounts for the set's "unusual inherent tolerance which, of course, plays an important part in simplifying the adjustment." The receiver is "surprisingly straightforward from a constructional angle and no more difficult to line up and adjust than the conventional superheterodyne."

89. SUPER-REGENERATION ON THE ULTRA-SHORT WAVES.—H. B. Dent. (*Wireless World*, 11th Oct. 1935, Vol. 37, pp. 393–394.)

Based on Ataka's work (3392 of 1935) and the writer's own results with high quench-frequencies. He concludes that 100–110 kc/s is the best frequency, at any rate for small portable receivers.

90. REDUCING INTER-STATION INTERFERENCE ON ULTRA-SHORT WAVES: NOTES ON METHODS AND EQUIPMENT USED IN THE BOSTON AREA.—Hadlock. (*See* 73.)

91. AN ULTRA-HIGH-FREQUENCY RADIO RECEIVER FOR POLICE USE [AVC Superheterodyne, with "Codan" Device for reducing A.F. Output in absence of Carrier].—G. N. Thayer. (*Bell Lab. Record*, October, 1935, Vol. 14, No. 2, pp. 66–70.)

92. A STUDY OF THE RECEPTION OF PHASE-MODULATED WAVES.—Sakamoto and Kamazawa. (*Nippon Elec. Comm. Engineering*, September, 1935, No. 1, pp. 30–34; in English.) The full paper, a summary of which was dealt with in 2624 of 1935.

93. ARRANGEMENT FOR DIRECTIONAL RECEPTION, PARTICULARLY OF SHORT WAVES [Leads from Antenna and Reflector coupled to Diagonal Points of Bridge Circuit: Receiver in One Branch of Bridge with an Electrical Image in Another].—W. Moser: Telefunken. (German Pat. 612 868, pub. 6.4.1933: *Hochf:tech. u. Elek:akus*, September, 1935, Vol. 46, No. 3, pp. 106–107.)

94. ON THE EVALUATION OF THE SELECTIVITY OF A RECEIVER.—E. S. Antseliovich. (*Izvestia Elektroprom. Slab. Toka*, No. 8, 1935, pp. 21–31.)

Author's summary:— Quasi-linear methods of evaluation are considered, and it is shown that even with such a simplified investigation of the question the conception of selectivity is far from being definite. Passing to a more general, non-linear method of evaluating the selectivity, this indefiniteness increases still more. As a conclusion, a method of more general evaluation, proposed by the author, is shown: here the band-width and the shape of the selectivity curve are not only given for a quasi-linear curve taken in normal conditions, but simultaneously corrections are provided for distortion of the curve for the variation of those conditions and for the transition from a quasi-linear to a non-linear selectivity curve.

95. The Quality of Broadcast Reproduction [Editorial: High Frequencies still Sacrificed: Variable Selectivity Desirable but Useless without Precautions: etc.].—P. David. (*L'Onde Élec.*, September, 1935, Vol. 14, No. 165, pp. 551–554.)

96. Automatic Selectivity Control.—R. I. Kinross. (*Wireless World*, 4th Oct. 1935, Vol. 37, p. 377.)

A "sucker" circuit is caused to increase the high-note output of a receiver when strong signals are being received. For the reception of weaker signals, on the other hand, the absorption effect is progressively and automatically reduced until practically full selectivity becomes available.

97. The Variable Selectivity Four [Six Stages: for A.C. Mains].—W. T. Cocking. (*Wireless World*, 1st and 8th Nov. 1935, Vol. 37, pp. 460–462 and 484–487.)

98. What's New in Radio for 1936? [including Various Methods for Variable Selectivity: High-Fidelity Systems: Volume Expansion: New Silent Tuning Method: etc.].—(*Electronics*, September, 1935, pp. 20–23.)

99. Contrast Expansion: the Difficulty of deciding For or Against.—(*Wireless World*, 4th Oct. 1935, Vol. 37, pp. 374–375.)

100. How Many Watts?—A. B. Howe. (*World-Radio*, 25th Oct. 1935, p. 20.) Prompted by the correspondence referred to in 3416 of 1935. The effect of broadcasting control in compressing the scale of intensities is taken into account.

101. Practical QAVC Circuits.—J. H. Reyner. (*Wireless World*, 27th Sept. 1935, Vol. 37, pp. 348–350.)

102. On Transient Phenomena in Receivers with Automatic Volume Control.—V. I. Siforov. (*Izvestia Elektroprom. Slab. Toka*, No. 7, 1935, pp. 27–35.)

When the strength of the incoming signal changes abruptly, especially on short waves, oscillations may appear in the a.v.c. circuit seriously affecting the quality of reception. A similar effect may also be produced by changes in the modulation of the signal.

It is shown in this paper that the cause of these oscillations is to be sought in the fact that when a change in the signal occurs a certain time interval elapses before the corresponding grid potential of the a.v.c. valve is stabilised. A transient process sets in which under certain conditions takes the form of periodic oscillations, sometimes lasting for several seconds. In order to reduce distortion the a.v.c. circuit should be so designed that the transient processes taking place in it are aperiodic. With this object in view the following two a.v.c. circuits, each connected across the h.f. amplifier, are examined separately: (a) where the grid bias for the h.f. amplifier is obtained from a battery through a resistance network in the anode circuit of the a.v.c. valve (Fig. 1), and (b) where the grid bias is controlled by the voltage drop across a resistance on the negative side of the anode battery (Fig. 4). It is shown that in (a) the new value of the grid potential is reached only after a period of oscillations round this value, while in (b) the transient process is aperiodic, being governed by the law $A_0e^{-\gamma t}$. Formulae are derived determining the time constants for (a) and (b) and also the frequency of oscillations for (a).

It appears that the difference in operation of the two circuits is due to the fact that only one resistance-capacity circuit is used in (b) instead of the two in (a). It does not, however, follow from this that when two or more resistance-capacity circuits are used the transient processes will necessarily be periodic.

103. Automatic Frequency Control [in Superheterodyne Receivers, to centre the Signal Carrier in I.F. Band].—C. Travis. (*Proc. Inst. Rad. Eng.*, October, 1935, Vol. 23, No. 10, pp. 1125–1141.) The full paper, a summary of which was referred to in 3013 of 1935.

104. A New Tuning Indicator [American Cathode-Ray Device "6E5 Tube"].—J. H. Reyner. (*Wireless World*, 18th Oct. 1935, Vol. 37, p. 418.) *See* also 4030 of 1935.

105. Phase Rotations and Non-Linear Distortions in Broadcast Receivers [Strength of Combination Tones due to Asymmetrical Resonance Curve].—R. Feldtkeller. (*Hochf: tech. u. Elek:akus.*, October, 1935, Vol. 46, No. 4, pp. 133–140.)

This paper discusses the strength of the combination tones produced by phase distortion in the band filters usually found in broadcast receivers. The "klirr" factor is taken as a measurement of the combination tones and determined from the asymmetry of the voltage curve by the semi-graphic method due to Kellogg (*J. Amer. I.E.E.*, Vol. 44, 1925, p. 490), here discussed in §§I, II. The phase distortions are explained (§§III, IV) by Bartels' method of side-band vectors (1929 Abstracts, p. 150). These methods are then combined to give a relation between phase distortion, degree of modulation, and "klirr" factor which is expressed in the form of curves (Figs. 9–17) applying to simple band filters. A numerical example is given.

106. Join-up Distortion in Class B Amplifiers [producing the Intolerable so-called "Class B Distortion": Analysis and Graphs].—F. R. W. Strafford. (*Wireless Engineer*, October, 1935, Vol. 12, No. 145, pp. 539–542.)

107. Modifications of the Push-Pull Output Stage. Part I [Load-Line Curvature as Fundamental Factor in "Quiescent" and "Partial" Push-Pull and "Class B" Systems: Graphical Investigation].—K. A. Macfadyen. (*Wireless Engineer*, October, 1935, Vol. 12, No. 145, pp. 528–534.)

108. The Regenerative Receiver operating under a "Hard" Régime.—Sekerskaia. (*See* 60.)

109. Short-Wave Receivers.—D. R. Parsons. (*Journ. I.E.E.*, November, 1935, Vol. 77, No. 467, pp. 727–728: abstract only.)

110. Two-Programme Reception.—J. Wayne. (*Wireless World*, 15th Nov. 1935, Vol. 37, pp. 531–532.) Discussing "parallel" circuits by which normal and short-wave transmissions may be received at the same time and with the same receiver.

111. Short-Wave Two.—H. B. Dent. (*Wireless World*, 15th Nov. 1935, Vol. 37, pp. 510–513.) Battery operated. The first valve, which is of the multiple type, combines the functions of an r. f. amplifier and detector. The waveband is from 12 to 94 metres.

112. Interfering Responses in Superheterodynes [and in particular a Type not generally Recognised: Method of Reducing].—H. K. Morgan. (*Proc. Inst. Rad. Eng.*, October, 1935, Vol. 23, No. 10, pp. 1164–1170.)

An off-resonance signal combines with the receiver oscillator and forms a signal, at the converter-valve plate, which lies in the vicinity of the intermediate frequency: high harmonic orders of this signal are present across the converter-valve plate circuit, and these recombine, by plate modulation, in the internal plate circuit with the oscillator, and form a signal at the intermediate frequency.

113. Superheterodyne Reception—Theory and Practice.—J. G. White. (*Brit. Rad. Annual*, 1934/5, pp. 84–91.)

Advantage of amplification before frequency changing: choice of i.f.: single-valve frequency changers only where space and cost are at a premium: advantages of a plate-tuned oscillator: "let us now build a modern Stenode infradyne": etc.

114. The "Octophone VI" All-Wave Superheterodyne Receiver.—P. Abadie. (*L'Onde Elec.*, September, 1935, Vol. 14, No. 165, pp. 606–611.)

115. The Small Superheterodyne [Chief Factors governing Design].—W. T. Cocking. (*Wireless World*, 25th Oct. 1935, Vol. 37, pp. 444–446.)

116. The 1936 Battery Monodial Super.—W. T. Cocking. (*Wireless World*, 27th Sept. and 4th Oct. 1935, Vol. 37, pp. 340–343 and 362–366.) Battery-operated version of the receiver dealt with in 3427 of 1935.

117. The Radio Companion [Three-Valve Pocket Receiver].—J. H. Reyner. (*Wireless World*, 25th Oct. 1935, Vol. 37, pp. 440–443.) With "straight" circuit and single earpiece, for satisfactory 50-mile range.

118. Midget Portable Receiver [with Regenerative Space-Charge Detector and One A.F. Stage: Plate Voltage 13.5 V: Frequencies up to 25 Mc/s].—R. Usher. (*QST*, October, 1935, Vol. 19, No. 10, pp. 53–54.)

119. The [British, French and German] Radio Shows Compared.—(*Wireless World*, 27th Sept. 1935, Vol. 37, pp. 357–358.)

120. Cheap Parts [and Their Failure in Broadcast Receivers].—(*Electronics*, September, 1935, p. 5: letter prompted by Editorial.)

121. Measurement Technique of Interference Suppression in Broadcast Reception.—W. Oehlerking. (*Hochf:tech. u. Elek:akus.*, September, 1935, Vol. 46, No. 3, pp. 94–97.)

Part 1. Theory of measurement of quantities involved in reception of interference *via* (1) the aerial, and (2) the mains, and of circuit elements required for its suppression. Conditions for use of condensers and chokes respectively. Part 2. Further theory of measurement with particular reference to generators; diagrams of arrangement of condensers and chokes.

122. Transmission-Line Insulators under Deposit Conditions.—W. J. John and F. M. Sayers. (*Journ. I.E.E.*, November, 1935, Vol. 77, No. 467, pp. 629–648.) For references to the radio-interference aspect *see* Discussion, pp. 648–662.

123. Control of Potential over Insulator Surfaces [in connection with Interference Reduction by Adherent Conducting Coatings: Suggested Improvement].—E. Bennett and G. Fredendall. (*Elec. Engineering*, October, 1935, Vol. 54, No. 10, pp. 1084–1087.)

124. The Fight against Broadcast Interference due to Electric Traction.—Restle and Schneider. (*E.T.Z.*, 14th Nov. 1935, Vol. 56, No. 46, pp. 1259–1260: summary only.)

125. The Problem of Interference with Broadcast Reception [Present Situation: Technical and Legal Developments].—(*Alta Frequenza*, August, 1935, Vol. 4, No. 4, pp. 426–436.)

126. The Revised RST System [Signal-Reporting Code].—(*QST*, October, 1935, Vol. 19, No. 10, p. 106.) *See* 1427 of 1935.

AERIALS AND AERIAL SYSTEMS

127. Discharge Phenomenon from Aerial Wires at Short [and Ultra-Short] Waves.—M. S. Neimann. (*Izvestia Elektroprom. Slab. Toka*, No. 7, 1935, pp. 1–7.)

Author's summary:—Whilst, for long waves, the slow discharge from aerial wires occurs in the form of corona and begins at very high voltages, for short waves the discharge can exist at much lower voltages in the form of the so-called "torch" discharge. Results of an experimental investigation of the torch-discharge phenomenon are considered and a physical explanation of the nature of this phenomenon is given. Experimental curves are presented of the voltages at which the torch discharge sets in, plotted against wavelength for wires of different diameters. On the basis of this information, conclusions are reached as to the maximum voltages allowable in practice on the radiators and transmission lines of short- and ultra-short-wave aerials.

128. On the Calculation of Capacity of Aerials and Counterpoises.—J. M. Kravetz. (*Izvestia Elektroprom. Slab. Toka*, No. 8, 1935, pp. 12–20.)

Author's summary:—In calculating the capacity of very wide aerials and counterpoises (where the ratio of breadth to length is large) by Howe's method, the general simplified formulae are not applicable. The exact formula exists only for two parallel conductors. Moreover, in determining the influence of the earth for this case it is not correct to assume that the image charges are concentrated in one point or even in one line.

Tables, graphs and formulae for the determination of the potential of wide aerials and counterpoises, from their own charges and from the influence of the earth, are given in this article. All results are given as mean values of potentials for any number of conductors, computed on the basis of the above-mentioned exact formula.

129. THE PRINCIPLE OF RECIPROCITY IN ANTENNA THEORY.—M. S. Neimann. (*Izvestia Elektroprom. Slab. Toka*, No. 8, 1935, pp. 1–11.

Author's summary :—On the basis of the principle of reciprocity given by Sommerfeld for infinitely small dipoles, and by M. P. Svechnikova for aerials of finite length, formulae are found for determining the current and power in a receiving aerial of any type by means of the radiation resistance and directivity factor of this aerial working as a transmitter. These formulae allow the theory of receiving aerials to be reduced to that of transmitting aerials, using for the design of the former the results obtained with the latter, and *vice versa*. Further, by means of reservations contained in the statement of the reciprocity theorem, the differences in the construction of receiving aerials, as compared with transmitting aerials, are established. It is shown that the principle of reciprocity gives a convenient criterion for evaluating these differences.

130. THE TUNING OF A TRANSMISSION LINE TO A TRAVELLING WAVE FOR TWO WAVELENGTHS. —G. J. Michelson. (*Izvestia Elektroprom. Slab. Toka*, No. 7, 1935, pp. 8–11.)

Continuation of the work dealt with in 1066 of 1935. Author's summary :—" A circuit (Fig. 1) with combined bridges for tuning a transmission line to a travelling wave for two wavelengths simultaneously (λ and λ_2) or for two multiple wavelengths ($\lambda_2 = 2\lambda$; $a = 0$; $b + c = \lambda/2$) is considered. For small values of the travelling wave factor ($K = U_{min}/U_{max} < 0.175$) combined bridge circuits (Figs. 3 and 4) are considered, for tuning to a travelling wave for two multiple wavelengths ; formulae (8–13) are derived and graphs (Fig. 5) are drawn for calculating the values of the combined bridges."

131. DISCUSSION ON " CONTROL OF RADIATING PROPERTIES OF ANTENNAS " [Earth-Loss Reduction only Small when Adequate Earth System is used].—Nickle, Dome and Brown. (*Proc. Inst. Rad. Eng.*, October, 1935, Vol. 23, No. 10, pp. 1264–1265.) *See* 1054 of 1935.

132. SHIFTING ANTENNA DIRECTIVITY BY PHASE SWITCHING : AN EFFECTIVE HOUSE-TOP SYSTEM FOR 14 MC.—Griffin. (*QST*, October, 1935, Vol. 19, No. 10, pp. 38–39.)

133. RADIO-FREQUENCY DISTRIBUTING SYSTEMS [Several Thousand Broadcast Receivers supplied by Common Aerial suitably Located: Transmission Lines : Coupling Elements and Amplifiers : Waldorf-Astoria Equipment : etc.].—F. X. Rettenmeyer. (*Proc. Inst. Rad. Eng.*, November, 1935, Vol. 23, No. 11, pp. 1286–1307.) Separate aerials in crowded districts often cause the output of a receiver to vary as much as 10 db owing to the tuning of a receiver on an adjacent aerial.

134. THE DEVELOPMENT OF THE WIRELESS AERIAL [from 1895 to Present Day].—J. A. Slee. (*Wireless World*, 27th Sept., 4th and 11th Oct. and 1st Nov. 1935, Vol. 37, pp. 344–345, 368–369, 396–398, and 468–470.)

135. ANTENNA TERMINATIONS [Methods of Correct Matching of Feeders and Aerial].—C. G. Dietsch. (*Electronics*, September, 1935, pp. 14–17.)

136. THE CURRENT-LOADING CAPACITY OF EARTH ELECTRODES [including Effect of Physical Characteristics of Soil : Coke-Breeze and Salt Treatment : (British E.R.A. Report)].—H. G. Taylor. (*Journ. I.E.E.*, October, 1935, Vol. 77, No. 466, pp. 542–560.)

137. EARTH RESISTIVITY AND GEOLOGICAL STRUCTURE.—R. H. Card. (*Elec. Engineering*, November, 1935, Vol. 54, No. 11, pp. 1153–1161.)

VALVES AND THERMIONICS

138. A LARGE-SURFACE HOT CATHODE [for Transmitter and Power-Amplifier Valves, Cathode-Ray Tubes, etc.].—R. Haefer and W. Scharpf. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 16, 1935, pp. 302–303.)

Outline of a new cathode recently patented. An isothermal, high-temperature, equipotential emitter of large surface is obtained, heated by electron bombardment and the mutual heating action between cathode and auxiliary cathode. The latter (*e.g.* the inner sphere A in Fig. 2) is initially heated by conduction, bombardment, or otherwise : this starts the cumulative heating-up process, and thereafter the auxiliary cathode depends entirely on the mutual heating action. This process reaches a stable condition owing to the action of a space charge : for given dimensions of the spheres, the current is limited (whatever may be the saturation current obtainable from the main cathode) by the potential across the two spheres, and if the heating produced by this current is enough to produce a saturation current greater than the space-charge-limited current, the electrical flow is stable. The necessary voltage is of the order of 100 v.

139. RECENT DEVELOPMENTS IN MINIATURE TUBES [Indirectly Heated " Acorn " Triode and Sharp Cut-Off Amplifier Pentode, going down to Micro-Wave Frequencies].—B. Salzberg and D. G. Burnside. (*Proc. Inst. Rad. Eng.*, October, 1935, Vol. 23, No. 10, pp. 1142–1157.) For a previous article *see* 1452 of 1935.

140. A Study of the Farnsworth Cold Cathode Oscillator.—Merle Starr. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, p. 485: abstract only.)

"A cold cathode regenerative oscillator . . . has been constructed to give self-maintained oscillations at a natural frequency near 5×10^7 sec^{-1} with 40 watts energy. The oscillator consists of a collecting ring and two symmetrically placed silver plates treated with oxygen and caesium in proportions to give high efficiency of secondary emission. In operation the two plates are connected to the negative of a potential source, the ring to the positive, and a uniform magnetic field applied parallel to the axis of the tube to prevent excess electron current to the ring. Measurements on a Lecher wire system show that the natural mode of oscillation is determined by the time required for an electron to travel from one plate to the other." The electrons produce several secondaries on impact with the plate, and multiplication increases to space-charge limitation. "Characteristic curves . . . are of a nature to make possible radio- or audio-frequency amplification."

141. The Secondary-Emission Multiplier.—Zworykin, Morton and Malter. (*See* 247.)

142. The Effect of Secondary Emission upon the Fluctuations of the Current in a Triode (Shot Effect) [Theory assuming Simultaneity of Secondary Emission and Primary Incidence].—W. H. Aldous and N. R. Campbell. (*Proc. Roy. Soc.*, Series A, 1st Oct. 1935, Vol. 151, No. 874, pp. 694–702.)

Recent measurements by Moullin (757 of 1935) were interpreted by him on the assumption that "secondary and primary emissions were wholly independent in time." The present writers reject this and assume instead that secondary emission and primary incidence are simultaneous; a theory of the effects of secondary emission is sketched and certain qualitative predictions are made which are on the whole confirmed by Moullin's experiments. The writers however conclude that "an adequate theory is far beyond our present reach" and "all conclusions concerning experiments in space-charge limited conditions are precarious." *Cf.* Zeigler, 2293 of 1935.

143. Shot Effects of Secondary Electron Currents [Measurements at 10^{-5}c/s: Calculations of Electronic Charge: Differences between Grid and Anode Shot Effects: Number of Reflected Primary Electrons and Number of Primaries emitting No Secondaries].—Lucy J. Hayner. (*Physics*, October, 1935, Vol. 6, No. 10, pp. 323–333.) *See* Hayner & Hull, 1929 Abstracts, p. 576.

144. Some Notes on Glow-Discharge Amplifier Valves [including Types due to Nienhold, Lübcke, Marx, Kossel, Seibt and Hund].—F. Schröter. (*Telefunken-Röhre*, January, 1935, No. 3, pp. 103–112.)

145. Current Flow between a Small (Point) Incandescent Cathode and a Very Large (Infinite) Anode for Glow Discharges in Different Gases [Current Density of (1) Diffusion Currents, (2) Currents in Electric Field: Effects in Hydrogen (Current Focusing), Oxygen and Nitrogen (Ion Mantle Effect): Theory and Experiment].—F. Keller. (*Zeitschr. f. Physik*, No. 1/2, Vol. 97, 1935, pp. 8–33.)

The flow of current in the rare [monatomic] gases is a diffusion current when the electron density round the cathode is sufficient to keep up the necessary gradient of concentration: it is a "gradient current," *i.e.* one due to the electric field, when the electron density round the cathode is too small to keep up the concentration gradient. In "molecular gases," "gradient currents" and "ion mantle currents" are distinguished and expressions for the corresponding current densities found; nitrogen has "gradient currents" alone; hydrogen has "gradient currents," with focusing of the discharge in front of the anode; oxygen and water vapour have "ion mantle currents" in which the negative ions form a mantle and confine the discharge to a long narrow tube.

146. Elementary Derivation of the Law of Space-Charge Currents.—P. Selényi. (*Zeitschr. f. Physik*, No. 5/6, Vol. 97, 1935, pp. 395–397.)

147. Current-Distributing Processes [in Valves: the Action of the Control Grid as an Allocator of Electron Flow rather than as a Stop-Cock].—W. Kleen. (*Telefunken-Röhre*, January and April, 1935, Nos. 3 and 4, pp. 118–124 and 130–141.)

Author's summary:—The control, by a control electrode, of the current flowing from a hot cathode to a positive electrode is in principle a current-distributing process, occurring in the low-potential region close in front of the hot cathode and consequently not measurably apparent outside. The slope of the control characteristic is calculated by differentiation of the space-charge equation, and is determined by the value of the anode current and the 'slope constant' [a in equation 9: it is the same as the slope when the anode current is 1 mA], the latter depending only on the design of the valve and forming, therefore, an absolute definition of a valve. Measurements on various valves confirm the theoretical results, apart from certain discrepancies due chiefly to inhomogeneities of the potential course in the space between grid and cathode. Since the 'slope constant' is, for adequately emissive cathodes, independent of the cathode temperature, slope measurements at different temperatures provide information on the quality and uniformity of emission of a cathode.

148. The Renode.—(*Wireless World*, 8th Nov. 1935, Vol. 37, pp. 489–490.)

A brief technical description is given of a new valve developed in Denmark. No grid, in the ordinary sense of the word, is employed, but, in addition to the cathode and anode, an auxiliary anode (or concentrating electrode) is incorporated, together with two deflector plates. As regards the external circuit, the action is very similar to that of the American Wunderlich valve, although its internal construction and mode of operation are quite different.

149. Quiet Amplifier Tubes [with Tests on Noise in Western Electric Valves: Conditions for Best Signal/Noise Ratio].—G. L. Pearson. (*Bell Lab. Record*, October, 1935, Vol. 14, No. 2, pp. 56–59.)

150. Making Metal Tubes.—RCA Radiotron. (*Electronics*, September, 1935, pp. 31–37.)

151. Distortions due to the Curvature of the $i = \phi(u)$ Characteristic of Triodes and Pentodes.—R. Watrin. (*L'Onde Élec.*, September, 1935, Vol. 14, No. 165, pp. 586–598.)

Baranow (1934 Abstracts, p. 264) has shown how the distortion due to the second harmonic in triodes may be calculated. The present paper generalises the method in order to apply it to the calculation of the distortions due to the second, third and fourth harmonics in triodes and pentodes. The algebraical and graphical methods arrived at are illustrated by application to a Mazda Type 42 l.f. pentode and to a RCA 2A3 triode: in both cases the two methods give results which agree almost exactly. For the pentode (and the results apply to all pentodes) they show that the distortion due to the 4th harmonic is negligible ($C = 0.1355$) while that due to the 3rd harmonic is preponderant ($B = 7.02$, compared with 2nd harmonic $A = 2.94$); whereas for the triode (and for all triodes) the third-harmonic distortion is negligible ($B = 0.509$) compared with the second-harmonic distortion ($A = 5.35$), while that due to the 4th harmonic is zero.

152. The Valves in Broadcast Receivers: Part II [Non-Linear Distortion in H.F. Amplifier Valves].—K. Wilhelm. (*Telefunken-Röhre*, January, 1935, No. 3, pp. 95–102.)

153. Join-Up Distortion in Class B Amplifiers.—Strafford. (*See* 106.)

154. Comparative Analysis of Water-Cooled Tubes as Class B Audio Amplifiers [particularly the Influences of Amplification Factor on Behaviour].—Mouromtseff and Kozanowski. (*Proc. Inst. Rad. Eng.*, October, 1935, Vol. 23, No. 10, pp. 1224–1251.)

155. The Graphical Methods of determining the Elements of Class B and Class C High-Frequency Amplifiers.—V. A. Babits. (*L'Onde Élec.*, October, 1935, Vol. 14, No. 166, pp. 668–674.)

Everitt's mathematical treatment (1934 Abstracts, pp. 205 and 613) can be replaced by the one here given, yielding a simpler graphical representation, the required values being found in two steps instead of four.

156. An Interesting Sign and Magnitude Relation between Slope, "Durchgriff" and Internal Resistance [with Practical Application to Mixing Hexodes].—G. Jobst and K. Steimel. (*Telefunken-Röhre*, January, 1935, No. 3, pp. 113–117.)

157. The New Mixing Valves: Part II [Amplification Theory and Measuring Methods: the Question of the Internal Resistance].—K. Steimel. (*Telefunken-Röhre*, January, 1935, No. 3, pp. 85–94.)

158. Valve Literature of the Year 1934.—K. Patermann. (*Telefunken-Röhre*, April, 1935, No. 4, pp. 176–184.)

159. Statistical Distribution Curves in the Radio Tube Industry [Variation in Curve Shape indicates Approach of Trouble in Tube Manufacture.].—W. Dehlinger. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, p. 474: abstract only.)

160. Operating Characteristics of the FP54 Thermionic Direct-Current Amplifying Tube [Most Suitable Characteristics for Steady Deflection and Electrometer Use].—P. A. Macdonald and W. E. Turnbull. (*Physics*, September, 1935, Vol. 6, No. 9, pp. 304–307.)

161. The Exact Measurement of Electron-Tube Coefficients [Analysis of Bridge Circuits extended to include Effect of Grid Current and Valve and Battery Capacitances: Application to Capacitance-Balancing Method].—R. W. Hickman and F. V. Hunt. (*Review Scient. Instr.*, September, 1935, Vol. 6, No. 9, pp. 268–276.)

162. The Plotting of the Characteristics of Transmitting Valves [by Matteini's Method: Equipment, Difficulties, and Examples].—G. Gramaglia. (*Alta Frequenza*, August, 1935, Vol. 4, No. 4, pp. 406–412.)

163. Anode Materials for High-Vacuum Tubes [and Methods of Cooling].—Spitzer. (*Elec. Engineering*, November, 1935, Vol. 54, No. 11, pp. 1246–1251.)

164. Kinetics of the Oxidation of Metal Filaments [Formula for Progress of Oxidation].—G. Valensi. (*Comptes Rendus*, 7th Oct. 1935, Vol. 201, No. 15, pp. 602–604.)

165. Pulverisation of Metals by Impact of Slow Ions and Measurement of the Limiting Value of Pulverisation Voltage [Measurement of Resistance Changes: Comparison with Calculations].—H. Lüder. (*Zeitschr. f. Physik*, No. 3/4, Vol. 97, 1935, pp. 158–170.)

166. Field Current Emission [from Tungsten Filament surrounded by Coaxial Copper Electrodes] at Small Currents [Linear Relation between Logarithm of Current and Reciprocal of Field Intensity].—F. R. Abbott and J. E. Henderson. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, p. 481: abstract only.) *See* Henderson, 1932 Abstracts, p. 588.

167. A Search for Temperature Changes accompanying Field Current Emission [No Change Detected].—J. E. Henderson and G. M. Fleming. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, pp. 486–487: abstract only.)

168. THE TOTAL ENERGY DISTRIBUTION FOR FIELD CURRENT ELECTRONS [using Tungsten Point Emitter at Centre of Two Concentric Spheres: Rapid Rise to Maximum when Work Done by Field was 4.5 v].—R. K. Dahlstrom, K. V. Mackenzie and J. E. Henderson. (*Phys. Review*, 1st Sept. 1935, Vol. 48, No. 5, p. 484 : abstract only.) *See* the two preceding abstracts.

169. THE CONTACT POTENTIAL DIFFERENCE BETWEEN CLEAN AND OXYGENATED TUNGSTEN [Experimental Determination : Discussion of Previous Experiments and Effectiveness of Oxygenation].—A. L. Reimann. (*Phil. Mag.*, October, 1935, Series 7, Vol. 20, No. 134, pp. 594–607.)

170. THE ADSORPTION OF HYDROGEN ON TUNGSTEN [Measured by Accommodation Coefficients of Neon for Surfaces with and without Adsorbed Films : Heat of Adsorption : Amount of Gas Adsorbed : Stability and Monatomic Nature of Film : Nature of Binding : Question of Activated Adsorption]. —J. K. Roberts. (*Proc. Roy. Soc.*, Series A, 1st Nov. 1935, Vol. 152, No. 876, pp. 445–463.)

171. SOME PROPERTIES OF ADSORBED FILMS OF OXYGEN ON TUNGSTEN [Experiments similar to those for Hydrogen : Second Film, stable at Ordinary Temperatures, formed on Top of Film stable up to 2 000° K].—J. K. Roberts. (*Proc. Roy. Soc.*, Series A, 1st Nov. 1935, Vol. 152, No. 876, pp. 464–477.) *See* above reference.

172. COMPOSITE FILMS OF OXYGEN AND HYDROGEN ON TUNGSTEN [Hydrogen Molecule thrown off when Oxygen Molecule adsorbed].—J. K. Roberts. (*Proc. Roy. Soc.*, Series A, 1st Nov. 1935, Vol. 152, No. 876, pp. 477–480.) *See* above references.

173. SURFACE CHEMISTRY [Early and Modern Theories of Adsorption : Measurement of Caesium-Atom Films : etc.].—I. Langmuir. (*Gen. Elec. Review*, September, 1935, Vol. 38, No. 9, pp. 402–414.)

174. THE LOW FREQUENCY ELECTRODELESS RING DISCHARGE [Possible Source of Positive Ions].—F. H. Crawford and C. G. Smith. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, pp. 477–478 : abstract only.)

DIRECTIONAL WIRELESS

175. SCATTERING, POLARISATION ERRORS, AND ACCURACY OF SHORT-WAVE DIRECTION FINDING [Results with Spaced-Frame D.F. System : Comparison with Adcock System]. —T. L. Eckersley. (*Marconi Review*, July/Aug. 1935, No. 55, pp. 20–30.)

See 2660 of 1935. The present paper gives results based on pulse transmissions from Nauen (41.45 m) and Montreal (32 m). " In the conditions so far examined the final accuracy of direction finding appears to be limited by the scattering spread which is of the order of 1–2 degrees. For distances beyond about 300 km the performance of the Adcock appears to approach this limiting accuracy. At shorter distances the Adcock aerial is subject to polarisation errors which increase as the range is reduced until such ranges are reached that the direct ray swamps the reflected one. In this region, *i.e.* less than 300 km, it would appear probable that the spaced-frame aerial would give accurate bearings at all distances and that when the incident angle of the reflected ray becomes too small the transmitter will be close enough to obtain bearings on the direct ray. The d.f. operations are greatly facilitated by using the transmission of impulses. It is assumed throughout that a wavelength is chosen for which the receiver lies outside the skip zone . . ." The Nauen observations on the spaced-frame system include some which suggest the presence of a diffuse scattering layer intermediate between E and F " which is probably the region where the main scattering (observed in Ongar experiments) originates. This is in agreement with Pawsey's experiments on longer waves " [1313 of 1935].

176. ON THE PROPAGATION OF HIGH-FREQUENCY SHORT RADIO WAVES OF LONG-DISTANCE TRANSMITTING STATIONS : PART I—OBSERVATIONS DURING A PERIOD OF THE POLAR YEAR [Sept. 1932/Dec. 1933].—T. Nakai. (*Res. of Electrotech. Lab.*, Tokio, No. 381, 1935, pp. 1–18 with Signal-Strength and Directional Curves : in Japanese, with English summary.)

For previous work *see* 1934 Abstracts, pp. 375 and 385. A direction finder generally indicates the true direction provided the observations are made " anywhere in the direction of the beam," except where the waves travel near a magnetic pole : in this case, during hours when auroras often occur in the vicinity, a direction deviating by " more than several degrees " may often be observed even though the beam is directed to the place of observation. Abnormally weak and strong ionisations near the N pole, and their respective effects, are mentioned : the strong ionisation seems " closely related to auroras or their agencies." Finally, " some new attenuation characteristics of high-frequency radio waves in the ionosphere should be sought to replace the old ones."

177. THE NATIONAL METEOROLOGICAL OFFICE'S RADIOGONIOMETRIC METHOD FOR THE MEASUREMENT OF THE DIRECTION AND VELOCITY OF THE WIND IN CLOUDY WEATHER [Direct-Reading and Continuously Recording Equipment, using Photoelectric Relay, giving Readings within Half a Degree in less than Five Seconds].—Corriez and Perlat. (*La Météorologie*, August, 1935, No. 125, pp. 368–384.)

178. THE PRESENT STATE IN THE ART OF BLIND LANDING OF AIRPLANES USING ULTRA-SHORT WAVES IN EUROPE [Lorenz Company's Glide-Path System].—E. Kramar. (*Proc. Inst. Rad. Eng.*, October, 1935, Vol. 23, No. 10, pp. 1171–1182.)

179. DECIMETRE WAVES IN AVIATION.—Hahnemann. (*E.T.Z.*, 14th Nov. 1935, Vol. 56, No. 46, p. 1259 : summary only.) The full paper was dealt with in 3078 of 1935.

180. The Magnetic Field and the External Impedance of a Ring-Shaped Earth Cable [as used on Aerodromes for Blind Landing: Calculations].—H. Buchholz. (*E.N.T.*, September, 1935, Vol. 12, No. 9, pp. 289–303.)

Blind landing of aircraft is assisted by a ring-shaped earth cable on the aerodrome; this carries an alternating current whose magnetic field acts on the frame aerial on the aircraft (*e.g.* Gromoll, 1932 Abstracts, p. 644). Calculations are here given of the magnetic field of such a cable buried in the earth and its external impedance, the earth being considered as a half-space bounded by a plane, with constant conductivity and permeability. The limiting cases of an infinitely long single cable and a ring on the earth's surface are worked out (§§ II 41 and II 5, III); the formulae in the latter case are brought into forms suitable for numerical calculation (eqns. 7, 8; Fig. 4). Fig. 6 gives a vector diagram for the vertical component of the magnetic field, the point of observation being supposed to move away from the plane of the ring along its axis [misprint H_2 for H_z]. In § IV 2 calculations are given for the magnetic field of the ring cable of very large radius in the zone where the magnetic field changes sign. Fig. 8 gives a vector diagram of the vertical component of the magnetic field, the point of observation moving parallel to the earth's surface away from a vertical plane through the centre of the ring at a distance of 25 m above the surface.

ACOUSTICS AND AUDIO-FREQUENCIES

181. Electro-Acoustical Problems: a Graphical Method of Solution [Resultant Motion of Stiffness-Controlled Device, supplied by Current of Known Wave-Form, found by "Load-Line" Method].—C. N. Smyth. (*Wireless Engineer*, October, 1935, Vol. 12, No. 145, pp. 543–547.)

182. An Electromechanical Representation of a Piezoelectric Crystal used as a Transducer [Application to Loudspeakers, Microphones, Filters, etc.].—W. P. Mason. (*Proc. Inst. Rad. Eng.*, October, 1935, Vol. 23, No. 10, pp. 1252–1263.)

183. The Measurement of Small Amplitudes of Vibration [with Application to Telephone and Loudspeaker Diaphragms].—G. F. Partridge. (*Phil. Mag.*, November, 1935, Supp. No., Series 7, Vol. 20, No. 136, pp. 953–963.)

Amplitudes of diaphragm vibration of the order of 10^{-6} cm can be measured at audio-frequencies by displacing the point of support of a rigid pendulum, originally in contact with the surface at rest, until the chattering of the pendulum produced by the vibration just ceases. The theory of the method is given and the experimental arrangement and results described. A transmitter of calculable amplitude at audio-frequencies is found in a quartz strip vibrator. A correction term is given in an appendix; this agrees with Warren's expression for flexible loudspeaker diaphragms (1931 Abstracts, p. 502).

184. Wide-Range Single Cone Loudspeaker.—N. Rollason. (*Wireless World*, 15th Nov. 1935, pp. 515–516.)

The author describes experiments he has conducted in an endeavour to improve the high-frequency response of loudspeakers with large cone diaphragms. Mica was found to be the most suitable material for the cone, but, owing to its expense, a compromise was effected by using it only for the centre of the cone, the outer portion being of air-dried vellum.

185. "Acoustic Clarifiers" [Resonant Cones in Loudspeaker Baffle, for Damping Out Cabinet Resonance].—Philco. (*See* 98.)

186. The Principles and Behaviour of Modern Loudspeakers [including Requirements for Sound-Films and "Sky Shouting"].—N. W. McLachlan. (*Brit. Rad. Annual*, 1934/5, p. 44: summary only.)

187. The Formation of Combination Tones in Spreading Sound Waves of Finite Amplitude [Calculations for Exponentially Decreasing and Spherical Waves].—N. W. McLachlan and A. L. Meyers. (*E.N.T.*, September, 1935, Vol. 12, No. 9, pp. 259–271.)

For previous work *see* 1479, 2682, and 3080 of 1935. The present paper considers the case when two different frequencies are simultaneously impressed on a medium by exponentially decreasing and spherical waves; calculations are given for the amplitudes, sound pressure and power of the sum and difference tones produced. The method of successive approximation is used to take into account the finite amplitude of the waves; a numerical example illustrates the practical application of the theory to the calculation of the power ratios of the combination tones in an exponential and a cone-shaped loudspeaker horn.

188. The Finite (Exponential) Horn.—A. A. Harkevich. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 5, 1935, pp. 536–541.)

The object of this paper is to compare the generally accepted theory of the finite horn (based on the theory of the infinite horn, as expounded by A. G. Webster in 1919) with the experimental results obtained by P. B. Flanders (1932 Abstracts, p. 589). An outline of the theory is given and the input and output impedances are calculated and plotted for a horn similar to that used by Flanders. The curves so obtained show a wide divergence from the experimental curves, especially if it is assumed that the sound waves in the horn are spherical. It appears therefore that a radical revision of the theory is necessary.

189. [Extension] Loudspeaker Volume Controls.—M. C. Smith. (*Wireless World*, 11th Oct. 1935, Vol. 37, pp. 391–392.)

Usual methods are inclined to introduce distortion. The writer suggests a compensating arrangement whereby over-accentuation of the bass or treble at low volume levels may be avoided.

190. Acoustics in the Open [P.A. Arrangements at Heidelberg "Thingstätte].—(*Wireless World*, 27th Sept. 1935, Vol. 37, p. 351.)

191. ECHOES IN PUBLIC ADDRESS SYSTEMS.—(*Wireless World*, 8th Nov. 1935, Vol. 37, p. 503.)

An arrangement used by German P.O. engineers to overcome repetitive echo effects resulting from the difference in time of arrival of sound waves from loudspeakers situated in different parts of a large open-air auditorium.

192. ON THE THEORY OF THE PARABOLIC SOUND REFLECTOR.—L. J. Gutin. (*Izvestia Elektroprom. Slab. Toka*, No. 9, 1935, pp. 9–25.)

A complete mathematical theory of the parabolic reflector is developed in this paper. The discussion begins with an examination of the sound field which is produced when a plane wave is reflected from a solid infinitely thin disc. A formula is then derived determining the sound pressure at the focus of the paraboloid, and the calculated results are compared with those obtained experimentally by Obata and Yosida (*Reports Aëron. Res. Institute*, Vol. 5, 1930, p. 230). A similar formula is also deduced in a different way, using the theorem of reciprocity. The sound pressure along the axis is next determined and also the velocity of the reflected wave at the focus. In the next section the field around the focus is examined, and finally the directive effect of the paraboloid is determined for a wave striking at an angle to the axis.

193. THE ACOUSTIC EFFECTS DUE TO IMPERFECT CENTERING OF GRAMOPHONE DISCS.—Corbino and Cambi. (*Alta Frequenza*, August, 1935, Vol. 4, No. 4, pp. 448–449: summary only.)

194. GRAMOPHONE RECORDING, RECORD MANUFACTURE, AND RECORD DEFECTS.—D. Aldous. (*Brit. Rad. Annual*, 1934/5, pp. 47–61.)

195. TONE CONTROL OF PIEZOELECTRIC PICK-UPS.—N. W. McLachlan. (*World-Radio*, 18th and 25th Oct. 1935, pp. 15 and 17: 15 and 19.)

196. MAGNETIC SOUND-RECORDING [particularly the New Steel-Powder-Film System and the Improvement of the Frequency Characteristic by Auxiliary Coils, etc.].—Ed. Schüller. (*E.T.Z.*, 7th Nov. 1935, Vol. 56, No. 45, pp. 1219–1221.)

197. THE MAGNETOPHON [with Steel-Powder Film: 25 Minutes' Run with Spool 30 cm in Diameter weighing 1 kg].—W. H. Hansen. (*E.T.Z.*, 7th Nov. 1935, Vol. 56, No. 45, p. 1232.)

198. TALKING BOOKS [for the Blind].—(*Wireless World*, 1st Nov. 1935, Vol. 37, p. 463.) Employing 12-inch records with only 100 grooves to the inch instead of the usual 200. Each disc contains about 4 000 words and, revolving at only 24 r.p.m., gives a playing time of about 25 minutes. *Cf.* Kleber, 1934 Abstracts, p. 398.

199. AN APPARATUS FOR THE SYNTHESIS OF SOUNDS BY PHOTOELECTRIC CELL: THE "CELLULOPHONE" ORGAN.—P. Toulon. (*L'Onde Élec.*, September, 1935, Vol. 14, No. 165, pp. 555–568.) *See* also 1934 Abstracts, p. 386.

200. A NON-DIRECTIONAL MICROPHONE [with Special Acoustic Screen mounted over Grid in front of Diaphragm].—R. N. Marshall. (*Bell Lab. Record*, October, 1935, Vol. 14, No. 2, pp. 34–38.)

201. A NEW HIGH-IMPEDANCE VELOCITY [Ribbon] MICROPHONE [and Its Advantages].—(*Electronics*, September, 1935, pp. 52 and 54.)

202. UNMASKED HEARING [primarily for Deaf-Aids: High-Frequency Alien Tones countered by supplying One Ear with Wanted High Frequencies only].—Poliakoff. (*Brit. Rad. Annual*, 1934/5, p. 45.)

203. HEARING AND AIDS TO HEARING [Effect of Intense Stimuli on Normal and Deaf Ears: Synopsis of British Association Discussion].—A. F. Rawdon-Smith. (*Nature*, 21st Sept. 1935, Vol. 136, pp. 483–484.)

204. DEAF AIDS.—N. W. McLachlan. (*Wireless World*, 11th Oct. 1935, Vol. 37, pp. 402–404.) Continuation of the article dealt with in 3489 of 1935.

205. THE RESPONSE OF MODULATORS AT HIGH AUDIO-FREQUENCIES.—Bell. (*See* 84.)

206. DISTORTIONS DUE TO THE CURVATURE OF THE $i = \phi(u)$ CHARACTERISTIC OF TRIODES AND PENTODES.—Watrin. (*See* 151.)

207. AMPLIFICATION OF TRANSIENTS: A CRITICAL DISCUSSION OF C. H. SMITH'S PAPER, WITH FURTHER INVESTIGATION.—D. A. Bell: Smith. (*Brit. Rad. Annual*, 1934/5, pp. 31–38.)

For the paper criticised *see* 2664 of 1935. "Smith's analysis assumes a particular method of stopping, or rather of decay, of the wave-trains, but is fundamentally inadequate because it takes no account of the *starting* of the wave-trains . . .".

208. MODIFICATIONS OF THE PUSH-PULL OUTPUT STAGE.—Macfadyen. (*See* 107.)

209. JOIN-UP DISTORTION IN CLASS B AMPLIFIERS.—Strafford. (*See* 106.)

210. A NEW "FEED-BACK" REPEATER [using Screened-Grid Pentode].—Bast and Stieltjes. (*P.O. Elec. Eng. Journ.*, October, 1935, Vol. 28, Part 3, pp. 225–231.)

211. METHOD OF PUPINISATION OF CABLES ALLOWING THE CHARACTERISTIC IMPEDANCE OF OVERHEAD CIRCUITS TO BE REPRODUCED.—T. Laurent. (*Ericsson Technics*, No. 4, 1935, pp. 43–53.)

212. NOTE ON THE EXTENSION OF CAMPBELL'S FORMULA [for Attenuation Constant] TO LIGHTLY-LOADED MUSIC PAIRS [where Natural Distributed Inductance cannot be neglected with respect to Lumped Loading-Coil Inductance].—H. J. Josephs. (*P.O. Elec. Eng. Journ.*, October, 1935, Vol. 28, Part 3, pp. 194–195.)

213. AN AUTOMATIC ANALYSER OF AUDIO-FREQUENCY CURRENTS.—M. I. Rodman. (*Journ. of Tech. Phys.* [in Russian], No. 2, Vol. 5, 1935, pp. 308–323.)

A description of an analyser developed in Leningrad and based on the principle of high-frequency (supersonic) modulation. The current under investigation is modulated by a variable high-frequency current (exploring note) and the side-bands so obtained are passed through a fixed frequency resonator and registered by means of an oscillograph. This particular analyser consists essentially of the following components :—(1) a.f. amplifier ; (2) h.f. oscillator covering a range of 50 000 to 60 000 c/s ; (3) modulator comprising two valves in push-pull with the h.f. voltages applied in phase to the grids, and the a.f. voltages in opposition ; (4) amplification stage ; (5) electromagnetic resonator operating at its 5th harmonic (60 000 c/s) ; (6) two more stages of amplification ; (7) detector, and (8) oscillograph using a mirror galvanometer and giving a spectrum of the current which can, if desired, be automatically recorded on a photographic plate.

The analyser covers a range of 100 to 10 000 c/s and its selectivity is such that voltages differing by some 30 or 40 c/s are discriminated on the spectrogram. It is also claimed that if two voltages of equal amplitude but differing by 100 c/s are applied simultaneously to the analyser, the switching on and off of one of the voltages does not alter the peak on the spectrogram corresponding to the other voltage by more than 2%. A bibliography of 60 items is included.

214. ON THE MEASUREMENT OF STREET NOISE.—I. M. Bronstein and L. S. Freiman. (*Journ. of Tech. Phys.* [in Russian], No. 3, Vol. 5, 1935, pp. 530–535.)

An account of experiments carried out with a portable noisemeter in the streets of Leningrad. The results obtained are compared with similar experiments in Berlin and New York, and a tentative analysis is offered of the composition and time distribution of street noise.

215. PORTABLE ACOUSTIMETER [with Visual Scale : for Several Types of Acoustical Measurements].—(*Journ. Scient. Instr.*, November, 1935, Vol. 12, No. 11, pp. 365–366.)

216. THE ACOUSTICALLY "DEAD" ROOM OF THE R.I.E.C., LEGHORN, FOR MEASUREMENTS ON APPARATUS AND MATERIALS.—(*Alta Frequenza*, August, 1935, Vol. 4, No. 4, pp. 495–501.)

217. ACOUSTICAL ABSORPTION AS A FUNCTION OF FREQUENCY AND ANGLE OF INCIDENCE [Measurement of Sound Beam reflected from Plane Surface of Absorbing Material].—F. A. Osborn and P. M. Higgs. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, p. 480 : abstract only.)

218. NEWER CONCEPTS OF THE PITCH, THE LOUDNESS AND THE TIMBRE OF MUSICAL TONES [General Account].—H. Fletcher. (*Journ. Franklin Inst.*, October, 1935, Vol. 220, No. 4, pp. 405–429.)

219. THE LOUDNESS OF CRACKING AND RUSTLING NOISES AND MUSICAL TONES [Linearity of the Ear].—W. Bürck, P. Kotowski and H. Lichte. (*E.N.T.*, September, 1935, Vol. 12, No. 9, pp. 278–288.)

A "crack" occurs as a transient phenomenon at the beginning and end of every musical note. The loudness of cracks of various durations (Fig. 1) is compared (§ 3 ; circuit Fig. 2, results Fig. 3) by determining the direct current of sudden onset (Fig. 1b) which various observers judged to be of the same loudness as the crack. An analytic treatment, using the Fourier-integral method, is given, and satisfactory agreement is obtained when the ear is treated as a linear receiver with a frequency characteristic given by its sensitivity curve, its time constant being about 50 msec. (§ 4). This disagrees with Steudel's conception of a non-linear ear (1933 Abstracts, p. 510). "The sensation of loudness is thus proportional to the deflection of an instrument which indicates effective values (*e.g.* a thermo-instrument) with the given time constant and connected to an e.m.f. with a time curve like that of the sound pressure through a filter resembling the sensitivity curve of the ear." Calculations are given for the loudness of the cracks occurring in film pure-tone technique and in dynamically-regulated amplifiers. These agree with experimental results. No non-linearity in the ear has been found to affect the observed loudness. Oscillograms of various sounds are given (Figs. 13, 14).

220. PUFF AND PROFILE THEORY OF THE VOWELS [Characteristic Vowel Profiles : Vibrations produced by Action of Glottal Puffs on Air in Vocal Cavity].—E. W. Scripture. (*Nature*, 14th Sept. 1935, Vol. 136, pp. 435–436.)

221. PHONEMES [Speech Sounds classified by Measurement-Numbers of Sound Tracks].—W. F. Twaddell : E. W. Scripture. (*Nature*, 19th Oct. 1935, Vol. 136, pp. 644 : 644–645.)

222. OVERLAPPING OF SPEECH SOUNDS [End of Vowel and Beginning of Consonant : Illustrative Records].—E. W. Scripture. (*Nature*, 9th Nov. 1935, Vol. 136, p. 759.)

223. THE VELOCITY OF SOUND IN FREE AIR IN THE FREQUENCY RANGE 3.5 TO 15 KC AS A FUNCTION OF HUMIDITY [Anomalous Dispersion Verified].—L. P. Delsasso and J. H. Munier. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, p. 481 : abstract only.)

224. THE ULTRASONIC VIBRATIONS OF SMALL PLATES [Chladni Figures up to 80 kc/s].—R. C. Colwell and L. R. Hill. (*Science*, 20th Sept. 1935, pp. 283–284.)

225. [Curved] PIEZOELECTRIC CRYSTAL GIVING CONVERGING SUPERSONIC WAVES [and Large Amplitudes at Focus].—J. Gruetzmacher. (*Zeitschr. f. Physik*, No. 5/6, Vol. 96, 1935, pp. 342–349.)

226. A SUPERSONIC TOTAL REFLECTOMETER FOR MEASURING THE VELOCITY OF SOUND IN AND THE ELASTIC CONSTANTS OF SOLID BODIES [Details of Experiments and Measurements of Various Metals and Glass].—W. Bez-Bardili. (*Zeitschr. f. Physik*, No. 11/12, Vol. 96, 1935, pp. 761–786.) *See* 2704 of 1935.

227. The Absorption of Supersonic Waves in Some Liquids [measured by Optical Diffraction: Results for Mixtures of Vaseline Oil and Petroleum].—P. Bazulin. (*Physik. Zeitschr. der Sowjetunion*, No. 3, Vol. 8, 1935, pp. 354–358: in German.)

228. Measurement of the Velocities of Supersonic Waves at Low Pressure [in Air and CO_2: Increase of Velocity with Decreasing Pressure: Possible Explanations].—E. J. Pumper. (*Physik. Zeitschr. der Sowjetunion*, No. 3, Vol. 8, 1935, pp. 300–310: in German.)

229. A Study of Arc Temperatures by an Optical Method [Determination of Sound Velocity by Photography of Sound Waves passing through Arc].—C. G. Suits. (*Physics*, October, 1935, Vol. 6, No. 10, pp. 315–322.) For previous work *see* 3113 of 1935.

PHOTOTELEGRAPHY AND TELEVISION

230. The Steady-State Response of a Network to a Periodic Driving Force of Arbitrary Shape [without Use of Fourier Analysis], and Applications to Television Circuits.—C. W. Carnahan. (*Proc. Inst. Rad. Eng.*, November, 1935, Vol. 23, No. 11, pp. 1393–1404.)

The periodic driving force is treated as a series of repeated transients: formulae are developed for the general response to several types of driving force encountered in scanning circuits, in terms of the general indicial response of the network. Applications to some typical scanning circuits are shown.

231. A New Amplifier for Cathode-Ray Oscillographs.—von Ardenne. (*E.T.Z.*, 31st Oct. 1935, Vol. 56, No. 44, pp. 1195–1197.)

Author's summary:—" The new amplifier gives a uniform voltage-amplification of 2 000 (1 200 in the earlier model of which Fig. 5 is the amplification curve) in the frequency range 0.2 c/s to about 2 Mc/s. The undistorted voltage-change at the output amounts to 500 v, so that a sufficiently deep oscillogram is obtainable even with insensitive cathode-ray oscillographs. For the sake of symmetrical working of the tube deflecting system the output stage is in push-pull. In a special model for a frequency range 0.2 to 2×10^4 c/s the attainable voltage amplification reaches 10^5." The actual text and illustrations refer to the earlier experimental model, going uniformly down to 0.5 c/s and up to 1 Mc/s, but a footnote mentions the improved model (same circuit) developed since the article was in publication and giving the 0.2 c/s to 2 Mc/s range and the 2 000 amplification quoted in the summary. All the models are mains-driven, with glow-discharge stabilisers so arranged that, in spite of the high amplification even at the very low frequencies, the effect of slow mains-voltage fluctuations is completely eliminated. The time constant of the grid coupling circuits is 20 s. Two arguments against increasing this value, so as to extend the frequency range still further downwards, are given on p. 1196 (paras. " 1 " and " 2 "): the second refers to the temperature of the valve-electrodes, particularly the grids.

232. A System for Amplifying the Photo-Currents of a 180-Line Cathode-Ray Television Transmitter.—A. D. Veisbrut and V. L. Kreutzer. (*Izvestia Elektroprom. Slab. Toka*, No. 7, 1935, pp. 11–26.)

When transmitting an image of 180 lines the amplifiers are required to operate at frequencies from 25 to about 540 000 c/s. In the present paper methods are indicated for preventing amplitude and phase distortion in resistance-coupled amplifiers operating over this frequency range. It is first suggested that in the case of multi-stage amplifiers corrective methods should be applied to each stage separately in preference to overall correction. The authors then proceed to examine the following two cases:—

A. *Correction at High Frequencies*. Dealing with amplitude correction first, the usual method of connecting a compensating inductance L in series with the coupling resistance R_a is discussed, and curves are given from which R_a and L can be readily determined in terms of permissible distortion, operating frequency, and grid/filament capacity of the subsequent stage. The phase relationship in the compensated circuit is next examined and curves are given for calculating the phase shift. It is shown that the requirements for the two corrections do not coincide and that in practice a compromise solution is to be aimed at.

B. *Correction at Low Frequencies*. The amplitude characteristic at low frequencies is determined entirely by the product $R_g C_g$, where R_g is the grid leak of the subsequent stage and C_g the coupling capacity. An additional compensating device is therefore required, and this takes the form of a resistance R_k, shunted by a capacity C_k and connected in series with R_a. In view of the difficulty of calculating R_k and C_k, a graphical method is proposed, and also a similar method for determining the phase shift. It is pointed out that for good reproduction the circuit in this case should be designed for the minimum phase shift.

In conclusion a description is added of a 7-stage amplifier which was designed on the basis of the above considerations. The voltage amplification factor of this is 200 000, and the amplitude and phase characteristics are practically straight up to frequencies of the order of 700 000 c/s.

233. Amplification in Television.—G. Krawinkel. (*Ann. des Postes T. et T.*, September, 1935, Vol. 24, No. 9, pp. 845–859.) French version of the paper dealt with in 1934 Abstracts, p. 623.

234. Cathode-Ray Tubes [Flared Tube replaced by Straight Cylinder with Concave End which combines with Convex Lens to throw Magnified Image on Viewing Screen].—von Ardenne. (*Wireless World*, 18th Oct. 1935, Vol. 37, p. 414.)

235. A Special Cathode-Ray Tube of High Beam Efficiency, with High Tension supplied by H.F. Oscillator.—George and others. (*See* 294.)

236. Chemical Materials used in Television Apparatus [Fluorescent Screens : Aquadag : etc.].—(*Electronics*, September, 1935, p. 40.)

237. New Time-Base Circuit [employing only Two Hard Valves in Push-Pull].—D. MacCarthy. (*Wireless World*, 4th Oct. 1935, Vol. 37, p. 367.)

238. Wide-Band Cable with New Kind of Insulation [Coaxial or Symmetrical Types, with Styroflex Insulation].—H. F. Mayer and E. Fischer. (*E.T.Z.*, 14th Nov. 1935, Vol. 56, No. 46, pp. 1245–1248.)

The symmetrical-type cable shown on the right of Fig. 5 is that used for the 12-km television circuit in Berlin (4 Mc/s band). Styroflex, derived from Trolitul, is about as flexible as paper and has a dielectric loss 75 times smaller. The special screening necessary for the coaxial cable, to keep out external interference, is discussed (Figs. 5, left-hand, 8 and 9). The attenuations of the two types are shown in Fig. 6 : in spite of the larger diameter of the symmetrical cable, it has a higher attenuation than the coaxial type.

239. Television Transmissions.—(*Wireless World*, 4th Oct. 1935, Vol. 37, pp. 371–372.) Technical details of the Baird and Marconi-E.M.I. systems to be employed at the experimental station now being erected in North London.

240. High-Definition Television : Specifications of the Baird and Marconi-E.M.I. Wave-Forms to be Radiated from the Alexandra Palace.—(*Electrician*, 4th Oct. 1935, Vol. 115, No. 2992, pp. 409 410.)

241. "The Status of Television in Europe."—Harrap : Cruse. (*Elec. Engineering*, November, 1935, Vol. 54, No. 11, p. 1276.) Prompted by Cruse's article (3964 of 1935). The Television Society questionnaire replies are mentioned.

242. Television [Survey of Present Position].—Warren and Kinman. (*B.T-H Activities*, July/Aug. 1935, Vol. 11, No. 4, pp. 127–130.) Concluded from preceding issue.

243. Television Transmitters Planned.—Farnsworth. (*Electronics*, September, 1935, pp. 28–29.)

244. Television at the 1935 Berlin Radio Exhibition.—R. Thun. (*Radio, B., F. für Alle*, October, 1935, pp. 179–184.)

245. Television—the Deaf-Mute's Telephone [Possibility of Lip Reading].—Panconcelli-Calzia. (*Radio, B., F. für Alle*, October, 1935, pp. 191–192.)

246. Screen Television.—I. S. Djighit and N. D. Smirnov. (*Izvestia Elektroprom. Slab. Toka*, No. 9, 1935, pp. 26–38.)

After discussing the principles underlying the solution of the screen-television problem, the writers describe a 3 000-element transmitting and receiving equipment constructed to their design at the Electrotechnical Institute, Moscow. Direct scanning is used at the transmitter, and a Kerr cell, arc lamp and lens disc combination provides an image on a screen 1 m square. Special amplifying apparatus is used.

247. The Secondary-Emission Multiplier.—Zworykin, Morton and Malter. (*Wireless World*, 22nd Nov. 1935, Vol. 37, pp. 539–540.)

General description of a new type of electron multiplier tube described and demonstrated before the Institute of Radio Engineers on 23rd Oct. 1935. "These valves may have a voltage amplification of several million in a single envelope with a signal-to-noise output that is from 60 to 100 times better than any existing amplifier. Furthermore, such an amplifier has a very wide frequency response, making it valuable for television . . . . Although the immediate application of the valve is to television, or sound movies, where a light source is the actuating impulse, Dr. Zworykin stated that thermionic cathodes can be used as well as photo-cathodes . . . . Valves shown by Zworykin had an output sensitivity of 10 amperes per lumen of light input—compared with the output of a good vacuum photocell of about 10 microamperes per lumen."

248. Characteristics of High-Vacuum Photo-cells with Secondary Radiation [Increase of Normal Saturation Current by Secondary Emission].—P. Görlich. (*Zeitschr. f. Physik*, No. 9/10, Vol. 96, 1935, pp. 588–592.)

For relevant papers see Farnsworth, 207 of 1935 ; Kluge, 1950 of 1935 ; Holst, de Boer, Teves and Veenemans, 1934 Abstracts, p. 331 ; P. Görlich, 1934 Abstracts, p. 41. A section of the cell used is shown in Fig. 1 ; it contains a secondary cathode *S*, consisting of two connected plates covered with a light-sensitive film, here made of Cs. Fig. 2 shows the circuit used and Figs. 3–7 give current/voltage characteristics for various values of the bias of the cathode relative to the secondary cathode. The increase of saturation current due to the secondary emission is clearly shown.

249. Investigation of the Frequency Variation of Gas-Filled Photocells in the Range 20–300 kc/s (approx.).—A. Raggendorf. (*Physik. Zeitschr.*, 15th Oct. 1935, Vol. 36, No. 20, pp. 660–673.)

The light incident on the photocell was modulated by a Kerr cell whose transparency was controlled by a.c. voltages of adjustable frequency. The a.c. part of the resulting photocurrent was determined by amplifying and rectifying it and measuring the resulting d.c. current by a sensitive rotating-coil instrument. Descriptions are given of the h.f. generator (§ C, circuit Fig. 6), the Kerr cell (§ D, Fig. 2, characteristic Fig. 3), the h.f. capacity-coupled resistance amplifier (§ E, scheme Fig. 4, circuit Fig. 5, appearance and construction Figs. 6, 7) and its calibration (§ F). Measurements and results are given in § G. The photocells employed are shown in Figs. 9 and 13, with characteristics in Fig. 10. Figs. 11, 12 and 14 give curves of photoelectric a.c. as a function of frequency for various cells, and Fig. 15 shows the general scheme of frequency variation. As the frequency increases, the photoelectric a.c. tends to a limiting value, in agreement with Ollendorff's theoretical predictions (1933

Abstracts, p. 107). The predicted oscillations in the curve were not found, but reasons are given for their absence in the photocells used.

250. The Dark Current from Barrier-Layer Photocells [Independent of Humidity over Normal Humidity Range: Much Larger Current in Atmosphere approaching Saturation].—P. R. Gleason. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, p. 486: abstract only.)

251. The Standardisation of Photoelectric Cells for the Measurement of Visible Light.—H. H. Poole and W. R. G. Atkins. (*Phil. Trans. Roy. Soc.*, Series A, 7th Aug. 1935, Vol. 235, No. 745 I, pp. 1–27.)

Details are given of an examination of representative types of vacuum emission and of rectifier photocells, which were standardised in light from different sources. Tables are given of constants for nineteen such cells.

252. A Simple Method for the Absolute Calibration of Photocells [Measurement of Photocurrent given by Illumination with Hefner Lamp].—H. Theissing. (*Physik. Zeitschr.*, 1st Nov. 1935, Vol. 36, No. 21, pp. 683–684.)

A quick method for the absolute calibration of a photocell of which the relative sensitivity curve is known consists in illuminating the cell by a source (*e.g.* a Hefner lamp) whose absolute sensitivity curve is known in the visible and near infra-red parts of the spectrum, and measuring the total photocurrent produced. The formula for obtaining the absolute sensitivity curve is given and illustrated by an example (Table 1).

253. Experiments to Elucidate the Spectral Photoelectric Multiple Selectivity at Various Surface Films.—W. Kluge. (*Zeitschr. f. Physik*, No. 9/10, Vol. 96, 1935, pp. 691–697.)

For previous work *see* 1934 Abstracts, p. 102: also 3151 and 3576 of 1935. Experiments are here described which confirm the writer's view that a distinction must be made between the centres to which the long-wave selective action is due and those causing the short-wave selectivity. Various surfaces of known spectral sensitivity are subjected to gradually increasing action of oxygen and their curves of spectral sensitivity are determined at various stages (Figs. 1–4). The work function is found to increase, while the emission diminishes. The long-wave maximum disappears with a very small amount of oxygen; its centres seem to be alkali particles adsorbed on the surface. A much greater degree of oxygen action is needed for the short-wave maxima to disappear. The position of the maxima in the spectrum does not change. A short general discussion of the relations with other photoelectric phenomena is given.

254. The Kerr Cell as a Light Modulator in Television and Sound Recording.—I. S. Djighit and N. D. Smirnov. (*Izvestia Elektroprom. Slab. Toka*, No. 8, 1935, pp. 31–35.)

For Smirnov's treatment of the neon tube, on the same lines, *see* 3574 of 1935. In the present paper the number of light gradations provided by the Kerr cell when used for television reception, and of sound gradations when it is used for sound-on-film recording, is determined experimentally. The term "light decibel," analogous to the sound decibel, is introduced for convenience in dealing with the light gradations. The nature of the relation between the "organised" signal and the "unorganised" signal (amplifier noise), and the masking effect of noise, are determined.

255. The Temperature Variation of the Electro-Optical Kerr Effect of Nitrobenzol at the Transition Point [between Two Liquid Phases: No Discontinuity of Kerr Constant].—Herzog. (*Zeitschr. f. Physik*, No. 3/4, Vol. 97, 1935, pp. 233–241.)

256. Notes on a High-Intensity Discharge Tube.—D. S. Stevens. (*Review Scient. Instr.*, September, 1935, Vol. 6, No. 9, p. 260.)
Improvements to the tube dealt with in 1541 of 1935.

257. A Point-Source Mercury Arc operating at Atmospheric Pressure.—R. Weller. (*Review Scient. Instr.*, September, 1935, Vol. 6, No. 9, pp. 289–290.)

MEASUREMENTS AND STANDARDS

258. [Rise in] the Electrical Conductance [and Small Decrease in Dielectric Constant] of Colloidal Solutions at High Frequencies [Measurements up to 16 000 kc/s: Increase in Conductance probably of Same Type as for Soils].—H. J. Curtis and H. Fricke. (*Phys. Review*, 1st Nov. 1935, Series 2, Vol. 48, No. 9, p. 775.)

259. On the Measurement of the Angle of Loss in Solid Dielectrics on Ultra-Short and Decimetre Waves.—K. A. Vodopianov. (*Izvestia Elektroprom. Slab. Toka*, No. 8, 1935, pp. 43–47.)

A discussion of special difficulties involved in such measurements. The method used is based on measuring the alteration in the width of the resonance curve of a Lecher system when a sample piece of the dielectric material is bridged across the conductors at one point. It is pointed out that on ultra-short waves it is necessary to take into account the losses in the Lecher conductors and also the alteration of the natural wavelength of the system when the short-circuiting metal bridge is displaced. A formula (1) is quoted in which these two factors appear. On decimetre waves a further complication arises from the difficulty, with such waves, of placing the dielectric exactly at the antinode. Accordingly a second formula (6) is derived covering the case when the dielectric is not at the antinode, and taking into account both its position and size. A table is appended showing the results of measurements with various dielectrics on a wavelength of 24 cm.

260. Frictional Dispersion of Polar Solutions with [Ultra-] Short Electric Waves [Variation with Temperature of Relaxation Time of Simple Dipole Molecule in Dipole-Free Solvent: Measurement of Dielectric Constant].—W. Müller. (*Ann. der Physik*, Series 5, No. 1, Vol. 24, 1935, pp. 99–112.)

261. A Method for the Simultaneous Determination of Dielectric Constant and Conductivity of Conducting Materials at High Frequencies (Two-Phase Bridge).—H. Gross and I. Hausser. (*Ann. der Physik*, Series 5, No. 2, Vol. 24, 1935, pp. 127–160.)

The method does not require the use of comparison resistances. A two-phase bridge is used (circuits Figs. 1, 14); this is an ordinary a.c. bridge, open at one corner and working with two e.m.fs, $\mathfrak{E}_m$ in the measuring arm and $\mathfrak{E}_v$ in the comparison arm. The amplitude of $\mathfrak{E}_v$ is kept constant but its phase is variable with respect to $\mathfrak{E}_m$, which is the standard. The theory of the method is given (§ A); tables and curves demonstrate the possibilities of the circuit and the choice of the most suitable elements to use with a given measuring condenser. § B describes the experimental arrangement (scheme Fig. 5), the theory and construction of the amplifier (circuit Fig. 6), the phase shifter (Figs. 7, 8), which depends on the use of a rotating magnetic field, its calibration (Fig. 12), the practical set-up and use of the bridge (Fig. 15), and its sensitivity (Fig. 17). The sources of error are discussed and auxiliary apparatus including the voltmeter and condensers is described. The method has been devised chiefly for application to physiological problems.

262. Application of Broadcast Waves to the Measurement of Dielectric Constants of Non-Conducting Fluids [Resonance Method simplified by taking Advantage of the High Degree of Frequency Constancy of Broadcast Waves as Oscillation Source: Measurements with Benzol and Nitrobenzol].—D. Doborzyński. (*Hochf:tech. u. Elek:akus.*, September, 1935, Vol. 46, No. 3, pp. 92–94.)

263. Dielectric Constant of Water Vapour [Accurate Data at Various Temperatures fall along Debye Line: Electric Moment of Water Molecule: Deviations from Linearity due to Polarisation contributed by Film of Water Molecules adsorbed on Insulator Surfaces].—J. D. Stranathan. (*Phys. Review*, 15th Sept. 1935, Series 2, Vol. 48, No. 6, pp. 538–544.)

264. Measurement of High-Frequency Dielectric Losses in Liquids [by Direct Method using Thermometer: Results for Various Organic Liquids].—M. Divilkowsky and M. Filippof. (*Physik. Zeitschr. der Sowjetunion*, No. 3, Vol. 8, 1935, pp. 311–318: in French.)

265. Precision A.F. Capacity and Power Factor Bridge.—(*Journ. Scient. Instr.*, October, 1935, Vol. 12, No. 10, pp. 328–329.)

266. Triode Bridge [for Measurement of High Resistances, Photoelectric Currents, etc.].—(*Journ. Scient. Instr.*, November, 1935, Vol. 12, No. 11, pp. 364–365.) For Brentano's work, on which this instrument is based, *see* 1929 Abstracts, p. 516.

267. A Routine Instrument for Measuring Small Capacities [for Tests on Moisture Content of Textile Fabrics, etc.: Ultra-Micrometer Circuit using Dynatron Oscillator with AVC].—J. L. Spencer-Smith. (*Journ. Scient. Instr.*, October, 1935, Vol. 12, No. 10, pp. 316–318.) It may also be used for recording (by c-r oscillograph) small rapidly varying tensions or pressures.

268. High-Frequency Differential Bridge for Impedance Measurements in the Broadcast Frequency Range.—(*Hochf:tech. u. Elek:akus.*, October, 1935, Vol. 46, No. 4, pp. 143–144.)

269. [Improved Circuits for] the Measurement of Effective Impedance by the Resonance Method [Introduction of Variable Resistance into Circuit under Test and Tuning Condenser into Circuit containing Current Source].—H. Nitschmann. (*Hochf:tech. u. Elek:akus.*, September, 1935, Vol. 46, No. 3, pp. 91–92.)

270. New Methods of Determination of Constants of Symmetrical Networks with the Aid of Impedance Measurements [where Attenuation Constant is Too High for Classical "Open and Closed" Method].—E. Selach. (*Journ. I.E.E.*, October, 1935, Vol. 77, No. 466, pp. 561–566.) For previous work *see* 2956 of 1935.

271. Measurement of Flux in Iron-Cored Coils and Realisation of a Direct-Reading Henry-Meter for Any Self-Inductance Whatever.—M. Robert and J. Faglia. (*Comptes Rendus*, 23rd Sept. 1935, Vol. 201, No. 13, pp. 520–522.)

The self-inductance of an iron-cored coil is defined as the ratio of the maximum flux Φ_m to the maximum current I_m. The theory shows that, when ohmic resistance is negligible, the measurement of Φ_m depends on that of the mean voltage across the coil, which may be measured by a voltmeter already described (1931 Abstracts, p. 567). I_m can be determined by the ammeter also described there. A circuit diagram is given of an apparatus for use when ohmic resistance is not negligible; the ohmic voltage Ri is automatically subtracted from the voltage across the coil and the method for negligible ohmic resistance is applicable.

272. The Exact Measurement of Electron-Tube Coefficients.—Hickman and Hunt. (*See* 161.)

273. Thermo-Transformers for H.F. Current Measurements [including Ultra-High Frequencies].—J. Stanek. (*E.T.Z.*, 14th Nov. 1935, Vol. 56, No. 46, p. 1258: summary only.)

274. A Valve Ammeter for the Measurement of Small Alternating Currents of Radio Frequency [up to 5 Mc/s: using Saturated Diode with M.C. Galvanometer: Current superposed on Filament Heating Current].—H. E. M. Barlow. (*Journ. I.E.E.*, November, 1935, Vol. 77, No. 467, pp. 612–617: Discussion pp. 623–628.) *Cf.* Martyn, 1930 Abstracts, p. 461.

275. ON THE APPLICATION OF THE ELECTROSTATIC VOLTMETER TO HIGH FREQUENCY MEASUREMENTS.—A. B. Sapojnikov. (*Izvestia Elektroprom. Slab. Toka.*, No. 9, 1935, pp. 66–68.)

An account of experiments carried out with the "Spindler and Hoyer" type of electrometer which operates on a similar principle to the gold leaf electroscope. The main object of the experiments was to determine the effect of frequency on the readings of the instrument. For this purpose the electrometer was connected across a variable condenser which in its turn was connected in series with a pick-up coil and a thermo-ammeter. The combined capacity of the condenser and electrometer was determined for each position by the method of beats. Currents of various frequencies were then induced in the circuit and the voltages across the variable condenser calculated and checked by direct readings of the electrometer. The results obtained indicated that within the wavelength range of the experiments (14 to 235 metres) the readings of the electrometer are independent of frequency.

276. A SELF-POWERED VACUUM-TUBE VOLTMETER OF HIGH SENSITIVITY: A SELF-CALIBRATING INSTRUMENT FOR PEAK MEASUREMENTS INCLUDING MODULATION CHECKING.—D. C. Duncan. (*QST*, October, 1935, Vol. 19, No. 10, pp. 42–44.)

277. INSTRUMENT FOR TESTING CIRCUIT COMPONENTS AT RADIO FREQUENCIES [the "Q-Meter"].—(*Journ. Scient. Instr.*, October, 1935, Vol. 12, No. 10, pp. 335–336.) *See* also 3196 of 1935.

278. BALLISTIC MEASUREMENTS WITH ELECTROMETER TUBE CIRCUITS [giving Increased Sensitivity and Decreased Error due to Statistical Fluctuations].—R. H. Varian and J. C. Clark. (*Review Scient. Instr.*, September, 1935, Vol. 6, No. 9, p. 284.)

279. THE FRENCH CENTRE OF MEASUREMENT AND CONTROL OF RADIOELECTRIC TRANSMISSIONS [at Noiseau].—G. Espinasse. (*Ann. des Postes T. et T.*, September, 1935, Vol. 24, No. 9, pp. 808–822.)

280. STANDARD FREQUENCY RADIO BROADCASTING SERVICE.—(*Tech. News Bull. Nat. Bur. of Stds.*, October, 1935, No. 222, pp. 97–98.)

281. LARGE INTERFERENCE WAVEMETER 6–6 000 m.—A. Habermann. (*Hochf:tech. u. Elek: akus.*, October, 1935, Vol. 46, No. 4, pp. 120–124.)

This wavemeter is an improvement on one designed in 1932 (Rohde and Schwartz, 1933 Abstracts, p. 49); the fundamental principle of double interference remains the same. The main alterations are "(1) the ranges in the coarse wavemeter are obtained by switches on a set of coils (Fig. 2) instead of by plug-in coils; (2) excitation by inductive reaction is used instead of the three-point circuit; (3) the ratio of ranges on the fine wavemeter is altered to 1 : 1.5 and the wavelength increased; the range is 80 to 120 m; (4) a ceramic ring-coil is used; (5) the temperature compensation of the fine wavemeter gives a temperature coefficient of $\pm 5 \times 10^{-6}$; (6) a crystal-excited 100 kc/s standard generator is built in; (7) the l.f. amplifier is two-stage and can be regulated." Details of these changes are given (wavemeter circuit Fig. 4); calibration shows the instrument to be accurate to 0.005% (§ VII) and reference is made to various applications (§ VIII).

282. LONGITUDINAL OSCILLATIONS OF RECTANGULAR QUARTZ PLATES [Three Types of Oscillations compared with Theory].—V. Petržilka. (*Zeitschr. f. Physik*, No. 7/8, Vol. 97, 1935, pp. 436–454.)

For previous work *see* 3184 of 1935. The present paper continues the investigation with an experimental study of the longitudinal oscillations in the direction of one or other of the sides, and of the two sides simultaneously, of a rectangular plate cut perpendicular to the optical axis. The theory is given and its results compared with those of experiment (Tables 2–8). The deviations from the theoretical results are discussed. Other modes of oscillation are theoretically possible but have not yet been found experimentally. Lycopodium figures of the nodal lines are shown (Figs. 2–25).

283. A GENERAL [Theoretical] SOLUTION FOR THE DISPLACEMENTS OF PIEZOELECTRIC MEDIA WHICH ARE SUBJECTED TO CONSTANT ELECTRIC FIELDS [with Specialisation to Case of α-Quartz: Close Prediction of Its Behaviour].—A. D. Hestenes and H. Osterberg. (*Physics*, September, 1935, Vol. 6, No. 9, pp. 291–293.)

284. SOME PIEZOELECTRIC AND ELASTIC PROPERTIES OF β-QUARTZ.—H. Osterberg and J. W. Cookson. (*Journ. Franklin Inst.*, September, 1935, Vol. 220, No. 3, pp. 361–371.)

The theory of the *yz*- and *zx*- shear modes is given; these modes are theoretically and experimentally shown to "exist independently in β-quartz, but not in α-quartz." "The piezoelectric and elastic properties of β-quartz are those which are theoretically characteristic of the hexagonal holoaxial class." At 847° C a transition point is found from β- to "γ-quartz" (which may be tridymite), which is not piezoelectric. A measured value of the elastic constant c_{44} is given. "β-quartz would be a valuable piezoelectric substance if it could be rendered stable at room temperature."

285. DIFFUSE SCATTERING OF X-RAYS FROM PIEZOELECTRICALLY OSCILLATING QUARTZ [No Effect of Oscillations on Diffuse Scattering: Effect on Laue Spots due to Change in Extinction Coefficient].—G. E. M. Jauncey and J. H. Deming. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, p. 462.)

286. PRINCIPLES IN DESIGNING A CRYSTAL HOLDER FOR A PIEZO-QUARTZ STABILISATOR.—Venkov. (*Izvestia Elektroprom. Slab. Toka*, No. 7, 1935, pp. 35–41.) Conclusion: *see* 3600 of 1935.

287. APPLICATION OF THE ELECTROMETER TRIODE TO THE DETERMINATION OF PIEZOELECTRIC CONSTANTS.—L. M. Myers. (*Brit. Rad. Annual*, 1934/5, pp. 15–20.)

288. [Curved] Piezoelectric Crystal giving Converging Supersonic Waves [and Large Amplitudes at Focus].—Gruetzmacher. (*See* 225.)

289. International and Absolute Electrical Units [Draft Memorandum of International Committee of Weights and Measures].—(*Nature*, 2nd Nov. 1935, Vol. 136, p. 728.)

290. Absolute Units and Electrical Measurements [Brief Explanation of Absolute and M.K.S. (Resistance) Systems].—R. T. Glazebrook. (*Nature*, 26th Oct. 1935, Vol. 136, pp. 667–669.)

291. Physical Units and Their Dimensions [Development of C.G.S. System: Arguments for Its Retention in Electrotechnics].—J. Larmor. (*Nature*, 5th Oct. 1935, Vol. 136, p. 548.)

SUBSIDIARY APPARATUS AND MATERIALS

292. Rays of Negative Ions in the Formation Period of High-Vacuum Cathode-Ray Tubes [produce Spot of Reduced Fluorescence on Screen].—von Ardenne. (*Arch. f. Elektrot.*, 5th Oct. 1935, Vol. 29, No. 10, pp. 731–732.)

During the process of formation of the cathode, a beam of negatively-charged oxygen ions appears to be emitted from it and to strike the fluorescent screen (from which the electrons have been deviated by a magnetic field). The subsequent fluorescing power of the spot they produce is reduced, but produces a disturbing effect on the images only at small anode voltages (below 3 000 v); the effect is scarcely noticeable at the higher voltages used in practical television. General observations on the phenomenon are here noted; it may be due to formation of a polarisation charge or to chemical changes in the material of the screen. *See* also Freisewinkel, 2383 of 1935.

293. Development of [High-Vacuum] Cathode-Ray Tubes for Oscillographic Purposes.—Orth, Richards and Headrick. (*Proc. Inst. Rad. Eng.*, November, 1935, Vol. 23, No. 11, pp. 1308–1323.)

Electron guns: light output, efficiency, space distribution of radiation, decay and spectral distribution, for willemite screens: starting and dynamic characteristics: electrostatic *versus* magnetic deflection: etc. With bibliography.

294. A Cathode-Ray Oscillograph for observing Two Waves [of Frequencies in Simple Multiple Relationship: by Electronic Switching Circuit].—George, Heim, Mayer & Roys. (*Elec. Engineering*, October, 1935, Vol. 54, No. 10, pp. 1095–1100.)

Using the special cathode-ray tube developed for television purposes (3205/6 of 1935) with high beam efficiency. "When the electron gun is operating properly, from 70 to 90% of the electrons leaving the cathode space charge reach the screen in the form of beam current. Consequently, the energy required to operate the electron gun is so small that it can be supplied from a small high-frequency oscillator." Both beam and sweep voltages are thus provided, with advantages in safety for television purposes. "Keystone" distortion is avoided by providing the two pairs of deflecting plates with grounded guard plates.

295. The Marconi High-Vacuum Cathode-Ray Oscillograph.—Young. (*Marconi Review*, July/Aug. 1935, No. 55, pp. 1–5.)

296. A Method of Electrostatically Biasing the Beam of a High-Speed Cathode-Ray Oscillograph [in both Abscissa and Ordinate Directions: without Additional Deflecting Plates: entirely Automatic].—Miller and Robinson: Ferranti Company. (*Journ. I.E.E.*, October, 1935, Vol. 77, No. 466, pp. 567–569.)

297. Cathode-Ray Tube Terminology [Tentative Definitions of Deflection Sensitivity: Gun-Current Efficiency, Screen (Luminous), Screen (Actinic) and other Efficiencies: Spot Distortion, etc.: Methods of Measurement].—Perkins. (*Proc. Inst. Rad. Eng.*, November, 1935, Vol. 23, No. 11, pp. 1334–1344: with bibliography.)

298. [Electrical] Disturbances in the Use of the Cathode-Ray Oscillograph [particularly at High Voltages (100 kV): Résumé of Most Common Disturbances and Their Elimination: Screening and Triple Spark Gap].—Messner. (*Arch. f. Elektrot.*, 5th Oct. 1935, Vol. 29, No. 10, pp. 722–728.)

299. Investigation of Electron Focusing by Concave Incandescent Cathode Surfaces with the Electron Microscope.—Kemmnitz, Knoll and Walcher. (*Zeitschr. f. Physik*, No. 9/10, Vol. 96, 1935, pp. 612–619.)

For previous work *see* 1933 Abstracts, p. 283 (r-h col.) and 439 of 1935: *also* Richter, 1934 Abstracts, p. 155, and Seemann, 533 of 1935.

The present paper describes an experimental confirmation of the view-point already adopted (*loc. cit.*) and an investigation with the electron microscope of the distribution of electrons throughout the space in front of curved incandescent cathode surfaces. The magnetic electron microscope used is shown schematically in Fig. 1; Fig. 3 shows the paths of electrons in front of a concave cathode and Figs. 4–7 give typical electron images for various cathode profiles. The geometrical electron optics of the image formation is finally compared with the experimental results.

300. Electron-Optical Investigations with the Braun High-Vacuum Tube [Measurements with Immersion Systems of Simple Construction].—Brüche. (*Arch. f. Elektrot.*, 10th Sept. 1935, Vol. 29, No. 9, pp. 642–654.)

301. Ion-Optical Images with Electric Lenses [Beam of Positively-Charged Potassium Ions forms Image on Fluorescent Screen: Comparison with Electron Images: Images of Surfaces emitting Ions].—Koch and Walcher. (*Zeitschr. f. Physik*, No. 3/4, Vol. 97, 1935, pp. 131–137.) *See* Knoll and Ruska, Abstracts, 1933, p. 51: Knoll, 1934, p. 219.

302. THE USE OF ELECTRON LENSES FOR β-RAYS [Magnetic Field Distributions and Optical Qualities of Various Electron Lenses : Single Electron Lenses producing Series of Electron Images from β-Ray Source detected by Geiger-Müller Counter : β-Ray Spectrograph of Two " Lenses " and Deflecting Magnetic " Prism "].—Klemperer. (*Phil. Mag.*, October, 1935, Series 7, Vol. 20, No. 134, pp. 545–561.)

303. THE THEORY OF IMAGE ERRORS IN THE ELECTRON MICROSCOPE [Three Errors produced by Rotation : Anisotropic Coma, Anisotropic Spherical Aberration, Anisotropic Drawing Error : Influence of Stop Position : General Optical Expedients with Rotational Symmetry : Necessary and Sufficient Condition for Rotational Errors to Vanish Identically].—Glaser. (*Zeitschr. f. Physik*, No. 3/4, Vol. 97, 1935, pp. 177–201.) *See* Abstracts, 1933, p. 399, and 1934, p. 107.

304. INVESTIGATION OF THE ELECTRON DISTRIBUTION IN THE FOCUS OF X-RAY TUBES WITH THE ELECTRON MICROSCOPE [Scheme of Apparatus with Magnetic Lens : Current Distribution in Focus of Tube : Potential Field and Electron Paths].—Dosse and Knoll. (*Arch. f. Elektrot.*, 5th Oct. 1935, Vol. 29, No. 10, pp. 729–730.)

305. ELECTRON OPTICS OF A 3000 kV X-RAY TUBE [Focal Length of Electron Lens less for Fast than for Slow Electrons : Focal Length of Electrostatic Electron Lens consisting of Two Coaxial Cylindrical Electrodes].—Webster, Hansen and Kirkpatrick. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, p. 486 : abstract only.)

306. A MAGNETIC ELECTRON LENS WITHOUT IMAGE ROTATION.—Stabenow. (*Zeitschr. f. Physik*, No. 9/10, Vol. 96, 1935, pp. 634–642.)

Two magnetic lenses through which the current flows in opposite directions are connected. Proper choice of the current strengths gives an inverted image, as in ordinary optics. This theoretical prediction is investigated experimentally, and curves are given for the angle of rotation of the image as a function of the ratio of the currents in the coils, for different positions of the coils along the tube (Figs. 4, 6).

307. MULTI-ELEMENT OPERATION OF THE CATHODE-RAY OSCILLOGRAPH [with Single-Element Tube, by Motor-Driven Commutating Discs].—Woodruff. (*Elec. Engineering*, October, 1935, Vol. 54, No. 10, pp. 1045–1047.)

308. A NEW AMPLIFIER FOR CATHODE-RAY OSCILLOGRAPHS.—von Ardenne. (*See* 231.)

309. TENDENCY TO OSCILLATION OF TUNED H.F. AMPLIFIERS AS A FUNCTION OF THE ANODE/GRID CAPACITY.—H. Frühauf. (*Hochf:tech. u. Elek:akus.*, September, 1935, Vol. 46, No. 3, pp. 90–92.)

" Calculations are given of the maximum allowable anode/grid capacity in the valve of a tuned h.f. amplifier. This capacity may be of the order of 10^{-2} μμF in modern circuits. A numerical example is given for a modern h.f. pentode with the usual oscillating circuits."

310. CONDUCTING FILMS IN HIGH VACUA [Defects of Usual Contact Methods avoided by " Cat's Whisker " and Drop of Colloidal Graphite].—Henshaw. (*Review Scient. Instr.*, September, 1935, Vol. 6, No. 9, pp. 287–288.)

311. THE POTENTIAL OF AN INSULATED COLLECTING SCREEN BOMBARDED BY ELECTRONS [*e.g.* Fluorescent Metallic Screen in Cathode-Ray Tube : Voltage Measurements : Screen Potential approximately That of Anode up to Voltage depending on Material and Angle of Incidence of Electrons : Secondary Emission].—H. Strübig. (*Zeitschr. f. Physik*, No. 7/8, Vol. 97, 1935, p. 538 : preliminary note only.)

312. LUMINESCENT MATERIALS FOR CATHODE-RAY TUBES [Comparison of Silicate, Sulphide, and Tungstate and Molybdate Phosphors for Various Purposes : Effect on Efficiency of Minute Manufacturing Details : Activators : etc.].—Perkins and Kaufmann. (*Proc. Inst. Rad. Eng.*, November, 1935, Vol. 23, No. 11, pp. 1324–1333.)

313. FLUORESCENCE, INTERMEDIARY MATERIALS, AND FLUORESCENT SYNTHETIC ORGANIC COLOURING SUBSTANCES.—Mougeot. (*Bull. Soc. franç des Élec.*, November, 1935, Vol. 5, No. 59, pp. 1132–1154.)

314. TWO APPLICATIONS OF THE SYLPHON BELLOWS IN HIGH-VACUUM PLUMBING.—Du Mond. (*Review Scient. Instr.*, September, 1935, Vol. 6, No. 9, pp. 285–286.)

315. SEAMLESS CORRUGATED FLEXIBLE METAL ELEMENTS.—Armleder. (*Zeitschr. V.D.I.*, 28th Sept. 1935, Vol. 79, No. 39, pp. 1175–1176.)

316. THE APPLICATION OF THE MAGNETIC FIELD TO THE FORMATION OF ION-ELECTRON BUNDLES [in Gaseous Discharges].—Slutzkin. (*Physik. Zeitschr. der Sowjetunion*, No. 3, Vol. 8, 1935, pp. 255–269 : in German.)

Method of bundle-production by concentration by magnetic field perpendicular to electric field : explanation of production mechanism : possibility of formation of strong ionic currents : factors influencing the current : passage of strong currents through narrow opening : production of relaxation oscillations.

317. ON ANCHORING THE MERCURY POOL CATHODE SPOT.—Tonks. (*Physics*, September, 1935, Vol. 6, No. 9, pp. 294–303.)

A number of metals have been examined and found to possess the property of " anchoring " the cathode spot. This depends upon wetting of the metal by the mercury and having a clean metallic surface. " The spot lengthens into a fine bright cathode line at the meniscus edge." This consists of " many small emitting areas in constant rapid and chaotic motion." Moving-film photographs showed that the details differed with the metallic anchor used. Cathode line phenomena are investigated, to explain the mechanism of spot freeing at large current densities: the upper limit for a circular anchored spot was found to be about 40 amp./cm.

318. THE CATHODE AS CURRENT LIMITER AND CURRENT CUT-OUT [Experiments with Mercury Cathode contained in Tungsten].—Nikiforow and Swiridow. (*Zeitschr. f. Physik*, No. 5/6, Vol. 97, 1935, pp. 398–401.)

The investigation refers to a mercury cathode with a very small surface, contained in a small tungsten tube. The arc extinction effect occurred when the current reached a certain strength. The phenomena depend on the cathode temperature. The chief cause of current limitation is recombination at the walls of the tungsten cylinder. Experimental data are given and explained by an equation due to Schottky and von Issendorf (*Zeitschr. f. Physik*, Vol. 31, 1925, pp. 162–202).

319. THEORY OF PHOTOGRAPHIC RECORDING PROCESSES AND THE PROBLEMS OF RESOLVING POWER, FINENESS OF TRACE, ETC.—Kaiser. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 16, 1935, pp. 303–314.) From the Carl Zeiss laboratories.

320. TWO METHODS OF MAPPING [Magnetic or Dielectric] FLUX LINES.—Godsey. (*Elec. Engineering*, October, 1935, Vol. 54, No. 10, pp. 1032–1036.)

With "resistance models" of low-melting-point waxes with carbon or graphite inclusions.

321. STYROFLEX, A NEW FLEXIBLE INSULATING MATERIAL.—Mayer and Fischer. (*See* 238.)

322. THE OPTIMUM FORMS OF IRON CORES FOR LIGHT-CURRENT CHOKE COILS AND TRANSFORMERS [Calculations].—P. Kotowski. (*E.N.T.*, September, 1935, Vol. 12, No. 9, pp. 271–278.)

The minimum loss for each individual dimension of the cores of ironclad and core transformers (Figs. 1, 2) is calculated in cyclical rotation, so that the absolute minimum and the optimum form can be determined. The iron losses in a closed iron circuit are first considered theoretically and the optimum air gap in the core is calculated by considering the variation of hysteresis losses with induction. The best approximation is found in general when the losses in the iron and the copper are equal. The optimum form is found to be independent of the permeability of the iron and the specific resistance of the windings, though losses with Al windings are found to be greater than with Cu. Table 1 gives the optimum dimensions of various transformers; their properties are described and various forms are illustrated in Figs. 3–6. The sharpness of the loss minimum is shown graphically in Fig. 7; comparison with other results and experimental tests are shortly described. *See* also 66.

323. THE ALLEI-FER-FREQUENTA COIL [with Sirufer-Iron Core and Holder of Insulating Material "Frequenta": Reduction of Ohmic Losses and Capacity].—(*Hochf:tech. u. Elek:akus.*, September, 1935, Vol. 46, No. 3, p. 98.)

324. FERROMAGNETIC PROPERTIES AT ULTRA-HIGH FREQUENCIES [125–47.5 cm Wavelengths: Permeability Tests on Iron, Nickel, and other Wires].—Sanger and Fejér. (*Helvet. Phys. Acta*, Fasc. 6, Vol. 8, 1935, pp. 492–493: in German).

325. PHYSICAL-TECHNICAL PROBLEMS OF FERROMAGNETISM AT WEAK FIELDS.—Goldschmidt. (*Helvet. Phys. Acta*, Fasc. 6, Vol. 8, 1935, pp. 497–498: in German.)

326. VARIATION IN INDUCTANCE OF IRON-FREE COILS DUE TO THERMAL EXPANSION [Theoretical Formulae: Methods of keeping Inductance Constant: Numerical Demonstrations].—Hak. (*Arch. f. Elektrot.*, 10th Sept. 1935, Vol. 29, No. 9, pp. 617-622.)

327. THE STABILITY OF INDUCTANCE COILS FOR RADIO FREQUENCIES.—Thomas. (*See* 82.)

328. CONTROL ARRANGEMENT FOR H.F. ENERGY LEADS [Coupled Comparison Leads with No Wave Reflection].—Leng. (German Pat. 607 336, pub. 27.8.1933: *Hochf:tech. u. Elek:akus.*, September, 1935, Vol. 46, No. 3, pp. 107–108.)

329. AN INEXPENSIVE D.C. AMPLIFIER [2A6 Duplex-Diode-Triode with Wall Galvanometer measures Current of 10^{-13} amp.].—Huntoon. (*Review Scient. Instr.*, October, 1935, Vol. 6, No. 10, pp. 322–323.)

STATIONS, DESIGN AND OPERATION

330. THE DROITWICH BROADCASTING STATION.—Ashbridge, Bishop and MacLarty. (*Journ. I.E.E.*, October, 1935, Vol. 77, No. 466, pp. 437–474: Discussions pp. 474–490.)

331. BROADCASTING IN INDIA [New Hyderabad Scheme].—(*Marconi Review*, July/Aug. 1935, No. 55, pp. 31–32.)

332. FRANCE WAKES UP [New French Regional Broadcasting Scheme].—E. C. Thomson. (*Wireless World*, 11th Oct. 1935, Vol. 37, pp. 388–390.)

333. ASYMMETRIC SIDE-BAND BROADCAST TRANSMISSION.—Eckersley. (*See* 83.)

334. BACKGROUND FOR SINGLE-SIDE-BAND 'PHONE: A SIMPLIFIED EXPLANATION OF MODULATION AND DETECTION PRINCIPLES.—Lamb. (*QST*, October, 1935, Vol. 19, No. 10, pp. 33–34.) This and future articles are based on an investigation asked for by the American Radio Relay League.

335. RADIO-DISTRIBUTION [Rediffusion] IN SOME EUROPEAN COUNTRIES [Survey of German, Swiss and Dutch Systems].—(*Ann. des Postes T. et T.*, October, 1935, Vol. 24, No. 10, pp. 921–937.)

336. THUNDERSTORM-WARNING APPARATUS FOR THE PROTECTION OF TRANSMITTING STATIONS AGAINST LIGHTNING.—AEG. (*E.T.Z.*, 17th Oct. 1935, Vol. 56, No. 42, p. 1157.)

337. THE RADIOELECTRIC INSTALLATIONS OF THE PACKET BOAT " NORMANDIE."—Villem and Aubert. (*L'Onde Élec.*, October, 1935, Vol. 14, No. 166, pp. 627–650.)

338. RECENT MODIFICATIONS AT PORTISHEAD RADIO STATION.—Potts. (*P.O. Elec. Eng. Journ.*, October, 1935, Vol. 28, Part 3, pp. 216–224.)

339. AN UNATTENDED ULTRA-SHORT-WAVE RADIO-TELEPHONE SYSTEM.—Schlaack and Polkinghorn. (*Proc. Inst. Rad. Eng.*, November, 1935, Vol. 23, No. 11, pp. 1275–1285.) *See* 3697 of 1935.

340. BUILDING BRIDGES BY RADIO [Ultra-Short-Wave Communication in San Francisco Bay Bridge Operations].—Tibbetts. (*Electronics*, September, 1935, pp. 7–9.)

341. A CONSISTENT ANTIPODAL EXPERIMENTAL CIRCUIT [Daily Communication between Washington and Watheroo—11 483 Miles—on 7-Mc Band].—Seaton and Lacey. (*QST*, November, 1935, Vol. 19, No. 11, pp. 15 and 74, 76.)

GENERAL PHYSICAL ARTICLES

342. CONTRIBUTION TO THE THEORY OF THE INFLUENCE OF THE MAGNETIC FIELD ON THE DIELECTRIC CONSTANT OF DIAMAGNETIC GASES AND LIQUIDS, *and* THEORY OF THE EFFECT OF THE MAGNETIC AND ELECTRIC FIELD ON THE DIELECTRIC CONSTANT.—Piekara. (*Acta Phys. Polonica*, Fasc. 1/2, Vol. 4, 1935, pp. 53–64: 163–176: in French.) For experimental work *see* 3712 of 1935.

343. THE ENERGY OF FORMATION OF NEGATIVE IONS IN O_2 [Attachment of Free Electrons to Molecules: Liberation of little more than 0.34 Electron-Volt of Energy].—Loeb. (*Phys. Review*, 15th Oct. 1935, Series 2, Vol. 48, No. 8, pp. 684–689.)

344. ON THE MECHANISM OF UNIMOLECULAR ELECTRON CAPTURE [Theory: Upper Limit of Electron Affinity: Dependence on Average Energy of Electrons].—Bloch and Bradbury. (*Phys. Review*, 15th Oct. 1935, Series 2, Vol. 48, No. 8, pp. 689–695.)

345. VISCOSITY OF AIR AND THE ELECTRONIC CHARGE [Discrepancies between Values of Electronic Charge measured by Oil-Drop and X-Ray Methods Explicable by Error in Viscosity Coefficient of Air].—Kellström. (*Nature*, 26th Oct. 1935, Vol. 136, pp. 682–683.)

346. REMARK ON ELECTROMAGNETIC WAVES OF DISCONTINUITY [in Anisotropic Medium: can Increase the Kinetic Energy of the Electrical Charges at the Expense of the Medium]. — Wisniewski. (*Acta Phys. Polonica*, Fasc. 1/2, Vol. 4, 1935, pp. 17–22: in French.)

347. DIRECT DETECTION OF THE ANGULAR MOMENTUM OF LIGHT [Measurement of Torque exerted on Quartz Plate by Beam of Circularly Polarised Light].—Beth. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, p. 471.)

348. THE RÔLE OF SPACE-CHARGE IN THE STUDY OF THE TOWNSEND IONISATION COEFFICIENTS AND THE MECHANISM OF STATIC SPARK BREAKDOWN [Space-Charge distorts Spark-Gap Field].—Varney, White, Loeb and Posin. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, p. 488: abstract only.)

349. THE THEORY OF THE GLOW DISCHARGE [Interpretation in Terms of Breakdown Curve for Same Gas and Electrodes].—Wheatcroft. (*Phil. Mag.*, October, 1935, Series 7, Vol. 20, No. 134, pp. 578–586.)

MISCELLANEOUS

350. A CONTRIBUTION TO THE SYMBOLIC CALCULUS [New Relations between Original and Image: Interpretation of Some Images: List of Results].—Niessen. (*Phil. Mag.*, November, 1935, Supp. No., Series 7, Vol. 20, No. 136, pp. 977–997.) *See* also van der Pol and Niessen, 1932 Abstracts, p. 300.

351. FRACTIONAL CALCULUS [and Conditions for Expansion of Complex Function in Riemann Series].—Fabian. (*Phil. Mag.*, November, 1935, Series 7, Vol. 20, No. 135, pp. 781–789.)

352. ON THE GENERAL SOLUTION OF A CLASS OF PHYSICAL PROBLEMS [Two-Dimensional Solution of Laplace's Equation with Rectilinear Boundaries].—Seth. (*Phil. Mag.*, October, 1935, Vol. 20, No. 134, pp. 632–640.)

353. ON POSITIVE HARMONIC FUNCTIONS IN A HALF-PLANE.—Verblunsky. (*Proc. Camb. Phil. Soc.*, October, 1935, Vol. 31, Part 4, pp. 482–507.)

354. STEADY FORCED VIBRATIONS OF SINGLE MASS SYSTEMS WITH SYMMETRICAL AS WELL AS UNSYMMETRICAL NON-LINEAR RESTORING ELEMENTS. — Jacobsen and Jespersen. (*Journ. Franklin Inst.*, October, 1935, Vol. 220, No. 4, pp. 467–496.) Practical method of solution of differential equation $m\ddot{x} + \alpha(x - c \sin \omega t) + \beta(x - c \sin \omega t)^3 = 0$, with experimental verification.

355. THE CIRCULAR AND HYPERBOLIC FUNCTIONS, ARGUMENT $x\sqrt{2}$, *and* THE CIRCULAR SINE AND COSINE FUNCTIONS, ARGUMENT $\log_e x$. —Airey. (*Phil. Mag.*, October, 1935, Series 7, Vol. 20, No. 134, pp. 721–731: pp. 731–738.)

356. THE USE OF [Heaviside] OPERATIONAL METHODS IN THE DYNAMICS OF CONTINUA [Theory of Operators: Application to Mechanics].—Baumann. (*Ann. der Physik*, Series 5, No. 1, Vol. 24, 1935, pp. 49–83.)

357. A GENERALISED INFINITE INTEGRAL THEOREM [Extensions to Heaviside Methods of Circuits Analysis].—Malti. (*Elec. Engineering*, November, 1935, Vol. 54, No. 11, pp. 1222–1227.) " Simplifying the mathematics of operational methods and giving a clearer insight into the connection between the physics and mathematics of transients."

358. OPERATIONAL METHOD OF CIRCUIT ANALYSIS [Fundamentals and Typical Examples: with Bibliography].—Robertson. (*Elec. Engineering*, October, 1935, Vol. 54, No. 10, pp. 1037–1045.)

359. THE PROPER DEFINITION OF THE VECTOR OPERATOR "*j*"—(*Electronics*, September, 1935, p. 5: Editorial.)

360. ON OSCILLATORY MATRICES [General Theorems].—Gantmacher and Krein. (*Comptes Rendus*, 7th Oct. 1935, Vol. 201, No. 15, pp. 577–579.)

361. SOLVED EXAMPLE ILLUSTRATING A NEW PROPERTY OF LEAST SQUARES [Vanishing of Cross-Product Term in Fitting by Least Squares].—Deming. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, p. 486: abstract only.) *See* 1241 of 1935.

362. RADIO RESEARCH IN AUSTRALIA [Notes on Australian Radio Research Board Reports on Polarisation, Propagation of Medium Frequency Waves, Atmospherics].—(*Nature*, 19th Oct. 1935, Vol. 136, p. 650.)

363. DIFFRACTION OF ELECTRONS, PROTONS AND POSITRONS FORMS NEW RESEARCH TOOL.—Phillips. (*Electronics*, September, 1935, pp. 24–26 and 42: with bibliography.)

364. THE INFLUENCE OF ULTRA-SHORT WAVES ON THE COMBUSTION VELOCITY OF GAS MIXTURES [20% Acceleration at about 9 m Wavelength].—Rossichin and Timkowsky. (*Physik. Zeitschr. der Sowjetunion*, No. 1, Vol. 8, 1935, pp. 100–104: in German.) For previous work *see* Malinowski, 1934 Abstracts, p. 633.

365. PROBLEMS OF THE SHORTEST RADIO WAVES [Survey].—Tank. (*Bull. Assoc. suisse des Élec.*, No. 19, Vol. 26, 1935, pp. 533–540: in German.)

366. "THE FUNDAMENTALS OF RADIO" [Book Review].—Ramsey. (*Proc. Inst. Rad. Eng.*, September, 1935, Vol. 23, No. 9, p. 1116.)

367. RADIO IN BOOKS AND JOURNALS OF THE YEAR 1934: A LITERATURE REVIEW.—Patermann. (*Telefunken-Zeit.*, August, 1935, Vol. 16, No. 71, pp. 52–54: to be continued.)

368. RECENT RESEARCH IN RADIO COMMUNICATION [Literature Review for Propagation, Ultra-Short-Wave, Television, Aerial, and High-Fidelity Research].—Hamburger. (*Elec. Engineering*, August, 1935, Vol. 54, No. 8, pp. 843–846.)

369. THE ORGANISATION OF A LIBRARY SERVICE IN SCIENCE AND TECHNOLOGY.—Bradford. (*Engineering*, 23rd Aug. 1935, pp. 202–203: to be continued.)

370. HISTORY OF ELECTRICAL MACHINES UP TO THE BEGINNING OF THE 19TH CENTURY [and the First Use of the Word "Electricity"].—Schimank. (*Zeitschr. f. tech. Phys.*, No. 9, Vol. 16, 1935, pp. 245–254.)

371. INVESTIGATIONS ON SHORT- AND ULTRA-SHORT-WAVE QUENCHED-SPARK GENERATORS FOR THERAPEUTIC PURPOSES.—Leistner and Schaefer. (*Physik. Berichte*, No. 16, Vol. 16, 1935, p. 1448.)

372. "GRUNDRISS DER KURZWELLENTHERAPIE" [Book Review].—Holzer and Weissenberg. (*Wireless World*, 15th March, 1935, p. 262.)

373. ANOMALOUS DISPERSION OF ULTRA-SHORT ELECTRIC WAVES (3–8 m) IN SOLUTIONS OF ORGANIC "ZWITTER"-IONS: A MOLECULAR RESONANCE PHENOMENON OF SPHINGOMYELIN.—Hausser, Kuhn and Giral. (*Naturwiss.*, 13th Sept. 1935, pp. 639–640.)

374. [Ultra-] HIGH-FREQUENCY CONDUCTIVITY OF ELECTROLYTES IN THE REGION OF ANOMALOUS DIPOLE ABSORPTION OF THE SOLVENT.—Kubo. (*Jap. Journ. of Phys.*, July, 1935, Vol. 10, No. 2, Abstracts p. 50.)

375. THE HIGH-FREQUENCY CONDUCTIVITY OF THE SOLUTION OF $MgSO_4$ IN A MIXTURE OF GLYCERINE AND WATER [Regular Deviations, inexplicable by Simple Theory, at −20°C].—Harada. (*Jap. Journ. of Phys.*, July, 1935, Vol. 10, No. 2, Abstracts pp. 50–51.)

376. SOME PHASES OF THE MITOGENETIC RAY PHENOMENON ["Oligoluminescence," "Gurwitsch" or "M" Rays].—Hollaender and Claus. (*Journ. Opt. Soc. Am.*, September, 1935, Vol. 25, No. 9, pp. 270–286.) For some of the past references *see* 1934 Abstracts, pp. 54, 110, 168, 284 and 340. The present paper contains a bibliography of 63 items.

377. FURTHER OBSERVATIONS ON THE POTENTIAL RHYTHMS OF THE CEREBRAL CORTEX DURING SLEEP.—Loomis and others. (*Science*, 30th Aug. 1935, pp. 198–200.) *See* 3290 of September.

378. THE MEASUREMENT OF RADIUM EMANATION IMPLANTS [Rapid Method based on Motion of Ionising Agent producing a Surge].—Macdonald and Campbell. (*Review Scient. Instr.*, August, 1935, Vol. 6, No. 8, pp. 212–214.)

379. ELECTRICAL PHENOMENA IN HUMAN BEINGS AND ANIMALS [including the Possible Conveyance of Speech to Deaf-Mutes by Loudspeaker Currents].—Koch. (*E.T.Z.*, 14th Nov. 1935, Vol. 56, No. 46, pp. 1248–1250: Discussion pp. 1263–1265.)

380. INTERFERENCE [with Delicate Apparatus] FROM D.C. MAINS WITHOUT CURRENT FLOW [Experiences with a Screened Biophysical Laboratory].—Boyd. (*Brit. Rad. Annual*, 1934/5, pp. 39–43.)

381. TEMPERATURES GENERATED BY THE PASSAGE OF HIGH-FREQUENCY ALTERNATING CURRENTS THROUGH ANIMAL TISSUE, WITH SPECIAL REFERENCE TO ELECTRO-SURGERY.—Huntoon. (*Phys. Review*, 1st Sept. 1935, Series 2, Vol. 48, No. 5, p. 478.)

382. TEMPERATURE INCREASE OF SMALL BODIES IN A HIGH-FREQUENCY FIELD [Mathematical Formulation of General Problem : Limits for Temperature Distribution in Microsystem (*e.g.* Bacteria Colony) deducible from Measured Distribution in Macrosystem].—Krasny-Ergen. (*Hochf:tech. u. Elek:akus.*, September, 1935, Vol. 46, No. 3, pp. 85–90.)

383. EARTH RESISTIVITY AND GEOLOGICAL STRUCTURE.—Card. (*Elec. Engineering*, November, 1935, Vol. 54, No. 11, pp. 1153–1161.)

384. DISTANT CONTROL OVER A.C. NETWORKS [by D.C. Signals superposed through Polarisation Cells instead of Resistances].—Schwab. (*Zeitschr. V.D.I.*, 13th July, 1935, Vol. 79, No. 28, pp. 863–864.)

385. "DIE TECHNIK DER FERNWIRKANLAGEN" [Tele-Metering and -Control : Book Review]. —Stäblein. (*Rev. Gén. de l'Élec.*, 24th Aug. 1935, Vol. 38, No. 8, p. 258.)

386. ELECTRICAL LINK TRANSMISSIONS BY ROTATING FIELD, WITH D.C. SUPPLY [Granat System for Telemetering, etc.].—Sornein. (*Rev. Gén. de l'Élec.*, 31st Aug. 1935, Vol. 38, No. 9, pp. 291–305.)

387. CARRIER-CURRENT TELEPHONY : SPEECH ON FREQUENCIES OVER 80 KC/S CONVEYED 400 KM WITHOUT REPEATERS ON DOUBLE OVERHEAD CIRCUIT OF 3 MM BRONZE WIRE, FREE FROM INTERFERENCE.—Vollmeyer. (*Elektrot. u. Masch:bau*, 15th Sept. 1935, Vol. 53, No. 37, p. 443.)

388. IMPROVEMENT OF TELEPHONIC TRANSMISSION ON PHANTOM CIRCUITS BY THE "DOUBLE-BAND" METHODS [as on German-Swedish Submarine Cable].—Chakravarti. (*L'Onde Élec.*, August, 1935, Vol. 14, No. 164, pp. 540–546.)

The "double-band" system, using the ordinary speech band in one direction and a carrier-current band, close to this, in the other, has several advantages. The writer here deals with his own application of this principle to the simultaneous use of two real circuits and the corresponding phantom circuit.

389. HIGH-FREQUENCY TELEPHONY ALONG HIGH-TENSION MAINS [Technical Requirements and Their Practical Satisfaction].—Wolman. (*Hochf:tech. u. Elek:akus.*, August, 1935, Vol. 46, No 2, pp. 64–67.)

390. A NEW CARRIER-CURRENT COUPLING CAPACITOR.—Eby. (*Elec. Engineering*, August, 1935, Vol. 54, No. 8, pp. 848–852.)

391. YEARLY MEETING OF THE VDE IN HAMBURG [Notes with Short Abstracts of Papers on H.F. Carrier Telephony, Condenser Dielectrics, Ultra-Short-Wave Generation, Ionospheric Cross-Modulation, Measurements of Broadcast Disturbance, etc.]—(*E.N.T.*, July, 1935, Vol. 12, No. 7, pp. 221–222.) *See* also 3565/7 and 3723/4 of 1935.

392. MICRO-WAVES TO DETECT AIRCRAFT.—Telefunken. (*Electronics*, September, 1935, pp. 18–19 : photographs and captions only.)

393. SHORT AND ULTRA-SHORT WAVES AT THE 1935 BERLIN RADIO EXHIBITION.—Wigand. (*Radio, B., F. für Alle*, October, 1935, pp. 173–178.)

394. OLYMPIA, 1935 : A SUMMARY OF TECHNICAL PROGRESS REVEALED AT THE SHOW.—(*Wireless Engineer*, September, 1935, Vol. 12, No. 144, pp. 481–490.) *See* also *Wireless World*, 23rd Aug. and 6th Sept. 1935.

395. OLYMPIA [a Stand-to-Stand Report].—(*Wireless World*, 16th Aug. 1935, Vol. 37, pp. 168–190.)

396. THE BERLIN RADIO EXHIBITION.—(*Wireless World*, 6th and 13th Sept. 1935, Vol. 37, pp. 266–269 and 277–278.)

397. PARIS RADIO EXHIBITION.—Aisberg. (*Wireless World*, 20th Sept. 1935, Vol. 37, pp. 328–330.)

398. RADIO EXHIBITIONS : SCIENTIFIC ASPECT NEGLECTED.—(*Wireless Engineer*, October, 1935, Vol. 12, No. 145, p. 527 : Editorial.)

399. THE 12TH GREAT GERMAN RADIO EXHIBITION. —Krawinkel. (*E.T.Z.*, 14th Nov. 1935, Vol. 56, No. 46, pp. 1251–1254.)

400. AN ELECTROMAGNETIC GUN DETECTOR [for Detection of Metallic Bodies : Mutual Inductance Balance].—Luck. (*Proc. Inst. Rad. Eng.*, July, 1935, Vol. 23, No. 7, p. 695 : summary only.) *Cf.* 3295 of 1935.

401. AN AID IN UNDERSTANDING ELECTRON TUBES AND THEIR APPLICATIONS [Bibliography and Index of American, and a few English, Articles].—McArthur. (*Gen. Elec. Review*, July, 1935, Vol. 38, No. 7, pp. 350–354.)

402 THE POSSIBLE APPLICATIONS OF GRID-CONTROLLED RECTIFIERS AND ELECTRONIC VALVES IN THE PAPER INDUSTRY.—Mehlo. (*E.T.Z.*, 22nd Aug. 1935, Vol. 56, No. 34, pp. 936–937.)

403 CATHODE-RAY OSCILLOGRAPH ENGINE INDICATOR.—Metropolitan-Vickers Company. (*Engineering*, 23rd Aug. 1935, pp. 183–186.)

404. DYNATRON ULTRA-MICROMETER FOR MOISTURE CONTENT AND VARYING TENSIONS IN TEXTILE MEASUREMENTS.—Spencer-Smith. (*See* 267.)

405. ULTRA-MICROMETER CIRCUITS USING ORDINARY VALVES : ELIMINATION OF VALVE AND BATTERY FLUCTUATIONS.—Dowling and O'Ceallaigh. (*See* 3823 of 1935.)

406. A METHOD OF SENDING LIGHT SIGNALS THROUGH FOGS [and Smoke Screens : Double Range obtained].—Nukiyama. (*Jap. Journ. of Phys.*, July, 1935, Vol. 10, No. 2, Abstracts p. 59.)

Some Recent Patents

The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each. A selection of abstracts from patents issued in the U.S.A. is also included, and these bear a seven-figure serial number.

AERIALS AND AERIAL SYSTEMS

434 409.—A half-wave aerial, suitable for television, mounted on the top of a metal pole and safeguarded from H.F. leakage losses.
Marconi's W.T. Co. Convention date (U.S.A.) 28th April, 1934.

1 999 258.—Directive frame aerial wound about a cylindrical core so that it responds only to the vertical magnetic field of the incoming signals.
W. van B. Roberts.

TRANSMISSION CIRCUITS AND APPARATUS

433 427.—Combined wireless transmitter and receiver using super-regeneration.
Cie Générale de T.S.F. Convention date (France) 6th February, 1934.

433 842.—Modulating micro-waves by passing them as a beam through vessels containing ionised gas.
Marconi's W.T. Co. Convention date (U.S.A.) 23rd December, 1933.

435 561.—Frequency-doubling circuit combined with means for modulating the output. For ultra short-wave working.
Radio Akt. D. S. Loewe. Convention date (Germany) 29th March, 1933.

435 565.—Transmitting circuit in which a constant ratio is maintained between signal strength and the amplitude of the radiated carrier wave.
Marconi's W.T. Co. and A. Banf. Application date 24th March, 1934.

1 999 143.—Controlling the amplitude of the carrier-wave in accordance with the strength of signal to be transmitted, and also making provision to offset distortion due to non-linear rectification at the receiving end.
L. Pungs.

2 000 130.—Transmission system for covering a wide band of frequencies, such as a combined television and sound programme. Includes multiplexing and repeating, and the application to wired-wireless. Single-side band modulation. Certain signalling channels may be dropped and others added at the repeating station.
L. Espenschied and E. I. Green (assignors to American Telephone & Telegraph Co.)

RECEPTION CIRCUITS AND APPARATUS

431 702.—" Switch " tuning-arrangement receiver which also cuts out background noise between stations.
Radio Frequency Laboratories Inc. Convention date (U.S.A.) 29th September, 1933.

431 755.—Variable-selectivity receiver comprising two intermediate-frequency channels arranged in parallel in the signal path.
Marconi's W.T. Co. Convention date (U.S.A) 29th November, 1933.

433 273.—Variable-selectivity receiver with adjustable iron-cored coupling-transformers in the intermediate-frequency stages.
N. V. Philips. Convention date (Germany) 18th June, 1934.

433 545.—Means for stabilising amplifiers against fluctuations in the supply voltages.
R. H. L. Bevan and others. Application date 16th February, 1934.

433 555.—Receiver in which silent tuning is ensured by breaking the circuit to the loud-speaker at all off-station settings.
J. H. Naden and C. G. H. Galloway. Application date 17th February, 1934.

433 707.—Receiver in which " quiet " A.V.C. is obtained by applying the rectified signal voltage in opposition to a fixed muting bias.
The Plessy Co. and C. E. G. Baily. Application date 14th February, 1934.

433 817.—Eliminating atmospheric disturbances by balancing the signal pick-up from two crossed frame-aerials.
B. von Trentini. Application date 29th May, 1934.

434 902.—Suppressing the " image " frequency in a superhet receiver by balancing the output from a pair of first-detector valves.
Marconi's W.T. Co. Convention date (U.S.A.) 12th August, 1933.

435 135.—Aerial-to-set input circuit comprising two branches which are balanced so as to eliminate inductive interference.
E. Bohm. Application date 19th March, 1934.

2 000 113.—Superhet receiver for covering a number of wave bands, in which the conversion gain of the first detector is kept uniform throughout the whole tuning range.
H. A. Wheeler (assignor to Hazeltine Corporation). Application date 16th November, 1933.

VALVES AND THERMIONICS

431 447.—Ultra-short waves are generated without the use of back-coupling by passing an electron stream through a hollow electrode which serves as a Faraday-cage " interrupter."
O. Heil. Convention dates (Germany) 23rd February, 1934, *and 29th January*, 1935.

431 599.—Short-wave oscillator in which an external Lecher-wire circuit is tuned by the interelectrode capacity into resonance with the working frequency.
General Electric Co., Ltd., and others. Application dates 17th April and 1st June, 1934.

434 818.—Multigrid valve suitable for use as a mixer in a superhet receiver.
Telefunken Co. Convention date (Germany) 8th March, 1933.

435 559.—Valve with apertured grids in which means is provided to vary the alinement of the apertures in order to regulate their effect on the electron stream.
C. S. Bull. Application date 23rd March, 1934.

DIRECTIONAL WIRELESS

432 500.—Fan-shaped array of aerials arranged to indicate the direction of incoming signals.
Marconi's W.T. Co. and C. S. Franklin. Application date 27th January, 1934.

433 026.—Compact short-wave directional equipment comprising a parabolic array of reflector-rods and an energised rod-aerial which forms an extension of the anode of an associated valve-generator.
N. V. "Meaf." Convention date (Germany) 3rd March, 1934.

433 843.—Directive aerial system which automatically changes its field characteristic to follow the particular direction from which a signal arrives.
Standard Telephones and Cables. Convention date (France) 5th May, 1934.

434 117.—Navigational system in which a more pronounced directional effect is secured by radiating a wireless beam divided longitudinally by a "silent" zone or crevasse.
Marconi's W.T. Co. and G. A. Mathieu. Application date 27th January, 1934.

434 637.—Directive aerial designed to radiate simultaneously two beams at an angle to each other.
Marconi's W.T. Co. Convention date (U.S.A.) 16th December, 1933.

1 999 232.—D.F. system used for directly calculating the direction and distance of a transmitter carried in a moving ship, etc. Used to avoid collisions in fog.
F. Eicke (assignor to Ship Control Corporation).

ACOUSTICS AND AUDIO FREQUENCY CIRCUITS AND APPARATUS

432 618.—Preventing grid-current distortion in mains-driven LF amplifiers by inserting a glow-discharge tube across the grid biasing potentiometer.
J. J. Numans. Convention date (Holland) 13th September, 1933.

437 112.—Gramophone motor with interchangeable resistance unit for adapting it to different supply voltages.
F. J. Offen and Garrard Engineering Co. Application date 20th April, 1934.

2 000 433.—Push-pull pentode amplifier provided with gain-control means so that both valves are accurately balanced at all times.
W. S. Barden (assignor to Radio Corporation of America). Application date 12th February, 1932.

TELEVISION AND PHOTOTELEGRAPHY

431 958.—Light valve, suitable for television, and designed to reduce the number of surfaces at which there may be a change of refractive index.
G. W. Walton. Application date 20th November, 1933.

432 989.—Television in natural colours.
Fernseh Akt. Convention date (Germany) 6th March, 1933.

433 295.—Preventing distortion due to fading in television.
Radio Akt. D. S. Loewe and H. H. Wolff. Convention date (Germany) 6th January, 1933.

434 274.—Method of correcting the tone values of a standard cinema film so as to make it more suitable for transmission by television.
Radio Akt. D. S. Loewe. Convention date (Germany) 31st January, 1933.

434 936.—High-speed cathode-ray scanning arrangement for film television.
Marconi's W.T. Co. Convention date (U.S.A.) 28th April, 1934.

435 103.—Correcting distortion due to the relative shift of the base of each successive line when scanning a continuously-moving film.
J. L. Baird and Baird Television, Ltd. Application date 15th December, 1933.

435 203.—Electrode system of cathode ray tube designed to eliminate the effect of fortuitous "wall" charges.
Radio Akt. D. S. Loewe. Convention date (Germany) 29th March, 1933.

435 574.—Eliminating distortion due to thermal agitation and to interelectrode-capacity effects when amplifying the output from a photo-electric cell.
D. M. Johnstone and Baird Television, Ltd. Application date 11th April, 1934.

1 999 378.—Time-base circuit for television in which means are provided for stabilising the frequencies generated in spite of small fluctuations in the supply voltages.
W. A. Tolson.

MEASURING APPARATUS

435 072.—Cathode-ray indicator for use on aircraft flying along a route mapped out by wireless beams.
Telefunken Co. Convention date (Germany) 26th September, 1933.

2 006 935.—Valve-amplifier with grid and plate circuits back-coupled through magnets impulsed by the teeth of a rotating stroboscopic disc. Used to measure the frequency of the electric mains or other source of A.C. supply.
L. J. Wolf (assignor to Westinghouse Co.).

MISCELLANEOUS

431 861.—Negative-resistance consisting of platinum pellets coated with a film of Vanadium oxide. Used as H.F. oscillator or amplifier.
E. Habann. Convention date (Germany) 13th January, 1933.

435 621.—Comparing and verifying barometric information transmitted by wireless from aircraft
J. Robinson. Application date 20th March, 1934.

437 201.—Construction of short-wave tuning unit which maintains a constant frequency in spite of temperature variations.
Telefunken Co. Convention date (Germany) 21st April, 1933.

A VALUABLE BOOK OF REFERENCE

The size of the above catalogue is 11″ x 8½″ over-all

Have you had your copy?

SECTION 7 of our catalogue (illustrated herewith) is a comprehensive work devoted to Measuring and Testing Equipment for the electrical and Communication Industries. It covers nearly fifty different precision instruments with full specification, factors and descriptive matter.

A Copy of this Book will be sent to any bona-fide enquirer.

OUR STAND AT THE PHYSICAL SOCIETY'S EXHIBITION WILL BE No. 82

MUIRHEAD & CO. LIMITED

MAKERS OF PRECISION INSTRUMENTS FOR OVER 50 YEARS

ELMERS END BECKENHAM KENT

[Telephone: BECKENHAM 0041, 0042]


FERRANTI
LP4
MADE IN ENGLAND
FERRANTI
H4D
MADE IN ENGLAND
VPT4
MOSTON
FERRANTI
ENGLAND

Printed in England for the Publishers, Iliffe & Sons Ltd., Dorset House, Stamford Street, London, S.E.1, by The Cornwall Press Ltd., Paris Garden, Stamford Street, London, S.E.1.