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AND

EXPERIMENTAL WIRELESS

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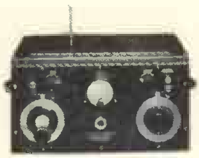	604	Recent developments have indicated that the radio-frequency transmission band around 56 Megacycles (5-Metres) holds most interesting possibilities, now being ceaselessly explored by up-to-date communications companies. The 604 Generator is useful in this work.	Range 3 to 100 Metres (100 Megacycles to 3 Megacycles). Has Capacity Attenuator, built in modulation with provision for variable external modulation. Output impedance .0002 mF: modulation input 5,000 Ohms R.-f. output: (a) Antenna 1 Volt and (b) at Jack, 5 to 10,000 microvolts.
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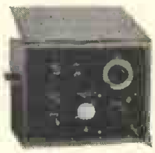
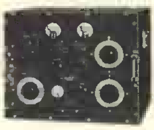
	601	Sensitivity measurements, etc., on batches of receivers on the production testing line. For airplane receiver and airway maintenance service. Also useful on field-intensity work.	Moderate precision combined with extreme portability and a very low price. Wide range (50 to 3,000 Metres). Ample Output. The ideal instrument for the smaller manufacturers.
	600	For extremely rapid checking, where the greatest possible speed and the highest possible precision are absolutely essential. Checks only the lower Broadcast waveband.	5-Channel selector, giving sensitivity and fidelity tests at 600, 800, 1,000, 1,200 and 1,400 KC, and selectivity tests at 600, 1,000 and 1,400 KC. Output 0.10 to 316,000 microvolts (= −26 to +104 DB).

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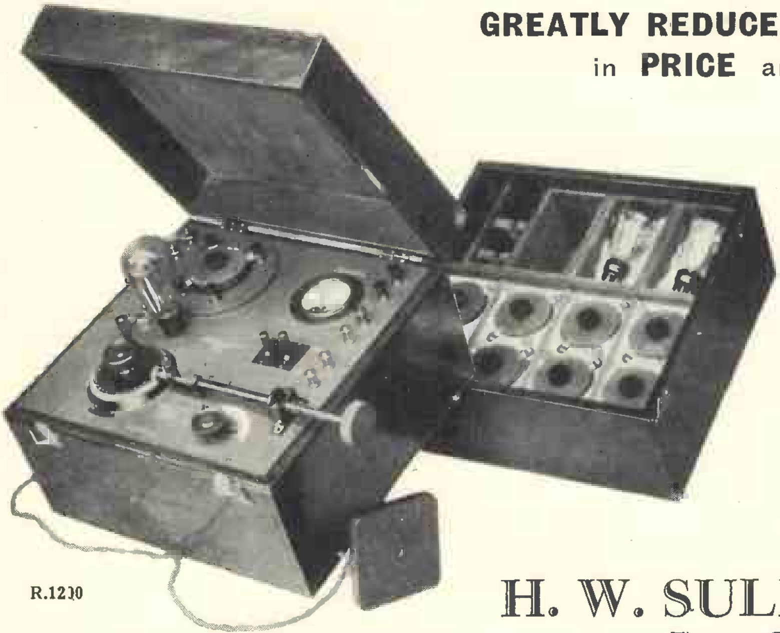

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The

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Editor
HUGH S. POCOCK

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

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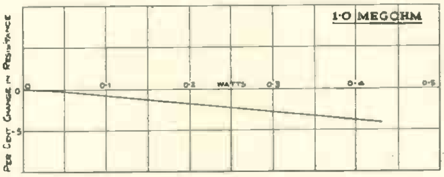

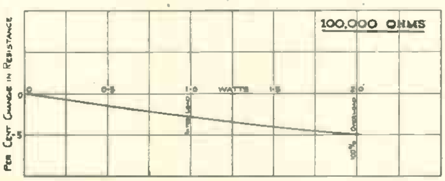

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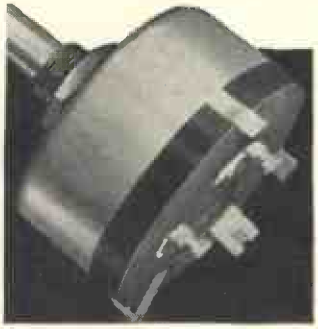

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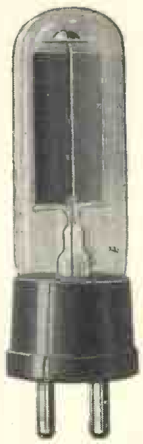

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THE

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VOL. X. APRIL, 1933. No. 115

Editorial

The Principles of Electromagnetism

IN our last number we published a letter from Professor Fortescue dealing with some of the points which were discussed in the January Editorial, and in the present number we publish letters from Mr. C. R. Cosens and Prof. Cramp dealing with the same subject. From these and from other letters which we have received, it is evident that the subject is one in which many people are deeply interested, and we therefore feel justified in returning to it.

We are pleased to note that Prof. Fortescue agrees with our criticism of the oft-quoted formula $f = m_1 m_2/\mu r^2$ and we must confess that if the unit pole is not misused in this way, but is used as a rigorously defined concept in air, we have no objection to it. It certainly lends itself to a simple treatment of many magnetic field problems, and we use it ourselves for this purpose. Our objection to the meaningless statement that the above formula applies when the poles are transferred from one medium to another is emphasised by Mr. Cosens in his letter.

A Unit Pole without Iron

There is a form of unit pole which can be transferred from one medium to another without any uncertainty as to its behaviour and which has other advantages over the historical unit pole of a permanent magnet. If a rod of square section—it need not be square, but this form lends itself to simple calculation—be wound uniformly with fine insulated wire and the rod be then removed, we shall have a coil similar to that shown in Fig. 1. We assume that the length is great compared with the side of the square section, and that the side is small compared with the centimetre. The leads to and from the coil can be used as a bifilar suspension. Two such coils can be made and, the current in each being the same, this current can be adjusted until the two like poles repel each other when the coils are placed 1 cm. apart in the same straight line with a force of one dyne. So long then as we keep this current

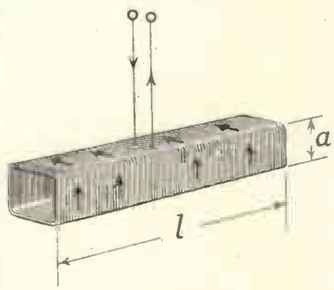

Fig. 1.

unchanged our coils have unit pole strength. It may occur to the reader that this would be one way of defining unit current. If l be the length of the coil, a the side of the square and T the number of turns, and we make the number of turns per cm. $T/l = 1/a^2$, and then carry out the above adjustment of current, we may define this current as our unit of current, but we shall be introducing no new unit, for it will be the old electromagnetic unit of 10 amperes. If the square rod has 1 mm. side it must be wound with 100 turns per cm. which sounds somewhat impracticable, but we will call such a coil a standard coil.

Now let one of our coils so constructed be placed at right angles to a magnetic field as shown in plan in Fig. 2. All the vertical

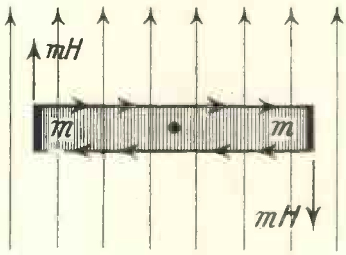

Fig. 2.

wires will experience forces as shown by the arrows and every force acts at an arm of $a/2$ about the centre of the coil. If I be the current in amperes, the force on each wire will be $BaI/10$ and the total torque will be $BaI/10 \times Ta = Ba^2TI/10$ where B is the magnetic induction of the uniform field in which the coil is placed. If the coil is a standard coil with $a^2T = l$, then the torque $= BlI/10$. Now let us come into line with the more familiar fiction and assume that the torque is really due to something called a quantity of magnetism m situated at each end of the coil and acted on by a force mH in the direction of the field. We can then equate this fictitious torque to the real torque and thus find m.

$$mHl = Ba^2TI/10 \quad \therefore m = \frac{B}{H}\frac{IT}{10l}a^2$$

and in a standard coil $m = \frac{B}{H}\cdot\frac{I}{10} = \mu\frac{I}{10}$

We have assumed m to be at the ends of the coil; in referring to permanent magnets the poles are often stated somewhat vaguely to be *near* the ends. If we consider the magnetic flux produced by the coil itself we have

$$\phi = B_c a^2 = \mu a^2 H_c = \mu a^2 \frac{4\pi}{10}\frac{IT}{l}$$

which is seen to be $4\pi m$.

If then the current be maintained constant the torque on such a coil will be proportional to the magnetic induction B of the field in which it is placed, but if on transferring it to another medium of different permeability, the value of the current be always adjusted until on reversal it gives the same deflection as before on a ballistic galvanometer connected to a coil wound around the middle of the coil, then ϕ is constant, and therefore also m, and the torque on the coil will be proportional to the magnetising force H of the field in which it is placed. This appears to be the assumption made for the unit pole of a permanent magnet, although in that case the change of medium is only external to the magnet.

The Nature of H and B

With regard to the vexed question of H and B Prof. Fortescue's letter shows that he does not realise the point of view of those who prefer to regard them as representing things of different natures, nor the reasons that led the International Electrotechnical Commission to give different names to the units of H and B. We suspect that the member of the Commission to whom Prof. Fortescue refers was seeking an excuse for avoiding further discussion when he gave the humourous reason for the action of the Commission. To many people the assertion that H and B are of the same nature savours of a claim to know more of the secrets of nature than have been revealed to the rest of us.

By the statement that the relation between the magnetising force H and the magnetic induction B can be regarded as in any way analogous to the relation between stress and strain, it must not be thought that it is suggested that magnetising force is in any way of the nature of stress, or magnetic induction of the nature of strain. We do not know enough of the real nature of either to warrant any such improbable assumption. What is suggested is that the mental concepts to which we give the names of magnetising force and magnetic induction are related to one another in a similar way to the mental concepts of stress and strain—perhaps it will make our meaning clearer if we add—or to the concepts of force and acceleration. It is a relationship between two related but different concepts which it is often convenient to regard as cause and effect.

A mechanical force F acts upon a test piece and causes throughout the material a phenomenon called strain to which a definite numerical value and direction can be assigned at every point. *Mechanical engineers introduce a concept to which they give the name "stress" and assume it to exist at every point of any cross-section such as that shown dotted in Fig.* 3. The actual force F is the original cause of the whole phenomenon, but so far as this dotted cross-section is concerned it is replaced by this concept of stress integrated over the whole area of the cross-section. (For the sake of simplicity we neglect the cosines of angles which enter into the integration.) The stress at each point is related to, and is often regarded as the cause of, the strain at that point. *The nature of this concept of stress is that of a force divided by an area.*

If the mental procedure which we have just outlined, and which is universally adopted in the study of mechanics, is allowable, are we not at liberty to follow the same mental procedure in considering the electromagnetic problem? We emphasise again that it is not a physical analogy which we are suggesting but the analogy of formation of concepts. If the following wording seems familiar a glance at the foregoing paragraph will show why.

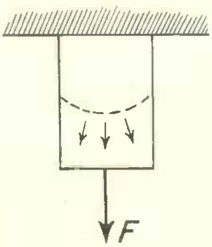

Fig. 3.

An electric current I acts upon a ring of iron (or wood, or air, or vacuum) and causes throughout the material or space a phenomenon called magnetic induction to which a definite numerical value and direction can be assigned at every point. *Electrical engineers introduce a concept to which they give the name "magnetising force" and assume it to exist at every point of any closed curve such as that shown dotted in Fig.* 4. The actual current I is the original cause of the whole phenomenon but so far as this dotted line is concerned it is replaced by this concept of magnetising force integrated over the whole length of the path. (For the sake of simplicity we neglect the cosines of angles which enter into the integration.) The magnetising force at each point is related to, and is often regarded as the cause of, the magnetic induction at that point. *The nature of this concept of magnetising force is that of a current divided by a length.*

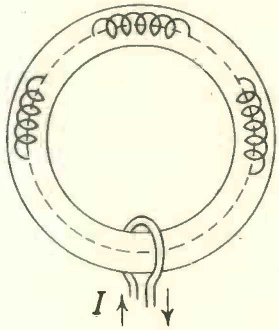

Fig. 4.

Just as the load F is replaced over the cross-section by a distributed system of forces, so the coil carrying the current I is replaced over the closed curve by a distributed system of current-carrying coils. Just as the stress will not be distributed uniformly, but the force per unit area at any point will be related to the strain at that point in a manner depending on a property of the medium known as Young's modulus, so the magnetising force H will not be distributed uniformly, but the ampere-turns per centimetre at any point will be related to the magnetic induction at that point in a manner depending on a property of the medium known as permeability (the Committee of the German V.D.E. proposed the name "induction constant").

It is open to anyone to refuse to use the concept of stress in the mechanical case or the concept of magnetising force in the electromagnetic case and to maintain that they can get on quite well without it. People sometimes boast that they can perform some feat with one hand tied behind them, but *cui bono?* It is also open to anyone to assert that he has been granted a deeper insight into the secrets of nature and that it has been revealed to him that the apparent cause and effect—whether stress and strain or magnetising force and magnetic induction—which appear so different to other people are really of the same nature and only differ from each other as a foot differs from a yard.

In his letter Prof. Fortescue says that

"stress and strain admit of independent measurement—the one by the load and the other by the extension—whereas in the magnetic case there is only one possible measurement, *i.e.*, the mechanical force on an elementary pole." We maintain that in each case there are three quantities capable of measurement; in one they are force or load, area, and strain or total extension, in the other, current, length, and magnetic induction or total flux. Not only are these capable of measurement but they are in each case the three magnitudes which are actually measured, or deduced from the readings of spring balances, extensometers, ammeters, flux meters and foot-rules.

What we have outlined here is the justification for what we are pleased to see Prof. Fortescue refers to as the more usual point of view, and although he claims to have been driven to a contrary point of view by "the logic of the situation," we would suggest that logic is like the railway; it will take you anywhere depending on the train you happen to get into.

With regard to his closing remark that the stress-strain analogy unlike the conception of the magnetic particle does not stand upon objective experiment, we will leave our readers to form their own opinion whether what we have outlined above—which, although parallel with, is entirely independent of any stress-strain analogy—or Prof. Fortescue's magnetic particle stands the more firmly upon objective experiment.

Mental Concepts and Physical Analogies

We have emphasised that we do not suggest that H is of the nature of a stress nor B of the nature of a strain. If one were to attempt to derive from a comparison of electromagnetic phenomena such as wave propagation and the storage of energy in electric and magnetic fields with the corresponding mechanical phenomena an analogy between the two sets of concepts, one would certainly look for the analogy to the static phenomena of stress and strain in the static phenomena of electric force and electric displacement. This would suggest that the electromagnetic analogy to Young's modulus is in the permittivity of the medium, or rather its reciprocal and not in the permeability.

If mechanical force is applied to matter which can move freely without resistance it causes a uniform increase in the velocity, and the relation between the acceleration and the applied force depends upon the dimensions of the body and a property of the material known as its density. Similarly, if electromotive force is applied to a perfectly conducting circuit, *i.e.*, to electricity which is free to move without resistance, it causes a uniform increase in the current and in the magnetic induction at every point, and the relation between the rate of growth of the current and the applied electromotive force depends upon the dimensions of the circuit and a property of the medium known as its permeability. It is interesting to note that the rate of increase of B depends only on the applied electromotive force and is independent of the medium, whereas the rate of increase of the current and therefore of H is inversely proportional to the permeability of the medium. This suggests that B would be more correctly associated with the cause, and H with the effect which depends on the nature of the medium. This reversal of the ordinary conception has been pointed out by Livens, but we do not think that any useful purpose would be served by following up this analogy.

In conclusion we wish to say that, however possible it may be to do so, we feel sure that any attempt to merge the various pairs of concepts which we have considered—whether it be stress and strain, force and acceleration, or magnetising force and magnetic induction—into one, would be a retrograde step in the evolution of the system of concepts by means of which we describe and calculate mechanical and electromagnetic phenomena.

G. W. O. H.

Iron-Content Cores for High-frequency Coils

By Alfred Schneider

THE idea of the employment of magnetic core materials for high frequency coils has recently come to the fore again through the development by Hans Vogt of the so-called "Ferrocart" material, so that in view of the interesting editorial in the January issue of *Wireless Engineer*, some further contribution about the theoretical considerations which led to this remarkable new magnetic material may be of interest to wireless engineers.

Theoretically speaking, the conclusion given in the editorial, that very thin iron wire, insulated and wound in the direction of the magnetic flux, should give the highest permeability at lowest losses, is doubtless correct, but also the doubts of the editor as to price and possibility of manufacturing such very thin wire, are perfectly justified.

As a matter of fact, the inventor of Ferrocart, when starting his researches, thoroughly examined the problem of making the material of insulated iron filaments ; the calculations proved, however, that the diameter of such wire would have to be less than 5μ, i.e., 0.005 mm. The difficulties of drawing filaments of this diameter out of the special alloys required for high frequency, of insulating them and of making cores of such wire, proved to be so enormous, however, that such a material could not be produced at a marketable price.

Vogt therefore tried to attain the same effect in another way, and, indeed, by his method a material was created, of a structure, which in its effect is almost identical with the ideal one of insulated magnetic filament, although for technological reasons he starts from iron particles and not from filaments.

The structure of the Vogt iron (Ferrocart) will be clear from Fig. 1. The insulated iron particles, having a shape similar to an ellipsoid and being of a very small size, are arranged in a very thin layer on an insulating paper strip, small channels are then made so as to sub-divide the continuous layer into small strips. These two stages, continuous layer and sub-division into channels, are shown in magnification. Now, by means of a D.C. solenoid coil through which the paper strip passes in its further course, the semi-liquid iron layer is solidified, the particles being all aligned in the longitudinal direction of the paper strip and solidified in this position. Thus, many continuous chains of particles, being interrupted by the thin insulating skin of each particle only, are

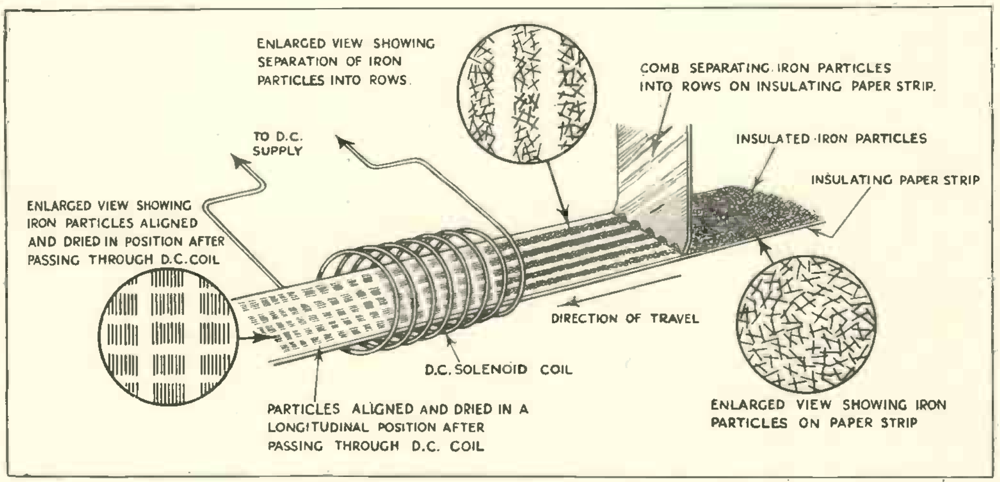

Fig. 1.—*Illustrating the processes in the manufacture of Ferrocart*

obtained in the longitudinal direction. As can be seen from Fig. 2, the coil cores are built up of many layers of such paper strips, which are jointed by a hot liquid binder. The paper strips are so arranged in the core, that their longitudinal axes corresponds to the direction of the magnetic flux in the coil.

From the above explanations it will be clear that in this case it is actually possible to base the calculation on the assumption that ellipsoid particles are in question, having their longer axes in the direction of the magnetic field. In fact through the particular arrangement and magnetic aligning the effect of insulated magnetic wire is so to say "imitated," the more so as the magnetic alignment also causes the particles to separate transversely due to the repelling force developed by their identical magnetisation. In addition, the magnetic alignment has a further favourable effect in so far as the objectionable end surfaces of the particles, which are difficult to insulate and tend to destroy the insulating skin of the neighbouring particles, are all directed so as to be in the longitudinal direction, where a metallic contact not only is without danger with regard to eddy current (as the eddy current electromotive forces are induced only in the transverse direction parallel to the inducing windings), but even desirable to improve the magnetic conductivity. Now, the question may be raised why, if each particle is insulated individually and aligned, the additional sub-division by paper and grooves is necessary. There are two reasons for doing this.

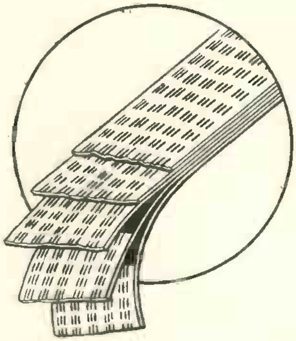

Fig. 2.—*Showing how Ferrocart is built up.*

First, as a matter of fact, the insulating skin around each particle is very thin and *must* be very thin in order to have a sufficient proportion of iron in the composition to obtain a reasonable permeability. Increasing the insulating skin by only a few millionths of a millimetre considerably reduces the effective permeability, because the proportion of iron is decreased, and the air gaps between the particles are augmented. Therefore the particles cannot be absolutely insulated from each other, although the contact resistance between the particles is rather high. Accordingly, a composition of such particles, without additional subdivision, represents a sort of semi-conductor, having a conductivity intermediate between that of good electric conductors and good electric insulators, as has been stated by one writer.* Accordingly, such compositions still represent a certain path for eddy currents, and, due to the relatively great electromotive forces, induced by the high frequency currents, especially with frequencies beyond 500 kilocycles, considerable eddy current losses are produced. To prevent these losses it has been proposed to remove the core with increasing frequency, thus effecting the so-called "permeability tuning."* This method, however, has not found its way into practice for various reasons. Vogt, on the contrary, as explained above, has found a definite solution of the problem of creating a material with low losses, even at frequencies beyond 500 kilocycles, by preventing the eddy currents from extending over the whole magnetic core by additional sub-division in the form of intermediate paper layers and grooves in the magnetic layers.

The intermediate paper layers and the grooves, however, have still *another function* than forming an interruption for galvanic eddy current, and this is the most remarkable new feature of the Vogt iron. As a matter of fact, many authors hitherto, when dealing with the question of magnetic compositions, have expressed the opinion that the losses cannot all be ascribed to hystereses and eddy currents, but that an unknown additional source of losses exists, the nature of which could not be determined. Also in the Editorial in the January issue, these additional losses are referred to and the hypothesis is mentioned according to which the losses might be due to mechanical movement of the particles in the insulating matrix.

From the investigations made in connection with the Vogt iron, it became obvious that such additional losses actually exist and represent a considerable share of the

* R. H. Langley, *Proceedings of the Radio Club of America*, April, 1932.

total losses in the magnetic core. Mechanical movements, however, proved not to be the cause, and, indeed, it is quite improbable that there should occur any mechanical movement of the particles in the matrix in consideration of the fact that the particles, which of course could be caused to move only by the changing magnetic field, would have to make about a million oscillations per second in both directions in the case of high frequency induction coils ; that means, they would practically remain in their original position like the pointer of a D.C. measuring instrument when connected to A.C. Indeed, the actual source of the additional losses is to be found from quite a different and new electro-physical consideration. There are produced in the core not only galvanic eddy currents, flowing in each individual particle and extending over a group of particles being in contact with one another, but also eddy currents, due to capacitive coupling, which were termed "capacitive eddy currents." Each two magnetic particles, which are separated from each other by the insulating skin, form a little condenser, the insulating skin representing the dielectric and the two particles representing the two condenser plates. Thus a capacitive coupling is formed and the eddy current, which cannot flow in the usual galvanic way due to the insulating skin, passes as a dielectric displacement current from particle to particle. This is, of course, possible only in the case of high frequency, where the capacitive effects are very considerable.

Low Losses Explained

This is the fundamental new discovery on which the Vogt iron is based, and, having discovered this source of losses, it was possible to take steps against them ; thus the additional sub-division was so dimensioned as to form not only an interruption for galvanic eddy currents but also to form a high "capacitive resistance" between the various groups of particles. In fact, measurements showed that although a thin intermediate paper layer was perfectly sufficient to insulate one layer of magnetic composition against the next one, the losses were further reduced by making the paper thicker (this is identical to increasing the distance between two condenser plates to increase the capacitive impedance). Also the dielectric conductivity of the insulating layer and of the insulating skin of each particle has a considerable effect.

This phenomenon is the principal reason for the low losses of the Vogt iron, and this also will explain why other inventors, although using very finely divided and well insulated iron particles, could not attain a definite success especially in the short wave range 200–600 m, but had to make the core movable, withdrawing it from the coil at these shorter waves.

Further Observations

In this connection, some other observations made during the researches in connection with Ferrocart may be of interest. First, the conclusions in the January Editorial, regarding the maximum attainable resulting permeability and regarding the influence of the specific permeability of the magnetic particles are perfectly verified by these investigations. Considering the fact that with regard to the above explained capacitive eddy currents the iron must be finely distributed, the share of magnetic material must be rather low, and therefore the specific permeability of this material is of quite an inferior importance due to the influence of the many small air gaps between the particles. In fact, the resulting permeability cannot be increased much beyond 18 without increasing the losses to an extent far outweighing the advantages of the higher permeability.

Another question, often raised with regard to such magnetic compositions, is whether the permeability is constant over a wide range of different loads. Indeed this question is of particular importance in case of tuning coils, for any change of the permeability would mean a change of the inductance, in other words, of the syntonisation. These objections are doubtless justified and in fact in the case of transmitter coils due care must be taken that the saturation current is not reached. In case of receivers, however, the magnetic fields are so extremely weak that the magnetic induction is strictly proportional to the magnetic field intensity, in other words, the permeability is constant.

I hope to have contributed in some way to elucidating the actual conditions, effects and properties of magnetic compositions under high frequency conditions.

Broadcasting on 7.85 Metres*

Experimental Work in Amsterdam

By P. J. H. A. Nordlohne

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FROM November, 1930, till October, 1931, the Physical Laboratory of N. V. Philips' Gloeilampenfabrieken, Eindhoven (Holland), carried out experiments on broadcasting on a wavelength of 7.85 m., first in Eindhoven, and then, from April 1931, in Amsterdam.

These experiments were intended as a test of the usefulness of such a wavelength for *local* broadcasting. That this broadcasting remains local, is due to the fact that :

1. Oscillations of such a high frequency (of the order of 40,000 kc/s.) are not reflected back to earth from the Kennelly-Heaviside layer ;

2. The direct rays cannot follow the curvature of the earth-surface to any great extent.

The absence of rays reflected from the upper atmosphere (the so-called indirect rays) has the advantage that fading and distortion, often involved thereby, do not occur. The reliability of the communication is the same during the whole of the 24 hours and is only dependent on local surroundings. Experience has taught that the condition of the lower atmosphere has no influence on the transmission over a few kilometres as required for local broadcasting in cities.

The experiments for testing the usefulness of such short wavelengths for local broadcasting involved the study of the *emission* as well as the *transmission* and the *reception* which will all be treated separately here.

As far as we know the Philips experiments are the first of that kind conducted in Holland, but we are aware that much research has been carried out abroad.

Dunmore and Engel (1) in 1923 reported on experiments with a wavelength of 10 metres and called attention to the nearly complete absence of atmospheric disturbances.

Wells (2) in 1925 described experiments of the Marconi Co. in 1922 and following years with a wavelength of 4 to 6 metres near Inchkeith. Also the French experiments from the Eiffel Tower are well known ; they were described by Beauvais and Mesny (3) in 1927. Further, the publication of Jouaust and Beauvais (4) relating to experiments between Fort de la Rève near Nice and the Col de Téghine on Corsica is well known ; a wavelength of 5 metres was used for this communication. The last-named authors claimed a range over sea that was 30 per cent. more than could be calculated from a consideration of the curvature of the earth-surface. They observed a pronounced dependence of the field on the condition of the lower atmosphere, as a result of an elevation or sinking of the electrical horizon, due to scattering.

Very much experimental work has been done by the Radio Corporation of America some years ago (5), using frequencies from 30,000 to 60,000 kc/s. These experiments led to a radiotelephonic communication among islands of the Hawaian group, covering distances of 200 miles with a wavelength of 8 metres, so that this communication could be connected to the international radio-telephone network. The transmitting as well as the receiving aerials were built on high hills or mountains. Radiotelephony was used because of the difficulty and cost of laying cables in the very deep seas separating the islands. Experiments with aeroplanes were also carried out. A ferry-boat over the Hudson was equipped with an installation for wireless navigation in foggy weather with much success. In connection with these latter experiments attention was called to the possibility of local wireless broadcasting provided the transmitting aerial has an elevated position.

Interesting experiments also were those carried out in 1929 by Gerth and Scheppmann (6), in aeroplanes and from the Brocken in the Harz Mountains (Germany).

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* Lecture held before the Nederlandsch Radio Genootschap at Amsterdam on February 13th, 1932.

Experiments have been carried out by Dr. Schaeringer, in the neighbourhood of Salzburg, but not published so far as I know.

Very important are the researches of Prof. Dr. A. Esau (7), Physical Institute in Jena (Germany). Prof. Esau perhaps is the first who systematically tested the usefulness of wavelengths below 10 metres for broadcasting in cities, for which purpose already in 1929 experiments were made in Chemnitz, repeated in 1930 with the aid of a multistage transmitter built by the C. Lorenz A.G. in Berlin. Later on this transmitter was removed to Berlin, in which city the experiments were continued in co-operation with the " Reichspost." Esau has also used ultra-short waves for communicating between the engine-driver and the guard of a long goods-train.

Dr. F. Schröter (8) has described experiments carried out in 1930 by the Telefunken Co. Dr. Schröter explains the possibilities for local broadcasting, and emphasises the particular usefulness of ultra-short waves for television, due both to the possibility of using a broad frequency-band, and to the absence of fading, and, as a consequence, of selective fading.

The experiments in Amsterdam undertaken by the Philips laboratory have confirmed that local broadcasting on an ultra-short wavelength of 7 to 8 metres is possible with simple receiving apparatus and with a transmitter of ¼ to ½ kw. aerial-power ; that this broadcasting is very reliable and that it has an absolutely silent background due to the total absence of atmospheric disturbances, even when conditions are such that these disturbances practically prevent the reception of the ordinary broadcast-stations. Also other local electrical disturbances have less influence than on the longer waves.

Only motor-cars cause a disturbance due to a broad spectrum of damped waves caused by the discharge through the spark-plugs ; the wires leading to spark-plugs and interruptor behaving as an aerial for short waves. These motor-car disturbances are commonly discernible up to a distance of about 20 metres. In the inner-town they are of course more frequent than in the outer suburbs, but this fact is counteracted by the circumstance that in the inner-town a receiver need not have critical reaction, so that in many cases these disturbances are not heard at all. It was possible to have good loud-speaker reception free from these disturbances in a room level with the street in Damrak, notwithstanding the considerable motor-car traffic in that part of the city. Moreover, the different motor-car types behave differently in that respect. For instance, the new Ford motor-car does not disturb at all, due undoubtedly to the particularly short strips from the spark-plugs to the interruptor. In connection herewith I may make mention of the fact that disturbances of this kind may be avoided by simply inserting resistances of 10,000 ohms between the spark-plugs and spark-plug-cables and near the interruptor. In some cases one resistance near the interruptor suffices. We have been successful in avoiding all disturbance from a Ford motor-car by one resistance as described above, to such extent that the disturbance could not be detected in a sensitive superheterodyne receiving apparatus placed with its antenna at a distance of 3 metres from the car.

Generally speaking, it may be stated that motor-car disturbances have more effect in the outer suburbs of the town where the receiver has to be more sensitive, and where, of course, the ratio of disturbance to signal is bigger. In that case a passing motor-car causes a disturbance of a low pitch for a short time ; it is much less irritable than an atmospheric disturbance ; in back rooms the disturbances as a rule are much less severe.

The Transmitting Apparatus

The first step was to design a transmitter of high quality, so that receiving-apparatus could be qualitatively tested. In testing receiving-apparatus there had to be no doubt of the quality of the transmitting apparatus. As it could be predicted that for the bigger distances critical reaction in the receiving-sets would be necessary, and on account of the intention to design adaptor-apparatus for superheterodyne-reception in combination with selective broadcast-receiving-sets, one of the primary objects was to avoid frequency-modulation, so that from the beginning the use of a piezo-quartz-crystal was decided upon.

It was further desirable to keep the transmitter as small as possible and to avoid machines in view of the small available room to be expected. This led to the design of a transmitter fed with alternating current, the necessary direct current being taken from rectifiers. Water-cooled valves, too, had to be avoided for the same cause, as water-cooled valves occupy a relatively large space. For the final stage we decided on the use of two big air-cooled screen-grid transmitting valves.

As our experience with quartz-crystals with a frequency in the order of 5,000 to 10,000 kc/s. was not favourable, our starting point was a crystal of about 2,398 kc/s. that was in our possession, so that after 4 times frequency-doubling a final frequency of 38,368 kc/s. could be obtained, equivalent to a wavelength of 7.85 m. The use of tourmalin-crystals was not yet known to us, otherwise we should certainly have contemplated a 10,000 to 20,000 kc/s. tourmalin-crystal.

Screen-grid transmitting valves were used, as this type of valve has the advantages that neutrodyning becomes unnecessary and that the excitation-power needed is less than that for an ordinary triode. This is because a screen-grid valve has a very small anode-reaction and a big grid space, so that a triode with a given amplification-factor (a big amplification-factor is advantageous because of the small anode-reaction) draws more grid-current than a tetrode at equal excitation.

The final stage was equipped with two Philips-tetrodes *QB* 3/500 and the foregoing stage with two *QB* 2/75. These tetrodes have thoriated tungsten filaments and can deliver respectively 500 and 75 watts high-frequency energy at longer wavelengths. The inter-electrode-capacities are very small.

Cap. in c.m.	QB 3/500	QB 2/75
Cag	0.01	0.022
Caf	8.9	6.3
Cgf	16	9.1

When we designed the transmitter we had no smaller transmitting tetrodes, so that the first stages are not equipped with the more modern *QC* 05/15 but with *TC* 04/10 and *TC* 03/5, respectively, small triodes with oxide-coated filament for 10 and 5 watts h.f. energy respectively when used on longer wavelengths. The transmitter has 7 stages. The first stage contains a *TC* 03/5 and the quartz-crystal for 2398 kc/s. The second stage doubles the frequency and contains two *TC* 03/5 valves. The excitation of these two triodes is such that no grid-current flows, so that the crystal-stage is not affected by reaction from later stages due to modulation. Hence this stage doubles the frequency and at the same time acts as a buffer; as a consequence, it can only deliver a very small amount of power to the 3rd stage.

In this 3rd stage the frequency is doubled again. Here also two valves *TC* 03/5 are mounted. The 4th stage is an amplifier and contains 2 valves *TC* 03/5. The 5th stage, containing two valves *TC* 04/10, doubles the frequency for the third time. In this stage the plate-tension is modulated with the aid of a Philips 50 watt l.f. amplifier with a special output-transformer. Such a 50 watt-amplifier, fed with a.c., is excited by a microphone-gramophone amplifier, to the input-terminal of which are connected a gramophone-pick-up and three or less microphones. The filament-current and the microphone-current are drawn from a 6-volt storage battery, the only d.c. source that is used in the transmitter; the plate-tension is delivered by commercial anode-rectifying apparatus. The stages 2 to 5 are all neutralised, this being necessary for frequency doubling stages. Frequency-doubling is performed by strong distortion of the anode-current and filtering the 2nd harmonic.

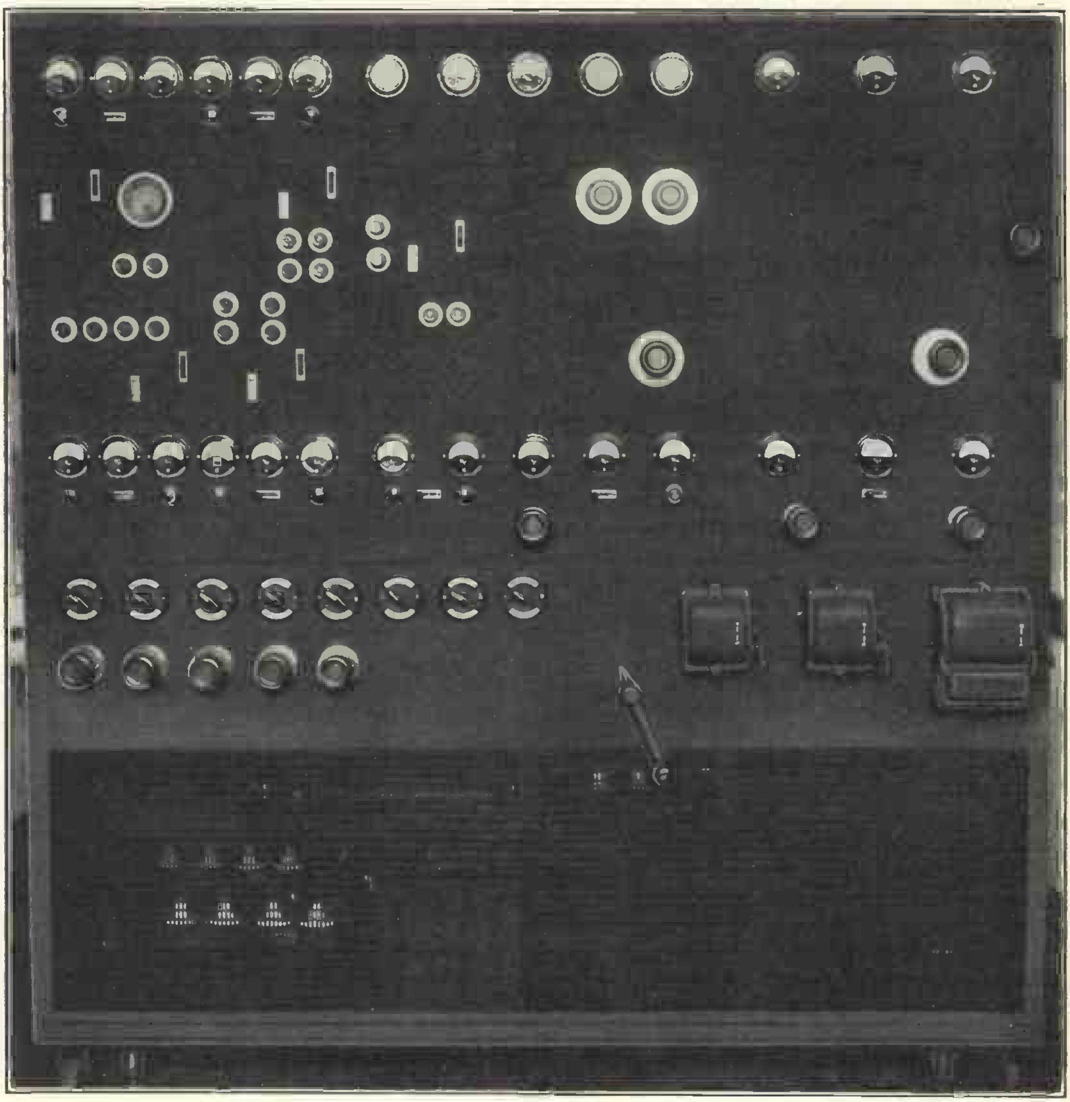
The 6th stage, containing 2 tetrodes *QB* 2/75 as remarked above, is a linear amplifier for the modulated energy and excites the grids of the valves in the final stage. This 7th stage, the final stage, contains two tetrodes *QB* 3/500; in this stage the power is raised to the final level and at the same time the frequency is doubled for the last time.

Each stage is mounted in a separate copper enclosure, the measuring-instruments, filters, etc., being enclosed in separate copper cases for each stage. A copper-plate separates the h.f. part of the transmitter from the l.f. part underneath, containing transformers, rectifiers, l.f. filters, etc.

In every stage the anode-direct current, the grid-direct current, anode-tension and filament-tension are measured, and in the last two stages also the screen-grid-tension. A thermo-ammeter measures the l.f. current in the plate oscillating circuit of the 1st stage. Another thermo-ammeter is coupled to the feeders between the transmitter and aerial.

The whole transmitter is built in an iron frame, covered with copper, copper-gauze and perforated iron. The back consists of two doors ; all high tension is automatically cut off by opening these doors. To obtain access to the first five stages the copper screening plates must be removed. The upper part of the front is of copper : all measuring instruments, tuning knobs, switches, etc., are mounted here.

All filaments, including the first stage, are fed with a.c. and all anode-tensions and grid-bias-tensions are taken from rectifiers, making use of small high-vacuum-diodes with oxide-coated filaments, and in the last two stages mercury-vapour diodes also with oxide-coated filaments.



Front view of the transmitter.

That there is no trace of a hum, notwithstanding this general use of a.c. throughout the transmitter, is due in the first place to the use of a quartz-crystal; omitting this a hum is heard due to frequency-modulation.

In the second place, a careful filtering of all anode- and grid bias-rectifiers is responsible for this absence of hum. These excellent filters for the first five stages are not expensive as only low tensions and small currents are dealt with. The filtering of these stages has to be superior also for the reason that the modulation-depth of a hum grows with each frequency-doubling. The cause of this is the relatively big grid-bias required for frequency-doubling.

For the same reason, however, the grid of each foregoing frequency-doubling stage needs much less than 100 per cent. modulation for a required 100 per cent. modulation of the final stage. The grid-oscillatory tension of the 7th stage, a frequency-doubling stage, will need, say, x per cent. modulation-depth for 100 per cent. modulation of the anode-power. As a consequence, also the grid of the linearly amplifying 6th stage needs only to be modulated with x per cent. The 5th stage is a frequency-doubler as mentioned above, in which the anode-tension is modulated. As a frequency-doubler, the anode-tension of this stage needs only, say, y per cent. modulation for 100 per cent. modulation of its anode-energy, and consequently, of the grid-tension of the 6th stage. As this latter has to be modulated x per cent., as we have seen, the anode-tension of the 5th stage has only to be modulated xy per cent. for 100 per cent. modulation of the aerial-power. The product xy is in the order of 25 to 40 per cent.; this low modulation-depth of the anode-tension of the 5th stage is easily obtainable linearly.

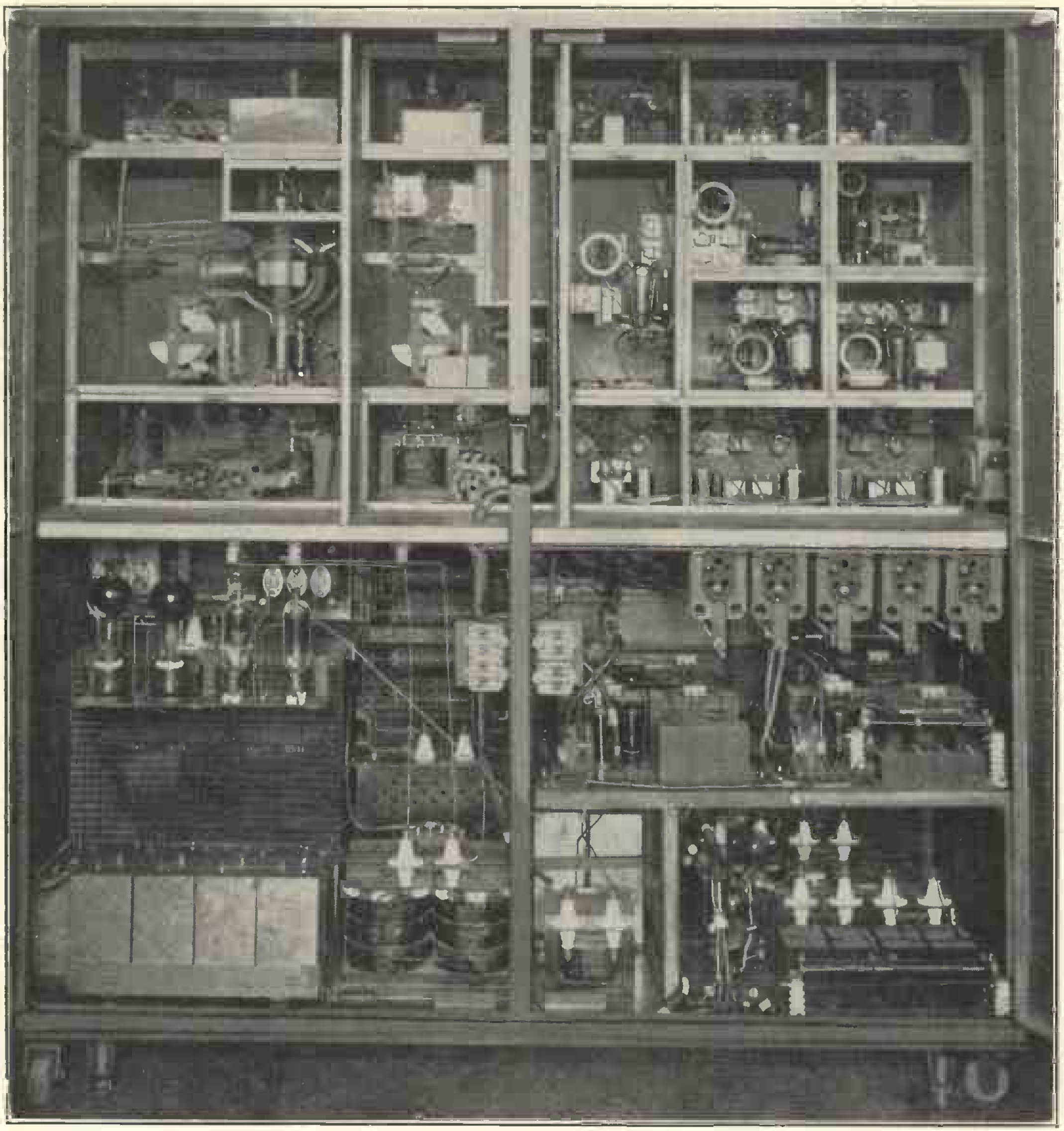
As before the 5th stage the frequency is twice doubled, it will be clear from the foregoing reasoning that more care has to be attributed to the l.f. filters as the first stage is approached. We have modulated the transmitter 100 per cent. by modulating the second stage only a few per cent., but no good quality could be maintained due to very small variations in the main-supply tension necessitating relatively big variations of the required settings of all succeeding stages, which is no simple matter, especially when using rectifiers. To avoid complications, we decided on modulating the 5th stage which could be done comparatively easily and did not suffer from important adjustment-difficulties when ordinary variations of the main-supply tension are prevalent. To modulate two *TC* 04/10 valves 25 to 40 per cent. a 50 watt amplifier is not necessary; a 25 watt amplifier would work as well.

The oscillating-circuit of the 7th stage looks somewhat strange, as it appears to be built up by connecting in series a self-inductance strip and a comparatively large variable condenser. The truth is that the oscillating circuit is built up by a self-inductance strip and the inter-electrode valve-capacities; the variable condenser is a tuning device in the self-inductance part of the circuit; it diminishes the inductive reactance and as a consequence has to be taken as large as possible; on the other hand, it must be small enough to serve as a smooth tuning-device. A much higher circuit-impedance is obtained from such a series-connected condenser than from a parallel-condenser with its long connecting leads and big dimensions and unavoidably large zero-capacity. One of the chief difficulties in ultra-short wave design consists in obtaining high impedance of the oscillating circuits. It should not be forgotten that coupling of the aerial already diminishes the anode-circuit-impedance considerably, so that no means should be neglected of increasing the impedance of the anode-circuit-impedance itself. The efficiency of the final stage remains, however, as low as 20 to 25 per cent., notwithstanding all precautions taken.

The antenna is a copper rod of half a wavelength. It is fastened by insulators to a wooden board which is attached to a wooden mast kept in position by steel guys subdivided by insulators. Close to the current-antinode a thermo-ammeter is coupled to the antenna. This thermo-ammeter is needed when searching for the best coupling of antenna and antenna feeders. Once this most favourable coupling is found it is of no further use, since then a second thermo-ammeter, coupled to the feeders in the transmitter room, may replace it.

The feeders are galvanically coupled with the antenna, and magnetically with the anode-circuit of the final valve-stage. Since the mast is located on the highest point of the Carlton Hotel (with the exception of the tower), the mid-point of the vertical dipole is about 45 m. over the street-pavement. The transmitter itself is located in a small room in the upper floor of the hotel, so that the antenna-feeders have a length of about 20 metres.

At first the reports on the quality of the transmissions were not unanimously favourable, notwithstanding the fact that a control-receiving apparatus in the immediate vicinity of the transmitter gave excellent results and neither frequency-modulation nor fading-distortion was to be feared. The cause of this was the poor construction of the receiving - apparatus used, the design of which demanded special care as will be shown later on. As these receivers were gradually improved it was recognised more and more that the quality of the transmitter



Back view of the transmitter with screens removed from top sections.

was in no respect inferior to that of the best broadcasting-transmitters.

The Receiving Apparatus

We shall now treat the receiver-apparatus, reserving the important link, the transmission, for the last chapter.

In the first place, we have to consider which types have to be taken into consideration and whether certain types have special advantages for ultra-short-wave reception. Our attention has been nearly exclusively limited to the design of adaptor-apparatus, which, combined with the ordinary broadcast-receivers, should constitute complete ultra-short-wave receivers.

The most simple adaptor has a reactive detector-valve, the grid-circuit being tuned to the ultra-high frequency, and the output terminals of which have to be connected to the gramophone-terminals of the broadcast-receiver, so that only the low-frequency-amplifying part of that apparatus is made use of. This simple and cheap adaptor is quite satisfactory up to a distance from the transmitter of 1 to 2 km. when using a small aerial of about 3 m. length in a room at the street-level.

A more sensitive device is a superheterodyne-adaptor which assures a good reception up to a distance of 4 to 5 km., other circumstances being equal. It is even possible to get very strong reception at much greater distances, but the Schrot-effect of the amplifying valves in that case becomes so pronounced that the ratio of signal to parasitic noise is too small.

With super-regenerative reception it is the Schrot-effect again that limits the range to the same order as with superheterodyne-reception. A great advantage, however, is the simplicity in tuning, the latter being not critical, and the absence of so-called capacity-effect. This capacity-effect is one of the serious difficulties in all ultra-short-wave reception.

Loose antenna-coupling, screening, and long insulated axes in tuning and reaction-devices are indispensable to freedom from this effect. The aerial-coupling has to be so loose that it has practically no effect on the natural frequency and the damping of the oscillation-circuits in the apparatus. This is necessary as usually fairly critical reaction has to be used and an effect of the nearby human body on the natural frequency of the aerial cannot be avoided. With too tightly coupled aerials the human body has a marked effect on the reaction and the tuning, rendering it impossible to get satisfactory reception, unless the electro-magnetic field is so strong (distance 1 to 2 km.) that critical reaction has not to be applied.

The screening must be good in order that the hand, when tuning, has no effect on the natural frequency and damping of the oscillating circuit in the apparatus; the same applies to the long tuning-rods. Now effective screening is not so simple as is usually the case when dealing with lower frequencies, due to the absence of a well-defined earthing point of the screen itself. The earth-lead, indeed, has a length of some metres, that is in the order of one or more quarters of a wavelength. A good earth is only to be had when the screen is a potential node of the aerial formed also by the earth-leads. Even in that case the earth-point is not defined as the different points on the screen already have not the same tension.

Since the antenna-coupling must not exceed a certain relatively low value, and, since the reaction depends on this coupling, this, together with the desired range, must be taken into account when deciding on the power of the transmitter.

In superheterodyne-reception capacity-effect is still more troublesome, since the natural frequency of the generator-valve-circuit is directly influenced by the approach of the human body, so that the intermediate frequency is also dependent on it. It is, of course, possible, after roughly tuning the adaptor-apparatus, to adjust the broadcast receiver ultimately when capacity-effect is troublesome, but this procedure is not easy unless the broadcast-receiver has one-knob tuning. Furthermore, care has to be taken that no ultra-high frequency energy penetrates in the broadcast-receiver, since in that case capacity-effect, when tuning the broadcast-receiver, is still present to some degree. There is still the danger that, after adjusting the broadcast-receiver, this appears accidentally to be tuned to a strong broadcast-transmitter in the ordinary broadcast-wave range, so that this transmitter interferes with the ultra-short wave-transmitter unless a very effective screening is provided of the adaptor-apparatus as well as of the leads connecting this with the aerial and earth-terminals of the broadcast-receiver. Then it is still possible to be troubled by an interference-note from a broadcast-transmitter with the transposed frequency. For these reasons it is better to construct the adaptor in such a way that it may not be necessary to adjust the broadcast-receiver.

As soon as the superheterodyne-adaptor is provided with a separate loose-coupled generator-valve all difficulties disappear when the other precautions mentioned above are not neglected.

In that case the aerial may be tightly coupled to the tuning circuit in the adaptor-apparatus, as this circuit, when very loosely coupled to the generator-valve, does not affect the natural frequency of the generator-circuit in an appreciable degree. The detection, too, is improved, since it appears difficult to get fair detection from an oscillating valve, especially when the oscillation-frequency is so high, as in this case the amplitude of the oscillations is not so easily controlled. It is, of course, necessary to decouple common leads to generator- and detector-valve (filament- and anode-leads) effectively for the ultra-high frequency by means of small filter-coils and air condensers.

In conclusion, I must call attention to the disagreeable property of the superheterodyne-adaptor that during the first quarter of an hour or so the frequency drifts, due chiefly to the gradual heating up of the generator valve, and, in much less degree, by the heating up of the circuit-components. We proved this by placing the valve outside the apparatus and cooling this valve, or, as an alternative, the circuit, by liquid air which immediately affected the frequency. After a quarter of an hour or so the frequency becomes constant. When using indirectly-heated cathodes the frequency-drift is much bigger than when using directly-heated filaments, since the temperature of valves with indirectly-heated cathodes becomes much higher. The above-mentioned value of a quarter of an hour is valid for indirectly-heated cathodes. Within that time the frequency may drift as much as 200 kc/s., that is about $\frac{1}{2}$ per cent. Still it remains indispensable to use valves with indirectly-heated filaments in an adaptor fed from the mains; otherwise a powerful hum due to frequency-modulation cannot be avoided, so that it seems impossible to avoid this quarter of an hour.

For a superheterodyne-adaptor it is still more important than for a reaction-apparatus that variable condensers have to meet special requirements; the spindles must be absolutely free from torsion and tolerance; the condenser must be very finely variable and must be so designed that there is no friction of metal on metal when adjusting the moving plates, so that the application of a condenser with two fixed plates and one variable plate moving in the vicinity of the fixed plates seems almost unavoidable. The other assembly-parts, too, must be of robust and rigid construction. With reaction-apparatus special attention must be paid to designs having the least dielectric and ohmic losses.

From the foregoing it may be seen that the reception of ultra-short waves in the order of 7 to 8 metres calls for special precautions, which are the more necessary as the field strength diminishes. This need not, however, lead to expensive apparatus; special attention must be paid to certain difficulties which do not arise in the reception of ordinary broadcast-waves, even down to 15 metres or so, and which are due to non-stationary potential distribution over the apparatus and to the small reactances of small stray-capacities.

The Transmission

As was remarked above, ultra-short waves such as are dealt with in this paper, are not reflected by the Kennelly-Heaviside layer. Observations have shown, however, that this does not apply to waves of more than 8 metres length. It appears, however, that waves of 5 to 6 metres are sometimes reflected as a freak-phenomenon, as may be seen from the description of the R.C.A. experiments. These reflections, however, rarely occurred and were always of very short duration (one minute or so). Reflections were observed of higher harmonics from Rocky Point at a distance of 800 miles; the receiver was tuned to 5–6 metres. On shorter distances these reflections were never observed.

Practically speaking, however, one may say that nothing comes back from the Heaviside layer when the wavelength is lower than 8 metres, and only the direct rays need be taken into account, so that the range is limited and fading cannot occur. This range remains relatively restricted due to:

(1) Considerable absorption;

(2) the fact that such rays cannot follow the curvature of the earth-surface to any great extent, so that there is a horizon beyond which they cannot be received, however great the transmitting power.

This horizon, of course, depends on the height of transmitting and receiving aerial. The French experiments between the Riviera and Corsica have taught, moreover, that this horizon is subject to variations, dependent on conditions of the lower atmosphere.

Assuming the rays not to follow at all the curvature of the earth-surface, the signal-range is (sufficient transmitting power and receiver-sensitivity being assumed):

$$D = 3.56 (\sqrt{h_t} + \sqrt{h_r})$$

wherein

D = signal-range in *km*.

h_t = height of transmitting aerial in *m*.

h_r = height of receiving aerial in *m*.

Assuming the height of the mid-point of the dipole of the Philips-transmitter on the Carlton Hotel to be 45 m. above street-level, and assuming a receiving-aerial at a height of 10 metres, the signal-range would come to 35 *km*. (absorption disregarded), so that Utrecht and Leiden would lie at the limit of signal-range.

Only from Haarlem and Heemstede (at 18 km. distance) were reports received from listeners not living in Amsterdam.

As for the absorption in the city, this is soon perceived when driving throughout the city in an autocar (as we did) fitted with a receiving-apparatus. The diminishing of field strength is very evident on passing from a broad street into a narrow by-street. We have carried out several measurements, some results of which we shall now discuss.

Position.	Volts Output of the Receiver.
Heerengracht	37.5
Kalfje, street-level	2.5
id., 1st floor	4
id., 1st floor at the end of a long room	2
id., outside the Kalfje, close to the Amstel	12 to 14

Particular attention is called to a measurement taken in the Philips showrooms (Heerengracht) at a distance of about 900 metres from the transmitter (in the Carlton Hotel) in a locality level with the street, and to a measurement in and near the restaurant "Het Kalfje" at the Amstel, at a distance of 6 km. from the transmitter.

The considerable increase of the field-strength when moving the receiving-apparatus from the interior of the restaurant to the side of the river Amstel, separated from the restaurant only by a road, is very remarkable.

Schröter made a rough estimate of the absorption in Berlin by comparing what may be expected when absorption is not taken into account and what actually is measured. He arrives at an absorption of 1 neper for each 500 metres that the waves travel through the houses, which corresponds to a reduction of the field-strength to 1/10 after travelling through 1 km. of buildings. This absorption can be diminished by choosing a very high position for the transmitting aerial; a high receiving aerial of course adds to the same improvement. The receiving-aerial must not be allowed to come too near the gable of the house and the lead-in insulator should be of good quality and of small capacity. The effective length of the aerial is very important, this being adjusted in the receiving-room or in the receiver-apparatus itself by an extra length of wire or by a small aerial-loading coil, so that a favourable current- and potential-distribution is arrived at, suitable for a convenient coupling with the receiver-circuit.

In connection with the transmission of these short waves, I may call attention to the following. From different sides (9, 10) it is proposed to avoid difficulties with superheterodyne-receiving-apparatus by omitting the generator-valve in each individual apparatus and replacing it by one common transmitter, having a frequency-difference from that of the modulated transmitter of 200 to 1,500 kc/s. As an alternative, it is proposed to modulate the broadcast-transmitters constantly with 200 to 1,500 kc/s. which modulation in its turn is modulated by the broadcast-programme.

Both procedures seem very attractive, but are quantitatively defective, as may be shown by the following reasoning. Our starting-point is the reception we observed repeatedly in "Het Kalfje" with the transmitter in the Carlton Hotel. We made use there of a two-valve superheterodyne-adaptor apparatus in combination with a Philips-broadcast-receiving apparatus, type 2511 (2 stages high-frequency ampl., linear detection, one stage low-frequency ampl. with a pentode). With this receiving assembly the Philips-transmitter was received and the gridswing of the 1st detector (in the adaptor) was about 0.1 mv., the heterodyning generator giving about 1 volt gridswing on the detector. The value of 0.1 mv. is calculated from the accurately known properties of the receiver 2511. One volt induced auxiliary grid-voltage-swing has been taken as this is a suitable value for the type of valve used; increase of this value does not improve the receiving properties, whereas decrease causes the output voltage of the receiver to decrease in the same proportion.

If it is desired to produce this one volt by an auxiliary transmitter placed beside the main Philips-transmitter, the former would have to produce a field-strength 10^4 times that produced by the Philips-transmitter itself. The power of this auxiliary transmitter then would have to be 10^8 times that of the Philips-transmitter. The auxiliary transmitter would have to have a power of 25.10^6 kw. to produce the same receiving-conditions in "Het Kalfje" as obtained with a local oscillator in the receiving-apparatus itself, as used by us. Instead of a broadcast-transmitter of $\frac{1}{4}$ kw. and an auxiliary transmitter of 25.10^6 kw., one might as well design two transmitters of each 2,500 kw., for, roughly speaking, the output of the broadcast-receiver is proportional to the product of the voltages induced on the grid of the 1st detector, due to signal and to auxiliary generator. The product of the powers of broadcast-transmitter and auxiliary transmitter therefore has to be kept constant. If only one transmitter is used, modulated at a high frequency which in its turn is modulated by the broadcast-programme, as mentioned above, then one may reckon on 50 per cent. high-frequency modulation at the most, as the high-frequency modulating voltage is to be modulated 100 per cent. by the transmitted signal. In this case it is easily calculated that the transmitter needs a power of about 10,000 kw. In the case of a broadcast-transmitter with an auxiliary transmitter of the same power, we have

$$a \sin \omega t + a \sin (\omega + \Delta\omega)t,$$

and in the case of one low- and high-frequency modulated transmitter, we have

$$b \sin \omega t(1 + 0.5 \cos \Delta\omega t) = b \sin \omega t + 0.25\, b \sin (\omega \pm \Delta\omega)t$$

so that $a^2 = 0.25\ b^2$ for equal receiving-conditions.

a^2 and b^2 determine the power of the transmitters considered.

One may raise the question how much these values change with the distance. From the measurements in our possession it is easily calculated that for 1 and 2 km. distance of the receiver from the transmitter, the 2 equal transmitters have each to be designed for 11 kw. and 115 kw. respectively. These calculations are based on measurements on the spot; they do not claim to be rigorously exact, but they are certainly of the right order. They show why the idea of a so-called superheterodyne transmitter was ruled out by us from the beginning. The required power, necessary for this procedure, could not be realised, quite apart from the economic side of the matter. Moreover, with the calculated transmitting powers we get receiving-conditions equivalent to those we obtained in "Het Kalfje" using the most sensitive apparatus we could attain to, and with a local oscillator; this reception was somewhat too weak for general use, since sufficient loud-speaker strength was accompanied by a prohibitive Schrot-effect. All powers, therefore, would have still to be multiplied by a factor of about 5 for real good receiving-conditions.

Conclusion

In conclusion, we may state that with an ultra-short-wave transmitter of about $\frac{1}{2}$ kw. aerial-telephony-power, transmitting on a wavelength of 7 to 8 metres, reliable local broadcasting of high quality is possible in a big city, provided a suitable receiving adaptor apparatus in combination with a sensitive broadcast receiving apparatus and a good aerial is used. The reception is characterised by a particularly silent background, even at times when ordinary broadcast-reception is totally spoiled by atmospheric disturbances. The frequency-range at our disposal is very broad; for equal frequency-difference of transmitting stations, as many stations as can be located within the wave-range of 200 to 2,000 m. may find a place within a wave-range of 7.5 to 7.8 m.; by this means, all important European broadcast-stations could be located within this wave-range. However, this wave-range is not needed since the signal-range of ultra-short-wave transmitters is limited, so that eventually all bigger cities might use the same wavelength without the possibility of interference. Principally these waves are particularly adapted for television, that means for development of the home-cinema, in which case synchronisation is easily obtained by making use of the local electricity-mains. Installations as described here are of much importance for communication between islands or between islands and the continent, where cables are too expensive, *e.g.*, for the communication between Java and Bali, two islands separated by a very deep sea. Furthermore, for communication over shorter distances, when this communication cannot readily be established in another way, ordinary radio being impossible because of interference with other services (police, fireguard, army and navy, long trains, ferry-boats in foggy weather, etc.).

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New Books

Short-wave Radio Reception

By W. Oliver.

A short book of elementary instruction and advice to amateurs wishing to construct and operate short-wave receivers, giving a brief description of typical sets and hints on tuning, learning the Morse code, tracing and repairing faults, etc., and including lists of the distinctive International Call letters, Amateur Nationality Prefixes and the Abbreviations used in Morse Transmission. Pp. 101 with 14 diagrams. Published by W. Foulsham and Co., London. Price 1s.

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Wireless Wrongs and How to Right Them

By "A Man in the Street."

A brief summary of faults prevalent in receivers, their more common causes, tests and possible means of remedy. Arranged in a conveniently tabulated form and followed, in the concluding pages of the booklet, with a few hints and tips regarding aerials, earths, batteries, valves and loud speakers. Pp. 25. Published by J. W. Arrowsmith, Ltd., Bristol. Price 6d.

Physics in Meteorology

By G. C. Simpson, C.B., C.B.E., D.Sc., LL.D., F.Inst. P., F.R.S., Director of the Meteorological Office, London.

A reprint of a lecture given before the Institute of Physics in November, 1932, showing the application of sound, light, heat, magnetism and electricity to the solution of problems of meteorology. Pp. 22 with 5 diagrams. Issued by the Institute of Physics.

Rundfunk Jahrbuch, 1933

Giving a general résumé of the progress of broadcasting in Germany, and the principal events of interest during the past year. Pp. 167, with many illustrations. Published by the Reichs-Rundfunk, Gesellschaft, Berlin. Price Rm. 1.50.

A Magnetron Oscillator for Ultra-short Wavelengths*

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SUMMARY.—The paper describes the characteristics and performance of a magnetron oscillator of improved design. The oscillator is primarily intended for operation on wavelengths between 1 metre and 10 metres, but it can be used on both shorter and longer wavelengths. At wavelengths down to about 3 metres an output of 40–50 watts is obtainable with a conversion efficiency of the order of 50 per cent. At shorter wavelengths the output falls off, reaching about 10 watts at 1 metre. In the range mentioned, the performance compares favourably with that of the normal triode oscillator, particularly at the shorter wavelengths.

Introduction

THE limitations of the conventional triode oscillator at very short wavelengths have led to an investigation of the practical possibilities of other circuits. Of these the magnetron circuit has been found particularly satisfactory and an account is given here of a medium power oscillator of this type for wavelengths of a few metres.

There are several possible ways in which magnetrons, that is valves operating in a magnetic field, can be used to produce short wave oscillations. An account of these different methods will be given in another paper.† It is only necessary to state here that the operation of the oscillator to be described on wavelengths of about 1 metre and longer depends on a "dynatron" (negative resistance) effect arising from the motion of electrons in combined electric and magnetic fields. The existence of such an effect was first demonstrated theoretically and experimentally by Habann[1] and a practical oscillator employing it has been briefly described recently by McArthur and Spitzer.[2] It has also been shown[3] that under certain conditions electronic oscillations (analogous to the triode oscillations of Barkhausen and Kurz) can be produced in magnetron circuits and by this means wavelengths down to a few centimetres have been reached. Such oscillations can be produced by the circuit to be described, but the output is small compared with the power obtainable from the longer wavelength dynatron oscillations. Only the latter are dealt with here.

The Valve and its Characteristics

The valve used consists of a cylindrical diode system with the anode divided into two equal segments and operates with a magnetic field in the direction of the electrode axis. The oscillatory circuit is connected between the anode segments. This arrangement has been called a "split anode" magnetron. Fig. 1 shows the valve used. The anode and filament leads are brought out at opposite ends of the bulb and the electrode system is arranged so as to introduce the least possible capacity, inductance and resistance into the oscillatory circuit. The bulb is made of low-loss hard glass.

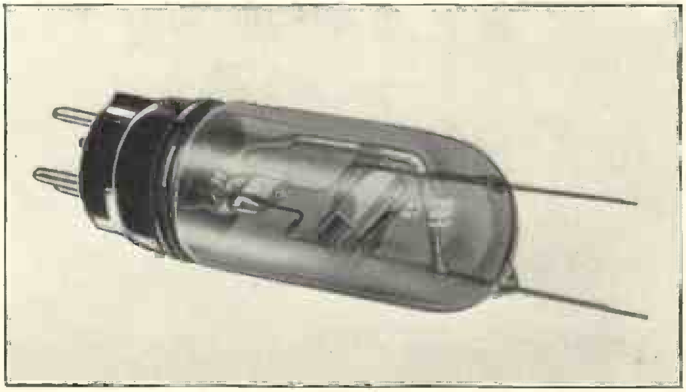


Fig. 1.—50 *watt split-anode magnetron.*

The pure tungsten filament takes a current of 2.5 A. at 4.0 V. for about 80 mA. emission current.

Without the magnetic field the anode voltage-current characteristics are those of

* Received by the Editor, August, 1932.

† To appear shortly in *Journ. I.E.E.*

an ordinary diode. The valve ordinarily operates under conditions which give emission saturation when the magnetic field is removed.

If the relation between total anode current and magnetic field strength is plotted with constant (common) anode voltage and con-

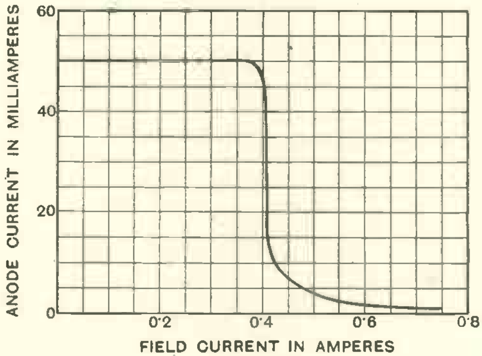


Fig. 2.—*Cut-off characteristic for* $E_a = 1,000$ *v.,* $I_e = 50$ *mA., and* $d_a = 1.0$ *cm.*

stant filament emission a curve of the type shown in Fig. 2 is obtained. This is the "cut-off" characteristic of Hull.[4] The critical field strength is independent of emission and is given approximately by

$$H_c = \sqrt{(180\, E_a)}/d_a \text{ (C.G.S. units)}$$

where E_a = anode-cathode p.d. (volts)

d_a = anode diameter (cm.)

To produce dynatron oscillations the field strength must be greater than the critical value H_c. Under these conditions none, or, in practice, only a small proportion of the electrons leaving the cathode reach the anode so long as the two anode segments are maintained at the same potential E_a. The emitted electrons form a rotating cylinder of space charge whose diameter is smaller than that of the anode. If an e.m.f. is applied between the anode segments so that the potential of one segment is raised to $E_a + \triangle E_a$ and that of the other segment depressed to $E_a - \triangle E_a$ the rotary motion is disturbed and electrons start reaching the anode. For a certain range of values of $\triangle E_a$ more electrons reach the low potential segment than the high potential one. If the electron current reaching the high potential anode segment is I_1 and that reaching the low potential segment is I_2 there will be a resultant power output to the circuit connecting the anode segments of

$$\triangle E_a \,.\, I_2 - \triangle E_a \,.\, I_1$$
$$= \triangle E_a(I_2 - I_1)$$
$$= e \,.\, i \,.$$

where e is the inter-segment voltage $(2\triangle E_a)$ and i is therefore equal to $\frac{1}{2}\ (I_2 - I_1)$. That is to say, the net output to the circuit is the same as that which would be produced by a current $\frac{1}{2}\ (I_2 - I_1)$ flowing in opposition to the inter-segment voltage e. If the circuit connecting the anode segments has suitable constants oscillations will be maintained in it in a manner somewhat similar to the operation of a triode push-pull oscillator.

The relation between e and i is the operating characteristic of the valve. This relation can be obtained from static measurements of $\triangle E_a$, I_1 and I_2 and is of the form shown in Fig. 3 (full line). With increasing e (positive or negative) i increases in the negative direction up to a point and then decreases, passes through zero and for large values of e (of the order of twice E_a) becomes positive. In Fig. 3 negative i is to be interpreted as current flowing in opposition to the applied e.m.f.

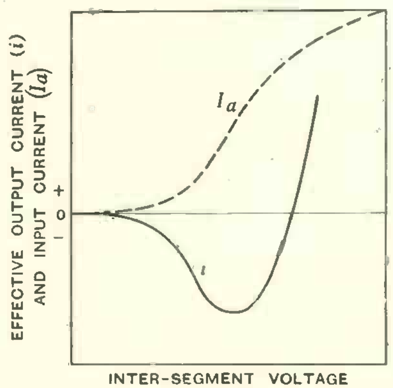


Fig. 3.—"*Dynatron*" *operating characteristics showing variation of effective output current* $i = \frac{1}{2}(I_2 - I_1)$ *and input current* $I_a = (I_1 + I_2)$ *with inter-segment voltage e.*

The second curve (dotted line) in Fig. 3 shows the form of the relation between e and $I_a = (I_1 + I_2)$, the current taken from the H.T. supply. From the two curves the output from the valve to the circuit and the input to the valve from the H.T. supply can be calculated, respectively, for various operating conditions. Such calculations have shown very close agreement with measurements made at frequencies sufficiently low

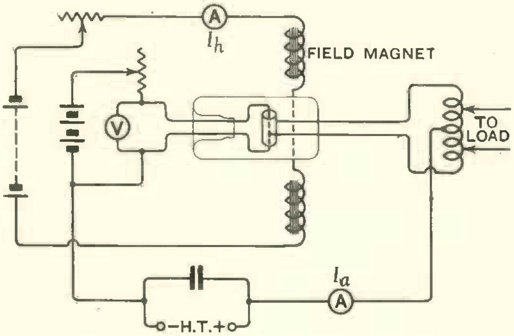


Fig. 4.—*Magnetron oscillator circuit.*

for circuit impedances and radio frequency voltages to be determined with accuracy.

When the operating frequency is so high as to approach the rotation frequency of the electrons in the magnetron the static characteristic is no longer followed and the dynatron effect begins to disappear. However, this limit occurs at a considerably higher frequency than the corresponding effect in the triode reaction oscillator. The effect of the valve constants on the oscillatory circuit impedance is also less in the magnetron than in the triode case. The effective inter-anode capacity of the magnetron described is only about 2.0 $\mu\mu$F when mounted between the magnet poles.

The Circuit

Fig. 4 shows the circuit diagram of the oscillator. The wavelength is determined by the constants of the circuit between the two anode segments. The H.T. is supplied *via* the electrical centre of this circuit. No H.T. choke is required. For wavelengths above 2 or 3 metres it is quite practicable to use "lumped" inductance and capacity in the tuned circuit owing to the low capacity of the valve itself. For shorter wavelengths a Lecher wire tuning system is preferable.

Apart from wavelength adjustment the behaviour of the circuit can be entirely controlled by means of the filament and field current rheostats. In the sense that it controls the oscillation strength and the efficiency of the oscillator the field control is analogous to the reaction control in an ordinary triode oscillator. The fact that this control is outside the radio frequency part of the circuit is an appreciable advantage at very short wavelengths.

The maximum output depends on the filament emission. As the space charge saturation current is much greater than the maximum permissible anode current the output increases continuously with filament emission in the working range.

The magnetic field is supplied by a field magnet described in the next section. The valve is mounted between the poles of this magnet with the electrode axis in the direction of the magnetic lines of force.

Fig. 5 shows a photograph of a complete oscillator in which the various parts of the circuit will be easily identified.

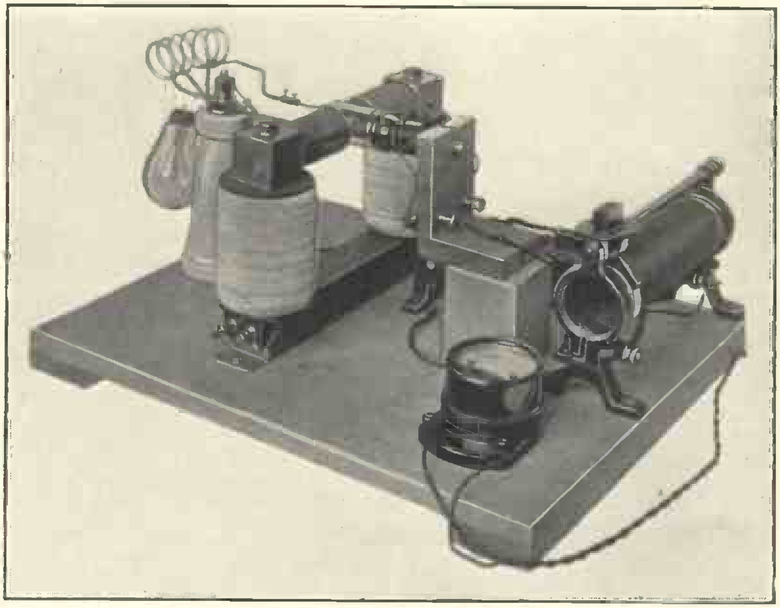
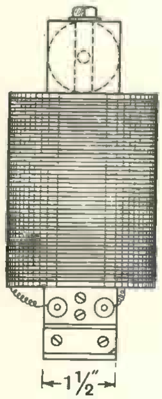


Fig. 5.—*Magnetron oscillator.*

The Field Magnet

The magnetron described has been designed to operate between the poles of an iron cored field magnet instead of inside a solenoid as was the case in previous short wave magnetron oscillators. Two important advantages result from this. The power required to produce the necessary field strength is greatly reduced and the air-blast cooling required by a comparable solenoid system can be dispensed with. Less important advantages are a reduced capacity between the anode segments and the field magnet and the fact that the electrodes are easily visible during operation.



A typical field magnet is shown in Fig. 6. The dimensions of the iron circuit, which is constructed of mild steel, are shown in the figure. The coils are each wound with 2,000 turns of No. 22 s.w.g., d.c.c. wire. With a current of 1 ampere this magnet gives a field strength at the centre of the gap approaching 1,000 c.g.s. units. This involves a power of 35 to 40 watts. Saturation occurs at about 1,700 c.g.s. units. With a 40 mm. airgap the field is sensibly uniform in the space occupied by the electrodes.

Operation

The following figures give typical operating data for a magnetron of the type described.

Normal anode voltage	= 500 to 1,000
Maximum anode voltage	= 1,200.
Maximum anode current	= 80 mA.
Maximum anode loss	= 50 watts.
Maximum magnetic field strength required	= about 1,000 c.g.s. units.

Maximum power output :

50 watts at 10 m. wavelength.
40 watts at 3 m.
10 watts at 1 m.

Optimum load impedance at 1,000 anode volts (estimated from experimental results at 3 m. wavelength) = 3,000–5,000 ohms.

Example of operating conditions :—

$E_a = 1{,}000$	$H = 900$ c.g.s. units.
$I_a = 80$ mA.	$\lambda = 3.0$ m.
Output = 40 w.	Conversion efficiency = 50 per cent.

Total efficiency, including field and filament power = 30 per cent.

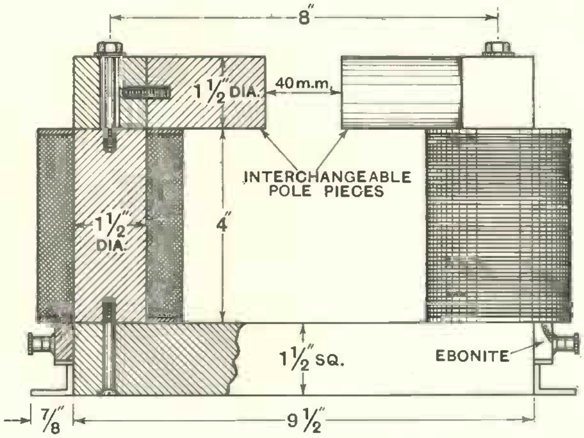


Fig. 6.—*Field magnet.*

The power output figures quoted above have been obtained by means of a load lamp connected to the oscillatory circuit. By adjusting an identical lamp, connected to supply mains, to the same brilliancy as the load lamp a fairly accurate estimate of the power output can be made.

The relation between oscillation wavelength and the length of a Lecher wire oscillatory circuit (wire diameter = 0.5 cm., spacing = 2.5 cm.) is shown in Fig. 7 for wavelengths up to 4 metres. The circuit length is measured from the anode centre to the Lecher wire bridge.

The filament emission and anode voltage have no critical optimum values and the possible output increases with both these quantities provided the field strength is increased with the anode voltage. The practical limits are set by filament evaporation and anode temperature.

Below about 1 metre the energy of the dynatron oscillation falls off rapidly. Provided the operating wavelength is not too near the limit the greatest output is obtained with a field strength of the order of twice the cut-off value. The optimum field strength decreases as the wavelength limit is approached.

If the operating wavelength is near the short wave limit, the efficiency decreases appreciably with decreasing anode voltage (and magnetic field strength) since the limit depends on the rotation frequency of the electrons in the valve. Experimental results indicate that the efficiency falls rapidly at a frequency which is about 4 times the electron rotation frequency for the anode voltage used and the corresponding cut-off field strength. The electron frequency is given approximately by

$$f_0 = \frac{3.3.10^7\sqrt{E_a}}{d_a}$$

The relation between output and anode voltage with fixed magnetic field strength is important since the output is most easily modulated by anode voltage variation. The form of this relation is shown in Fig. 8, which also shows the relation between mean anode current and anode voltage (dotted curve). The output reaches a maximum at an anode voltage of about 0.7 of the cut-off voltage. On the high voltage side of the maximum the oscillation amplitude decreases continuously reaching zero at approximately the cut-off value of anode voltage. On the low voltage side, however, the oscillations cease suddenly at a point which depends on the operating conditions and in particular on the circuit loading. As the anode current increases continuously with anode voltage up to the cut-off value this means that for linear modulation there is a choice between large percentage modulation with low efficiency, and restricted modulation range with much higher efficiency, according to whether the mean anode voltage is above or below the value for maximum output. By loading the circuit heavily it is possible to avoid the discontinuity but only at the cost of reduced maximum output and efficiency.

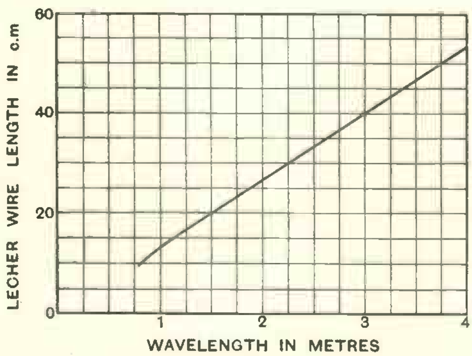


Fig. 7.—*Relation between oscillation wavelength and length of Lecher wire oscillatory circuit.*

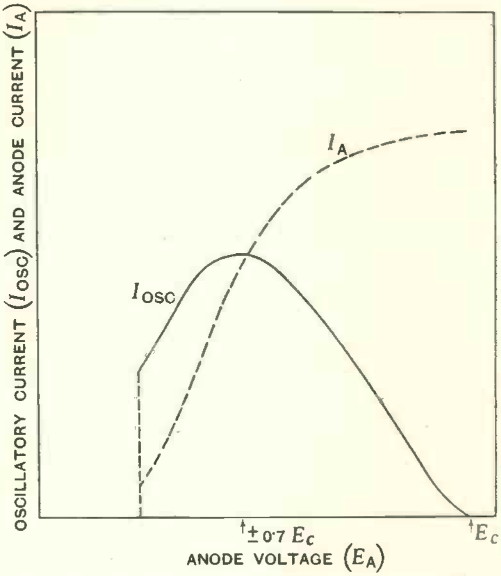


Fig. 8.—*Variation of* (1) *oscillatory current and* (2) *mean anode current with anode voltage (magnetic field strength constant).*

Conclusion

Developments in radio communication during the past year or two have indicated an increasing need for a reliable medium power generator of continuous waves of a few metres length. Short distance directional communication, television, and radio beacons come under this heading. In several departments of physical and engineering research, such as the study of dielectrics and of wave propagation, similar requirements have arisen. It is hoped that the magnetron oscillator described here will suggest a means of meeting some of these requirements more satisfactorily than is possible with the conventional triode oscillator. The chief advantages of the former are (1) greater output and efficiency at wavelengths under about 5 metres, (2) lower effective inter-electrode capacity, and (3) greater simplicity of adjustment and greater reliability of operation at high loading. The chief disadvantage of the magnetron oscillator is the necessity of an auxiliary supply for the field magnet. This disadvantage has been reduced to such an extent in the present design that a total efficiency of about 30 per cent. including the field and filament power is possible at 3 metres wavelength (which compares favourably with the anode conversion efficiency of most triode oscillators at this wavelength). It is also quite practicable to operate a mobile transmitter, with an output of the order of 20 watts at a few metres wavelength, from a 12 volt car battery.

The problem of high percentage modulation with good efficiency in the magnetron oscillator is at present under investigation and is not likely to prove insoluble. Magnetron designs for considerably larger output are also being investigated.

While the chief field of usefulness for the magnetron is undoubtedly for very short wavelengths, it is likely to find applications at longer wavelengths in circuits where a very low internal capacity is of importance. Also as a symmetrical negative resistance, available at any frequency at which measurements are possible, it may prove a valuable addition to the radio laboratory.

In conclusion, I have much pleasure in thanking Mr. B. S. Gossling for valuable advice and suggestions during the development of the oscillator described in this paper.

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Correspondence

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

The Principles of Electro-Magnetism

To the Editor, The Wireless Engineer.

SIR,—Your February editorial, "The Principles of Electro-Magnetism," calls attention to the confusion of thought which often arises between B and H (not to mention B_0). As you point out "both views are correct," so long as one does not mix them up, but I would suggest that the "Heaviside view," as you term it, is made more confusing than it need be because we are in the habit of defining H in one way, from "unit pole" considerations, and then treating it as if we had defined it electrically [$4\pi IT/10l$].

The difficulty can only be illustrated by starting at the beginning; if my argument seems to lack rigidity, this must be put down to the need of cutting it as short as possible.

We begin by defining that "purely mathematical abstraction," a "unit pole," from the equation $m_1m_2/r^2 = f$, the force in dynes between poles; we do not consider the values which might arise in a magnetic medium, and do not therefore need to introduce μ. Having thus provided a "unit pole," we attach it to a spring-balance (of brass or non-magnetic material), which is graduated in dynes, and send an observer to walk about with this instrument in the neighbourhood of "permanent magnets" and wires carrying "electric currents"; the observer finds that he gets a force on his "unit pole," measured by his spring-balance, in these cases, and we will call this force F or "Field-strength" [it is, of course, usually called H, but as will be seen later, it is at present desirable to call it by some other name, avoiding the use of H, and F for "field" seems suitable].

Now let us build a large anchor-ring, big enough for our observer to get inside; to fix ideas, let us suppose a fireclay tube, 2 metres in diameter and a kilometre long, the ends being bent round to meet. Our observer in the inside of the ring measures the cross-sectional area, which he calls A cm², and the distance he has to walk round to return to his starting-point (we have suggested a kilometre), which he calls l cm. While he is doing this, we wind round the ring a winding of T turns, which we connect in series with a reversing switch, carbon rheostat, and a "blank" moving-coil ammeter, to a battery. (The ammeter is of necessity blank, since we have not yet defined a unit of current.) On closing the switch and screwing up the rheostat, the observer in the inside of the ring, who has with him his "unit pole," reports from time to time the force on it, and we note that equal increments of force correspond to equal increments of angular movement of the ammeter needle. When the observer finds the force F on his unit pole is equal to $4\pi T/10l$ we mark the scale of our ammeter "1," when F has twice this value, we mark the scale "2," etc., and we have thereby defined the Ampere, ten of which form the *absolute CGS Electromagnetic Unit of Current;* and we use for current the symbol I. Having done this, we can calculate the force F the observer will find is acting on his unit pole, by the equation

$$F = 4\pi IT/10l \qquad \ldots \quad \ldots \quad \ldots \quad (\alpha)$$

from the reading of the ammeter which we have now calibrated. To save circumlocution, we must now mention something not yet defined, namely the Volt, using the symbol E for "number of volts," and we want an instrument which will read the time-integral of volts, $\int Edt$. Being practical electricians, we can imagine something that would do this, such as, for example, a commercial ampere-hour meter in series with a large constant resistance (only it would have to be vastly more sensitive), or we have, in fact, the very instrument ready made and called a "fluxmeter" (only please remember we have not yet heard of "flux," still less defined it).

We now wind a "secondary coil" of T_2 turns round our anchor-ring, and join the ends of it to our meter measuring $\int Edt$, or as we may call it, our "Volt-second meter." We then find that any change in the force F on our observer's unit pole is accompanied by a proportional change in the deflection of our volt-second meter.

When the change of F, say ΔF, amounts to $10^8/AT_2$, we mark the scale of our new meter "1," a further change of the same amount and we mark the scale "2," etc. We have thus defined the "volt-second," and thereby, since we possess a clock, we define the volt. Note that up to now we have not had any magnetic material present, no need for any μ.

If our observer is not available, we can still calculate the force F on his unit pole from the reading of our new meter, by the equation

$$\Delta F = \frac{\int Edt \times 10^8}{AT_2} \qquad \ldots \quad \ldots \quad (\beta)$$

Suppose, having rescued our observer from the interior, we fill the anchor-ring with molten cast iron, and let it solidify; after it has cooled, our observer propounds the conundrum, "what is now the force F on my unit pole, which I forgot to rescue and which is now somewhere inside the cast iron?" We cannot measure it directly, and we are not inclined to agree with the suggestion that we should bore a "small" hole in the iron, introduce another unit pole, and see; for we should not then be measuring F actually *inside* the iron, but only in air in a hole in the iron, which we suspect may be quite different. The argument that as a "unit pole" is a "purely mathematical abstraction" we can suppose it small enough to pass between the constituent atoms of the cast iron does not, to the writer at any rate, make it any easier to imagine. I even venture to suggest that the value of F is quite unknowable. "Oh no, calculate it from your ammeter reading, using equation [α]," says someone; another suggests confirming the result by the reading of the Volt-second meter, but behold this instrument has buzzed right round the scale an incredible number of times, and gives a value for F (calculated by equation [β], a thousand or more times (actually μ times) as big as the result calculated by our ammeter reading and equation [α]. Which is "right"? I suggest that we cannot possibly tell; quite possibly neither! But the two numerical values calculated from [α] and [β] must have names, and we christen them H and B respectively.

H is now (and for the first time) defined by the equation:

$$H = 4\pi IT/10l \qquad \ldots \quad \ldots \quad \ldots \quad (\gamma)$$

and similarly B is defined by:

$$B = \frac{\int Edt \times 10^8}{AT_2} \qquad \ldots \quad \ldots \quad (\delta)$$

Note the sequence of the definitions, the "unit pole" enables us to define F, the "field-strength" or "Magnet*ic* Force" From F we define current I and volts or volt-seconds $\int Edt$. From I we define H, and from $\int Edt$ we define B. μ is then a ratio of two physically different quantities (as E = stress/strain).

Now the confusion arises in the usual practice, for we next proceed to confuse F (magnet*ic* force) with H (magnet*ising* force) and proceed to cover up our confusion by using the symbol H to stand not only for that defined by [γ], but for what I have hitherto called F. They are certainly different conceptions, for F is used *via* I, in order to define H.

It is true that we have so chosen or "cooked" our units of measurement, that *in air*, F, H, and B are all represented numerically by the same number, but they are really distinct and different concepts.

In Iron (or magnetic material) F is inconceivable, as even with the assistance of mathematical abstractions we cannot conceive of a way of measuring it (this is unimportant, for F and the "unit pole" have served their turn, and as soon as we can define I and E by their means, they can be discarded). It would be no conceivable use to know F, the force on a non-existent "unit pole," in any practical case.

If anyone be found to maintain that in iron F must of necessity be equal to H, I will asseverate that F must be equal to B, or to $\sqrt{BH}$, or to some other function* of B and H, and every argument used in favour of one equality will be equally valid for the other.

The truth is that we are enquiring, when we ask the value of F in iron, "What happens to a purely mathematical abstraction when it is transferred to another medium," as you put it in your editorial. I submit that the answer was given to Alice by Humpty-dumpty, "It means just what I choose it to mean, neither more nor less."

C. R. Cosens.

To the Editor, The Wireless Engineer.

Sir,—In his letter to you of February 10th, Professor Fortescue makes two bold statements, upon each of which, with your permission, I should like to ask him a question.

The first statement is that by no possible experiment can H and B be distinguished. Now I have always believed that, in the case of a long air-cored solenoid, the value of H was $4\pi/10$ times the

* *Any* function of B and H that reduces to B (or H) when $B = H$ will do!

ampere-turns per cm; measurable, therefore, by counting the turns and reading an ammeter. The value of B, however, cannot be derived from these measurements, but it can be obtained by measuring the area of the core and reading the throw of a ballistic galvanometer attached to a search coil when the current is interrupted. These measurements in turn give no idea of H. Does Professor Fortescue mean to deny the existence or reliability of such tests?

The second statement is that it is absurd to adopt different dimensions for H and B when each is referred to a crevasse measurement. Now, in his daily work, Professor Fortesque must surely often use the Electrostatic Units. Does he realise that, in this system, which is just as logical as the E.M. system, the dimensions of H and B are different? Would he say that, on the E.S. system, H and B are analogous to stress and strain, but not on the E.M. system; or would he say that the crevasse theory is applicable to the E.M system, but that in the E.S. system it is "absurd"?

The University, Birmingham. WILLIAM CRAMP.

Vibrations of a Coil-driven Paper Cone

To the Editor, The Wireless Engineer.

SIR,—To solve Mr. F. R. W. Strafford's problem (see p. 141, March, 1933, issue) we have to prove the existence of a force on the coil the frequency of which is half that applied to the power valve. Assuming the beat oscillator to be above suspicion, and that no negative resistance effects involving relaxation oscillations are present in the valve circuits (*W.E.*, p. 134, March, 1932), the precedure is given below. Neglecting radiation and losses the force equation is Accelerational + Axial Constraint = Driving Force

or
$$m\frac{\partial^2\xi}{\partial t^2} + s\xi = F\cos\omega t \quad \ldots \quad (1)$$

where m = effective mass, s = axial constraint ξ = axial displacement from equilibrium position. From the given data one concludes that the speaker magnet is small. The axial distribution, assumed symmetrical, will probably resemble an inverted parabola. The flux density at any point distant ξ from the central plane of the gap is $B_g = B_. - \psi\xi^2$ where B = density at centre and ψ is a constant depending upon the flux distribution. The force on the coil per unit current is $C = \int\frac{B_g l d\xi}{b}$ where l is total length of wire uniformly spaced on coil, and b is the axial width of the gap. The limits of integration when the coil centre is distant ξ from the central plane are $-(b/2 - \xi)$ and $(b/2 + \xi)$. Using the preceding value of B_g, performing the integration and inserting limits, we obtain $C = C_1 - \psi l\xi^2$, where $C_1 = Bl - \psi lb^2/12$. The driving force $F = CI$, so (1) becomes

$$m\frac{\partial^2\xi}{\partial t^2} + s\xi = (C_1 - \psi l\xi^2)I\cos\omega t \quad \ldots \quad (2)$$

Putting $\omega t = 2z$ we get $\partial t = \frac{2\partial z}{\omega}$ and $\partial t^2 = \frac{4\partial z^2}{\omega^2}$ which on substitution in (2) yields

$$\frac{\partial^2\xi}{\partial z^2} + (a\xi^2 - b)\cos 2z + c\xi = 0 \quad \ldots \quad \ldots \quad (3)$$

where

$$a = \frac{4\psi Il}{\omega^2 m};\ b = \frac{4C_1 Il}{\omega^2 m} \text{ and } c = \frac{4s}{\omega^2 m} = 4\left(\frac{\omega_0}{\omega}\right)^2,\ \omega_0$$

corresponding to the fundamental frequency of the diaphragm on the axial constraint. The solution to (3) is on somewhat similar lines to that given by the writer in *W.E.* October, 1932. It contains an infinite number of terms (alien frequencies) the frequency of the one being half that of the fundamental. The physical explanation is that owing to variation of the field *within* the magnet, the coil in moving to one side of its central position tends to move further, *i.e.*, the rectification effect. Its progress in this direction, however, is foiled by the axial constraint, so the coil dallies at each end of its excursion. The net result is that a motion of half frequency, together with a myriad of others, is superposed on the fundamental. Owing to the radial mode resonances its presence is revealed, otherwise it would be of minor account at frequencies of 1,000 ∼, especially with a large diaphragm or a gap of greater width giving a more uniform field distribution axially.

This probably diagnoses Mr. Strafford's trouble, but I should be glad if he would confirm the diagnosis by using a long coil protruding 4 to 6 mm. from each side of the gap. The flux interlinkages will then be substantially constant throughout the travel of the coil, even though the driving current distorts the field. The constancy of interlinkage is, of course, the criterion for absence of alien frequencies. At the same time, he might test the influence of varying a and b by halving the current and of reducing c by removing fairly large pieces from the annular surround and centering device.

London. N. W. McLACHLAN.

The Dynatron

To the Editor, The Wireless Engineer.

SIR,—I was interested to see the paper by F. M. Colebrook on the use of the "Dynatron" arrangement for amplification, as I had tried the scheme qualitatively a year or two ago. From the academic point of view one is always pleased to see theoretical analysis confirmed by experiment; but the use of audio-frequencies for measurements obscures the practical difficulties which would be experienced in applying such a circuit to selective radio-frequency amplification.

In the first place the use of a low anode voltage tends to increase cross-modulation; admittedly variable-mu valves were not available at the time of my experiments, but in the absence of definite information I am inclined to doubt whether these valves would remain free from this trouble when used in a dynatron circuit. The absence of a definite reaction coupling associated with the tuned circuit has its disadvantages; for example, if a H.F. choke is employed at any point in the anode circuit, oscillation may occur at its resonant frequency before the desired degree of selectivity of the tuned circuit has been attained. This precludes the use of the tuned grid type of inter-valve coupling. Then again the chief advantage suggested is the absence of special components to provide reaction, but reaction is most commonly required in "straight" sets where the tuned circuits will have to cover a wide range of frequencies. Whereas a reaction circuit can be designed to give fairly constant results, using a reaction condenser ganged to the tuning if necessary (*cf. Wireless World* "Autotone" receiver), the dynatron circuit requires readjustment of one of the valve potentials at each frequency to compensate for the change in decrement of the tuned circuit. Finally, it would be impossible to use the valve in question for volume control by variation of grid bias.

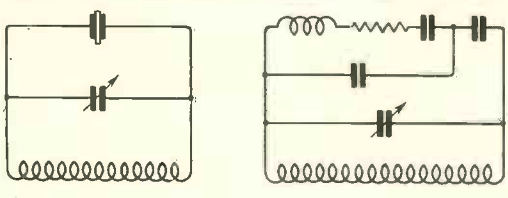
D. A. Bell.
Magdalen College, Oxford.

The Researches of the late Dr. D. W. Dye on the Vibrations of Quartz

THE meeting of the I.E.E. Wireless Section on Wednesday, 1st February, was devoted to a lecture on the above subject by Dr. E. H. Rayner of the National Physical Laboratory.

Referring first to the work of Langevin in the submarine application of the quartz crystal as a supersonic source (for depth sounding), the lecturer discussed the work of Prof. Cady in the application to radio-frequency measurements and the association of the late Dr. D. W. Dye in this connection. He then showed various models of quartz crystals, including a large-size model illustrative of the hexagonal shape. From this he explained the various axes, optical and electrical, stating that the resistance across the electrical axes was of the order of 10^{-5} of that across the optical. Various atomic models were also exhibited, showing the disposition of the atoms within the quartz structure and their effect upon the optical and electrical axes.

The lecturer then turned to Dr. Dye's own work, referring particularly to the need for knowledge of the mechanical processes involved in the vibration of quartz. The equivalent circuit of the quartz crystal was illustrated as shown in Fig. 1, and the



(a) (b)

Fig. 1.—*Quartz resonator and its equivalent electrical circuit.*

lecturer showed the application of the crystal as a resonator, illustrating the crevasses and the different frequencies of response. He then discussed the effect of air gaps between the crystal and electrodes, the increase of frequency shown (in a slide) being due to increase of the air-gap having the effect of decreasing the equivalent series condenser. Referring briefly to other well-known piezo-electric crystal materials, the lecturer quoted rochelle salt, which was objectionable because of the tendency to liquefy, but suggested that tourmaline might have application to the higher frequencies.

Dr. Rayner then proceeded to describe in detail Dye's classical work on the modes of vibration of the quartz crystal. First he illustrated the principle of stationary patterns by interference fringes, on which Dye's method was based, and described Dye's arrangements for examining the crystal under conditions of vibration, including his method of examining the crystal under short light flashes. Thereafter he showed an extensive series of Dye's pictorial results, illustrating flexural stresses and compressional vibrations. Dye's methods of examining both sides of the crystal while under vibration were also discussed, and the various designs illustrated were explained. From this the lecturer described Dye's reconstruction of a three-dimensional vibrating crystal system from the two-dimensional pictures, a model again being illustrated.

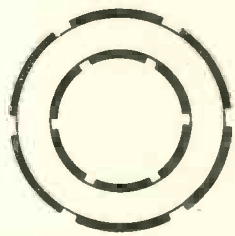


Fig. 2.—*Dye's ring oscillator and electrode system.*

Lastly, the speaker described Dye's type of ring oscillator, developed just before his death and its performance being confirmed posthumously. The ring and the disposition of the electrodes is shown in Fig. 2, while the lecturer showed the method of cutting the oscillator from the piece of quartz and of predetermining the frequency. The performance of this oscillator as a frequency-standard was then shown, the 20 kc. oscillator being stepped down to 1 kc. for control of a phonic motor, and compared both with a known 1,000 ~ fork and a standard clock. The performance of such an oscillator brought it definitely into the class of a standard-frequency source.

C

Abstracts and References

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PROPAGATION OF WAVES

DIE BEEINFLUSSUNG ELEKTROMAGNETISCHER WELLEN DURCH HOCHSPANNUNGSFREILEITUNGEN (The Effect of High-Tension Overhead Lines on the Propagation of Electromagnetic Waves). — H. Zuhrt. (*E.N.T.*, Jan., 1933, Vol. 10, pp. 25–38.)

When electromagnetic waves strike such a line, they produce in the pylon high-frequency currents which flow through the earth wire to earth on both sides, with the result that a current distribution typical of a T-aerial takes place. If the waves have a frequency in the neighbourhood of the sharply marked natural frequency of such a T-aerial, reflection and screening effects occur. The magnitudes of these effects are theoretically determined in this paper. For the sake of simplification an infinitely long series of pylons is considered, equally spaced at such a distance that they do not mutually affect their natural frequencies; the transmitter is so far away that the wave front is considered as plane, and the waves are in resonance with the fundamental wave of the system.

Section I deals with the calculation of the fundamental wave (equations 5 and 5a); section II with the secondary radiation field (made up from the pylon radiation and the earth-wire radiation); section III with the radiation resistance and the current induced in the pylon system; and section IV with the resultant field. Section V gives a numerical example, for a line with 20-metre pylons spaced 200 m (such as is often used for a 110-kv supply); it is found that at a distance of 200 metres past the line a decrease in amplitude of about 10% occurs.

ELECTROMAGNETIC SHIELDING AT RADIO FREQUENCIES.—L. V. King. (*Phil. Mag.*, Feb., 1933, Series 7, Vol. 15, No. 97, pp. 201–223.)

This theoretical paper starts from the Maxwell-Faraday laws and finds formulae for the alternating field inside (*a*) a closed conducting spherical shell of uniform thickness, and (*b*) a cylindrical shell of uniform thickness, produced by plane electromagnetic waves of length large compared with the linear dimensions of the shell in question. Formulae suitable for numerical calculation are found in the case of thin shells and a method of calculating the shielding ratio for thin shells is developed, which also takes into account the effect of magnetic permeability. " Numerical calculations indicate marked advantages in the use of shielding containers of iron." An approximate formulae is given for the shielding ratio at radio frequencies.

MESSUNGEN DER REFLEXION AN DER HEAVISIDE-SCHICHT (Measurements of the Reflection at the Heaviside Layer).—G. J. Elias and C. G. A. von Lindern. (*E.N.T.*, Jan., 1933, Vol. 10, pp. 1–8.)

Apart from a few slight changes in the numerical deductions, this paper corresponds to the Dutch paper dealt with in 1932 Abstracts, p. 396.

COMPARATIVE FIELD STRENGTHS GIVEN BY LONG AND SHORT BROADCAST WAVES [550–1 450 kc/s].—Byrne. (*See* abstract under " Stations, Design and Operation.")

SOME CHARACTERISTICS OF SHORT-WAVE PROPAGATION.—J. Hollingworth. (*Wireless Engineer*, Feb., 1933, Vol. 10, No. 113, pp. 89–90.)

Abstract of the I.E.E. paper, a short summary of which was dealt with in February Abstracts, p. 91. Some of the subsequent discussion is included.

A NOTE ON AN AUTOMATIC FIELD STRENGTH AND STATIC RECORDER.—Mutch. (*See* under " Measurements and Standards.")

PORTABLE LONG WAVE TESTING APPARATUS [Field-Strength Measuring Set].—de Coutouly. (*Ibid.*)

NORTH ATLANTIC SHIP-SHORE RADIOTELEPHONE TRANSMISSION DURING 1930 AND 1931 [Analysis of Short-Wave Data: Field Strength Contour Diagrams, etc.].—C. N. Anderson. (*Proc. Inst. Rad. Eng.*, Jan., 1933, Vol. 21, pp. 81–101.)

SHORT-WAVE TRANSMISSION TO SOUTH AMERICA [Survey of Transmission Conditions: Absence of Seasonal Effect: Characteristics of Atmospheric Noise, etc.].—C. R. Burrows and E. J. Howard. (*Proc. Inst. Rad. Eng.*, Jan., 1933, Vol. 21, pp. 102–113.)

For a summarised comparison with transatlantic transmission, and reasons for the differences, *see* pp. 109 and 112–113.

TRANSOCEANIC RECEPTION OF HIGH-FREQUENCY TELEPHONE SIGNALS [and the Correlation of Magnetic Activity and Signal Strength].—Morris and Brown. (*See* under "Stations, Design and Operation.")

THÉORIE PHOTOMÉTRIQUE DES ÉCLIPSES DE LUNE (Photometric Theory of Lunar Eclipses [Leading to the Deduction of an Absorbing Layer at about 150 Kilometres]).—F. Link. (*Comptes Rendus*, 23rd Jan., 1933, Vol. 196, No. 4, pp. 251–253.)

THE IONISING EFFECT OF METEORS IN RELATION TO RADIO PROPAGATION.—A. M. Skellett. (*Proc. Inst. Rad. Eng.*, Dec., 1932, Vol. 20, pp. 1933–1940.)

See February Abstracts, p. 92: also below. Author's summary:—"From a study of available meteor data it is concluded: (1) that meteors expend the larger part of their energy in the Kennelly-Heaviside regions, that is, in the regions of the upper atmosphere which control the propagation of all long-distance radio waves; (2) that the major portion of a meteor's energy goes into ionisation of the gases around its path; (3) that this ionisation extends to a considerable distance from the actual path—in some cases several kilometres or more—and lasts for some minutes after the meteor has passed; (4) meteor trains are produced only in the lower Kennelly-Heaviside layer.

"A table of the various sources of ionisation of the upper atmosphere is given with values for each in ergs cm^{-2} sec^{-1}. These include sunlight, moonlight, starlight, cosmic rays, and meteors. During meteoric showers the ionising effect does not appear to be negligible compared with that due to other ionising agencies occurring at night. A meteor of one-gram mass or greater will produce, on the above assumptions, sufficient ionisation to affect propagation. One explanation of the general turbulent condition of the ionised layers may be provided by the continuous bombardment of meteors."

OBSERVATIONS OF KENNELLY-HEAVISIDE LAYER HEIGHTS DURING THE LEONID METEOR SHOWER OF NOVEMBER, 1931.—J. P. Schafer and W. M. Goodall. (*Ibid.*, pp. 1941–1945.)

See preceding abstract and back reference. "While the results are not conclusive, due to the fact that a moderate magnetic disturbance occurred during this same period, there is some reason to believe that the presence of meteors in unusual numbers caused increased ionisation of an intermittent nature in the region of the lower layer."

THE THEORETICAL FREQUENCY DISTRIBUTION OF PHOTOGRAPHIC METEORS.—P. M. Millman. (*Proc. Nat. Acad. Sci.*, Jan., 1933, Vol. 19, pp. 34–39.)

THE INTERFERENCE PATTERN OF THREE CARRIER WAVES [Investigation of Three Transmitters each radiating the Same Speech Message with a Frequency Separation of about 7 Kilocycles/Second].—A. W. Ladner and H. J. H. Wassell. (*Marconi Review*, Nov.-Dec., 1932, No. 39, pp. 19–29.)

SUPERPOSITION OF TWO MODULATED RADIO FREQUENCIES [and the Distortions in the Resulting Envelope: Treatment applicable to All Cases where the Signal consists of a Direct and a Reflected Beam].—Roder. (*See* under "Properties of Circuits.")

RADIO COMMUNICATION BY MEANS OF VERY SHORT ELECTRIC WAVES.—G. Marconi. (*Marconi Review*, Nov.-Dec., 1932, No. 39, pp. 1–6.)

First part of the R.I. lecture dealt with in February and March Abstracts, pp. 91 and 153.

FIELD STRENGTH MEASUREMENTS OF ULTRA-SHORT WAVES FROM EMPIRE STATE BUILDING. (*See* abstract under "Miscellaneous"—"Looking Ahead as 1933 Opens.")

THE ULTRA-SHORT-WAVE SERVICE BETWEEN CORSICA AND THE CONTINENT.—de Cléjoulx. (*See* under "Stations, Design and Operation.")

DER FARADAYEFFEKT IN IONISIERTEN GASEN BEI WELLEN VON 4 CM LÄNGE (The Faraday Effect in Ionised Gases for Waves of Length 4 cm.).—P. Keck. (*Ann. der Physik*, 1932, Series 5, Vol. 15, No. 8, pp. 903–925.)

This paper gives a full description of work already referred to in February Abstracts, p. 92.

DISPERSIONSUNTERSUCHUNGEN MIT UNGEDÄMPFTEN ULTRAKURZWELLEN (Investigations of Dispersion [in Liquids] with Undamped Ultra-Short Waves).—M. Seeberger. (*Ann. der Physik*, Jan., 1933, Series 5, Vol. 16, No. 1, pp. 77–99.)

This paper describes measurements of the refractive index and absorption of various liquids (water, propyl alcohol, glycerine, solutions of various salts) at wavelengths of 12.6, 13.6, 14, 19 and 24 cm. Three methods were investigated (1) Lecher wire system including the liquid container, (2) reaction on the emitter of the waves reflected from the end of a trough filled with liquid and containing the emitter, (3) Lecher system with the liquid container at the end. The last method was found to be the best. The numerical results of the measurements are given. The emitter used was that described by Collenbusch (1932 Abstracts, pp. 403–404).

ÜBER DIE VERWENDBARKEIT DER RESONANZMETHODE ZUR MESSUNG VON DIELEKTRIZITÄTSKONSTANTEN WÄSSERIGER ELEKTROLYTLÖSUNGEN (The Applicability of the Resonance Method to the Measurement of Dielectric Constants of Aqueous Solutions).—M. Ježewski. (*Physik. Zeitschr.*, 15th Jan., 1933, Vol. 34, No. 2, pp. 88–94.)

Variations de Phase par Réflexion sur Couches métalliques très minces (Phase Changes at Reflection by Very Thin Metallic Layers).—P. Rouard. (*Comptes Rendus*, 30th Jan., 1933, Vol. 196, No. 5, pp. 339–341.)

Some workers have found that such reflection produces an advancement of phase, others a retardation, while Wernicke found sometimes one and sometimes the other, according to the state of the metal. The writer describes his own experiments, with silver films of gradually varying thickness, which show that the phase variation for reflection at a silver-on-glass surface is first a lag which, for any wavelength, passes through a maximum, diminishes, and vanishes as the thickness increases; it then changes to a lead which grows very rapidly, passes through a maximum, diminishes, and becomes constant around 0.30 λ. The thickness of metal which annuls the phase difference increases with the wavelength. Silver-on-mica surfaces give similar results.

The Reflection of Light at a Surface Covered by a Monomolecular Film [Theoretical Investigation].—C. Strachan. (*Proc. Camb. Phil. Soc.*, Jan., 1933, Vol. 29, No. 1, pp. 116–130).

This paper investigates the effect of a two-dimensional assembly of scattering centres at a plane boundary between two optically different, homogeneous media. Allowance is made for the possibility of molecular orientation.

Lichtstrahlen und Wellenflächen in allgemeinanisotropen Körpern (Light Rays and Wave Surfaces in General Anisotropic Bodies).—P. Frank. (*Zeitschr. f. Physik*, 1933, Vol. 80, No. 1/2, pp. 4–18.)

Sulla Pressione di Radiazione per Rifrazione (On the Pressure of Radiation at Refraction).—C. Bellia. (*Nuovo Cim.*, Dec., 1932, Vol. 9, No. 10, pp. 328–334.)

The Characteristics of a Deep Focus Earthquake: a Study of the Disturbance of February 20, 1931.—F. J. Scrase. (*Phil. Trans. Roy. Soc. London*, 13th January, 1933, Vol. 231, No. A 699, pp. 207–234.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

Sonnenrotation und Luftstörungen (Solar Rotation and Atmospherics).—F. Schindelhauer. (*Naturwiss.*, 13th Jan., 1933, Vol. 21, No. 2, p. 25.)

This letter is a second preliminary communication (for the first *see* 1932 Abstracts, p. 633) on the correlation between the 27-day period of solar rotation and the frequency of atmospherics. From the primary impulse described in the first communication, 1, 2 and 3 solar rotation periods are counted before and afterwards, and pulses are obtained which show a gradual doubling of the maximum given by the primary impulse. The writer deduces from this the existence of two electrically active layers on the sun of which one rotates in 27 days and the other slightly more slowly. The existence of this second layer has already been considered by other geophysical writers.

Directional Studies of Atmospherics at High Frequencies.—K. G. Jansky. (*Proc. Inst. Rad. Eng.*, Dec., 1932, Vol. 20, pp. 1920–1932.)

Author's summary:—A system for recording the direction of arrival and intensity of static on short waves is described. The system consists of a rotating directional antenna array, a double detection receiver and an energy-operated automatic recorder. The operation of the system is such that the output of the receiver is kept constant regardless of the intensity of the static. Data obtained with this system show the presence of three separate groups of static: Group 1, static from local thunderstorms; Group 2, static from distant thunderstorms, and Group 3, a steady hiss-type static of unknown origin.

Curves are given showing the direction of arrival and intensity of static of the first group plotted against time of day and for several different thunderstorms. Static of the second group was found to correspond to that on long waves in the direction of arrival and is heard only when the long-wave static is very strong. The static of this group comes most of the time from directions lying between south-east and south-west, as does the long-wave static.

Curves are given showing the direction of arrival of static of group 3 plotted against time of day. The direction varies gradually throughout the day going almost completely around the compass in 24 hours. The evidence indicates that the source of this static is somehow associated with the sun.

A Note on an Automatic Field Strength and Static Recorder.—Mutch. (*See* under "Measurements and Standards.")

Relation entre les Variations diurnes du Courant tellurique et du Champ magnétique terrestre (Relation between the Diurnal Variations of the Earth Current and of the Terrestrial Magnetic Field).—D. Stenquist. (*Comptes Rendus*, 16th Jan., 1933, Vol. 196, No. 3, pp. 205–207.)

On the Relations of Stellar Electricity and Magnetism to the Phenomena of the Sun's Atmosphere.—R. Gunn. (*Science*, 23rd Dec., 1933, Vol. 76, No. 1982, pp. 577–583.)

On the Propagation of a Lightning Discharge through the Atmosphere.—E. C. Halliday. (*Phil. Mag.*, Feb., 1933, Supp. No., Series 7, Vol. 15, No. 98, pp. 409–420.)

From the author's summary:—Experiments have been described in which a camera with rotating lenses has been successfully used to obtain some indication of the manner of propagation of three lightning flashes. It has been shown that it is possible for a lightning discharge to be propagated from the ground towards the cloud, and that a flash starting at the ground may join up with a flash starting in the cloud, as was earlier shown by Boys. Two instances have been described in which discharges started at a point above the ground and were propagated both upwards and downwards. The photographs have demonstrated that two flashes may, for part of the distance between cloud and ground, traverse the same path. A flash has been photographed showing forking towards the cloud at the top and towards the ground at the bottom. In this case at least, the direction of the forking cannot be a criterion of the direction of propagation of the flash.

SPARK-GAP BREAKDOWN: CHARACTERISTIC PROPERTIES OF THE GLOW DISCHARGE.—R. Hellman: Rogowski. (*Electrician*, 13th Jan., 1933, Vol. 110, No. 2850, pp. 31–32.) *See* also Rogowski, 1932 Abstracts, p. 635.

DIE KORPUSKULARE NATUR DER ULTRASTRAHLUNG UND IHR ERDMAGNETISCHER EFFEKT (The Corpuscular Nature of Cosmic Radiation and the Effect of Terrestrial Magnetism).—J. Clay. (*Naturwiss.*, 20th Jan., 1933, Vol. 21, No. 3, pp. 43–44.)

A short account of work already published in *Proc. Roy. Acad. Amsterdam*, 17th Dec., 1932. The writer has confirmed and extended results already obtained (Jan. Abstracts, p. 34) on the variation of cosmic ray intensity with magnetic latitude (for which he gives a graph) which indicated that cosmic radiation was corpuscular by nature. He determines the minimal value of the energy which the rays must have to penetrate the earth's atmosphere and gives a curve for the distribution of corpuscles as regards energy and the variation of the primary rays with the earth's magnetic field. He reaches the conclusion that the primary cosmic radiation observed at the earth's surface is the part possessing most energy of a corpuscular radiation of almost exponential distribution and mean energy 3×10^{10} electron volts. This radiation is cut off at 3.6×10^{9} electron volts, and this explains the observed constancy of the radiation between 50° magnetic latitude and the magnetic poles. He also finds that the radiation must become harder as the equator is approached.

BEMERKUNG ZUM INTENSITÄTSVERLAUF DER ULTRASTRAHLUNG IN GROSSEN HÖHEN (Remark on the Variations of Cosmic Ray Intensity at Great Altitudes).—H. Kulenkampff. (*Naturwiss.*, 13th Jan., 1933, Vol. 21, No. 2, pp. 25–26.)

Recent measurements of Regener (Jan. Abstracts, p. 33, and below), appear to contradict the presence of a maximum in the altitude/intensity curve of cosmic rays, which was hitherto expected to be produced by the gradual saturation of primary by secondary radiation. The writer of this letter shows that consideration of the effects of the earth's magnetic field in producing curvature of the paths of the secondary electrons gives no theoretical maximum, but a gradual tendency to a limiting value, as found experimentally by Regener.

ENERGY OF COSMIC RAYS.—E. Regener. (*Nature*, 28th Jan., 1933, Vol. 131, p. 130.)

This preliminary letter corrects the value of the intensity I_{∞} of cosmic radiation at its entrance to the atmosphere, given recently by the writer (Abstracts, 1932, p. 634; *also* Jan., p. 33), to a value corresponding to the production of 333 pairs of ions per cc per sec. in air at N.T.P. 1.02×10^{8} pairs of ions are found to be produced altogether by total absorption of cosmic rays by a column of air of 1 sq.cm section. "The flux S of energy coming to the earth from the cosmic rays is found to be 5.2×10^{-3} erg per sq. cm per sec." The temperature of space corresponding to the flux of cosmic rays is also considered.

COSMIC RAYS MAY BE BORN OF NEUTRAL RAYS FROM STARS.—R. Gunn. (*Sci. News Letter*, 21st Jan., 1933, Vol, 23, No. 615, p. 41.)

A note on a new theory suggested by Gunn. "Out in the stars that are still young there are born in great 'star-spots,' like sun spots on our sun, negatively charged ions or electrons which are given great energies. These pass through the outer layers of the star and each picks up a positive ion, and the two together form an energetic neutral pair of some 10 to 100 thousand million electron volts. When such particles hit the earth they become separated in the upper atmosphere by electromagnetic forces or collisions and become cosmic rays."

MILLIKAN AND COMPTON DEBATE COSMIC RAY FACTS AND THEORIES.—Millikan: Compton. (*Sci. News Letter*, 7th Jan., 1933, Vol. 23, No. 613, pp. 6–7.)

ON COMPTON'S LATITUDE EFFECT OF COSMIC RADIATION.—G. Lemaitre and M. S. Vallarta. (*Phys. Review*, 15th Jan., 1933, Series 2, Vol. 43, No. 2, pp. 87–91.)

The full paper, an abstract of which was dealt with in March Abstracts, p. 152.

EINSTEIN BACKS LEMAITRE IDEA THAT COSMIC RAYS ARE BIRTH CRIES.—Lemaitre. (*Sci. News Letter*, 21st Jan., 1933, Vol. 23, No. 615, p. 37.) *See* Feb. Abstracts, p. 95.

HOW FAR DO COSMIC RAYS TRAVEL?—F. Zwicky. (*Phys. Review*, 15th Jan., 1933, Series 2, Vol. 43, No. 2, pp. 147–148.)

This preliminary letter examines the two proposed suggestions as to the nature of cosmic rays, (1) that they are of local origin, and (2) that they have been produced throughout interstellar or intergalactic spaces, and establishes "a relation between them and the red shift of extragalactic nebulae."

ÜBER DIE DRUCK- UND TEMPERATURABHÄNGIGKEIT DER IONISATION BEI ULTRASTRAHLUNG (The Dependence of Cosmic Ray Ionisation on Pressure and Temperature).—B. Gross. (*Zeitschr. f. Physik*, 1933, Vol. 80, No. 1/2, pp. 125–133.)

X-RAYS MADE AS COSMIC RAYS PLOUGH THROUGH GAS [and cause Part of the Charge in an Ionisation Chamber used for Ray Measurements].—G. L. Locher. (*Sci. News Letter*, 21st Jan., 1933, Vol. 23, No. 615, p. 37.)

SOME COMMENTS ON THE RELATION BETWEEN IONISATION AND IONISATION CURRENT IN GASES AT HIGH PRESSURES.—W. R. Harper. (*Proc. Camb. Phil. Soc.*, Jan., 1933, Vol. 29, No. 1, pp. 149–155.)

"The phenomena which limit saturation in a high-pressure ionisation chamber are examined with particular reference to the rôle played by preferential recombination."

STUDIE ÜBER DIE METHODIK DER IONENZÄHLUNG (Study of the Methods of Ion Counting [in Air]).—H. T. Graziadei. (*Physik. Zeitschr.*, 15th Jan., 1933, Vol. 34, No. 2, pp. 82–88.)

PROPERTIES OF CIRCUITS

TRANSMISSION CURVES OF HIGH-FREQUENCY NETWORKS.—S. J. Model. (*Proc. Inst. Rad. Eng.*, Jan., 1933, Vol. 21, pp. 114–143.)

From the Radio Transmitter Research Institute, Leningrad. Author's summary :—The aim of this article is to deduce the design data on frequency transmission, which are necessary in designing the networks for high-frequency modulated waves. In the first section the general laws of current variations in circuits tuned to carrier frequency with and without tube generator are derived ; the interdependence of current curves of various circuits forming a given network is also clarified.

The second section gives the derivation of the transmission curve equation for a two-circuit system, analyses the curve shape as dependent upon the parameters of the circuits and the coupling factor between them, and also explains the part the tube generator plays in restricting the field of application of formulas derived. Moreover, the equation of the current curve for inaccurately tuned circuits is given, which shows that inaccurate tuning results in asymmetrical curves and for that reason is not to be recommended. The third section contains the derivation of the transmission curve equation for a three-circuit system and the analysis of the curve shape as dependent on parameters of circuits and coupling factors between them.

EQUIVALENT CIRCUITS OF AN ACTIVE NETWORK.—J. G. Brainerd. (*Proc. Inst. Rad. Eng.*, Jan., 1933, Vol. 21, pp. 144–153.)

Author's summary :—The problem considered in this paper is that of setting up an exactly equivalent circuit for a four-terminal network containing one e.m.f. and any number of impedances connected in any manner. Several relatively simple circuits which can be used to represent any such active network, and some others which can be used in special cases, are completely specified.

ÜBER DIE THEORIE DES FREISCHWINGENDEN KREISES (On the Theory of the Freely Oscillating Circuit).—M. Rousseau : Osnos. (*Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, pp. 27–28.)

After referring to Osnos' papers (1932 Abstracts, pp. 457 and 635–636) the writer gives some more transformations of the usual formulae and a number of deductions to be made from them. Thus "half the ohmic resistance must equal the geometric mean of the inductive resistance and the absolute value of the whole (necessarily negative) inductive-capacitive resistance." Again, the condition for oscillatory discharge is shown to be that the time constant of the L, R system must be greater than a quarter of the relaxation time of the C, R system. The writer uses one section to show that the use of the ideas of "impedance" and "non-ohmic resistance" is only logical in the theory of *forced* oscillations.

SOME NOTES ON DEMODULATION.—Roder. (*See* under "Reception.")

SUPERPOSITION OF TWO MODULATED RADIO FREQUENCIES [and the Distortions in the Resulting Envelope].—H. Roder. (*Proc. Inst. Rad. Eng.*, Dec., 1932, Vol. 20, pp. 1962–1970)

Author's summary :—If two modulated radio frequencies are added, the envelope of the resulting signal can be found by means of a vector diagram. A number of envelopes corresponding to various conditions are shown. The distortions in the resulting envelopes are mainly due to phase shifts of audio frequency. Low percentage modulation helps to keep distortions small. The treatment applies to common-frequency broadcasting and to all cases in which the received signal consists of a direct and a reflected beam.

FREQUENCY DOUBLING IN A TRIODE VACUUM TUBE CIRCUIT.—C. E. Smith. (*Proc. Inst. Rad. Eng.*, Jan., 1933, Vol. 21, pp. 37–50.)

Author's summary :—"This paper gives a quantitative analysis of operating performance of a triode vacuum tube as a frequency doubler. With slight changes this analysis can be applied to tripling, quadrupling, etc. Three methods of attack have been outlined : theoretical analysis, graphical solution, and experimental results. The theoretical analysis furnishes a general solution to the problem, from which general conclusions as to the best operating conditions can be drawn. The graphical solution furnishes a simple method by which rapid calculations can be made for a particular case. The experimental results are valuable for comparison because they give the actual results of operation.

"The primary object of this work has been to investigate the conditions that will give maximum plate efficiency and consequently the most desirable operating conditions, also keeping in mind that power output and power amplification are important factors to consider in the practical application of the frequency doubler." The writer refers to the work of Marique, Mesny, and Bunimowitch (Abstracts, 1929, p. 325 ; 1930, p. 332 ; and 1931, p. 209).

VOLTAGE AMPLIFICATION WITH HIGH SELECTIVITY BY MEANS OF THE DYNATRON CIRCUIT.—Colebrook. (*See* under "Reception.")

GRID CURRENT COMPENSATION IN POWER AMPLIFIERS.—Baggally. (*See* under "Acoustics and Audio-frequencies.")

TRANSMISSION

Berechnung des Anfachmechanismus von Schwingungen bei einer Elektronenröhre in Barkhausen-Kurz-Schaltung (Calculation of the Mechanism of Oscillation Onset with a Valve in the Barkhausen-Kurz Circuit).—H. Edler. (*Archiv f. Elektrot.*, 9th Dec., 1932, Vol. 26, No. 12, pp. 841–849.)

The writer adopts energy considerations as his starting-point and finds a differential equation governing the motion of electrons in the valve, under the assumption that an external alternating e.m.f. from the connected Lecher system acts between anode and cathode of the valve; he neglects internal friction and interaction between the electrons themselves. Solving the equation, he finds an expression for the amplitude of oscillation of the electrons which itself varies with time. The fluctuations of the amplitude give the boundaries of the oscillation regions; the amplitudes of the oscillation voltages can also be calculated and the influence exerted by the dimensions of the valve and the voltages on its electrons can be estimated. The maximum developable power is determined, with the conditions under which it is attained. Good agreement is obtained with the experimental results of Wundt (1931 Abstracts, pp. 94–95).

Short- and Ultra-Short-Wave Transmitting Circuit with Several Lecher Pairs of Mica-Insulated Copper Strip.—H. Rothe and H. O. Roosenstein. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Nov., 1932, Vol. 40, No. 5, p. 184.) *See* Fig. 17.

Points of Connection of Feeders to Lecher System in Ultra-Short-Wave Transmitter.—B.D.H. Tellegen: Philips' Company. (*Ibid.*, p. 184.)

To prevent the leakage of r.f. energy to the cathode, the feeders are not connected to the potential nodes but are symmetrically displaced with respect to these, the points 14 and 15 (Fig. 18) being so chosen that no a.c. potential difference exists between them and the cathode. The choke 13 can then be dispensed with.

Discussion on "A New Circuit for the Production of Ultra-Short-Wave Oscillations."—N. Carrara: Kozanowski. (*Proc. Inst. Rad. Eng.*, Dec., 1932, Vol. 20, p. 1975.)

Pointing out the similarity between the Kozanowksi circuit and Carrara's own circuit—*cf.* February Abstracts, p. 114, Carrara.

An Oscillator having a Linear Operating Characteristic [and High Frequency Stability].—L. B. Arguimbau. (*Proc. Inst. Rad. Eng.*, Jan., 1933, Vol. 21, pp. 14–28.)

Author's summary:—"A review of conventional linear equilibrium conditions is given. It is shown that these conditions are not usually at all applicable to practical oscillators because the operating region is not to be so simply described. The relation of non-linear effects to frequency modulation is pointed out. A modified type of oscillator which conforms to the elementary linear conditions is described and its properties are discussed. The results are applied to a conventional grid-leak and condenser oscillator to explain its modulating characteristics. The simplicity of the new circuit permits a discussion of amplitude inertia effects."

In conclusion, the author sums up:—"It has been seen that an oscillator, where the change in plate resistance is brought about by an automatically shifted bias, conforms closely to linear theory. Computations show that such an oscillator has high frequency stability and linear modulating characteristics. It has been shown that dynamic effects can be minimised by a proper choice of the constant k [equation 10]. In the practical design of an oscillator, a compromise is usually necessary between freedom from frequency modulation and freedom from dynamic hysteresis. A desirable solution to both of these troubles can usually be obtained by choosing a sufficiently high proportionality factor between the rectifier output and the amplitude of swing. This sharper control of equilibrium conditions is the essential advantage of the linear oscillator which has been described."

Carrier Noise in Short-Wave Transmitters.—A. J. A. Gracie and E. J. C. Dixon. (*P.O. Elec. Eng. Journ.*, Jan., 1933, Vol. 25, Part 4, pp. 300–303.)

The writers sum up as follows:—Carrier hum is increased by doubler circuits adjusted to operate at good efficiency, and may limit the commercial effectiveness of the transmitter. In telephone transmitters, where the carrier hum must be at a very low level, it is best to eliminate the ripple at the source by adequate smoothing arrangements and the use of d.c. supplies wherever possible. In telegraph transmitters a.c. hum may be saturated out at the doubler stages, and the required modulation applied at their output. The saturation point in bright-emitting cathodes of high efficiency is fairly critical, and the effect of using valves of higher gain with dull-emitting filaments is being investigated.

Les Émetteurs à Ondes entretenues modulées des Stations côtières françaises (The Modulated C.W. Transmitters of the French Coast Stations).—M. Bruniaux. (*Ann. des P.T.T.*, Jan., 1933, Vol. 22, No. 1, pp. 59–78.)

New B.B.C. High-Power Transmitter to replace Daventry Long-Wave Set [using "Series Modulation"].—(*Marconi Review*, Nov.–Dec., 1932, No. 39, p. 30.)

Paragraph mentioning that the new transmitter will employ "a new system of modulation, known as 'series modulation.'" up to 90%. The frequency characteristic will be straight between 30 and 10 000 c/s.

RECEPTION

Filter für Zwischenfrequenzverstärker (A Filter for the Intermediate-Frequency Amplifier [of a Superheterodyne Receiver]).—H. Piesch. (*Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, pp. 23–26.)

Description and analysis of "a new type of filter circuit" specially suitable for the purpose named. A single stage is found to be considerably superior in sharpness of tuning and in shape of characteristic to a single-stage i.f. amplifier with two resonance transformers. Within the band-pass zone the no-load output voltage is higher than the input voltage. This property and the fact that its point of maximum effect can be adjusted within the pass band, enables the filter to be adjusted if desired to correct any frequency distortion in the r.f. or a.f. part of the superheterodyne receiver.

Each series element of the filter consists of a resonance circuit with a capacity in series; each parallel element consists of a similar combination. The calculated damping characteristic for a loss-free filter for a band of 10 kc/s is shown in Fig. 3, left-hand curve: the measured characteristic is given by the right-hand curve. Fig. 4 refers to a single-stage filter with a middle frequency of 77 kc/s and a band-breadth of only 5 kc/s. The left-hand curve shows the frequency characteristic of the output voltage, the right-hand curve that of the ratio output voltage/input voltage. The latter curve, with its dip near the middle frequency, represents a filter which could well be used with a superheterodyne receiver having a sharply tuned r.f. part; the dip would compensate the r.f. resonance curve and give the combination the desired rectangular characteristic. On the other hand if compensation is required in the a.f. part of the receiver, this correction can be accomplished by detuning the parallel element of the filter.

For the broadcast and short-wave receivers at present on the market, a single-stage filter is selective enough, but there is no difficulty in extending the principle to two stages (Fig. 6).

FIDELITY COMPENSATION BY REGENERATION [by Feeding-back Part of Output in Phase to Screen-Grid Circuit of Tetrode].—A. C. Matthews. (*Electronics*, Jan., 1933, p. 18.)

The compensation applied to the s.g. circuit does not affect the otherwise normal frequency characteristic. The impedance of the s.g. circuit decreases with frequency, so that the voltage fed back through the tetrode is greater for the lower frequencies. If compensation at the higher frequencies is also required, a double-humped curve is obtained by a series resonant circuit shunted across one of the s.g. circuit resistors.

EIN NEUARTIGER NIEDERFREQUENZVERSTÄRKER (A New Type of L.F. Amplifier [Glow-Discharge Tube Coupling: for Frequencies from 0 to 10 000 c/s]).—O. Schäfer: H. Peek. (*Radio, B., F. f. Alle*, Feb., 1933, pp. 49–55.)

An almost rhapsodic appreciation of Peek's new amplifier for direct and alternating currents, dealt with in 1932 Abstracts, p. 535. Apart from its use for photoelectric cell researches (for which it is "outstandingly suitable") it is admirably adapted to the broadcast reception of the local station, in combination with a very good loud speaker: the perfection with which the lowest notes are reproduced "spoils" the listener for the ordinary receiver. On long-distance reception its advantages are wasted: even the local station transmissions are not worthy of it if too long a cable is involved. The new amplifier can be simply and cheaply constructed from ordinary commercial components.

The writer discusses at length the development of the new circuit from the ordinary direct-coupled amplifier circuit with a compensating battery in the grid lead, and from the Loftin-White direct-coupled circuit which, unlike the latter, is suitable for mains operation. The advantages of the new circuit over these, and over the resistance-coupled amplifier, are described: as regards the latter amplifier, the fundamental advantage presented by the new system is that the glow-discharge tube has, for a.c., a resistance practically independent of frequency and ranging from about 10 to 100 ohms according to the design of the tube. Finally, he gives the design data and diagram of a two-valve amplifier for use with an a.c. mains unit, giving at about 1 c/s an amplification factor of half the normal value (the latter, with an output valve of factor 10, being about 270), while between 50 and 8 000 c/s the amplification is constant, "which can be said of hardly any other circuit!" A worn-out triode is used, in conjunction with a bell transformer in parallel with the heating circuits, as a rectifier to provide the necessary grid voltage. A milliammeter in the anode circuit of the output valve is necessary for the adjustment of the amplifier.

VOLTAGE AMPLIFICATION WITH HIGH SELECTIVITY BY MEANS OF THE DYNATRON CIRCUIT.—F. M. Colebrook. (*Wireless Engineer*, Feb., 1933, Vol. 10, No. 113, pp. 69–73.)

Author's summary:—In an ordinary tuned-circuit triode or tetrode amplifying stage without retroaction, the selectivity is less than that of the tuned circuit alone. If, however, a tetrode valve is used in a dynatron or negative resistance condition, the selectivity of the amplifying stage is considerably greater than that of the tuned circuit alone, and the voltage amplification comparable with that given by the valve used in the normal manner. With a given tuned circuit at a given frequency the normal and the dynatron tetrode amplifying circuits can only be made comparable in selectivity by using a high degree of retroaction with the former. In this condition the voltage amplification given by the normal circuit will exceed that of the dynatron circuit, but the dynatron circuit has the advantage of simplicity, since no additional winding or other auxiliary apparatus is required.

The above distinction between the two types of circuit is deduced analytically and confirmed by experiments with a tuned audio-frequency amplifier.

SOME NOTES ON DEMODULATION.—H. Roder. (*Proc. Inst. Rad. Eng.*, Dec., 1932, Vol. 20, pp. 1946–1961.)

Author's summary:—"The audio output of a detector depends upon two magnitudes which are independent each from the other. These magnitudes are the radio-frequency envelope of the input and the rectification characteristic of the detector. In problems dealing with the distortions caused by selective circuits or by the superposition of several modulated signals it becomes necessary to treat both magnitudes separately.

" A new method to find graphically the radio-frequency envelope for the 'general modulated signal,' is given. An analysis is made showing how to find the detector output if the input radio-frequency envelope and the rectification characteristic of the detector are known."

The author feels justified in dealing with the subject in some detail because " numerous publications on these problems do not consider that distortions in the audio output are due to *two independent* sources, one of which is arbitrarily adjustable to a much higher extent than the other."

Discussion on " Some Notes on Grid Circuit and Diode Rectification."—F. E. Terman : Nelson. (*Proc. Inst. Rad. Eng.*, Dec., 1932, Vol. 20, pp. 1971–1974.)

Terman, referring to Nelson's paper (1932 Abstracts, p. 583), points out that the expression there given for the input resistance, $R/2\cos^2\theta$, yields a value always higher than that actually obtained ; it is derived by assuming that the losses in the input resistance equal the energy consumed by the grid leak, so that the energy lost in the rectifying device at the input electrode is neglected. He also considers Nelson's relation for distortionless grid rectification, $x/R \geq m$, to be less strictly correct than the Terman-Morgan relation $X/R \geq m/\sqrt{1 - m^2}$, though unless the degree of modulation is high the difference is too small to be very important.

Nelson replies : Fig. 3 of his paper shows that $R/2\cos^2\theta$ gives results which are too high, while the Terman-Morgan $R/2\cos\theta$ gives (as the authors showed) results which are too low. His expression $X/R \geq m$ picks the point where the rate of change of the envelope is greatest, *i.e.* when either a sine or a cosine wave is passing through zero. " This holds for all percentages of modulation and this theory explains why it is possible to obtain good quality with 100% modulation and $X/R \geq 1$." He adds that " some might object to the theory developed by saying that the distortion is caused by a low ratio of a.c. to d.c. impedance. There is some truth in this, particularly when the X/R ratio is very low. The writer hopes to cover this subject in the near future, as a few preliminary checks show that the effect of too low a ratio of a.c. to d.c. impedance may be separated from the effect discussed here."

Inter-Carrier Noise Suppression : a New System [using the Wunderlich B Valve and Automatic Volume Control].—N. E. Wunderlich. (*Electronics*, Jan., 1933, p. 13.)

" A simplified system which requires no additional tubes and hence is much less expensive than more complicated systems, although performing the same functions. These results are attained by taking advantage of circuit arrangements made possible by the strategic electrode construction of the Wunderlich B tube, which has a longer cathode and a small additional anode placed at the top of the structure and shielded from the other elements. By this extra anode, the AVC potentials are amplified before being applied.

" Performance curves show the 'threshold' level of the receiver may be set to any desired value while retaining the AVC action. The sustaining action of the AVC may be caused to release at any desired lower signal level. The point of release may be adjusted by means of the sensitivity control." This action is very sharply defined because of the above-mentioned amplification of the AVC potentials.

Automatic Volume Control [with Double-Diode Triode, giving Quiet, Amplified and Delayed AVC].—C. N. Smyth. (*Wireless World*, 17th Feb., 1933, Vol. 32, pp. 134–136.)

Circuits for Amplified Automatic Volume Control [using the Duplex Diode Triode].—L. E. Barton : C. Travis. (*Electronics*, Jan., 1933, pp. 16–17.)

For references to these valves *see* Abstracts, Jan. and Feb., pp. 41 and 102, l-h cols. ; 1932, p. 587, r-h col. In the circuit here described the steady d.c. voltage generated by the diode detector is amplified in the triode unit of the valve together with the detected a.f. signal, and is used as an AVC bias after this amplification. " There results a very sensitive and level AVC system." The advantages of the circuit are analysed.

Adding Automatic Volume Control to an Existing Receiver with a Variable-Mu H.F. Stage.—(*World Radio*, 10th Feb., 1933, Vol. 16, No. 394, p. 200.)

New Automatic Bias Scheme.—E. G. Bowen. (*Wireless World*, 24th February, 1933, Vol. 32, p. 157.)

There is a definite tendency among constructors of battery sets to follow mains practice and provide automatic bias for both r.f. and a.f. valves. A new bias scheme is described in this article which overcomes the difficulties hitherto associated with battery variable-mu valves.

New Apparatus and Appliances [Special Transformer and Output Choke for " Quiescent Push-Pull."].—(*Electrician*, 10th Feb., 1933, Vol. 110, No. 2854, pp. 200–201.)

Q.P.P. with Triodes.—W. I. G. Page. (*Wireless World*, 24th February, 1933, Vol. 32, pp. 152–153.)

Up to the present the principles of quiescent push-pull have been applied to pentode valves. Where, however, the major consideration is valve cost rather than power output, triodes in quiescent push-pull will probably find wide application, especially as matching is not essential and moving-iron speakers can be used satisfactorily.

An Obscure Cause of Poor Reception [Faulty Combination of Parallel-Feed Transformer and Automatic Grid Bias Resistor].—M. G. Scroggie. (*World Radio*, 10th Feb., 1933, Vol. 16, No. 394, p. 202.)

The All-Wave Monodial Super.—W. T. Cocking. (*Wireless World*, 27th January and 10th February, 1933, Vol. 32, pp. 60–63 and 109–112.)

A seven-valve battery-operated receiver for the amateur constructor. The principal feature is that the receiver covers a waveband of 12 to 100 metres in addition to the customary medium and long broadcast wavebands.

AUTO-RADIO AN EXPANDING MARKET IN 1933: POLICE RADIO INCREASES.—(*Electronics*, Jan. 1933, pp. 8–9.)

DIE FUNKINDUSTRIE IN DER SAISON 1932/1933 (The Radio Industry in the Season 1932/1933 [Analysis of Types, Prices and Sales]).—H. Menzl. (*E.T.Z.*, 12th Jan., 1933, Vol. 54, No. 2, pp. 25–26.)

COUNTERACTING FADING BY PERIODIC DETUNING OF RECEIVER.—Deutsche Tel:werke u. Kabelind. A.G. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Nov., 1932, Vol. 40, No. 5, p. 184.)

The receiver is detuned by 500 to 1 000 c/s. at a frequency of from 5 to 50 per second, by means of a rotating condenser or a valve device.

AIRPLANE RADIO FREED FROM IGNITION INTERFERENCE.—Jenkins. (*See* under "Aerials and Aerial Systems.")

AERIALS AND AERIAL SYSTEMS

ANPASSUNG VON SPEISELEITUNGEN AN KURZWELLEN-SENDEANTENNEN (Matching Feeders with Short- [and Ultra-Short-] Wave Transmitting Aerials).—S. Issakowitsch-Kosta. (*E.N.T.*, Jan., 1933, Vol. 10, pp. 9–19.)

Of the four components into which the over-all efficiency of a transmitting system can be divided, namely the partial efficiencies of generator, feeder-coupling circuit, feeder, and dipole aerial, the writer deals with the middle two. The matching conditions are derived for the single-wire feeder with return through the dipole capacity to earth and the earth itself, and for the parallel-wire feeder. With the former, a transmission of energy is only possible when the matching is perfect: with the latter and with the mechanically difficult concentric feeder (which is not dealt with in this paper, except that a reference is given to Moser's work—Abstracts, 1929, p. 105), the conditions are not so critical. The efficiencies and over-all damping are found in terms of Roosenstein's "wave ratio" (the ratio of the potentials at node and antinode—1931, p. 36: *see* also p. 441), and the choice of the point or points of connection on the aerial is investigated. Finally, the theoretical results are confirmed by tests on a 9-m wave.

RECHNERISCHE ERMITTLUNG DER IMPEDANZ VON ANTENNEN (The Calculation of the Impedance of Aerials [with Mid-Point Feed: for Various Values of l/λ)].—J. Labus. (*Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, pp. 17–23.)

The usual practical formula for the reactance of an aerial is $X = -\sqrt{L/C} \cdot \cot(\omega l\sqrt{LC})$, which is derived under the assumption that the aerial can be treated as a homogeneous line with uniformly distributed inductance and capacity. This formula is strictly applicable only when the aerial length is negligible compared with the wavelength. Other workers have calculated the reactance of centre-fed aerials (*e.g.*, Carter, 1932 Abstracts, p. 585) but only for the special case where the aerial length is a whole number of half wavelengths (dipole aerial).

The writer therefore starts from the Maxwell equations and calculates, with the help of the line integral (1), the required impedance, which is made up of two components, one real (the radiation resistance) and the other imaginary (the reactance). To do this he first determines the scalar and vector potentials at the surface of the conductor. He arrives at equation (18) for the reactance at the feeding point: if the aerial length is small compared with the wavelength this simplifies down to equation (19), in which the only determining values are the length and radius of the wire. The important difference between this latter formula and the usual one quoted at the beginning of this abstract is that by the former the reactance is independent of the wire spacing d of the feeder (Fig. 1*b*), whereas by the latter the reactance involves this factor. The discrepancy between the two formulae is shown in Fig. 6, where the reactance is plotted against different values of l/λ.

THE RADIATION CHARACTERISTICS OF A VERTICAL HALF-WAVE ANTENNA.—J. A. Stratton and H. A. Chinn. (*Proc. Inst. Rad. Eng.*, Dec., 1932, Vol. 20, pp. 1892–1913.)

Authors' summary:—Extensive measurements have been made of the field distribution about a vertical antenna operating at 29 megacycles over sea water. With the help of a small, non-rigid airship observations were made at various altitudes which permitted the plotting of the space characteristic and the determination of the attenuation as dependent on altitude. The experimental results are compared with field intensities computed for the given physical conditions from the theoretical expressions of Sommerfeld and Strutt. Of interest is the manner in which the field is attenuated in the immediate vicinity of the ground plane, and the marked effect on the general intensity distribution of the effective height of the antenna above ground.

Details are given of the design of the apparatus required for carrying out the measurements.

MUTUAL IMPEDANCE OF TWO SKEW ANTENNA WIRES.—F. H. Murray. (*Proc. Inst. Rad. Eng.*, Jan., 1933, Vol. 21, pp. 154–158.)

Author's summary:—In a recent communication P. S. Carter derived a formula for the mutual impedance of two antenna wires intersecting at an angle θ, as a sum of two definite integrals [1932 Abstracts, p. 585]. It has been shown that related double integrals can be reduced to sums of logarithmic integrals and their limits; in the present paper this reduction will be generalised. The mutual impedance of two antenna wires in space which do not intersect may be calculated in terms of the integrals discussed, but these integrals can be evaluated by known tables only if the wires are in the same plane. The integrals of Carter result from a suitable limiting operation; a direct evaluation is also possible and is given.

ON THE NUMERICAL CALCULATION OF THE CURRENT IN AN ANTENNA [and the Reduction of Related Double Integrals].—F. H. Murray. (*American Journ. of Mathematics*, 1931, Vol. 53, pp. 889–890.) *See* also preceding abstract.

THE NEW HIGH-POWER BROADCASTING STATION AT VIENNA, WITH REFLECTOR TOWER FOR DIRECTIVE WORKING.—Telefunken Company. (*E.T.Z.*, 9th Feb., 1933, Vol. 54, No. 6, pp. 137–138.)

Rapid progress is being made with Bisamberg station, on a mountain ridge to the north of Vienna. Since it lies near the north-eastern boundary of Austria, radiation is required to be chiefly in the west and south-west directions, and therefore a reflector tower (13-metre iron lattice), exactly similar to the aerial tower, is being erected 110 metres to the east of the latter (*cf.* Wilmotte, March Abstracts, p. 158). Both towers oscillate at a quarter wavelength. A capacity earth (a network of 12 kilometres of copper wire) is supported on 36 small masts. The modulated aerial circuit power is 150 kw.

AIRPLANE RADIO FREED FROM IGNITION INTERFERENCE.—C. F. Jenkins. (*Sci. News Letter*, 21st Jan., 1933, Vol. 23, No. 615, p. 40.)

Brief summary of recent U.S. Patent. The inventor found that radiation from the engine ignition system spread spherically, but a cone-shaped zone free of radiation existed behind the plane, having its apex at a point directly behind the engine. The effect is probably due to absorption by the metal parts of the fuselage. The antenna is flown from the tail structure axially in this zone and thus avoids ignition interference.

DIE ELEKTRISCHE RAUHREIF-ABHEIZUNG VON FREILEITUNGEN (The Electrical Heating of Overhead Lines against Hoar Frost).—K. Halbach. (*E.T.Z.*, 12th Jan., 1933, Vol. 54, No. 2, pp. 33–36.)

SCHWINGHEBELDÄMPFER FÜR FREILEITUNGEN (A Vibration-Damping Lever for Attachment to Overhead Lines near Point of Suspension).—H. Schmitt. (*Zeitschr. V.D.I.*, 14th Jan., 1933, Vol. 77, No. 2, pp. 52–53.)

VALVES AND THERMIONICS

OUTPUT STAGES: THE CHOICE OF VALVES FOR USE IN LOW-FREQUENCY AMPLIFIERS [Rapid Test Method].—C. C. Whitehead: Brain. (*Wireless Engineer*, Feb., 1933, Vol. 10, No. 113, pp. 78–82.)

After giving a résumé of Brain's paper on determining the operating conditions for a given valve for maximum undistorted output (1929 Abstracts, p. 388), the writer describes an extension of the method to a rapid test on commercial power valves to determine their suitability or otherwise for use in the output stage of any given amplifier, the anode voltage of which is limited to a definite figure. "Incidentally, it also led to the solution of the following problems:—(1) the minimum anode voltage required to obtain a given output and efficiency, and (2) whether a *reasonable* efficiency [taken as 25%] is obtainable without exceeding the maximum anode voltage recommended by the makers. . . . It is surprising how many alleged 'power' valves . . . fail to pass this test."

TUBES WITH COLD CATHODES [Glow Discharge as Electron Source].—A. Hund. (*Electronics*, Jan., 1933, pp. 6 and 22.)

Summary of a recent I.R.E. paper on the work referred to in Abstracts, 1932, pp. 38 and 349: *cf.* also p. 168, Guntherschulze and Keller. The only illustration shows one of Seibt's gas-discharge valves (1932, p. 286), but Hund implies that his own valves eliminate the "Seibt region" where the increase of current with voltage is very slow and uniform, and also the second region where the curve is very steep, and work in the third region, giving a plate characteristic very similar to that of an ordinary valve. Demonstrations were given.

A "LOW-HUM" VACUUM TUBE [No. 262A High-Gain A.F. Amplifier for A.C. Mains].—J. O. McNally: Western Electric Company. (*Bell Lab. Record*, Feb., 1933, Vol. 11, No. 6, pp. 158–162.)

For public address systems, sound picture projection, speech input equipment for broadcasting, etc. "Disturbance currents in the 262A tube due to the alternating current supply of the heater are somewhat greater than the shot effect and slightly less than the thermal noise." *See* also 1932 Abstracts, pp. 639–640.

INTER-CARRIER NOISE SUPPRESSION: A NEW SYSTEM [using the Wunderlich B Valve with Additional Anode for Amplifying the AVC Potentials].—Wunderlich. (*See* under "Reception.")

VACUUM TUBES [Survey for 1932].—L. J. Davies. (*Electrician*, 27th Jan., 1933, Vol. 110, No. 2852, p. 103.)

THE PLACE OF NICKEL IN RADIO TUBE MANUFACTURE.—A. J. Marino. (*Electronics*, Jan., 1933, pp. 4–5.)

I.E.E. WIRELESS SECTION: CHAIRMAN'S ADDRESS. PART I: THERMIONIC VALVES. PART II: SPONTANEOUS FLUCTUATIONS IN VALVE AMPLIFIERS.—L. B. Turner. (*Journ. I.E.E.*, Jan., 1933, Vol. 72, No. 433, pp. 10–30.)

In the section on improvements in receiving triodes the writer compares the 1918 Army "R" valve with a modern directly heated type: "I have tabulated μ^2/ρ because this, I think, measures, as well as any single quantity can, the practical gain obtainable from an amplifying valve in terms of power or square of voltage. Despite a filament power divided by 13, in its operation the new valve may be said to be 10 decibels better than the old." A further advance is given by the development of indirectly heated cathodes (in England, out of every three receiving valves sold only one is of the indirectly heated type: but on the other hand "while the sale of receiving valves is still increasing, the sale of the directly heated type appears to have reached its maximum ").

The 500 kw demountable valve referred to by Angwin a year before (Abstracts, 1932, p. 112) has undergone alterations, and the new design is described and illustrated, as is also a 40 kw valve of the same general type.

The penultimate section of Part 2 quotes some estimates and experimental determinations of the limits of smallness of amplifiable signal voltage, and gives some results obtained with a sensitive wide-band amplifier (P.O. Research Department) for cross-talk and other telephonic measurements. The special low-noise valves of Metcalfe and Dickinson (1932, p. 587) are referred to.

NON-LINEAR VALVE CHARACTERISTICS: A BRIEF DISCUSSION ON THEIR USE.—C. S. Bull. (*Wireless Engineer*, Feb., 1933, Vol. 10, No. 113, pp. 83–88.)

Author's summary:—In this article a method is given for showing how the frequencies in an input signal are added and subtracted by a curved valve characteristic. The resultant frequencies are not all able to give an output voltage across the anode load, since the load is generally reactive or resistive to a limited range of frequencies only. Simple rules are given for determining the effective combination of frequencies, and modulation rise, cross modulation, detection, modulation, and high-frequency mixing are considered in detail.

DIE BESTIMMUNG DER AUSTRITTSARBEIT AN OXYDKATHODEN (Determination of the Work Function of [Barium] Oxide Cathodes).—W. Heinze. (*Ann. der Physik*, Jan., 1933, Series 5, Vol. 16, No. 1, pp. 41–76.)

Author's summary:—Reasons are given for considering it more correct to determine the work function by means of the cooling caused by emission rather than by using Richardson's equation. The errors of previous measurements by the cooling method are indicated. The experimental arrangement is improved and designed in such a way that errors, in particular those due to the internal resistance of the valve, are avoided. The heating effect of the emission current is either kept as small as possible by suitable leads, or else calculated, using its relation with the heating current; the effect of re-radiation of heat from the anode is eliminated.

An empirical relation is found between the emission current in the saturation region and the anode voltage; in the case of oxide cathodes this takes the place of the effect of the electrostatic image rule and enables the work function found experimentally to be converted to that corresponding to zero external field. The work functions for [barium oxide] cathodes made by the metallic vapour and paste methods have mean values of 2.05 and 1.87 volts respectively; in this it appears probable that the work function increases with the temperature.

ÜBER DIE RÄUMLICHE VERTEILUNG DER EMISSION VON GLÜHKATHODEN [The Spatial Distribution of the Emission from Incandescent Cathodes).—F. Hamacher. (*Archiv f. Elektrot.*, 7th Jan., 1933, Vol. 27, No. 1, pp. 47–56.)

The distribution of emission from linear and non-linear incandescent cathodes is investigated by observing the fluorescent images they produce on a screen which also serves as the anode. The effect of a Wehnelt cylinder is also considered, and measurements are made of the distribution behind a slit cylindrical anode, to explain the leakage round stops raised to a high potential.

DIRECTIONAL WIRELESS

LA RADIOGONIOMÉTRIE ET LES RADIOCOMPAS STROBOSCOPIQUES (Direction Finding and Stroboscopic Direction Finders).—R. Hardy. (*Rev. Gén. de l'Élec.*, 21st Jan., 1933, Vol. 33, No. 3, pp. 85–94.)

Theory and practical development of the direct-reading direction finder dealt with in 1932 Abstracts, p. 642.

ACOUSTICS AND AUDIO-FREQUENCIES

SUR LA PROPAGATION DES ONDES SONORES D'AMPLITUDE FINIE (The Propagation of Sound Waves of Finite Amplitude [Mathematical Analysis with Results applicable to High-Power Horn Loud Speakers]).—Y. Rocard. (*Comptes Rendus*, 16th Jan., 1933, Vol. 196, No. 3, pp. 161–164.)

Equation 3 applies to a large exponential horn. If $y = a \sin \omega t$ represents the motion imposed on the air at the horn entrance, certain harmonics, superposed on this, are found at the mouth: the amplitude of the p^{th} harmonic is proportional to a^p. If R is the ratio of the air velocities for the second harmonic and the fundamental, at the horn mouth, the value of R is given by equation 4. If it is considered necessary, for the sake of quality, to limit the value of R for a given frequency (say $R = 1$ at 3 000 c/s), equation 4 gives a limit for a, which corresponds to a limit for the acoustic power W supplied (per square centimetre) at the entrance to the horn. This limiting value is given by

$$W = R^2 \rho c^5 m^2 / 8\pi^2(\gamma + 1)^2 n^2;$$

this, for a horn with a low cut-off at 70 c/s and for $R = 1$ at 3 000 c/s, works out at $W = 0.82$ watt/cm², corresponding to pressures of 25 000 baryes at the entrance. "Such pressures are easily obtained in powerful modern loud speakers, and this example (where the energy in free space of the second harmonic is equal to that of the fundamental) shows that the consideration of waves of finite amplitude, and the equations governing them, may become very necessary in many cases."

ACCESSION TO INERTIA OF, AND POWER RADIATED BY, A SPHERE VIBRATING IN VARIOUS WAYS; WITH APPLICATIONS TO HORNLESS LOUD SPEAKERS [Theoretical Investigation].—N. W. McLachlan. (*Phil. Mag.*, Feb., 1933, Supp. No., Series 7, Vol. 15, No. 98, pp. 443–472.)

The writer finds "that, under certain conditions, a radially vibrating sphere gives perfect reproduction of acoustic pressures." He calculates the increase of low-frequency output of discs and spheres due to a large baffle. "When two diaphragms vibrate in opposition along a common axis, it is indicated that a baffle is unessential provided the useful radiation is confined to the external surfaces of the vibrators." In the case of a sphere having nodal circles, the low-frequency radiation is found to decay rapidly with increase in the number of nodal circles. "This arises from interference due to oppositely vibrating segments. It follows that the l.f. interference concomitant with free-edge discs or conical diaphragms executing diametral modes is extremely large, provided the system is substantially symmetrical. By aid of formulae given in the analysis, the mechanical impedance of various types of spherical vibrator can be found."

SOUND DISTRIBUTION FROM A HORN [Theoretical Determination of Conditions for Validity of "Rigid Disc" Substitution for Mouth of Horn].—N. W. McLachlan. (*Wireless Engineer*, Jan., 1933, Vol. 10, No. 112, pp. 26–27.)

MESURE DE LA PHASE ET DE L'AMPLITUDE DE HAUT-PARLEURS ÉLECTRODYNAMIQUES (Measurement of the Phase and Amplitude of Moving-Coil Loud Speakers).—W. Binder. (*Ann. des P.T.T.*, Jan., 1933, Vol. 22, No. 1, pp. 86–91.)

French version of the German paper referred to in 1932 Abstracts, p. 229.

LAUTSPRECHER-ANPASSUNG (Matching the Loud Speaker with the Output Stage).—H. Keller. (*Radio, B., F. f. Alle*, Feb., 1933, pp. 67–69.)

The writer discusses the effects of under- and over-matching: the former (internal resistance of valve too large) causes a loss of the lower notes; the latter (internal resistance too high) a loss of the high notes. He concludes that in practice the best compromise between fidelity and amount of output is obtained when "the internal resistance is about 2 000 times the loud speaker inductance."

L'ÉVOLUTION ET L'ÉTAT ACTUEL DE LA TECHNIQUE MICROPHONIQUE (The Evolution and Present Condition of Microphone Technique).—P. Chavasse. (*Ann. des P.T.T.*, Jan., 1933, Vol. 22, No. 1, pp. 9–58.)

VELOCITY [RIBBON] MICROPHONES: PRACTICAL CONSTRUCTION OF TWO TYPES THAT ARE EASY TO MAKE.—C. W. Melotte: G. A. Elliot. (*QST*, Feb., 1933, Vol. 17, pp. 23–25.)

EIN KOMPENSATIONSMIKROPHON SEHR KLEINER DIMENSIONIERUNG (A Compensation Microphone of Very Small Dimensions [for Sound Field Measurements]).—W. Geffcken. (*E.N.T.*, Jan., 1933, Vol. 10, pp. 39–40.)

The "compensation" method of measuring sound intensities without distorting the sound field depends on the readings being taken when the measuring microphone has its diaphragm at rest. But though this device prevents distortion by a secondary field, it does not get over the distortion due to the obstacle presented to the sound waves by the microphone; it is therefore very desirable that the dimensions of the latter should be very small. The compensation microphone here described was made from a Siemens-Reiniger-Veifa "Ohrsprecher" for the deaf, using the magnetic system of this as the compensation device and adding a second diaphragm to form a capacity microphone. The latter is connected in Riegger's "half resonance curve" circuit, the output of which leads to an amplifier and telephones: silence in the telephones indicates that the diaphragm is at rest. The compensating voltage is led to the magnet system through a Brücke "compensator" which allows the phase to be adjusted. The arrangement is very free from all kinds of external disturbance and is considerably more sensitive than a capacity microphone of the usual size.

RETARDING RELAY FOR SYNCHRONISING DIRECT RECEPTION AND LOUD SPEAKER RECEPTION IN PUBLIC ADDRESS SYSTEMS [using Magnetic Repetition from Revolving Steel Ring].—L. Gaumont. (Summary of French Patent in *Rev. Gén. de l'Élec.*, 28th Jan., 1933, Vol. 33, No. 4, p. 32 D.)

THE MODERN A.C. QUALITY AMPLIFIER [Self-contained Gramophone Equipment].—W. I. G. Page. (*Wireless World*, 17th February, 1933, Vol. 32, pp. 128–131.)

A two-stage a.c. mains-driven amplifier for the amateur constructor. The speech output is six watts.

CONTROL OF SOUND QUALITY IN PICTURE PRODUCTION.—C. Dreher. (*Electronics*, Jan., 1933, pp. 10–12 and 22.)

DAS LÄRMPROBLEM VOM STANDPUNKT DES INGENIEURS (The Noise Problem from the Standpoint of the Engineer.)—K. W. Wagner. (*Zeitschr. V.D.I.*, 7th Jan., 1933, Vol. 77, No. 1, pp. 1–9.)

GESELLSCHAFT FÜR ELEKTRISCHE MUSIK (The Society for Electrical Music).—(*E.T.Z.*, 9th Feb., 1933, Vol. 54, No. 6, p. 139.)

Note on the recent formation of this Society by Schünemann, Director of the State High School of Music, Berlin, and Leithäuser, of the Heinrich-Hertz Institute.

KEYBOARD AND LOUD SPEAKER.—R. Raven-Hart. (*Wireless World*, 27th January, 1933, Vol. 32, p. 67.)

A short technical description of the "Neo-Bechstein" electrical piano.

SYNTHETIC SOUND.—Herbert Rosen. (*Wireless World*, 3rd February, 1933, Vol. 32, p. 101.)

The author describes a method developed by Rudolph Pfenniger of producing "sound films" by making pencilled outlines—using the variable area system—on paper strips.

GRID CURRENT COMPENSATION IN POWER AMPLIFIERS.—W. Baggally. (*Wireless Engineer*, Feb., 1933, Vol. 10, No. 113, pp. 65–68.)

Taking a practical example of the design of a power amplifier free from grid current distortion, the writer shows that for the conditions given the input circuit resistance must not exceed 1 000 ohms and must deliver a total voltage excursion of 350 volts without appreciable distortion. With regard to these "very severe requirements" he says: "It might be thought that we could reduce the impedance of the drive circuit by using a step-down transformer, but although this is done in the American 'class B' amplifiers, using special high-magnification output valves, it is not usually easy to get sufficient undistorted voltage from the secondary of the transformer to swing our British low-impedance triodes. The arrangements now to be described have the advantage of virtually reducing the impedance of the penultimate stage to a low value without in any way interfering with the voltage-handling capacity, though when used in this way the stage does not amplify the applied voltage, but in fact introduces a small amount of attenuation. This is not usually of any consequence, as it merely involves increasing the gain of the previous amplifying stages somewhat."

HARMONIC CONTENT IN AMPLIFIERS [Indiscriminate Use of Power Basis and Amplitude Basis in Specification: the Need for Uniformity].—H. L. Kirke. (*Wireless Engineer*, Jan., 1933, Vol. 10, No. 112, p. 26.)

A NEW TYPE OF L.F. AMPLIFIER [Glow-Discharge Tube Coupling: for Frequencies from 0 to 10 000 c/s].—Schäfer: Peek. (*See* under "Reception.")

OUTPUT STAGES: THE CHOICE OF VALVES FOR USE IN LOW FREQUENCY AMPLIFIERS [Rapid Test Method].—Whitehead: Brain. (*See* under "Valves and Thermionics.")

ENDVERSTÄRKER FÜR FERNSPRECHTEILNEHMER (Received Speech Amplifier for Telephone Subscribers [Single-Valve, Mains Operated: Five-fold Amplification]).—Siemens & Halske. (*E.T.Z.*, 2nd Feb., 1933, Vol. 54, No. 5, p. 111.)

THE AUDIO TRANSFORMER AS A SELECTIVE AMPLIFIER.—M. Pawley. (*Journ. Franklin Inst.*, Feb., 1933, Vol. 215, No. 2, pp. 133–147.)

Author's summary:—A selective amplifier is developed which is simple, and more flexible than other types. It utilises an audio transformer with a variable series resistance in the primary circuit, and a variable secondary load capacitance, both of which may be adjusted to give broad or narrow peaked amplification at any frequency within a wide range, or flat amplification throughout this range. Theoretical and experimental amplification curves are shown, and a transient solution gives the primary and secondary currents resulting when a voltage is suddenly applied to the amplifier. This analysis shows that the time constants for the circuit are comparable with those for other peaked amplifiers. Oscillograms are shown illustrating the transient behaviour of the amplifier.

LA QUALITÉ EN RADIOTÉLÉPHONIE (Quality in [Broadcast] Radiotelephony).—P. David. (*Rev. Gén. de l'Élec.*, 4th Feb., 1933, Vol. 33, No. 5, pp. 139–145.)

The writer begins by discussing the far greater complexity of the problem compared with that of commercial telephony (as dealt with by Chavasse in the paper referred to in 1932 Abstracts, p. 44): thus in broadcasting the instantaneous power involved may vary in the ratio of 1 to 10^{-7} for a mere symphony, while as regards "sensational" noises the American measurements are quoted (lion's roar 87 db above audition threshold, aeroplane engine at 6 metres' distance 110–120 db, etc.). This (and the consequent "compression" of light and shade in transmission) is only one of the complicating factors: others are the increase in frequency range from 2½ to 9 or 10 octaves; the much more exacting demands of the listener when bent on amusement than when engaged in business; fading, etc., etc. The practical worthlessness of the usual "intelligibility" tests in this sphere is pointed out: the fact that children, unaccustomed to listening, are more exigent than adults, who become hardened to certain faults, is quoted.

Thus to obtain quantitative results which can be worked out and made to lead to further progress, the consideration of over-all quality must be abandoned in favour of separate analyses of the various causes of distortion, and in Section V the writer deals with "non-uniform" distortion—*i.e.*, the unequal reproduction of different frequencies. Some results of Snow and of Fletcher (Abstracts, 1932, pp. 98–99: 1931, pp. 329 and 620) are given, and embodied in a diagram showing the rôles of the various portions of the spectrum (Fig. 2). The frequency characteristics of a m.c. loud speaker, a condenser microphone, and a ribbon microphone (taken from papers by Grutzmacher and Just and by Hartmann) are shown in Fig. 3, and the improved reproduction given by combining several loud speakers in Fig. 4. Section VI deals briefly with non-linear distortion, and Fig. 7 gives some rasping factor curves. Section VII deals with parasitic noises.

FOURIER ANALYSIS AND VOWEL CURVES.—E. W. Scripture. (*Nature*, 24th Dec., 1932, Vol. 130, pp. 965–966.)

A critical comparison of the application of known methods of Fourier analysis to the resolution of vowel curves. All are found unsatisfactory and the requirements of a new method, now under development, are stated.

A NEW HARMONIC ANALYSER [Synchronous Disc and M.C. Voltmeter].—B. G. Gates. (*Journ. Scient. Instr.*, Dec., 1932, Vol. 9, pp. 380–386.)

ON THE ACCURACY OF THE AURAL METHOD OF MEASURING NOISES [Unexpectedly High Accuracy Found].—J. Obata and S. Morita. (*Journ. Acoust. Soc. Am.*, Oct., 1932, Vol. 4, No. 2, pp. 129–137.)

AKUSTISCHE MESSGERÄTE FÜR PRAKTISCHEN GEBRAUCH (Acoustic Measuring Instruments for Practical Use).—W. Jaekel: Siemens & Halske. (*Zeitschr. V.D.I.*, 28th Jan., 1933, Vol. 77, No. 4, pp. 98–99.)

AMPLITUDES OF SOUNDS FROM MUSICAL INSTRUMENTS.—K. W. Wagner. (*Electronics*, Jan., 1933, p. 24.)

Summary only. A number of sound pressure amplitudes are quoted (large choir, piano and organ concerts, soprano solo, etc.), and also the maximum powers developed by various instruments.

THE VIBRATIONS OF A CHLADNI PLATE.—R. C. Colwell. (*Phil. Mag.*, Feb., 1933, Series 7, Vol. 15, No. 97, pp. 317–324.) *See* also Abstracts 1931, p. 563: January, 1933, p. 43 (two): and back references.

DIAGONAL SYMMETRY IN CHLADNI PLATES.—R. C. Colwell. (*Journ. Franklin Inst.*, Feb., 1933, Vol. 215, No. 2, pp. 169–177.)

A VACUUM TUBE OSCILLATOR FOR CHLADNI PLATES.—R. C. Colwell. (*Science*, 9th Dec., 1932, Vol. 76, No. 1980, pp. 547–548.)

A METHOD FOR THE DETERMINATION OF THE VELOCITY OF SOUND IN SOLIDS [based on Boyle and Rawlinson's Law and using a Thermocouple to measure Intensity].—W. T. Richards. (*Science*, 8th July, 1932, Vol. 76, No. 1958, pp. 36–37.)

THE THEORY OF ACOUSTIC FILTRATION IN SOLID RODS.—R. B. Lindsay and F. E. White. (*Journ. Acoust. Soc. Am.*, Oct., 1932, Vol. 4, No. 2, pp. 155–168.)

GRUNDLEGENDE UNTERSUCHUNGEN ÜBER SCHALL-ABSORPTION (Fundamental Investigations on the Absorption of Sound).—E. Wintergerst and H. Klupp. (*Zeitschr. V.D.I.*, 28th Jan., 1933, Vol. 7, No. 4, pp. 91–95.)

The sound absorption of various materials was investigated by placing a sample at the end of a 10-cm wide tube, at whose other end a loud speaker provided pure sinusoidal notes. The maximum and minimum pressure-amplitudes of the stationary waves formed by reflection were measured by means of a microphone-probe (a long fine rigid tube attached to a microphone and adjustable along the axis of the main tube) with amplifier and valve voltmeter. From these values the absorption coefficient was calculated. The materials were either freely hanging, stretched, or in the form of plates. The improvement of a material is discussed, as regards the serious defect of a coefficient varying with frequency, by combining it with another material, by partially perforating it and thus using the resonance effect of the holes, and by other methods. Finally the "prices per unit of absorption" of the various materials are compared.

TRANSMISSION OF SOUND THROUGH PARTITIONS.—A. H. Davis. (*Phil. Mag.*, Feb., 1933, Series 7, Vol. 15, No. 97, pp. 309–316.)

COMBINED REVERBERATION TIME FOR ELECTRICALLY COUPLED ROOMS.—A. P. Hill. (*Journ. Acoust. Soc. Am.*, July, 1932, Vol. 4, No. 1, Part 1, pp. 63–68.)

A MODIFIED FORMULA FOR REVERBERATION.—G. Millington. (*Ibid.*, pp. 69–82.)

RESONANCE IN SMALL ROOMS.—V. O. Knudsen. (*Journ. Acoust. Soc. Am.*, July, 1932, Vol. 4, No. 1, Part 1, pp. 20–37.)

WEIGHT AS A DETERMINING FACTOR IN SOUND TRANSMISSION.—P. E. Sabine. (*Ibid.*, pp. 38–43.)

ACOUSTICS OF BROADCASTING AND RECORDING STUDIOS.—G. T. Stanton and F. C. Schmid. (*Ibid.*, pp. 44–55.)

ACOUSTICS OF LARGE AUDITORIUMS.—S. Lifshitz. (*Journ. Acoust. Soc. Am.*, Oct., 1932, Vol. 4, No. 2, pp. 112–121.)

ACOUSTIC PICK-UP FOR PHILADELPHIA ORCHESTRA BROADCASTS.—J. P. Maxfield. (*Ibid.*, pp. 122–128.)

RICHTWIRKUNG UND STRAHLUNGSLEISTUNG VON AKUSTISCHEN STRAHLERN UND STRAHLER-GRUPPEN IN DER NÄHE EINER REFLEKTIERENDEN EBENEN FLÄCHE (Directive Effect and Radiated Power of Acoustic Radiators and Radiator Groups in the Neighbourhood of a Reflecting Plane Surface).—F. A. Fischer. (*E.N.T.*, Jan., 1933, Vol. 10, pp. 19–24.)

A theoretical investigation. The writer deals first with the case where the reflecting surface is infinitely impervious to sound in comparison with the propagating medium, so that there is no phase-change on reflection: a practical example of this is the reflection of a sound wave in air at the surface of the earth or sea. He then considers the opposite case, where the reflecting surface is, in comparison, completely permeable to sound, as when submarine signals are reflected at the surface of the sea: in this case a reversal of phase occurs.

In both cases he takes first the simplest example of a single radiator, small in comparison with the wavelength, at a distance h from the reflecting surface. By combining the radiator and its image into a two-radiator group of spacing $2h$ and common phase (for the first case) or opposed phase (for the second) and by using the appropriate formula for a two-radiator group (formula 1 or 7) he obtains the corresponding polar diagrams (*e.g.*, Figs. 2 and 7d, both for $h = 3\lambda$). In the case of reflection without phase-change, he points out that whatever the relation between h and λ there is always a radiation maximum coinciding with the surface itself, while with reflection with phase-reversal there is always a radiation minimum along the surface.

In the latter case there are no further minima so long as $2h/\lambda \leq 1/2$. Fig 7 gives the diagrams for various values of $2h/\lambda$. In curve a the ratio is much less than $1/\pi$ and the characteristic is the well-known figure-of-eight curve of the wireless frame aerial, of which, here, only one half has a physical significance. As h/λ increases, the minimum along the surface becomes more and more sharp, till for $h = \lambda/2$ a second minimum appears (curve c).

The calculation of the radiated power, in both cases, can be accomplished by integration or by Rayleigh's formula (equation 2 or 9). The curve of the expression in the brackets is given in Fig. 3 for unchanged-phase reflection and in Fig. 8 for reversed-phase reflection. The directive characteristic of a group of radiators is given by the product of the characteristic of the group in an infinitely extended medium and the characteristic of a two-radiator group spaced by a distance $2h$, of common phase in one case and of opposed phase in the other. Thus Fig. 9 gives the diagram of a quadruple group at a depth in the sea of 3λ: it is the product of 5a, the characteristic of such a group in an infinitely extended medium, and 7d, the diagram for a simple radiator at a depth of 3λ. Similarly, for reflection without phase-change, Fig. 5b shows the combination of the same group-characteristic 5a and the simple radiator diagram Fig. 2. The radiated power from such groups of radiators can be found from the appropriate Rayleigh formula (equation 6 or 11, according to the nature of the reflection).

The paper ends by a discussion of the more complex case where a second reflecting layer has to be considered, as in submarine signalling where the sea bottom has its effect.

POSITION FINDING BY UNDER-WATER SOUND SIGNALS.—B. R. Hubbard. (*Journ. Acoust. Soc. Am.*, Oct., 1932, Vol. 4, No. 2, pp. 138–154.)

PROCÉDÉ OPTIQUE POUR LA MESURE DE L'ABSORPTION DES ONDES ULTRA-SONORES PAR LES LIQUIDES (Optical Method of Measuring the Absorption of Supersonic Waves by Liquids [based on the Diffraction of Light due to the Supersonic Waves]).—P. Biquard. (*Comptes Rendus*, 23rd Jan., 1933, Vol. 196, No. 4, pp. 257–259.)

See March Abstracts, p. 150 (Lucas), for the work leading up to this method.

QUASI-STANDING WAVES IN A DISPERSIVE GAS.—D. G. Bourgin. (*Ibid.*, pp. 108–111.)

PREPARATION OF COLLOIDS BY SUPERSONIC DISPERSION.—N. Marinesco. (*Comptes Rendus*, 30th Jan., 1933, Vol. 196, No. 5, pp. 346–348.)

PHOTOTELEGRAPHY AND TELEVISION

AN INVESTIGATION OF VARIOUS ELECTRODE STRUCTURES OF CATHODE-RAY TUBES SUITABLE FOR TELEVISION RECEPTION [Size of Spot independent of Intensity Modulation, etc.].—A. B. Du Mont. (*Proc. Inst. Rad. Eng.*, Dec., 1932, Vol. 20, pp. 1863–1877.)

Leading to the development of a tube with dual accelerating electrodes (Fig. 13), the first a disc with a hole in it, and the second a hollow cylinder. To increase the spot intensity without loss of sensitivity, an additional anode of silver is deposited on the funnel-shaped part of the bulb. The vacuum is of the order of one millionth of an atmosphere. A signal of several volts will modulate the spot from minimum to maximum brightness. Very similar results were obtained with only one accelerating electrode (with a very fine "gun"—Fig. 12).

INTENSITÄTSSTEUERUNG GASKONZENTRIERTER ELEKTRONENSTRAHL MITTELS WEHNELT-ZYLINDER (Intensity Control of the Gas-Concentrated Cathode Ray by Wehnelt Cylinder).—W. Kleen. (*Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, pp. 28–30.)

A short paper on the work dealt with in February Abstracts, pp. 105–106.

CATHODE-RAY OSCILLOGRAPHY [Physical Society Discourse].—Watson Watt. (*See* under "Subsidiary Apparatus and Materials.")

MODULATION FREQUENCIES IN VISUAL TRANSMISSION.—E. L. White. (*Proc. Inst. Rad. Eng.*, Jan., 1933, Vol. 21, pp. 51–55.)

Author's summary:—A method of computing the maximum frequencies produced in television transmission is shown. This method is based on the consideration of the degree of edge definition produced. It is shown that these frequencies are independent of the amount of detail in transmitted pictures for equal edge definition.

For a picture scanned by the usual method, N pictures per second, with L lines, having a ratio r of width to height and having the ratio K between the width of scanning line and width of edge shadow, it is shown that $f = KNrL^2/2$. Two systems varying from the normal [decreased number of lines away from centre of picture] are discussed and compared with the normal system in regard to the magnitude of the frequencies produced.

MARCONI TELEVISION TRANSMITTER TYPE TT5.—R. J. Kemp. (*Marconi Review*, Nov.–Dec., 1932, No. 39, pp. 7–18.)

Using 50-scan lines per picture and a picture repetition frequency of 15/sec. This number of scan lines was chosen because it gives detail sufficiently good to enable recognisable head and shoulders, and even full-length images, to be received. Any increase in the number would lead to an appreciable increase in the bulk of the apparatus and the necessity for a radio transmitter of special design, whereas the apparatus is intended for use with the existing type of high-quality broadcasting transmitter.

TELEVISION TESTS ON ULTRA-SHORT WAVES FROM EMPIRE STATE BUILDING.—(*See* abstract under "Miscellaneous"—"Looking Ahead as 1933 Opens.")

TELEVISION [Survey for 1932].—W. G. W. Mitchell. (*Electrician*, 27th January, 1933, Vol. 110, No. 2852, p. 115.)

ÜBER DIE ABHÄNGIGKEIT DER ELEKTROMOTORISCHEN KRAFT VON KUPFEROXYDULPHOTOZELLEN (SPERRSCHICHTPHOTOZELLEN) VON DER BELEUCHTUNGSSTARKE UND WELLENLÄNGE (The Dependence of the E.M.F. of Copper Oxide [Barrier Layer] Photocells on the Intensity of Illumination and Wavelength).—A. Goldmann and M. Lukasiewitsch. (*Physik. Zeitschr.*, 15th Jan., 1933, Vol. 34, No. 2, pp. 66–73.)

The writers find that their measurements can all be comprised by the formula

$V = M \cdot L/(L + MN)$, (V = e.m.f., L = intensity of illumination, M and N constants). Various bases for this formula are discussed and it is found that it can be deduced if the resistance of the barrier layer is a linear function of the cell voltage. Measurements were made with monochromatic light in various spectral regions and the boundary potential (for $L \to \infty$) appears to be independent of the wavelength to a first approximation.

ÜBER DIE ABHÄNGIGKEIT DER ELEKTROMOTORISCHEN KRAFT DER SELENSPERRSCHICHTPHOTOZELLEN VON DER BELEUCHTUNGSINTENSITAT (The Dependence of the E.M.F. of Selenium Barrier-Layer Photocells on the Intensity of Illumination).—A. Goldmann. (*Physik. Zeitschr.*, 15th Jan., 1933, Vol. 34, No. 2, pp. 74–75.)

The writer finds that the formula for the e.m.f. of a barrier-layer photocell given in the preceding abstract also holds for selenium cells.

ZUR FRAGE DER EXISTENZ EINES SPERRSCHICHT-PHOTOEFFEKTS AM BLEISULFID (The Question of the Existence of a Barrier-Layer Photoelectric Effect in Lead Sulphide).—E. Tiede and G. Brückmann. (*Zeitschr. f. Physik*, 1933, Vol. 80, No. 5/6, pp. 302–304.)

In this preliminary communication the writers state that they find no " back surface " [Hinterwand] photo-electric effect at a nickel/lead sulphide boundary and that the " front surface " [Vorderwand] photoelectric effect is really a thermoelectric effect.

REVERSAL OF THE CURRENT FROM A CUPROUS OXIDE PHOTO CELL IN RED LIGHT.—H. H. Poole and W. R. G. Atkins. (*Nature*, 28th Jan., 1933, Vol. 131, p. 133.)

Details are noted of a small reverse current obtained with a cell of the " Serpidox " make exposed to red light.

SELF-GENERATING PHOTOCELL [Dry-Disc Cell giving 5–7 Milliamperes in Direct Sunlight].—T. Rhamstine. (*Electronics*, Jan., 1933, p. 25.)

SELENIUM CELL EMPLOYING NEW PRINCIPLE [Layer of Selenium fused on Iron Disc, with Transparent Film of Sputtered Precious Metal].—Süddeutsche Apparatefabrik. (*Ibid.*, p. 26.)

For a 10 cm² surface the current ranges from 5.1 to 445.5 microamperes, for a 25-watt lamp and a 500-watt projector lamp respectively, at a distance of one metre.

MODERN METHODS OF MANUFACTURING PHOTOELECTRIC CELLS. PART II.—G. Déjardin. (*Rev. Gén. de l'Élec.*, 14th Jan., 1933, Vol. 33, No. 2, pp. 36–53.)

Second and final part of the survey dealt with in March Abstracts, p. 169. Throughout the paper, footnotes give the appropriate journal and patent references.

ÜBER DAS AUFTRETEN UND DIE DEUTUNG DER SELEKTIVEN LICHTELEKTRISCHEN ELEKTRONENEMISSION AN ZUSAMMENGESETZTEN ALKALIKATHODEN (The Occurrence and Explanation of the Selective Emission of Photoelectrons at Composite Alkali Cathodes).—W. Kluge. (*Physik. Zeitschr.*, 1st Feb., 1933, Vol. 34, No. 3, pp. 115–126.)

For composite layers of the type $Ag\text{–}M_2O\text{–}M$, where M is an alkali metal, the writer finds two emission maxima, one at the high-frequency and one at the low-frequency end of the spectrum. The former are tentatively explained on lines already indicated by Ives (Ives and Briggs, 1932 Abstracts, p. 102) and the latter are satisfactorily explained by the theory of Gudden and Pohl published in 1925.

SUR LE CALCUL D'UN AMPLIFICATEUR DE BASSE FRÉQUENCE POUR CELLULE PHOTOÉLECTRIQUE (The Calculation of a L.F. Amplifier for a Photoelectric Cell).—G. A. Boutry. (*Comptes Rendus*, 27th Dec., 1932, Vol. 195, No. 26, pp. 1384–1387.)

For a densitometer working on constant deflections. Since the cell impedance R, under the conditions of use, is very considerable (of the order of 6 000 ohms), a transformer of impedance suited to such a circuit is not practical: the classical coupling by resistance and condenser was therefore investigated. If the cell delivers its output to a resistance r connected to the grid through a large capacity C, and the total ohmic resistance of the grid circuit (leakage, internal resistance, etc.) is σ, while ρ and R_2 represent the internal resistance of the anode circuit and the impedance of the coupling to the next stage, respectively, then it is found that the employment of screen-grid valves is necessary and that the optimum energy amplification is obtained when $\rho = R_2$ and when $\sigma r = R^2$. In practice it is impossible to exceed $r = \sigma =$ 100 ohms without compromising the stability of the stage.

The above theoretical results have been confirmed experimentally. The current amplifications of the stage, given approximately by the equation $\mu = k \,.\, 1/(\rho + R_2) \,.\, r\sigma/(\sigma + r)$, where k is the amplification coefficient of the valve, agrees within 10 % with the experimental value. It is easy to obtain values of μ between 10 000 and 20 000: to exceed this, " a very well insulated and protected material must be available. If the stage is followed by a triode detecting by grid characteristic curvature, the intensity of a photoelectric current of 10^{-9}A can be multiplied by 90 000."

PHOTOELECTRIC CURRENTS IN GASES BETWEEN PARALLEL PLATE ELECTRODES [Theoretical Investigation].—L. A. Young and N. E. Bradbury. (*Phys. Review*, 1st Jan., 1933, Series 2, Vol. 43, No. 1, pp. 34–37.)

The theory developed in this paper is based on the fact that the main factor governing the current observed is the Ramsauer scattering by gas atoms. An equation is found for the ratio of current to its saturation value as a function of the field strength and other constants of the gas. The ratio should vary as the square root of the field strength for small field strengths. This agrees with experimental results already obtained by one of the writers (Bradbury, 1932 Abstracts, p. 532).

The Passage of Photoelectrons through Mica.—N. E. Bradbury and L. A. Young. (*Phys. Review*, 1st Jan., 1933, Series 2, Vol. 43, No. 1, pp. 84–85.)

The theory referred to in the foregoing abstract may be extended to apply to solid dielectrics. This letter describes experiments with mica which give agreement with the theory.

The Photoelectric Effect of Electric Spark Radiation.—J. Meiklejohn. (*Phil. Mag.*, Jan., 1933, Series 7, Vol. 15, No. 96, pp. 146–163.)

From the author's summary :—The results obtained indicate that the intensity of the photoelectric radiation and the quantity of electricity discharged from single sparks were both quadratic functions of the minimum sparking potential. . . . The effect of the electrode substance tends to confirm the photoelectric theory of sparking potentials . . . the intensity of the photoelectric radiation was approximately a linear function of the quantity of electricity discharged and also of the energy of the spark. . . . Experiments on the effect of oxide on the sparking potential showed that surface conditions play a part in determining the sparking potential.

MEASUREMENTS AND STANDARDS

Das Paralleldrahtsystem als Messinstrument in der Kurzwellentechnik (The Parallel Wire [Lecher Wire] System as a Measuring Instrument in Short-Wave Technique).—O. Schmidt. (*Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, pp. 2–16.)

The writer's primary object is to point out the many applications of the " line without internal losses " as a measuring instrument in short-wave technique, where other methods fail : for the measurement of resistances, characteristic impedances, currents and voltages (magnitude and phase), power and damping. In the course of his paper he investigates the errors liable to arise from practical deviations from the ideal conditions, such as the presence of internal damping ; effects due to the spacing not being infinitely small compared with the wavelength ; lack of homogeneity in the wires (*e.g.*, the presence of insulator caps, bends, divergence of the wires, etc.) ; change of dielectric constant by fog. Thus in a long Lecher pair (length from measuring point to end 93.5 m) an average displacement of nodal point amounting to about 30 cm was found as a result of autumnal fog. Rain had no effect.

In the first (mathematical) part of his paper the writer shows that a parallel wire system can be regarded as a non-quasistationary oscillating circuit, and brings out the analogies between such a circuit and a quasistationary circuit with concentrated capacity and inductance. He shows also that the geometrical locus of the impedance of a line without internal loss, for a constant coupled damping, and the corresponding locus of the impedance for a constant distance between potential nodes, form orthogonal circles to each other (Fig. 6). For the impedance in the case of a finite internal damping he obtains an approximate formula (26), in which the internal damping of the line is expressed as a concentrated load and the line is considered to be otherwise free from losses.

The final part of the paper deals with the various applications mentioned at the beginning of this abstract.

Measurement of the Frequency of Ultra-Radio [Ultra-Short] Waves [using Special Lecher Wire System].—J. B. Hoag. (*Proc. Inst. Rad. Eng.*, Jan., 1933, Vol. 21, pp. 29–36.)

Author's summary :—" An analysis of a particular Lecher wire system, whose characteristic impedance matches its input impedance and whose output end is short circuited, has led to an equation permitting the measurement of ultra-radio frequencies to three significant figures. The method is independent of end effects and has been applied to a determination of the velocity of propagation along iron wires."

In the course of the paper the writer points out that the frequency and strength of the source must remain constant during the time needed to obtain a complete set of data ; this time, however, may be shortened without undue sacrifice of accuracy by limiting the data to two peaks at opposite ends of the Lecher wires. With a complete set of data the accuracy is fully ten times that of the usual peak-to-peak method for these frequencies, the calculated wavelengths being reliable to three significant figures.

Messungen von Wellenwiderstand und Scheinwiderstand von symmetrischen und unsymmetrischen Freileitungen bei hohen Frequenzen (Measurements of the Characteristic Impedance and Apparent Impedance of Symmetrical and Unsymmetrical Overhead Lines at High Frequencies [in Connection with the Propagation of Interference with Broadcast Reception].—A. Clausing. (*E.T.Z.*, 19th Jan., 1933, Vol. 54, No. 3, pp. 54–56.)

Undertaken by Siemens and Halske at the request of the VDE. Theory demands that with increasing frequency a definite limiting value of characteristic impedance is reached asymptotically. The measurements have produced no evidence to the contrary, but could not be carried out with sufficient accuracy (for reasons which are discussed) to prove the theory completely.

A Note on an Automatic Field Strength and Static Recorder.—W. W. Mutch. (*Proc. Inst. Rad. Eng.*, Dec., 1932, Vol. 20, pp. 1914–1919.)

Sample records of short-wave signal intensities made by this equipment were shown in the paper by Potter and Friis dealt with in 1932 Abstracts, p. 344. The primary aim of the equipment was to record the energy received from a fading signal during periods of the order of ten seconds. The method adopted is that the gain of the measuring set is changed at short intervals in such a way as to hold the average output constant, a commercial recorder controller being used to operate the gain control and to record the changes in gain with time. This controller is an instrument containing a sensitive moving coil galvanometer actuated (in this case) from the output circuit of the measuring set: a set of jaws closes every two seconds across the arc of swing of the needle, and the position of the needle when thus clamped controls the motion of the attenuator potentiometer.

PORTABLE LONG WAVE TESTING APPARATUS [Field-Strength Measuring Set].—G. C. de Coutouly. (*Bell Lab. Record*, Feb., 1933, Vol. 11, No. 6, pp. 178–183.)

A NEW WAY OF MAKING USE OF THERMOELECTRIC PHENOMENA.—Égal. (*See* under "Subsidiary Apparatus and Materials.")

THE BROWNIAN MOTION OF THE RESONANCE RADIOMETER.—G. A. Van Lear, Jr. (*Review Scient. Instr.*, Jan., 1933, Vol. 4, pp. 21–27.)

ON A SOLUTION OF THE MOTION OF A GALVANOMETER EXCITED BY ANY PERIODIC CURRENT. —R. Yoneda. (*Journ. I.E.E. Japan*, Sept., 1932, Vol. 52 [No. 9], No. 530: English summary pp. 99–100.)

THE LIGHT RAY AS POINTER FOR TECHNICAL MEASURING INSTRUMENTS.—K. H. Sieker. (*Zeitschr. f. Fernmeldetech.*, 15th Dec., 1932, Vol. 13, pp. 186–190.)

A SENSITIVITY CONTROL FOR THE LINDEMANN ELECTROMETER.—L. G. Grimmett. (*Proc. Physical Soc.*, 1st Jan., 1933, Vol. 45, Part 1, No. 246, pp. 117–119.)

I.E.E. METER AND INSTRUMENT SECTION: CHAIRMAN'S ADDRESS.—R. S. J. Spilsbury. (*Journ. I.E.E.*, Jan., 1933, Vol. 72, No. 433, pp. 30–36.)

ALTERNATING-CURRENT BRIDGES FOR MEASUREMENTS OF ELECTRICAL INSULATING MATERIALS [at Frequencies from 60 c/s to 1.5 Mc/s).—W. A. Ford and S. I. Reynolds. (*Gen. Elec. Review*, Feb., 1933, Vol. 36, pp. 99–105.)

MESSUNG KLEINER ELEKTRO-DYNAMISCHER KRÄFTE MIT DEM KONDENSATORMIKROPHON (The Measurement of Small Electrodynamic Forces with the Condenser Microphone).—A. Agricola. (*Hochf:tech. u. Elek:akus.*, Jan., 1933, Vol. 41, pp. 30–33.)

Author's summary:—The calibration of a condenser microphone for measuring small pressures is described. The force is applied by the measurable homogeneous magnetic field in a plate conductor, in which there is an opening into which the microphone is introduced. The measured forces lie between the limits of 0.5 and 120 mg on the 24 cm^2 surface.

A TRIPLE INTERFEROMETER FOR DISTINGUISHING FLEXURAL AND LONGITUDINAL VIBRATIONS IN QUARTZ.—H. Osterberg. (*Journ. Opt. Soc. Am.*, Jan., 1933, Vol. 23, pp. 30–34.)

SILVERING TO LOWER CRYSTAL FREQUENCY [Controlled Deposition of Silver Electrodes to cure Quartz Crystals ground to Too High a Frequency].—W. P. Hunter. (*QST*, Feb., 1933, Vol. 17, pp. 48–49.)

LÄNGS- UND BIEGUNGSSCHWINGUNGEN VON TURMALINPLATTEN (Longitudinal and Flexural Vibrations of Tourmalin Plates).—V. Petržilka. (*Ann. der Phys.*, 1932, Series 5, Vol. 15, No. 8, pp. 881–902.)

ÜBER NORMALIEN FÜR WELLENMESSUNG DER ULTRAKURZEN WELLEN (On Standards for Measurement of Ultra-Short Waves).—G. Leithäuser and V. Petržilka. (*Funktechnische Monatshefte* 9/1932.)

The writers recommend the use of tourmalin instead of quartz for resonators in the ultra-short wave-band, as the optical and electrical axes of tourmalin coincide and circular plates can be used. A resonator using neon gas containing a little hydrogen is described, but the direct use of this is not advised, as the resonance point is not exactly defined; the parallel incandescent lamp method (Feb. Abstracts, p. 109), however, is accurate. Even harmonics of the tourmalin plate can also be used.

AN OSCILLATOR HAVING A LINEAR OPERATING CHARACTERISTIC [and High Frequency Stability].—Arguimbau. (*See* under "Transmission.")

THE WIRELESS WORLD DIRECT READING STATION FINDER.—H. F. Smith. (*Wireless World*, 13th January, 1933, Vol. 32, pp. 20–22.)

An absorption wavemeter calibrated directly in "station names," for the amateur constructor.

TIME-KEEPING—OLD AND NEW.—F. Hope-Jones. (*Journ. Scient. Instr.*, Feb., 1933, Vol. 10, pp. 43–49.)

THE CLINKER ELECTRIC CLOCK FOR MAINS WHICH ARE NOT TIME-CONTROLLED.—British Thomson-Houston Company. (*Ibid.*, p. 54.)

An *LC* combination has parallel resonance at the working frequency when the pendulum, carrying a magnetic member, is remote from the magnetic circuit of the iron-cored inductance: the pendulum is thus always attracted to the central or vertical position by a force greater than that which retards it after this position is passed.

A NEW TYPE OF FREE-PENDULUM CLOCK [Free Pendulum Self-Maintained *in vacuo* by means of Electrostatic Impulses and having a Closely Governed Arc].—G. A. Tomlinson. (*Proc. Physical Soc.*, 1st Jan., 1933, Vol. 45, Part 1, No. 246, pp. 41–48.)

AUTOMATIC EQUIPMENT FOR THE TRANSMISSION OF THE EXACT TIME OVER THE TELEPHONE SYSTEM.—(*Alta Frequenza*, Sept., 1932, Vol. 1, No. 3, pp. 474–477.)

SYNCHRONISATION OF CLOCKS OVER TELEPHONE NETWORK.—Brillié Frères. (Summary of French Patent in *Rev. Gén. de l'Élec.*, 28th Jan., 1933, Vol. 33, No. 4, p. 29 D.)

SUBSIDIARY APPARATUS AND MATERIALS

CATHODE-RAY OSCILLOGRAPHY [Physical Society Discourse].—R. A. Watson Watt. (*Journ. Scient. Instr.*, Feb., 1933, Vol. 10, pp. 37–43.)

A summary of this discourse was referred to in March Abstracts, p. 172. Dealing, in the latter half, with the applications of the c.-r. oscillograph, the writer takes in turn its various "disposable variables" and shows how use can be made of them. The "double linotime" scheme, for overcoming the persistence of vision by spreading the bases into a venetian blind pattern, is described and demonstrated. The process has been applied to visual counting at rates of a few thousand per second. "A similar combination of timing voltages at higher speeds gives the image-scanning structure required in television processes depending on c.-r. oscillographs."

The disposable variable, or group of related variables, provided by the differing properties of various fluorescent materials (colour of response, duration of afterglow, etc.) is discussed and demonstrated.

Finally the use of the oscillograph as a relay, the electron beam being trapped in a Faraday cage the incidence or release of whose charge can be used to control a train of events, is illustrated by a self-releasing time-base (after Rogowski) and by the lecturer's directional radio-receiver responding only to signals from a selected direction.

APPLICATIONS OF THE CATHODE-RAY OSCILLOGRAPH [Factors affecting Accuracy of Measurements, and Their Compensation: Oscillograph with Magnetic Deflection).—R. R. Batcher. (*Proc. Inst. Rad. Eng.*, Dec., 1932, Vol. 20, pp. 1878–1891.)

The writer concludes that the threshold effect must be considered when small amplitudes are being measured: deflection plate leakage is important when high-impedance, low-power circuits are being measured: the effect of diagonal path can usually be neglected: it is of the same order as the screen curvature error and is opposite to this: unbalanced magnetic deflection fields show up on calibration curves and can be corrected by physical changes in the coil assembly: stray fields should be eliminated by external magnetic shielding, and the effect of filament field distortion can be eliminated by the use of a d.c. filament supply if the field cannot be balanced out.

In gas-concentrated tubes "tests have indicated that somewhat better focusing at high frequencies is obtained if the large end of the tube is heated, although definite conclusive tests on this effect have not been completed. Incomplete experiments also seem to show a deflection amplitude change at high frequencies that cannot be explained entirely by the effect of the finite impedance of the deflection plates, possibly also due to changes in the velocity of the stream with rapid lateral movements due to the varied effects of the space charge."

A tube with magnetic deflection coils only, having a sensitivity of about 28 ampere turns per inch with an anode voltage of 800, is discussed and illustrated. The problem of the calibration factor for magnetic deflections is analysed.

INTENSITY CONTROL OF THE GAS-CONCENTRATED CATHODE RAY BY WEHNELT CYLINDER.—Kleen. (*See* under "Phototelegraphy and Television.")

ÜBER DIE GRUNDLAGEN DER GEOMETRISCHEN ELEKTRONENOPTIK (The Foundations of Geometrical Electron Optics).—E. Brüche. (*Zeitschr. f. tech. Phys.*, No. 2, Vol. 14, 1933, pp. 49–58.)

BEITRÄGE ZUR THEORIE DER GEOMETRISCHEN ELEKTRONENOPTIK (Contributions to the Theory of Geometrical Electron Optics).—J. Picht. (*Ann. der Physik.*, 1932, Series 5, Vol. 15, No. 8, pp. 926–964.)

This theoretical paper considers the differential equations of electron beams for regions near the axis. It shows how to calculate the potential distribution corresponding to a given focal length of the electrical lens. Formulae are found for calculating the positions of the focal points of a given potential distribution.

ÜBER DIE ELEKTRISCHE ELEKTRONENSAMMELLINSE (The Electric Electron Condensing Lens).—H. Johannson and O. Scherzer. (*Zeitschr. f. Physik*, 1933, Vol. 80, No. 3/4, pp. 183–192.)

ELECTRON LENSES.—C. J. Davisson and C. J. Calbick. (*Phys. Review*, 15th Nov., 1932, Series 2, Vol. 42, No. 4, p. 580.)

A letter correcting an error in a formula given by the writers in 1931.

ZUR THEORIE DER ELEKTRONENOPTISCHEN LINSENFEHLER (The Theory of the Lens Errors in Electron Optics).—O. Scherzer. (*Zeitschr. f. Physik*, 1933, Vol. 80, No. 3/4, pp. 193–202.)

THE CATHAUTOGRAPH: AN ELECTRONIC PENCIL [using a Fluorescent Screen with a Decay Period of about 30 Seconds].—A. B. Du Mont. (*Electronics*, Jan., 1933, p. 7 and front cover.)

Suggested applications include communication between aircraft and ground stations and between small ships and land stations; office intercommunication; police cars; noiseless instructions to broadcasting artists; advertising purposes; and for Chinese and Japanese services.

STUDY OF THE DISCHARGE IN AN IONIC TUBE [working on the Low Voltage of 1 000 v with High Intensity] with the help of a Cinematographic Apparatus.—V. Dolejšek and K. Dráb. (*Comptes Rendus*, 30th Jan., 1933, Vol. 196, No. 5, pp. 334–336.)

EIN EINFACHES VERFAHREN ZUR BEOBACHTUNG HOCHFREQUENTER SPANNUNGSKURVEN (A Simple Method of Observing High-Frequency Voltage Wave Forms [Cathode-Ray Oscillograph and Rotating Mirror]).—U. Bab. (*Zeitschr. f. tech. Phys.*, No. 1, Vol. 14, 1933, pp. 18–19.)

The method consists in applying to the two pairs of deflecting plates the high frequency under investigation and a sinusoidal high frequency differing from the first by an audible frequency, and using a rotating mirror to view the resulting figure. The conditions for a faithful reproduction of the wave form are shown to be $a = \lambda kA$ and $n = A(f_1 - f_2)/2a$, where a is the distance of mirror from screen, k the number of surfaces on the mirror, n the rotations per second, A the half-breadth of the image on the screen, and $f_1 - f_2$ the audio-frequency; it is found, however, that these conditions need only be obtained approximately, by adjustment in operation, so that the method is very practical.

A SPECTROSCOPIC METHOD OF DETERMINING THE EXCITATION OF LUMINESCENCE [for the Rapid Choice of the Ultra-Violet Wavelength suitable for Various Fluorescent Substances].—G. Heyne and M. Pirani. (*Zeitschr. f. tech. Phys.*, No. 1, Vol. 14, 1933, pp. 31–33.)

A MERCURY SEALED GAS VALVE.—S. F. Essig. (*Review Scient. Instr.*, Dec., 1932, Vol. 3, pp. 762–763.)

A FILTER FOR AN X-RAY POWER SUPPLY [giving 30 mA at 20 kv with a Ripple of less than 0.02%: Greinacher Rectifier Circuit and Balanced Pi-Type Low-Pass Filter].—J. B. Hoag and V. J. Andrew. (*Review Scient. Instr.*, Dec., 1932, Vol. 3, pp. 750–752.)

X-RAY TUBE INPUT CONTROL.—W. R. Harper. (*Journ. Scient. Instr.*, Jan., 1933, Vol. 10, pp. 10–12.)

It is shown that the fluctuations of a.c. mains cannot be counteracted by a control confined to the primary side of the h.t. transformer, owing to changes in wave form introduced by the control itself. The correct methods of control are described.

EIN ZEITTRANSFORMATOR ZUR AUTOMATISCHEN REGISTRIERUNG KURZER ZEITEN (A Time Transformer for the Automatic Registration of Short Times).—M. Steenbeck and R. Strigel. (*Archiv f. Elektrot.*, 9th Dec., 1932, Vol. 26, No. 12, pp. 831–840.)

Authors' summary:—A time transformer has been designed for the measurement of short times. The principle on which it is based is that a condenser is charged up by a constant current during the period of time to be measured and then discharged by a small, constant current. Thus the discharge period is proportional to the period of charging. Measurement of the discharge time enables times to be measured which are too short to be measured directly. Two arrangements are described, of which one simply measures the mean value of a large number of single times, while the other registers the magnitude of each single time. Two designs are developed, one measuring times down to 10^{-4} sec. and the other times from 10^{-8} sec. upwards. In the arrangements described, charge and discharge of the condenser each take place *via* a valve. It would also be possible to arrange ohmic resistances in the two circuits, to limit the currents, *i.e.*, in general to use homologous circuits for charging and discharging the currents.

KLEINZEITFORSCHUNG IN DER TECHNIK (The Analysis of Processes occurring in Very Short Times [by High-Speed Cinematography up to 80 000 Pictures per Second]).—W. Ende. (*Zeitschr. V.D.I.*, 7th Jan., 1933, Vol. 77, No. 1, pp. 10–12.) *See* also Abstracts, 1932, p. 598 (von Ohnesorge: Thun) and February, p. 112 (Ende).

AN OSCILLOGRAPH FOR TEN THOUSAND CYCLES.—A. M. Curtis. (*Bell S. Tech. Journ.*, Jan., 1933, Vol. 12, No. 1, pp. 76–90.)

This paper describes a method of attack of the problem of extension of frequency range of oscillographs, not by increasing the natural frequency of the vibrating element, but by employing a vibrator with only a moderately high natural frequency and "equalising the response of the string by electrical circuits both up to and beyond the fundamental resonance frequency."

MESSUNGEN AN SPERRSCHICHTGLEICHRICHTERN (Measurements on Barrier-Layer Rectifiers [New and Aged: Bergstein's Classification: Wagner's Theory]).—W. Meyer and A. Schmidt. (*Zeitschr. f. tech. Phys.*, No. 1, Vol. 14, 1933, pp. 11–18.)

One of the primary objects of this experimental investigation was to test Bergstein's division (Abstracts, 1930, pp. 522–523) of barrier-layer rectifiers into two groups, based partly on their electrical behaviour and partly on their mechanical structure: one group including the copper-oxide rectifier and the other the iodine and the selenium rectifiers. As a result of their work the writers conclude that this division has only a "formal" significance, and that there is no fundamental difference between the two groups. They also conclude that Wagner's attempt (1931, p. 625) to explain the rectifying action without reference to a barrier layer, by means of a special conducting mechanism of the ion-lattice-forming semi-conductor, cannot be accepted: they find most helpful of all the theory put forward by Schottky (1930, pp. 636–637; 1931, pp. 103 and 451; 1932, p. 232; etc.) and developed by van Geel and by Nordheim (1931, p. 513; 1932, pp. 420 and 597; also Wilson, 1932, pp. 108 and 597) of a forced electron discharge through the barrier layer.

The tests were carried out on plates taken from small commercial rectifiers such as are used for accumulator charging. The ageing effects in these are chiefly due to the high current densities employed and the consequent comparatively high temperatures endured: by good cooling or light loading they can be practically avoided. Moreover, the changes—some of them large—found in the individual resistances as a result of service are for the most part of little importance as regards d.c. output, owing chiefly to the large leakage of the transformers used with these small rectifiers. The rectifiers tested were of the following types: lead/copper iodide copper, copper/copper oxide graphite, copper/copper oxide copper, and lead/selenium nickel, the stroke representing the barrier layer in each case. Measurements were taken of the equivalent series and parallel resistances and of the capacity, for new and old plates of the various types, and were plotted against various polarising voltages.

STEUERKURVEN UNSTETIG GESTEUERTER GASENTLADUNGEN (The Control Curves of Intermittently Controlled Gas Discharges [in Grid Controlled Rectifiers, etc.]).—E. Lübcke. (*Zeitschr. f. tech. Phys.*, No. 2, Vol. 14, 1933, pp. 61–64.)

THE "STABILISATOR" [Glow-Discharge Potential Divider and Voltage Regulator].—Stabilovolt Company: Körös. (*Hochf:tech. u. Elek:akus.*, Nov., 1932, Vol. 40, No. 5, pp. 185–187.)

Illustrated description of the commercial article whose theory was dealt with in 1932 Abstracts, p. 655.

DAS ÄTZNATRON-ELEMENT (The Caustic Soda Primary Battery with Depolarisation by Atmospheric Oxygen).—Le Carbone Company. (*E.T.Z.*, 9th Feb., 1933, Vol. 54, No. 6, pp. 131–132.)

"The smoothness of the discharge curve for prolonged discharge is much the same as that given by an American copper-oxide cell . . . , but the Le Carbone caustic soda element has a working voltage about 80% higher" [1.2 to 1 V for a 0.5 to 3 A discharge].

TESTS ON THE PERFORMANCE OF DRY CELLS.—U. Ruelle. (*L'Elettrotec.*, 15th Dec., 1932, Vol. 19, No. 35, pp. 853–860.)

SUL CALCOLO DELLE BOBINE DI AUTOINDUZIONE A NUCLEO DI FERRO (The Calculation of Iron-Cored Chokes [for Telephonic Frequencies]). —F. Marocchi. (*Alta Frequenza*, Sept., 1932, Vol. 1, No. 3, pp. 376–411.)

The writer derives the following simple formula for the losses in the iron plates or wires, taking into account the non-uniform distribution of the magnetic flux and the eddy currents, and assuming limited values of B:— $P_{fe} = k_i B^2 f^{1.5} + k_{cp} B^2 f^{2.5}$. The coefficient k_i and k_{cp}, characterising the losses by hysteresis and by eddy currents, can readily be obtained by measurements of inductance and resistance on a sample of the material, and are relatively constant in sufficiently wide zones of variation of B and of f. Making use of this expression, and of certain geometrical considerations, the properties of any iron-cored choke can be summarised by means of two characteristic parameters R_r and Q, functions of a core dimension and of the number of turns and the diameter of the wire of the winding. It can thus be shown that the logarithmic decrement $\delta = R/2fL$ can be given a minimum, by varying either f or L (when the latter variation is produced by altering the size of the air gap). When both quantities fulfil the conditions simultaneously, a "minimum minimum" decrement is obtained. The parameters R_r and Q are easily calculated for a choke for a definite frequency or band of frequencies, and from them valuable design data can be derived.

SCREENING OF A CORE-LESS OIL-COOLED CHOKING COIL BY MEANS OF AN AUXILIARY WINDING. PART I.—J. Hak. (*E.T.Z.*, 9th Feb., 1933, Vol. 54, No. 6, pp. 123–125.)

TRANSFORMERS WITH PEAKED WAVES [*e.g.* for Neon Lamp Stroboscopes].—O. Kiltie. (Summary in *Review Scient. Instr.*, Jan., 1933, Vol. 4, No. 1, p. 41.)

BEITRAG ZUR VORAUSBERECHNUNG DER GÜNSTIGSTEN DIMENSIONEN VON ELEKTRISCHEN TRANSFORMATOREN UND MASCHINEN (Contribution to the Calculation of the Optimum Dimensions of Electrical Transformers and Machines).—J. La Cour. (*Ingeniörs Vetenskaps Akademien, Sweden*, Handlingar No. 120, 1933, 165 pp. In German.)

LIGHT-WEIGHT TRANSFORMERS FOR AIRCRAFT [for Transmitters and Receivers].—D. W. Grant. (*Bell Lab. Record*, Feb., 1933, Vol. 11, No. 6, pp. 173–177.)

For transformers working at low power levels (*e.g.*, input for transmitter, output for receiver) permalloy cores are used: for those working at higher levels (*e.g.*, output for transmitter, "retardation coil" for receiver—in smoothing circuit) silicon steel is retained and other steps are taken to reduce the weight. As a result, a complete receiving set weighs only 17 lbs.

NEW APPARATUS AND APPLIANCES [Special Transformer and Output Choke for "Quiescent Push-Pull"].—(*Electrician*, 10th Feb., 1933, Vol. 110, No. 2854, pp. 200–201.)

ELECTROMAGNETIC SHIELDING AT RADIO FREQUENCIES.—King. (*See* under "Propagation of Waves.")

NEUES VERFAHREN MAGNETISCHER MESSUNGEN AN BLECHSTREIFEN (A New Method for Magnetic Measurements on Strips of Sheet Metal).—P. C. Hermann. (*Zeitschr. f. tech. Phys.*, No. 1, Vol. 14, 1933, pp. 39–44.)

DIE FLUSSVERDRÄNGUNG IN EISENBLECHEN IN WECHSELWIRKUNG MIT EINEN LUFTSPALT (Magnetic Skin Effect in Laminated Iron with an Air Gap).—H. Kaden. (*Zeitschr. f. tech. Phys.*, No. 2, Vol. 14, 1933, pp. 69–72.)

The writer's analysis shows that as a general rule the reluctance of such a circuit at all frequencies can be calculated with sufficient accuracy as the sum of the air-gap reluctance for a uniform field distribution and the iron reluctance, without attention to their mutual effects.

PERMEABILITY OF IRON AT ULTRA-RADIO FREQUENCIES.—J. B. Hoag and H. Jones. (*Phys. Review*, 15th Nov., 1932, Series 2, Vol. 42, No. 4, pp. 571–576.)

WAS IST DAS ANOMALE VERHALTEN DER PERMEABILITÄT BEI HOCHFREQUENZ? (What is Anomalous Behaviour of Permeability at High Frequencies?)—W. Arkadiew. (*Zeitschr. f. Physik*, 1932, Vol. 79, No. 7/8, pp. 558–561.)

INSULATING SUSPENSIONS OR SUPPORTS FOR SHORT-WAVE COMPONENTS, TO AVOID DIELECTRIC LOSSES: THE USE OF METALLIC WINDINGS OF HIGH INDUCTANCE AS INSULATORS.—Telefunken Company. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Nov., 1932, Vol. 40, No. 5, p. 183.)

CAPILLARY ACTION IN IMPREGNATED PAPER INSULATION.—J. B. Whitehead and E. W. Greenfield. (*Physics*, Dec., 1932, Vol. 3, No. 6, pp. 324–330.)

INSULATING MATERIALS—SOME RECENT DEVELOPMENTS [Elephantide Press-Papers, Alkyd Resins, etc.].—A. R. Dunton. (*Electrician*, 13th Jan., 1933, Vol. 110, No. 2850, pp. 33–34.)

PLASTIC MATERIALS IN ENGINEERING.—W. Röhrs. (*Zeitschr. V.D.I.*, 17th Dec., 1932, Vol. 76, No. 51, pp. 1233–1239.)

COMMERCIAL TESTING OF SOLID DIELECTRICS [Survey of Methods in Various Countries].—G. Caviglia. (*L'Elettrotec.*, 15th Dec., 1932, Vol. 19, No. 35, pp. 860–864.)

A SUMMARY OF YEAR'S INSULATION RESEARCH.—J. B. Whitehead and others. (*Elec. Engineering*, Feb., 1933, Vol. 52, pp. 99–106.)

VDE TEST SPECIFICATIONS FOR CONDENSERS FOR BROADCAST RECEIVERS AND INTERFERENCE PREVENTION.—Verband Deutscher Elektrotechniker. (*E.T.Z.*, 9th Feb., 1933, Vol. 54, No. 6, pp. 140–142.)

POTENTIOMETERS: A SURVEY.—H. B. Brooks. (Summary in *Review Scient. Instr.*, Jan., 1933, Vol. 4, No. 1, p. 42.)

A PEN RECORDER FOR D.C. MILLIVOLTS AND MICROAMPERES AT ENERGY LEVELS OF 4–5 MICROWATTS.—H. L. Bernarde and L. J. Lunas. (*Elec. Engineering*, Feb., 1933, Vol. 52, p. 124: summary only.)

THE MEASUREMENT OF THE PHASE ANGLES OF SHIELDED RESISTORS.—L. J. Berberich. (*Physics*, Dec., 1932, Vol. 3, No. 6, pp. 296–313.)

"The small, but not always negligible phase angles of 'non-inductive' shielded resistors are often ignored because of the supposed extreme difficulty of their measurement." A substitution method is described which needs no very special apparatus and gives an accuracy sufficient for the most precise measurements in which such resistors may be used. Time constants as low as 10^{-8} sec. were measured with less than 10% error.

A NEW CONTINUOUSLY VARIABLE RESISTANCE.—(*E.T.Z.*, 8th Feb., 1933, Vol. 54, No. 6, p. 133.)

A flexible stranded constantan wire lies freely in the spiral groove of a rotatable cylinder and also passes in a figure-of-eight round a capstan-shaped "contact-wheel" sliding on a sprung shaft parallel to the cylinder axis. The device is made for various resistances and for currents up to 15 A; it can be non-inductive if so desired.

100 000-OHM WIRE-WOUND RESISTANCES [for Noiseless Operation of Volume Control, etc.].—Clarostat Company. (*Electronics*, Dec., 1932, p. 379.)

UN NOUVEAU MODE DE RÉALISATION DES PHÉNOMÈNES THERMOÉLECTRIQUES (A New Way of Making Use of Thermoelectric Phenomena [Many Thermojunctions in Series, with Unbroken Continuity in case of Failure of One or More Junctions]).—A. Égal. (*Comptes Rendus*, 30th Jan., 1933, Vol. 196, No. 5, pp. 332–334.)

Two practical designs are shown carrying out the general principle that the more resistive metal (*e.g.*, constantan) forms a continuous spiral, while the second metal (*e.g.*, iron) is made to short-circuit alternate half-turns of this spiral. In the second design the iron is actually deposited on the half-turns.

CONTROL BY "NON-LINEAR" CIRCUITS [Transformer Combinations, etc.].—General Electric Company. (*Electronics*, Jan., 1933, p. 19.)

No details are given. One circuit produces slow oscillations which will turn on and off an incandescent lamp several times per second or as slowly as once in thirty seconds. "It was known for some time that high frequencies could be produced in transformers under certain conditions, but these frequencies are always multiples or integral fractions of the frequency of the power supply. The new oscillator will produce any frequency in its range of usefulness; vibrations of 5 000 c/s already have been observed. . . . Still another application of non-linear circuits has been in resonance relays [working on current and voltage resonance]. . . . A voltage change of as little as 1/100th of 1% will cause a current change of 100%."

GLOW-DISCHARGE RELAY ACTUATED BY INCREASING THE ELECTRODE GAP.—Landis and Gyr. (Summary of French Patent in *Rev. Gén. de l'Élec.*, 28th Jan., 1933, Vol. 33, No. 4, p. 32 D.)

At rest, the electrodes are so close that the first cathode dark space cannot form and no current can pass. If a magnet approaches the end of the discharge tube, it moves one electrode so as to increase the gap, and allows the glow discharge to form, the consequent current being used in an external circuit. Thus by mounting the magnet on the spindle of an electricity meter, the device can be used for distant registration of the meter.

RELAY CIRCUIT FOR POINTER INSTRUMENTS, REPLACING POSITIVE CONTACT BY SPARK OR BRUSH DISCHARGE WHICH TRIGGERS A GLOW DISCHARGE RELAY.—(Summary of French Patent in *Rev. Gén. de l'Élec.*, 31st Dec., 1932, Vol. 32, No. 26, p. 205–206 D.)

THE HEAVY-CURRENT GLOW DISCHARGE AT ATMOSPHERIC PRESSURE: A NEW TYPE OF DISCHARGE.—W. Krug: Thoma and Heer. (*Zeitschr. f. tech. Phys.*, No. 1, Vol. 14, 1933, p. 26.)

A letter prompted by the paper referred to in February Abstracts, p. 112, and referring to the writer's own results (1932 Abstracts, p. 658.)

A DIRECT CURRENT AMPLIFIER WITH GOOD OPERATING CHARACTERISTICS [using Radiotron Valves: practically Free from Effects of Filament and Anode Battery Drifts].—A. H. Taylor and G. P. Kerr. (*Review Scient. Instr.*, Jan., 1933, Vol. 4, No. 1., pp. 28–32.)

THE APPLICATION OF A THERMIONIC AMPLIFIER TO THE PHOTOMETRY OF THE STARS.—A. E. Whitford. (*Ibid.*, p. 37: summary only.)

"A marked improvement in stability has been obtained by evacuating the space around the photoelectric cell and amplifier tube." Amplification factor is about 2 200 000.

A D.C. AMPLIFIER FOR PHOTOMETRIC PURPOSES.—P. Donzelot and J. Divoux. (Long summary in *Rev. Gén. de l'Élec.*, 4th Feb., 1933, Vol. 33, No. 5, p. 150.)

Analysis of the relations between the photoelectric current and the three parallel resistances open to it (R_m, the high external resistance; R_g, the resistance of the space between filament and grid; and R_f, the leakage resistance of socket, etc.) shows that for great amplification R_m/R_g must be as small as possible; but R_m must for the same reason be very large, so R_g must be very large indeed (though "if R_g were negative and equal to R_m the amplification would be infinite; but as the grid currents are not stable when R_g is negative, this part of the characteristic can hardly be used"). Another condition is that the slope must be steep: all these conditions do not appear to be satisfied in any one valve on the market. The writers therefore use three separate stages: (1) a Philips electrometer valve with R_g very large; (2) a stage with very high coefficient of voltage amplification, using Jouaust and Decaux' device of a two-grid valve with united grids; and (3) a stage with very steep slope, using two valves in parallel. For the writers' special method of compensating the current of repose in the output circuit, *see* February Abstracts, p. 113.

A DIRECT CURRENT AMPLIFIER.—P. A. Macdonald and J. T. Macpherson. (*Phil. Mag.*, Jan., 1933, Series 7, Vol. 15, No. 96, pp. 72–81.)

The current sensitivity S_c of a direct current amplifier is given by $S_c = G_m S_g R$, where G_m is the mutual conductance of the valve used, S_g the sensitivity of the meter in the anode circuit and R the resistance employed to connect the control grid and filament of the valve. The writers describe a circuit in which G_m has been increased and S_g kept constant by using the unidirectional conductivity of an auxiliary vacuum tube to alter the potential of the grid of a triode when its grid current changes direction. The overall amplification obtained was 10^8, the stability was good. Greater sensitiveness would be obtained by increasing both G_m and S_g.

A TWO-STAGE MAINS-DRIVEN AMPLIFIER ENABLING A PHOTOCELL TO OPERATE A COMMERCIAL RELAY.—H. L. Kagamaster. (*Electronics*, Jan., 1933, p. 19.)

THE AUDIO TRANSFORMER AS A SELECTIVE AMPLIFIER.—Pawley. (*See* under "Acoustics and Audio-frequencies.")

A FILTER FOR THE INTERMEDIATE-FREQUENCY AMPLIFIER [of a Superheterodyne Receiver].—Piesch. (*See* under "Reception.")

THE PROPERTIES AND CALCULATION OF THE MULTIPLE BRIDGE FILTER.—W. Cauer: Jaumann. (*E.N.T.*, Dec., 1932, Vol. 9, pp. 502–504.)

A letter prompted by Jaumann's paper (1932 Abstracts, pp. 595–596). Cauer refers to patents taken out by himself, and points out various printers' errors. Jaumann replies.

A NEW SUBSTITUTE FOR THE SLIDE RULE.—P. Ravigneaux. (*Comptes Rendus*, 9th Jan., 1933, Vol. 196, No. 2, pp. 96–97.)

A NEW HARMONIC ANALYSER [Synchronous Disc and M.C. Voltmeter].—B. G. Gates. (*Journ. Scient. Instr.*, Dec., 1932, Vol. 9, pp. 380–386.)

A MECHANICAL AID TO THE ANALYSIS OF COMPLEX SPECTRA.—G. R. Harrison. (*Review Scient. Instr.*, Dec., 1932, Vol. 3, pp. 753–759.)

CURVE PLOTTER AND COMPARATOR FOR LABORATORY AND PRODUCTION TEST USES.—S. Isler. (*Electronics*, Dec., 1932, p. 361.)

Developed by Wired Radio, Inc., for use in testing receiving and transmitting filters for frequency and overall output characteristics.

THE DARBOUX-KOENIGS PLANIGRAPH.—E. J. Nyström. (*Societas Scientiarum Fennica, Commentationes Physico-Mathematicae*, Vol. 6 [Nos. 1–15], 1932, No. 15, pp. 1–29.)

STATIONS, DESIGN AND OPERATION

ULTRA-SHORT RADIO WAVES AND THE CARDIFF-WESTON-SUPER-MARE RADIO LINK [Hutton to Lavernock].—F. E. Nancarrow. (*P.O. Elec. Eng. Journ.*, Jan., 1933, Vol. 25, Part 4, pp. 303–306.)

Simple half-wave horizontal dipoles are used, supported by 50-ft. wooden poles. The use of a beam system was allowed for but found unnecessary for this particular service. "High power" modulation is used, and both oscillating and modulating valves are of the type V.T.24. The transmitting and receiving huts are spaced some 100 yds apart to minimise cross-talk.

LA LIAISON RADIOTÉLÉPHONIQUE ENTRE LA CORSE ET LE CONTINENT PAR ONDES TRÈS COURTES (The Ultra-Short-Wave Service between Corsica and the Continent).—B. de Cléjoulx. (*Ann. des P.T.T.*, Jan., 1933, Vol. 22, No. 1, pp. 79–85.)

Short description of the equipment used for the service dealt with in Jan. Abstracts, p. 54. The voice-operated device for the duplex working is briefly discussed. The paper ends: " In spite of the great number of listening hours in the past two years, no fixed rules regarding propagation have been found. It is very variable. It seems, however, that propagation is better in summer than in winter, or more exactly, in dry weather than in wet. The influence of humidity on the strength of reception is perhaps due to causes at the stations themselves (bad aerial insulation, losses in the receivers) rather than to propagation. But it is to be noted that very good reception was possible one day last January when La Turbie was under snow: the aerial insulators were transferred into blocks of ice. Even during the melting of the snow the same good working persisted.

" Selective fading, moreover, has been noticed fairly frequently. The signal minimum, which is sometimes absolute silence, occurs on both waves with some minutes' interval. It is only very rarely that fading affects one wave only. Its total duration is seldom more than 20 to 25 minutes. It has been noticed at all hours of the day."

Some Practical Experiments on Ultra-Short Waves [7.75 Metres: B.B.C. and Marconi Company's Preliminary Tests].—N. Ashbridge. (*World Radio*, 3rd Feb., 1933, Vol. 16, No. 393, pp. 141 and 144.)

Among points mentioned are the following:—The power radiated was about ¼ kw, the aerial being of the Franklin type with two "stacked" half-wave aerials. If, with a fairly sensitive receiver, moderately good reception is obtained at 15 miles, a decrease in distance to 10 or 7½ miles does not give as much improvement as might be expected, and the heavy background hiss due to the carrier wave still persists: this result is explained by the rapid attenuation over the first few miles and the extreme weakness of the fields at the greater distances, giving readable reception where much stronger signals on ordinary wavelengths would be drowned by static. The merits of a single-valve superheterodyne adaptor, a super-regenerative receiver, and a detector with reaction followed by one or two a.f. stages, are compared. No advantages of a vertical dipole receiving aerial, as compared with an ordinary type of broadcast aerial, were found: in fact, efficient aerials of the latter type gave the best results.

Experimenteele Radio-Omroep op een Golflengte van 7.85 Meter te Amsterdam (Broadcasting Tests on a 7.85-Metre Wavelength in Amsterdam).—P. J. H. A. Nordlohne. (*Tijdschr. Nederland. Radiogen.*, July, 1932, Vol. 6, No. 1, pp. 1–20.) *See* 1932 Abstracts, p. 657.

Long *versus* Short Broadcast Waves.—J. F. Byrne. (*Electronics*, Jan., 1933, p. 19.)

Summary of measurements in Ohio of the field strengths of nine stations on various frequencies in the broadcast band. Reduced to a common basis, the data showed that a 1 kw station on 1 450 kc/s would have a field strength of 0.2 mv/m at 45 miles; on 1 070, 700 and 550 kc/s the corresponding distances would be 75, 110 and 135 miles: thus the distance is roughly inversely proportional to the frequency. For the same sequence of frequencies the costs of providing a field of 0.5 mv/m over one square mile are 15.50, 5.88, —, and 2.06 dollars (based on an annual charge of 50 000 dollars for a 1 kw station). *See* also Editorial on p. 20, where the importance of Byrne's results is emphasised. Frequencies of 1 000 kc/s or over are uneconomical for large coverage and high power: low-power stations are at present "wasting good low-frequency assignments that are suitable for high power and large coverage."

The Use of Telephonic Circuits for Special Transmissions: Broadcast Relaying: Picture Transmission: Conferences by Telephone.—C. Höpfner. (Summary in *Rev. Gén. de l'Élec.*, 26th Nov., 1932, Vol. 32, pp. 687–688.)

The Bisamberg (Vienna) High-Power Broadcasting Station with Reflector Tower.—Telefunken Company. (*See* abstract under "Aerials and Aerial Systems.")

Some New Foreign Broadcasting Stations [Prague, Sottens and Beromunster, Westerglen].—M. Adam. (*Rev. Gén. de l'Élec.*, 10th Dec., 1932, Vol. 32, No. 23, pp. 771–779.)

Ansager und Ansagen (Announcers and Announcing).—H. Lebede. (*Radio, B., F. f. Alle*, Jan., 1933, pp. 39–42.)

How should the Sound Archives of Broadcasting be Used?—H. Lebede. (*Radio, B., F. f. Alle*, Feb., 1933, pp. 91–94.)

The Madrid Conference: Amateur Representatives Successful, as Fourteen-Weeks' Meeting Continues All Amateur Bands.—K. B. Warner. (*QST*, Feb., 1933, Vol. 17, pp. 9–17.)

Radioelectric Communication with Ships at Sea.—E. Picault. (*Ann. des P.T.T.*, Dec., 1932, Vol. 21, pp. 1021–1044.)

North Atlantic Ship-Shore Radiotelephone Transmission during 1930 and 1931 [Analysis of Short-Wave Data: Field Strength Contour Diagrams, etc.].—C. M. Anderson. (*Proc. Inst. Rad. Eng.*, Jan., 1933, Vol. 21, pp. 81–101.)

Short-Wave Transmission to South America [Survey of Transmission Conditions: Absence of Seasonal Effect: Characteristics of Atmospheric Noise, etc.].—C. R. Burrows and E. J. Howard. (*Proc. Inst. Rad. Eng.*, Jan., 1933, Vol. 21, pp. 102–113.)

For a summarised comparison with transatlantic transmission, and reasons for the differences, *see* pp. 109 and 112–113.

TRANSOCEANIC RECEPTION OF HIGH-FREQUENCY TELEPHONE SIGNALS [Short-Wave Relaying for International Broadcasting].—R. M. Morris and W. A. R. Brown. (*Proc. Inst. Rad. Eng.*, Jan., 1933, Vol. 21, pp. 63–80.)

Dealing with the method used in rating the suitability of the reception for re-broadcasting, the effects of magnetic disturbances upon transmission, the correlation of magnetic activity with transmission, and the forecasting of magnetic disturbances and resultant transmission conditions.

HIGH POWER TRANSMISSION AND RECEPTION AT ONE STATION [Beam Station at Salisbury, Rhodesia].—Marconi Company. (*Rad. Engineering*, Dec., 1932, Vol. 12, p. 19.)

SYSTEM FOR THE ELIMINATION OF EFFECTS OF FADING AND ATMOSPHERICS IN HIGH-SPEED TELEGRAPHY, USING SIGNAL REPETITION METHOD.—Telefunken Company: Schröter. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Nov., 1932, Vol. 40, No. 5, p. 184.) See Figs. 19 and 20.

DIE DEUTSCHEN ANLAGEN FÜR DEN DRAHTLOSEN ÜBERSEEVERKEHR (The German Stations for Oversea Service [Nauen, Beelitz, and the Central Offices in Berlin and Hamburg]).—W. Hahn. (*E.T.Z.*, 15th Dec., 1932, Vol. 53, No. 50, pp. 1197–1201.)

RADIO-TELEPHONY [Survey for 1932, including the "Compandor" Device].—H. Faulkner. (*Electrician*, 27th Jan., 1933, Vol. 110, No. 2852, pp. 109–110.)

"A new device known as the 'Compandor' is being tried out, principally on the long-wave transatlantic circuit, which is found to give a considerable improvement in signal/noise ratio. The device is arranged to amplify the weak syllables of speech to a greater extent than the stronger at the transmitting end, and to reverse the process at the receiving end. Thus noise entering the circuit at a point beyond the transmitting unit is—so long as it is of lower mean level than the speech—attenuated along with the weaker speech elements before being passed on to the listener. Since the weaker speech elements, however, are only attenuated to their correct proportionate strength, a net reduction in noise is achieved, while speech is received in its correct proportions. This device has been in operation now for several months and has been found to effect a real improvement in the circuit conditions."

GENERAL PHYSICAL ARTICLES

THE ANALYSIS OF COMPOUND WAVE FORMS.—J. S. Thompson. (*Phil. Mag.*, Jan., 1933, Series 7, Vol. 15, No. 96, pp. 1–15.)

This paper classifies the forms which may arise in the analysis of a wave form compounded of a pair of sine waves, and provides a convenient method for performing the analysis.

ON SOME APPLICATIONS OF THE ABSOLUTE DIFFERENTIAL CALCULUS TO PHYSICS [to Hooke's Law in Elasticity Theory and the Constitutive Relations in Electromagnetic Theory].—C. Kaplan. (*Phys. Review*, 15th Jan., 1933, Series 2, Vol. 43, No. 2, pp. 137–142.)

ÜBER DIE GRUNDLAGEN DER GEOMETRISCHEN ELEKTRONENOPTIK (The Foundations of Geometrical Electron Optics).—E. Brüche. (*Zeitschr. f. tech. Phys.*, No. 2, Vol. 14, 1933, pp. 49–58.)

DIE AUSBILDUNG DER MAXWELLVERTEILUNG IM LANGMUIRSCHEN PLASMA (The Formation of the Maxwell Distribution in a Langmuir Plasma [Theoretical Investigation]).—D. Gábor. (*Physik. Zeitschr.*, 1st Jan., 1933, Vol. 34, No. 1, pp. 38–45.)

QUANTUM MECHANICS OF COLLISION PROCESSES, PART II.—P. M. Morse. (*Reviews of Mod. Phys.*, July, 1932, Vol. 4, No. 3, pp. 577–634.)

ZUR ERKLÄRUNG VON LICHTERSCHEINUNGEN BEIM ELEKTRISCHEN GASDURCHSCHLAG (The Explanation of Luminous Phenomena [in Absence of Appreciable Voltage Drop] in Spark Discharge through Gases).—W. Fucks. (*Zeitschr. f. tech. Phys.*, No. 2, Vol. 14, 1933, pp. 59–61.)

CONTEMPORARY ADVANCES IN PHYSICS, XXV. HIGH FREQUENCY PHENOMENA IN GASES, SECOND PART.—K. K. Darrow. (*Bell S. Tech. Journ.*, Jan., 1933, Vol. 12, No. 1, pp. 91–118.)

For the first part *see* March Abstracts, p. 174.

DIELECTRIC CONSTANT AND PARTICLE SIZE.—J. W. Williams and J. L. Oncley. (*Physics*, Dec., 1932, Vol. 3, No. 6, pp. 314–323.)

MISCELLANEOUS

PROBABILITY THEORY AND TELEPHONE TRANSMISSION ENGINEERING.—R. S. Hoyt. (*Bell S. Tech. Journ.*, Jan., 1933, Vol. 12, No. 1, pp. 35–75.)

This paper "contributes methods, theorems, formulas and graphs to meet a previously unfilled need in dealing with certain types of two-dimensional probability problems—especially those relating to alternating current transmission systems and networks" with two dimensional variables.

ON THE PRIOR PROBABILITY IN THE THEORY OF SAMPLING.—H. Jeffreys. (*Proc. Camb. Phil. Soc.*, Jan., 1933, Vol. 29, No. 1, pp. 83–87.)

REMARK ON THE PAPER BY G. KÖHLER AND A. WALTHER: ON THE FOURIER ANALYSIS OF FUNCTIONS WITH DISCONTINUITIES, CORNERS AND SIMILAR PECULIARITIES.—R. Feinberg. (*Archiv f. Elektrot.*, 7th Jan., 1933, Vol. 27, No. 1, pp. 15–18.)

For reference to the paper named *see* 1932 Abstracts, p. 113. The writer of this note finds that infinite series occurring in the Fourier analysis of discontinuous functions, etc., may diverge and cause the method to fail. He also gives a graphical method of analysis. In a succeeding note (pp. 19–20) Walther shows the divergence to be unimportant as far as applications are concerned and gives the history of the method.

DEVELOPMENT AND PROGRAMME OF THE DIFFERENTIAL ANALYSER.—V. Bush. (Summary in *Science*, 2nd Dec., 1932, Vol. 76, No. 1979, p. 519.)

Results achieved with, and probable development of, the machine referred to in 1932 Abstracts, p. 113.

DISSEMINATION OF SCIENTIFIC KNOWLEDGE.—E. Leifson. (*Science*, 30th Dec., 1932, Vol. 76, No. 1983, p. 624.)

It is suggested that short "previews" of scientific papers should be "submitted to the journal of previews after the full reports have been accepted for publication by a standard journal. Within one month the previews should appear in print."

TABLE OF ORGANISATION AND PROGRAMME OF HIGHER EDUCATION IN ELECTRICAL ENGINEERING IN DIFFERENT COUNTRIES.—(*Rev. Gén. de l'Élec.*, 31st Dec., 1932, Vol. 32, No. 26, pp. 860–863.)

ÜBER DAS ORDNEN TECHNISCHEN SCHRIFTUMS (On the Classification of Technical Papers [The Brussels Decimal Classification System]).—F. Moench. (*E.N.T.*, Dec., 1932, Vol. 9, pp. 496–500.)

THE U.S.A. PATENT "POOL."—(*Wireless Engineer*, Jan., 1933, Vol. 10, No. 112, p. 18.)

NEW APPLICATIONS AND THE EXPANSION OF RECENT USES OF ELECTRICITY: RECENT APPLICATIONS OF ELECTRICAL METHODS.—G. F. Sills: D. H. Bishop. (*Journ. I.E.E.*, Jan., 1933, Vol. 72, No. 433, pp. 45–50: 51–55.)

LOOKING AHEAD AS 1933 OPENS.—(*Electronics*, Jan., 1933, p. 2–3.)

New aids to television: Rochelle salt crystals to modulate the light beam: Myers mercury-vapour lamp (March Abstracts, p. 168): ultra-short waves (field-strength measurements on signals from Empire State Building aerials 1 280 ft from ground). Photo-sensitive cells (speed-traps for motorists: restaurant "magic doors" save enough dish-breakage to offset the carrying cost of the installation, and speeding-up of service amounts to equivalent of 2 500 dollars worth of rental space). Power uses of rectifiers: new type of metal-envelope tube (indirectly heated cathode) rectifying 100 A at usual voltage and frequencies. Beauty the new note in broadcast receivers.

RADIO-TELEPHONY IN MINES.—F. Noack. (Summary in *Electronics*, Dec., 1932, p. 377.)

RADIO-TELEPHONY [Survey for 1932, including the "Compandor" Device].—Faulkner. (*See* under "Stations, Design and Operation.")

THE THEORY OF HEATING BY INDUCED H.F. CURRENTS.—G. Ribaud. (*Journ. de Phys. et le Rad.*, Nov., 1932, Vol. 3, pp. 537–554.)

THE PRODUCTION OF THE MERGET PHENOMENON [Gaseous Thermodiffusion] BY D'ARSONVALISATION BY ULTRA-SHORT WAVES.—H. Bordier. (*Comptes Rendus*, 23rd Jan., 1933, Vol. 196, No. 4, pp. 255–257.)

"RADIO KNIFE" EMPLOYING INDUCED CURRENTS [thus dispensing with Electric Cord Connection]. (*Electronics*, Jan., 1933, p. 27.)

RECORDING AND MEASURING BLOOD PRESSURE BY A PIEZOELECTRIC METHOD.—L. Bugnard, P. Gley and A. Langevin. (*Comptes Rendus*, 23rd Jan., 1933, Vol. 196, No. 4, pp. 293–295.)

Further development of the work referred to in 1930 Abstracts, p. 647 (Boullé and Langevin).

USE OF THE PHOTOELECTRIC CELL IN BIOLOGY [Study of Area and Shape of Blood Cells].—A. Savage. (*National Research Council, Canada, 14th Annual Report*, 1930–1931, p. 126.)

The method dealt with in 1931 Abstracts, p. 170, has been applied to the comparison of normal and anaemic blood cells.

PHOTOPHONY [Photo-Telephony] WITH VOLTAGE MODULATION OF INCANDESCENT LAMP—VIEWED FROM ITS WAVE FORM.—S. Suzuki. (*Journ. I.E.E. Japan*, Dec., 1932, Vol. 52 [No. 12], No. 533: English summary p. 134.)

The successful use of an incandescent lamp at the transmitter has already been described by Kujirai (1932 Abstracts, p. 540). The present writer has previously shown that the wave form of the filament temperature takes the integrated form of the square of the applied voltage, if the frequency is within the range of audible frequencies. In this paper he deals with the transient state of the filament temperature with periodic wave form. A diagram of the photophone is given on p. 961.

VARIATION OF LUMINOUS INTENSITY OF INCANDESCENT LAMPS AS A FUNCTION OF VARIATION OF APPLIED VOLTAGE [for Various Types of Filament].—H. Pécheux. (*Rev. Gén. de l'Élec.*, 31st Dec., 1932, Vol. 32, No. 26, pp. 867–871.)

MEASUREMENT OF YARN THICKNESS AND EVENNESS [by Photoelectric Method].—Stanbury. (*Electronics*, Dec., 1932, p. 370.) For similar use on silk *see* February Abstracts, p. 117, top l. h. column.

CLOTH-DYEING MACHINE WITH PHOTOELECTRIC REVERSER: ELECTRIC EYE WATCHES BOWLING-ALLEY "FOUL LINE": SMOKE RECORDER AND TRUCK-HEIGHT INDICATOR IN HOLLAND TUNNEL.—(*Ibid.*, p. 371.)

METHODS OF MEASURING AND RECORDING RAPIDLY VARYING PRESSURES [as in Aeroplane Engine Cylinders: a Photoelectric Method].—A. Labarthe and M. Demontvignier. (*Comptes Rendus*, 19th Dec., 1932, Vol. 195, No. 25, pp. 1240–1242.)

A [Photoelectric] SMOKE DENSITY METER.—R. D. Bean. (*Journ. Scient. Instr.*, Dec., 1932, Vol. 9, pp. 391–392.)

EXPERIMENTS ON POLARIMETRY BY PHOTOELECTRIC TECHNIQUE: MEASUREMENTS OF THE ROTATORY DISPERSIONS OF SOME SUGARS.—G. Bruhat and P. Chatelain. (*Journ. de Phys. et le Rad.*, Nov., 1932, Vol. 4, pp. 501–511.)

THE IMPORTANCE OF THE BARRIER-LAYER PHOTO-CELL IN ILLUMINATING ENGINEERING.—L. Bloch. (Summary in *Rev. Gén. de l'Élec.*, 12th Nov., 1932, Vol. 32, pp. 619–620.)

TORSIONAL VIBRATIONS IN AXLES AND SHAFTS AND THE RESONANCE OSCILLATIONS IN FILTERS [Suggestion of a Method of Testing].—S. Treves. (*Alta Frequenza*, Sept., 1932, Vol. 1, No. 3, pp. 429–431.)

A letter prompted by Sacerdote's paper on ultra-micrometric and other methods (1932 Abstracts, pp. 480 and 601).

TESTS ON HIGH-SPEED DIESEL ENGINES BY ELECTRICAL [Piezoelectric, Ultra-Micrometric, etc.] METHODS.—A. Nägel. (*Zeitschr. V.D.I.*, 10th Dec., 1932, Vol. 76, No. 50, pp. 1213–1217.)

MEASUREMENT OF THE DISSIPATION OF VIBRATORY ENERGY IN A STEEL BAR BY AN ELECTRICAL METHOD.—A. L. Kimball. (Summary in *Rev. Gén. de l'Élec.*, 24th Dec., 1932, Vol. 32, No. 25, p. 826.)

In a series of articles on papers dealing with "Various Applications of Electricity" read at the International Electricity Congress.

THE EMPLOYMENT OF THE RECIPROCITY RELATIONS IN THE INVESTIGATION OF MECHANICAL VIBRATIONS.—A. Steinheil. (*Zeitschr. f. tech. Phys.*, No. 1, Vol. 14, 1933, pp. 36–39.)

THE INVESTIGATION OF MECHANICAL VIBRATIONS BY PHASE MEASUREMENT [using a Glow-Discharge Lamp rotating with the Machine and fed through a Contact-Breaker influenced by the Vibrations].—W. Späth. (*E.T.Z.*, 5th Jan., 1933, Vol. 54, No. 1, pp. 10–12.)

THE SICCOMETER: AN ULTRA-MICROMETER FOR THE TESTING OF MOISTURE IN THE MANUFACTURE OF PAPER.—H. Carsten and C. H. Walter: Siemens & Halske. (*E.T.Z.*, 2nd Feb., 1933, Vol. 54, No. 5, p. 109.)

Cf. Walter, 1932 Abstracts, p. 651, and back reference (Jaekel).

THE [Ultra-Micrometric] MEASUREMENT OF SMALL ELECTRODYNAMIC FORCES WITH THE CONDENSER MICROPHONE.—Agricola. (*See* under "Measurements and Standards.")

THE SOUNDING STRING AS A MEASURING APPARATUS [as Ultra-Micrometric Device for Small Movements in Buildings, Hulls, etc., and Lathe Investigations].—H. Haake. (*Zeitschr. V.D.I.*, 10th Dec., 1932, Vol. 76, No. 50, pp. 1228–1229.)

Two electromagnetically vibrated strings are used, tuned to the same note. An accuracy of ± 1% is given.

MEASUREMENT OF VELOCITY OF PROJECTILES BY MEANS OF KERR CELL.—Cranz, Kutterer and Schardin. (Summary in *Zeitschr. V.D.I.*, 26th Nov., 1932, Vol. 76, No. 48, p. 1183.)

ELECTRONIC DEVICES FOR INDUSTRIAL CONTROL.—F. H. Gulliksen. (*Elec. Engineering*, Feb., 1933, Vol. 52, pp. 106–110.)

THE INTERNATIONAL ORGANISATION OF BROADCASTING.—P. Brenot. (*Rev. Gén. de l'Élec.*, 17th Dec., 1932, Vol. 32, No. 24, pp. 185–186B.)

THE 8TH "DEUTSCHE PHYSIKER- UND MATHEMATIKERTAG," BAD NAUHEIM, 1932.—(List of Papers, and short Summaries, in *E.T.Z.*, 29th Dec., 1932, Vol. 53, No. 52, pp. 1247–1250.)

SCIENTIFIC INSTRUMENTS AND AERONAUTICS.—H. E. Wimperis. (*Journ. Scient. Instr.*, Nov., 1932, Vol. 9, pp. 337–341.)

RECENT RADIO RESEARCH. (*Nature*, 4th Feb., 1933, Vol. 131, pp. 156–157.)

A note on the *Report of the Radio Research Board for the Year* 1931.

THE ACTIVITIES OF THE PHYSIKALISCH-TECHNISCHE REICHSANSTALT IN THE YEAR 1931.—(*E.T.Z.*, 15th Dec., 1932, Vol. 53, No. 50, pp. 1203–1204.)

THE PHYSICAL SOCIETY'S EXHIBITION, JANUARY 1933.—(*Journ. Scient. Instr.*, Feb., 1933, Vol. 10: Exhibition Number. Also *Wireless World*, 13th Jan., 1933, Vol. 32, pp. 34–35; *Wireless Engineer*, Feb., 1933, Vol. 10, pp. 74–77; *World Power*, Feb., 1933, Vol. 19, pp. 75–79.)

PITTSBURGH'S CONTRIBUTIONS TO RADIO.—S. M. Kintner: Fessenden. (*Proc. Inst. Rad. Eng.*, Dec., 1932, Vol. 20, pp. 1849–1862.)

NOTES ON WIRELESS HISTORY.—J. E. Taylor. (*P.O. Elec. Eng. Journ.*, Jan., 1933, Vol. 25, Part 4, pp. 295–299.)

ELECTRODELESS DISCHARGE AND SOURCES OF MONOCHROMATIC LIGHT.—F. Esclangon. (*Review Scient. Instr.*, Jan., 1933, Vol. 4, No. 1, p. 38.)

Summary of a paper on the work previously dealt with in a *Comptes Rendus* Note (1932 Abstracts, p. 422).

THE PERMANENT ELECTRET.—M. Eguchi. (Summary in *E.T.Z.*, 2nd Feb., 1933, Vol. 54, No. 5, p. 112.)

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.

RECTIFYING VALVES

Convention date (U.S.A.), 17th September, 1930.
No. 379736

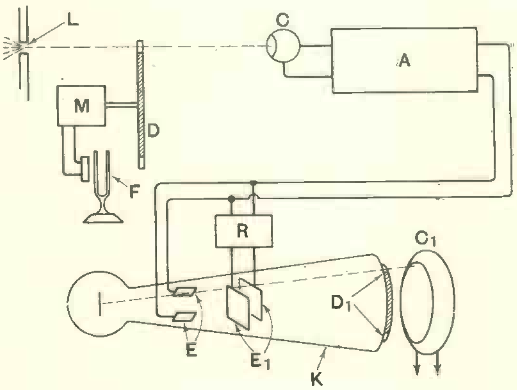
In order to prevent "arcing" between the anodes of a double-wave rectifier, the cathode is made in the form of a strip or ribbon and is mounted spirally between two supports, so as to form a shield between the two anodes. The cathode is partly surrounded by a reflector element, which confines the heat and helps to maintain a uniform operating temperature.

Patent issued to Standard Telephones and Cables, Ltd.

HIGH-FREQUENCY GENERATORS

Convention date (France), 9th March, 1931.
No. 381087

An electrically-driven tuning fork *F*, thermostatically controlled for constant frequency, is used to generate an alternating current which is fed through an amplifier (not shown) to a synchronous motor *M*. This drives a toothed disc *D* which intercepts the light from a lamp *L* falling on a photo-electric cell *C*. The output from the cell passes through an amplifier *A*, which may include frequency-doubling stages, to the control electrodes *E*, E_1 of a cathode ray tube *K*. A phase-shifting reactance *R* is interposed in the connection to one pair of electrodes E_1, so that the cathode ray is swept in a circular path over the periphery of a toothed disc D_1 located at the far end of the tube. The interrupted ray falls on to



No. 381087

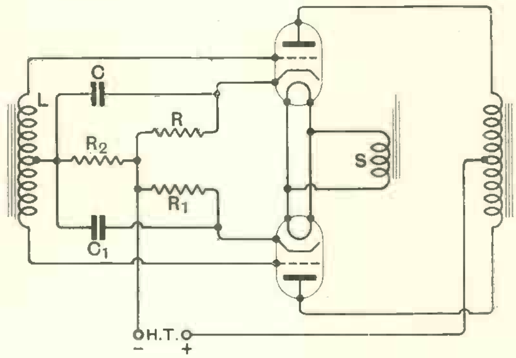
a photo-electric cell C_1, and the resulting current pulsations are fed to current amplifiers and used to energise a transmitting aerial. The equipment is capable of generating a frequency of 21,000 kilocycles.

Patent issued to Cie Générale de Telegraphie sans Fil.

PUSH-PULL CIRCUITS

Convention date (U.S.A.), 9th July, 1930.
No. 381233

A push-pull circuit, used either for high-power amplification or as an oscillation generator, is characterised by the provision of individual grid-biasing resistances *R*, R_1 inserted in the plate-filament circuit between H.T. negative and a



No. 381233

centre-tapping on the input coil *L*. A high resistance R_2, common to each grid, is shunted by condensers *C*, C_1, and forms a filter circuit to eliminate any "hum" components present in the space current. Both valves are energised from the same heating-secondary *S*, as shown, though with directly-heated A.C. valves a separate centre-tapped secondary is provided for each valve. The arrangement permits valves having slightly different characteristics to be accurately "matched," and also prevents one valve from damage by excessive plate current should the other valve become inactive for any reason.

Patent issued to Electrical Research Products Inc.

AUTOMATIC TONE COMPENSATION

Convention date (U.S.A.), 29th April, 1930.
No. 378539

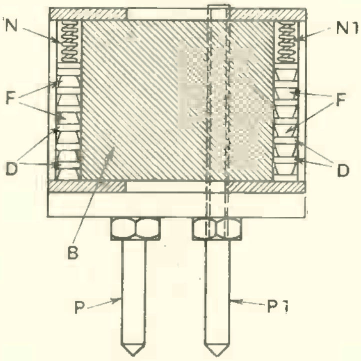
In order to preserve an "apparent" fidelity in reproducing speech or music, it is necessary to offset an inherent defect in the human ear by lowering the proportion of the lower notes to the higher, as the overall intensity of the volume of sound is increased. To secure this result the input to a multi-valve low-frequency amplifier is divided into two parts, one passing through the amplifier, and the other into a regulating or pilot circuit in which a variable voltage is produced to bias the control electrodes of the main amplifier. The adjustments are such that an increase in signal input results in a greater amplification of the high notes than the low in the final output.

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

DETECTORS OR RECTIFIERS

Application date 26th June, 1931. *No.* 381555

A cylindrical body *B* of ebonite or similar insulating material is formed with four peripheral slots (of which only two are shown) each containing a column of superposed copper-oxide rectifying-



No. 381555

discs *D* approximately one-twelfth of an inch in diameter and one-thirtieth of an inch thick. At the centre of each disc is a contact zone formed by coating the oxide surface with graphite by means of a hard pencil. Interposed between each disc is a soft-metal contact-member *F* formed as the frustum of a cone, the smaller end being coated with tin. The rectifying elements are kept in contact by means of springs *N*, N_1. Prongs *P*, P_1 allow the device to be plugged into a standard type of valve-holder.

Patent issued to A. V. Tomlinson.

AMPLIFIER CIRCUITS

Convention date (U.S.A.), 19th March, 1931. *No.* 380377

A four-electrode valve is operated with a high positive voltage on the grid adjacent to the anode so as to have a negative-resistance characteristic, and is used as a high-frequency amplifier with a tuned input and tuned output. The electrode potentials are adjusted so that the variation of the ratio of the external plate impedance to the internal plate-cathode resistance is automatically reduced as the output circuit is tuned down through the broadcast waveband, whereby the normal gain with frequency is reduced, and a straight-line frequency response is ensured. Alternatively the ratio of plate load impedance to plate-cathode resistance is made substantially independent of the frequency to which the output circuit is tuned.

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

AMPLIFYING CIRCUITS

Convention date (Germany), 24th February, 1931. *No.* 380694

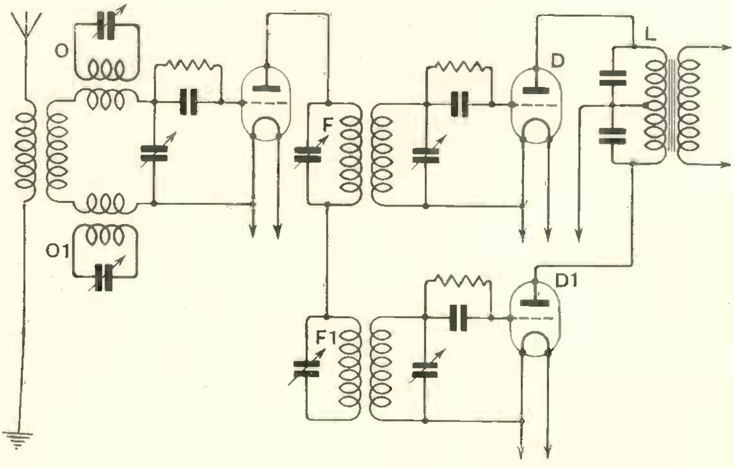
When a detector valve is followed by large low-frequency amplification, stray fields from the supply transformer induce L.F. voltages in the grid coil which are substantially amplified in succeeding stages and give rise to undesirable noise in the loud-speaker. To prevent this the grid coil is divided into two equal and oppositely-wound parts, arranged either in series or parallel, so that any extraneous voltage pick-up reaches the grid in phase-opposition and therefore produces no effect in the output.

Patent issued to Ideal Werke A-G fur drahtlose Telephonie.

ELIMINATING INTERFERENCE

Convention date (Austria), 19th December, 1930. No. 381784

Incoming signals are heterodyned by two local oscillators *O*, O_1, to produce two beat frequencies, one *F* of which is audible, the other F_1 supersonic. Both derived frequencies are passed to separate detector valves *D*, D_1, coupled in opposition to an output coil *L*. In the output from valve *D* there will be present the desired signals and the interference. In the output from valve D_1 only the interference will be audible, since the beat frequency is supersonic. Since the two are in opposition, the interference is cancelled out, leaving the signals alone to pass through; to the secondary of the output coil *L*.



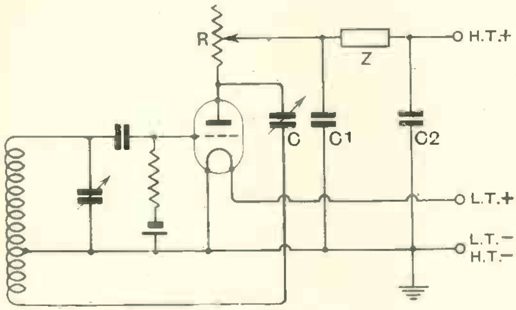
No. 381784

Patent issued to J. Fuchs.

DETECTOR-OSCILLATORS

Application date 21*st July*, 1931. *No.* 382286

Relates to means for ensuring sufficient feed-back, as well as efficient rectification, over a wide range of frequencies in a self-oscillating detector, as used, for instance, in a superheterodyne receiver. The output circuit of the valve comprises a variable



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resistance *R*, of the same order as the internal valve impedance, in series with an output or coupling impedance *Z* of much higher value. Reaction is provided through a variable condenser *C*, whilst by-passing condensers *C*1 and *C*2 are inserted on each side of the impedance *Z* coupling the detector valve to the intermediate frequency stages.

Patent issued to The Marconi International Marine Communication Co., Ltd., and S. E. A. Landale.

TELEVISION SYSTEMS

Application date, 14*th July*, 1931. *No.* 381254

In order to utilise more advantageously the limited frequency-band available for radio transmission, the initial scanning-frequencies are condensed into a smaller band by means of a series of frequency changers and associated filters before being transmitted. To recompose the picture in reception the incoming signals are applied to filters, the output in each case being either passed through frequency-changers or applied to circuits resonant to the original frequencies. The system is also stated to simplify the synchronisation and phase-control of the scanning means used at the transmitting and receiving ends.

Patent issued to J. C. Wilson *and* Baird Television, Ltd.

Application date, 27*th July*, 1931. *No.* 382326

Relates to a television system of the kind in which the received picture is built up on a closely grouped bank of lamps, each lamp corresponding to a definite picture element or signal. According to the invention, a secondary "light" frame—of—reference, is superposed on the main surface so that the brightness of any particular point on the picture is judged by contrast with the illumination of the frame of reference, and not by contrast with the previous picture-signal corresponding to that point. For instance, if the secondary group of lamps forming the "reference frame" is supplied with current modulated in a direction the reverse of that carrying the actual picture, the relative intensity of the picture as judged by the eye will be doubled.

Patent issued to Marconi's Wireless Telegraph Co., Ltd., *and* H. M. Dowsett.

SCANNING DISCS

Convention date (*Germany*), 10*th April*, 1931. *No.* 379646

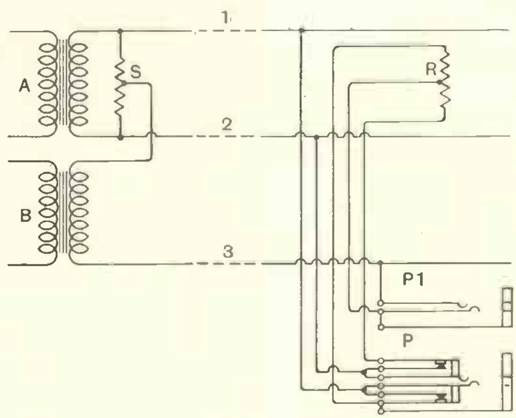
Scanning discs used in television are usually cut-away for some distance from the hub so that the outer parts are supported only by spokes of solid material. When running at high speed these spokes create friction with the air which tends to cause the disc as a whole to "flutter" transversely and to produce undesirable noise. According to the invention such transverse vibrations are prevented by mounting on each side of the scanning disc, and on the same driving shaft, an auxiliary disc of thin metal, stout paper, or cardboard extending radially as far as the "spoked" portion of the main disc. The effect is to produce a more or less quiescent air-space between the main and auxiliary discs, which ensures a steady and quiet rotation.

Patent issued to Fernseh A-G.

WIRED-WIRELESS SYSTEMS

Application date 22*nd February*, 1932. *No.* 381449

Each subscriber is given the choice of two programmes over a three-wire distributing network. The output from one receiver *A* is connected to the lines 1, 2, whilst that from a second receiver *B* is taken to a line 3 and to a mid-point tapping on a resistance *S* shunting the output from the first receiver, so that the programme in this case is carried by a "phantom" circuit comprising the line 3 and the lines 1, 2 in parallel. The circuits at the receiving end are shown at *R*, and the



No. 381449

alternative plug-points at *P* and *P*1, the arrangement being such that the phantom circuit is automatically opened when the loud-speaker is inserted across the lines 1, 2, so as to limit the load on these lines.

Patent issued to J. W. Field and J. E. Ball.

TRANSMITTING CIRCUITS

Convention date (Germany), 11th February, 1931.
No. 380682.

When renewing or replacing one valve generator by another in a transmitting installation, it is generally necessary to re-calibrate the circuits over the whole of the working wavelengths owing to the varying interelectrode capacities of different valves. According to the invention an auxiliary condenser is inserted in the tuned H.F. circuit, in shunt with the inherent valve capacity, so as to supplement the latter. When an existing valve oscillator is changed for another, it is only necessary to readjust the supplementary condenser for one selected wavelength to ensure a complete recalibration of the circuit for all frequencies.

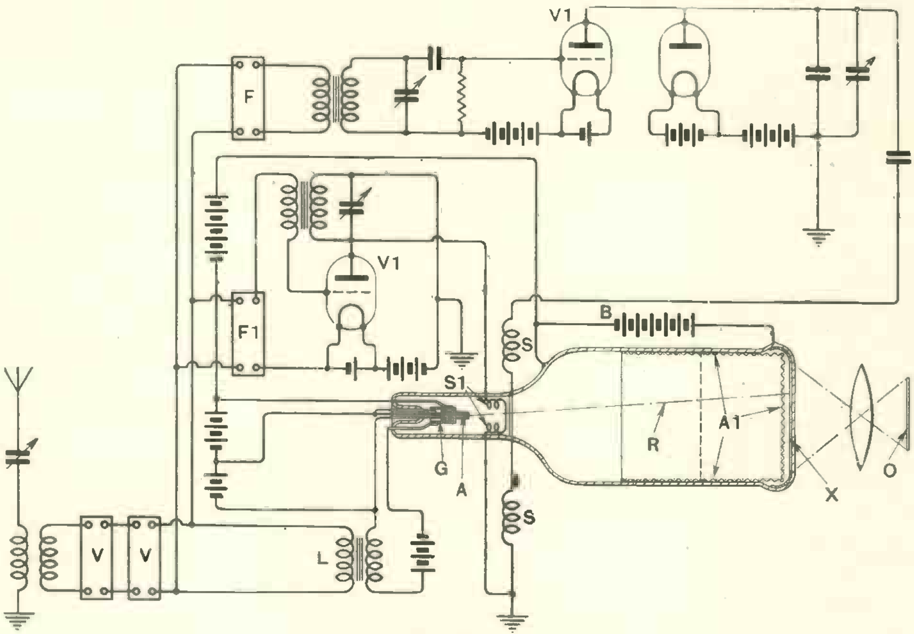
Patent issued to C. Lorenz A-G.

CATHODE-RAY TELEVISION

Convention date (U.S.A.), 25th September, 1930.
No. 381306

Relates to systems of the type in which the light-and-shade effects of the original picture are reproduced by the varying velocity of impact of an electron stream upon a fluorescent screen. The invention is directed to the provision of means for ensuring that the deflection necessary to traverse the ray over the viewing-screen is effected whilst the stream is moving at a relatively-low speed, the stream being subsequently accelerated to secure a bright image. The scanning ray *R* is produced from a cathode gun comprising a heater, cathode, grid *G* and anode *A*. The incoming signal elements are applied to the grid from a coil *L* after passing through amplifiers *V*. Synchronising frequencies are tapped off through filters *F*, *F1* and are applied through amplifiers *V1* to a pair of deflecting coils *S*, *S1* which cause the ray to traverse the fluorescent screen *X* at the speed necessary to produce persistence of vision. The picture may finally be projected through a lens on to an observation screen *O*. The ray is accelerated towards the end of its travel by a second anode *A1* formed as a cup-shaped meshwork housed in the end of the cathode tube, as shown, and carrying a high positive voltage from a source *B*. The anode *A1* makes contact with a silver lining deposited on the inner walls of the tube.

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



No. 381306

SCREEN-GRID AMPLIFIERS

Application date, 17th April, 1931. No. 380827

In order to increase the permissible voltage swing applied to the last stage of S.G. amplification, without passing over the "knee" of the characteristic curve and so giving rise to cross-modulation, the internal electrodes of the valve are modified by widening the pitch of the control grid and enlarging the mesh of the screening grid, so as to reduce the internal impedance to a fraction of the normal value. The valve is then operated with screen and plate potentials set below the potential difference at which secondary emission from the plate occurs.

Patent issued to The Gramophone Co., Ltd., and C. S. Bull.

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