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AND

EXPERIMENTAL WIRELESS

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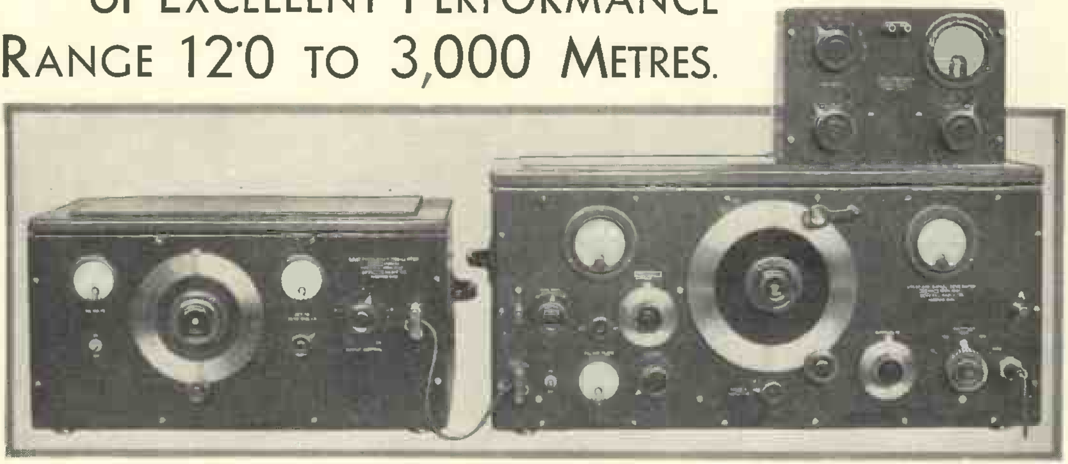

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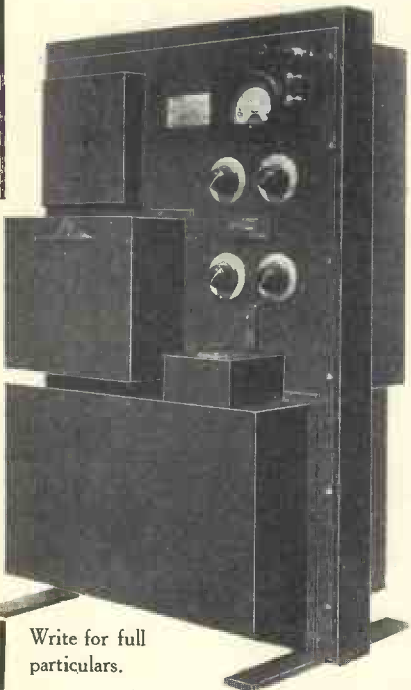

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and EXPERIMENTAL WIRELESS

A Journal of Radio Research & Progress

Editor
HUGH S. POCOCK

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

VOL. X. No. 120

SEPTEMBER 1933

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THE

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VOL. X. SEPTEMBER, 1933. No. 120

Editorial

Iron-Powder Cores

IN April we published an article entitled "Iron-content cores for high-frequency coils," by Herr Alfred Schneider, who is presumably associated with Hans Vogt in the development of the so-called Ferrocart material. In this article Herr Schneider not only gave a very interesting description of the manufacture of the material, but stated that Vogt had been led to the special construction by a "fundamental new discovery." In ordinary iron-powder cores the particles cannot be absolutely insulated from each other, although the contact resistance is rather high, thus making the material a sort of semi-conductor. The paper and grooves in Ferrocart have, stated Herr Schneider, still another function than forming an interruption for galvanic eddy currents, viz., to form a high "capacitive resistance" between the various groups of particles and thus reduce the "capacitive eddy currents." This was not very clear, but in our June issue we published a letter from Herr Nissen pointing out that if by these capacitive eddy currents it was intended to suggest that appreciable losses occurred in the dielectric matrix in which the iron particles are embedded, such a contention was baseless. In the June issue we showed by a simple calculation that any such dielectric eddy-current losses are negligibly small.

In this issue will be found a letter from Herr Schneider in which he points out that by capacitive eddy-currents he means something different, and that the losses to which he refers do not take place in the dielectric, but at high-resistance contact points between particles, due to imperfect insulation. If a ring of particles are in contact except at certain points in the ring, current will still flow in the ring as a conduction current where there is galvanic contact and as a capacity current where there is a break. With his letter will be found a sketch showing his conception of the arrangement of particles in which capacitive eddy-currents flow. This would be all very well if there were only a single ring of particles, but if, as he says, "we imagine that only at a few points purely capacitive conductance is present, while the preponderating part of the eddy-current path is formed by galvanic conductance," this will apply to the whole mass of particles and the whole mass of material may be regarded as having a galvanic conductance. There would be no need for the current to pass as a capacity current, for there would be numerous conducting by-paths, and it appears very unlikely that the capacity effect would be of any account. Whatever the nature of the eddy currents, in so far as they flow in the bulk of the material and not in the isolated particles themselves, Vogt's paper and grooving will be effective in reducing them. Unlike Herr Nissen, we are not questioning the constructive part of Herr Schneider's article or the efficacy of Vogt's process, but we want some more reasonable and convincing explanation of the "fundamental new discovery" than Herr Schneider appears able to give. He says that "whenever the results of practical experiment do not agree with the theoretical calculations, it is more probable that the calculations are based on wrong or imperfect assumptions." This is quite beside the point; he gives no results of experiments; it is not a case of calculation *versus* experimental result, but of calculation *versus* assertion unsupported by any evidence.

Dielectric Losses

It is quite possible that the contact between the supposedly insulated iron particles behaves in a manner different from an ordinary resistance, and that the effective bulk resistance depends on the frequency and the voltage, but this is a matter for research and not for guessing.

There is another source of loss which must not be overlooked in interpreting the results of tests made on coils with iron-powder cores, and that is the dielectric loss which will occur in the material of the core as it does in any former on which a coil is wound. The electric field between the parts of the coil at different potentials will pass to some extent through the core material, and on account of the embedded conducting particles the effective dielectric constant and the potential gradient will be increased. The actual loss will depend on the coil design and on the quality of the insulating material in which the iron particles are embedded. If Herr Schneider's picture of the material with its myriads of conducting bridges is correct, we may neglect the dielectric material and regard the core as a high-resistance conductor; but if the particles are for the most part insulated from each other, and if we assume as a rough approximation that they are little cubes arranged symmetrically, we can calculate the effective dielectric constant and the effect of the particles on the dielectric loss. With a volume space-factor of 0.5, the apparent dielectric constant will be about 3.5 times that of the insulating material employed. About a third of the insulating material will be subjected to a potential gradient about five times the apparent potential gradient, and the losses per cubic cm. in it will therefore be increased about twenty-five times; the total dielectric loss will be increased to about 3.6 times what it would have been with a solid dielectric. Assuming then a space factor of about 0.5, both the dielectric constant and the dielectric losses will be increased in the same ratio, viz., about 3.5 by the presence of the perfectly insulated conducting particles in the dielectric.

It should be a relatively simple matter to test the material of any core to see to what extent its particles are insulated from each other and to what extent they are in contact. In a material like Ferrocart the properties will be different in different directions, and it does not follow that because the stratification is in the correct direction to reduce the eddy currents, it is also in the best direction to reduce the ordinary dielectric losses. We make these suggestions because Herr Schneider's letter appears to infer that experiments have given results which cannot be explained without calling in Vogt's "fundamental new discovery."

In order to reduce the losses in such coils to a minimum, it appears desirable to keep the stray electric fields as small as possible by suitably spacing those parts of the winding between which there is a large potential difference.

G. W. O. H.

Beat Frequency Oscillator*

A Mains-operated Instrument Primarily Designed for Testing Talking Picture-recording Apparatus and Commercial Amplifier Equipment

By Marcus F. Cooper and Leonard G. Page

(Publicity Films, Limited)

IN reviewing the various test signal sources now available, the mains-operated beat frequency oscillator holds out a number of attractive features which include :—

(1) High degree of signal purity.
(2) Substantially constant output voltage over frequency range.
(3) Continuous variation of frequency from fifty to ten thousand cycles per second or more.
(4) Reasonable accuracy of frequency with dial setting.
(5) Portability and small maintenance.

Against these advantages has been high cost of instrument, and, up till quite recently, impossibility of obtaining a mains operated model.

It is the purpose of this article to put into the hands of workers in the field of Low Frequency Amplification, information that will enable them to construct for themselves this type of test signal source, and owing to the fact that it is usual to construct an instrument of this sort to meet individual and specialised requirements, the broader principles will be discussed rather than minute details.

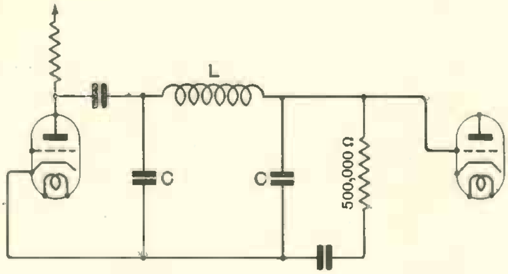


Fig. 1.—*If a filter circuit such as the above were used, it would be necessary for L to have a value of 8 henrys.*

(A) Design Principles

Literature on the subject is sparse, and as far as the authors can trace, the most informative article on the subject was one by Kirke[2], which appeared in *The Wireless Engineer* (then *Experimental Wireless*) dated February, 1927. The instrument described in this article embodies much of Kirke's work, although of course it has a number of modifications.

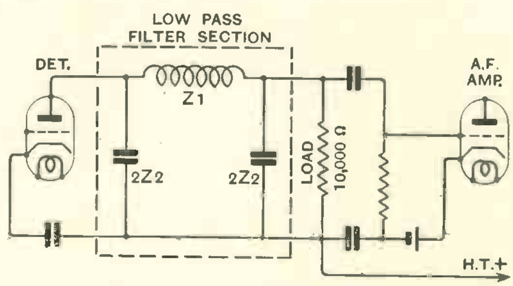


Fig. 2.—*Filter circuit used, redrawn for ease of conception. Z1 = 0.2 henrys ; Z2 = 0.002 mfd. ; fc = 16,000 cycles per second (cut off frequency).*

As is well known, the beat frequency oscillator consists of two separate oscillatory circuits working at radio frequency, one fixed, and one capable of being varied by means of a tuning condenser. These two circuits are separately coupled to a detector where they heterodyne each other, and an audio frequency note of a frequency equal to the difference of those of the two radio frequency oscillators is produced. The detector usually feeds a single stage amplifier of controllable gain.

Steps have to be taken to minimise coupling between the two radio frequency oscillators, otherwise when their respective frequencies approach each other "pulling" will ensue. Shielding has therefore to be particularly thorough and decoupling resistances and condensers used where possible. The coupling of the two oscillators to a common detector is also a problem. In this case it was overcome by making the coupling coil $L3$ consist of only a single turn of wire,

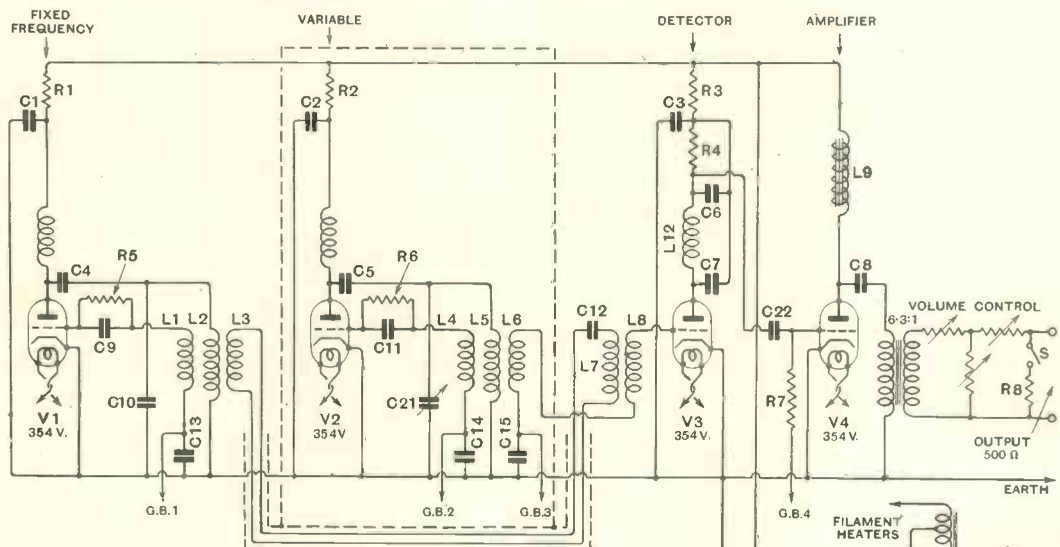
* MS. received by the Editor, October, 1932.

and separately feeding it to the detector coil *L*8.

In the oscillator developed by Dr. L. E. Ryall at the Post Office Research Laboratories (shown at the recent Physical Society's Exhibition), the two oscillators are coupled in the manner shown in Fig. 4, which commends itself on account of its simplicity, and (provided the detector draws no grid current) its effectiveness. In the Marconi Oscillator[5] each radio frequency oscillator feeds its own "trap" valve in order to avoid this possibility of "pulling" and by comparison this appears rather clumsy.

It is important in an instrument of this nature that the harmonic content of the output signal shall not exceed about 2 per cent., and preferably should be less than this. In order to avoid harmonics as much as advantage of the fact that low frequency harmonics due to the carriers can only occur if there are harmonics in *both* of them.

On the subject of constancy of output voltage, it may be stated that with careful design this may be made sufficiently good for commercial amplifier characteristics to be taken without the necessity for a measuring device across the input. Where great accuracy is required, a corrective network is best employed, because it is the experience of the writers in talking picture work that the more instruments required to take an ordinary gain-frequency curve of an amplifier, the less often is this measurement likely to be made. With an oscillator of reliably constant output over its frequency range, a curve can be taken with minimum time and trouble.



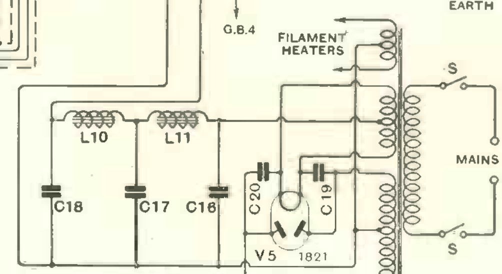


Fig. 3.—*Values of Components.*

Resistances : *R*1, *R*2, 25,000 *ohms* ; *R*3, 50,000 *ohms* ; *R*4, 10,000 *ohms* ; *R*5, *R*6, 100,000 *ohms* ; *R*7, 500,000 *ohms* ; *R*8, 500 *ohms.*

Condensers : *C*1, *C*2, *C*3, 2 *mfds.* ; *C*4, *C*5, 0.01 *mfd.* ; *C*6, *C*7, 0.001 *mfd.* ; *C*8, *C*13, *C*14, *C*15, 2 *mfds.* ; *C*9, *C*11, 0.001 *mfd.* ; *C*10, *C*12, 0.005 *mfd.* ; *C*21, 0.005 (*fixed*) + 0.0015 (*variable*) + 0.00005 (*variable*) *mfd.* ; *C*16, *C*17, *C*18, 4 *mfds.* ; *C*19, *C*20, 0.01 *mfd.* ; *C*22, 0.25 *mfd.*

Inductances : *L*1, *L*4, 170 μH ; *L*2, *L*5, 680 μH ; *L*7, 330 μH ; *L*6, 30 μH ; *L*8, 14 μH ; *L*3 (*one turn only*) ; *L*9, *L*10, *L*11, *B*1 *chokes* ; *L*12, 0.2 *H.*

possible in the rectified output, a tuned filter circuit is used to couple the *fixed* oscillator to the detector, and so take

When two signals, a weaker and a stronger, heterodyne one another, the rectified output is proportional to the weaker signal. The first step towards constancy of output is therefore to make the fixed frequency oscillator have a smaller output than the variable one, and we effect this by very loosely coupling the tuned filter circuit referred to above.

Precautions have to be taken to avoid high note loss and the introduction of harmonics in the detector stage. In practice, no difference could be detected between a 354V valve and one with a lower amplification factor such as the 164V from the standpoint of high note loss. The 354V was therefore retained for this stage.

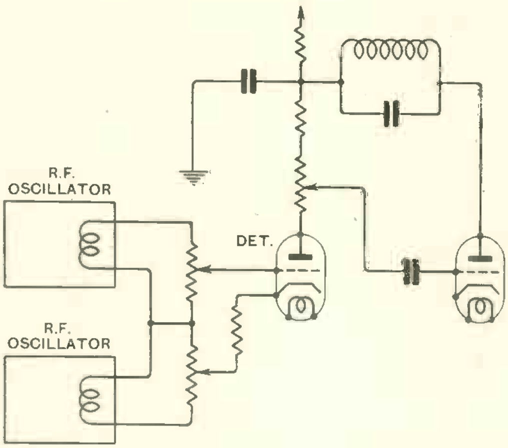


Fig. 4.—*Method of coupling the two radio frequency oscillators to their detector used in L. E. Ryall's oscillator.*

Before construction was commenced, the question of calibration stability was given due consideration. It was appreciated that slight drifting on the part of one of the radio frequency oscillators would of course upset the accuracy of the audio frequency calibration. For example, should the frequency of the fixed oscillator vary from 150,000 cycles to 150,020, this would cause the audio frequency to vary by 20 cycles. This would be of little consequence in the region of 10,000 cycles, but intolerable at say fifty cycles. With a view to minimising this error, some American instruments use a piezo crystal in their fixed radio-frequency oscillator, and this system has much to recommend it. The idea was not incorporated in our own instrument mainly because we had not access to high frequency measuring instruments and standards, and also because it was felt that most of the factors which would cause a drift in one of the oscillators would tend to cause an equal drift in the other in the same direction, and that "chaining" down one circuit would tend to make matters worse unless very frequent zero adjustments were made. In addition, the piezo oscillatory circuit is very rich in harmonics, and a more efficient tuned filter circuit would probably be required. Our own instrument has not given us any trouble due to frequency drift, and we attribute this largely to the rigid construction, and to the use of grid condensers and leaks in both the radio frequency oscillators.

Anode bend detection was used because for a constant and adequate input voltage there is very little to choose between this method of detection and leaky grid, and the former is more simply adapted to the circuit in question.

It is very desirable that no radio frequency component should be passed on from the detector stage to the grid of the low frequency amplifier. On the score of efficiency the idea of a properly terminated low-pass filter seemed preferable to the ordinary high frequency choke. Such a filter in its ideal state would eliminate all frequencies over say 20,000 cycles per second. A circuit as shown in Fig. 1 immediately presented itself, using the grid leak as load resistance.

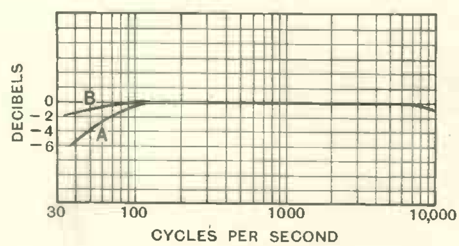


Fig. 6.—*Output curves; A—line output, B—plate output.*

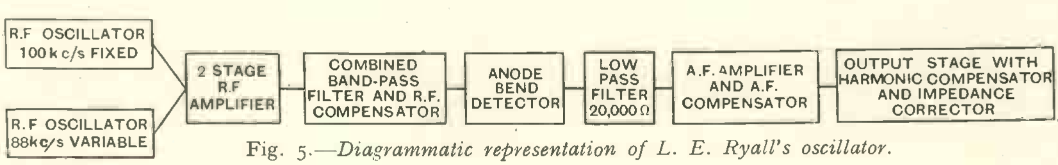


Fig. 5.—*Diagrammatic representation of L. E. Ryall's oscillator.*

Fig. 7.—*Front view of the oscillator.*

We finally adopted a method used in certain American instruments whereby the anode resistance of the detector becomes at the same time the loading of the filter, and in Fig. 2 this portion of the circuit is redrawn for ease of conception.

Before passing to constructional data, some details of the new Post Office instrument previously referred to will be of interest. Dynatron radio frequency oscillators are used, and the coils themselves are Sullivan-Griffith thermal compensated inductances. The fixed oscillator is tuned to 100 kilocycles, and the variable one to a minimum of 88 kc/s. They are coupled to a two-stage radio frequency amplifier. Between this latter and the detector is a combined band-pass filter and high frequency compensator. After the detector is a low-pass filter designed to cut off at 20,000 cycles, followed by an audio frequency

When however, we came to work out the values of the components, it was found that L would have to be of the order of 8 henrys, and the capacity of a choke of this value would be such as to render it valueless at the frequencies for which it was required.

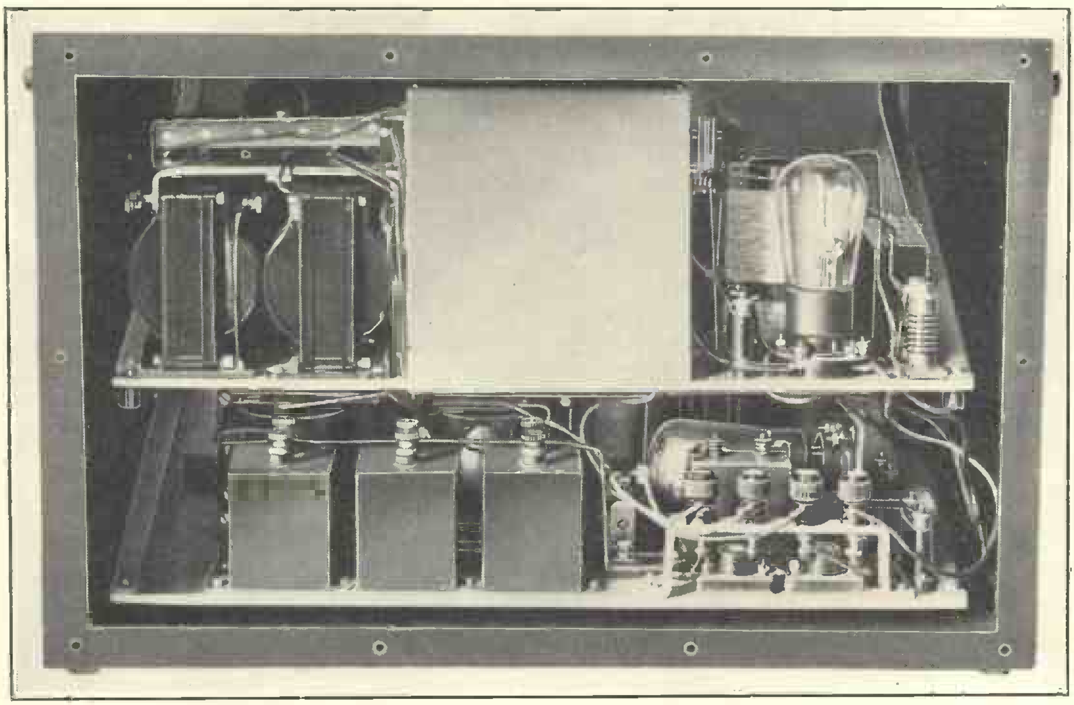


Fig. 8.—*Back view of the oscillator with cover removed.*

amplifier and response compensator. The output stage incorporates a novel harmonic compensator which reduces by ten decibels the harmonics produced due to curvature of valve characteristics. There are two scales 0—50 and 50—12,000 and as the beat frequency is a linear function of the capacity increment in one of the oscillator circuits, these are both able to be constructed for uniform accuracy. The oscillator which is mains operated is diagrammatically represented in Fig. 5.

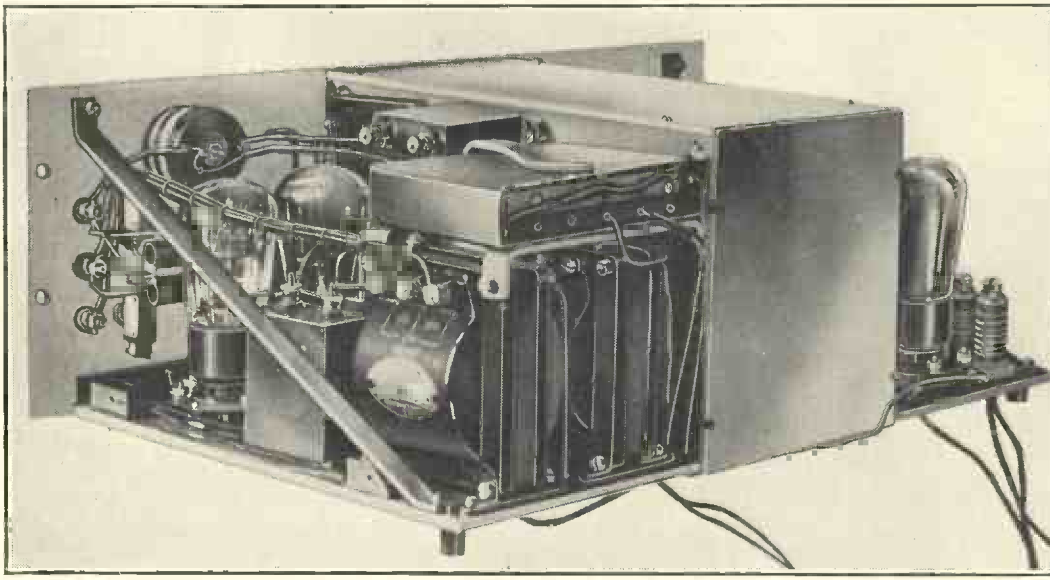


Fig. 9.—*The oscillator illustrating the detector and audio-frequency stage.*

(B) Constructional Details

As the amplifiers with which we have to deal are designed to work into and from 500-ohm lines or loads, it was desirable that the oscillator output should be capable of direct connection. The best loading for the 354 V. output valve is about 20,000 ohms and a transformer capable of giving a step down of $\sqrt{\frac{20{,}000}{500}}$ or 6.3 to 1 is therefore required. Actually the 7 : 1 winding of a Ferranti OPM 5 output transformer was used. A refinement consisted in the fitting of a dummy 500-ohm non-reactive load capable of being brought into use by means of a switch when the oscillator is being checked on a valve voltmeter. This load is also switched in when the oscillator is directly connected to the input of a bridging amplifier. The output transformer is choke capacity coupled from the last stage by means of a 50-henry choke.

The volume control is a triple gang potentiometer manufactured by the H. H. Eby Manufacturing Co., Inc., of Philadelphia, P.A., which when correctly terminated maintains the load on the transformer output terminals at a constant value of 500 ohms at whatever its setting. It is for all practical purposes non-reactive, and has no measurable effect on the frequency response. It is also capable of being calibrated in decibels.

The eliminator, although in the same case, is built as a separate unit, and is of conventional design. The only point of interest is that the smoothing circuit is rather more thorough than that used on most radio receivers. The high tension voltage was considerably higher than necessary, and was reduced by separate series resistances in each stage which acted as decouplers. A Philips 1821 was used as rectifier. Automatic bias was not incorporated, and would be an undoubted improvement. Normally it would be bad practice to decouple a detector with an impedance of the same order of value as that of the detector itself owing to the fluctuation in the value of the anode current. In this case, however, there is no appreciable fluctuation, since both the radio frequency oscillating circuits are unmodulated.

Actually the eliminator was very satisfactory, and the percentage of ripple in the output very small indeed. As a matter of interest the hum was examined in order to find out which was really the most persistent component. Accordingly, the oscillator was set to zero cycles at full gain, and its hum output raised in level some 100 decibels and fed to the oscillograph of our recording camera. An enlarged photograph of the record is shown in Fig. 14. The sprocket holes which are $\frac{3}{16}$in. or 0.0104 seconds apart provide a time scale.

It is clear from the oscillograph record that the eliminator unit is not giving the theoretical 100 per cent. rectification, as the original form of the 50-cycle mains wave can still be discerned. The record also demonstrates the formation of the 100-cycle note which some of us hear in the loud speakers of our radio sets. The most likely reason for this lack of perfect rectification is that the centre tap on the transformer is not at the exact electrical centre of the winding. The condition would also be caused by the rectifying valve having different impedances to each plate, but the former reason is the more probable. Of interest also is the high frequency component which when measured is found to have a value of about 3,300 to 3,400 cycles per second. This is the sound record of what is termed "valve hiss," a phenomenon that one is always up against when working at high gains.

Reverting to practical details, the tuning and filter coils [12] were wound on 3in. diameter ribbed formers with 9/40 Litz wire, each strand single silk covered, and the whole double silk covered. Those contemplating building an instrument for research work would be well advised to consider using Griffith's thermal compensated type of inductance[11] for use in the radio frequency oscillators.

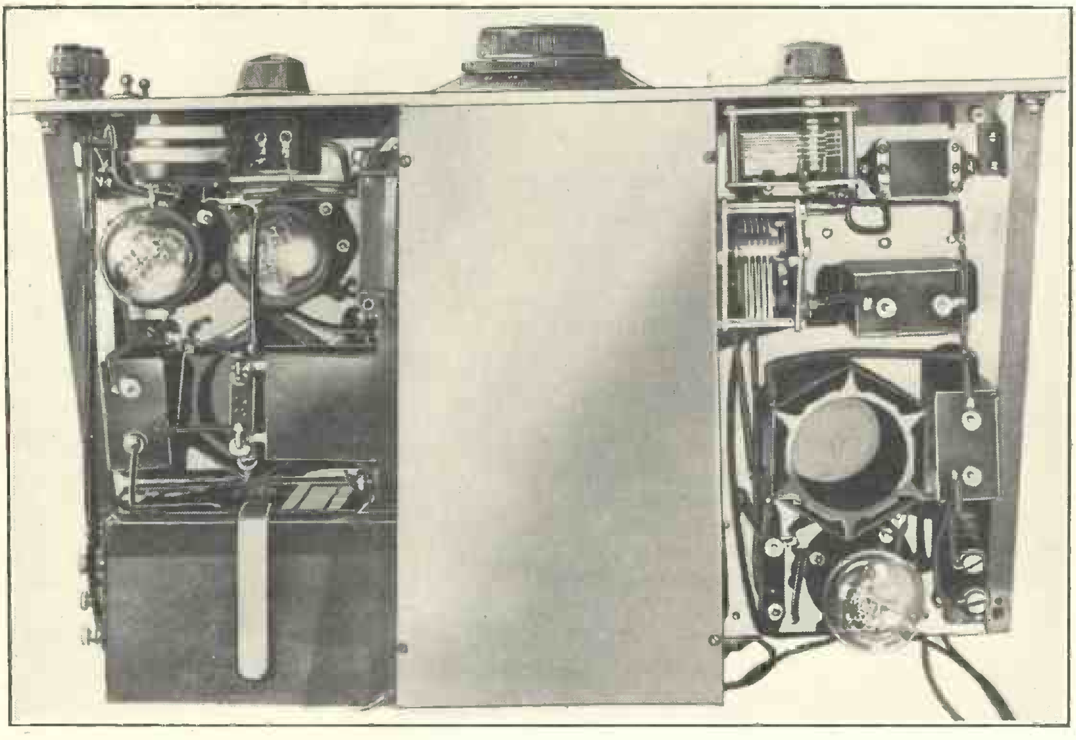


Fig. 10.—*Top view of the oscillator unit.*

The front panel, base plates, and shielding were carried out entirely in $\frac{3}{16}$in. aluminium sheet for the purpose of rigidity, and the final mounting was in a welded aluminium cabinet. All mains wiring was kept below the base plate, and only one pair of "non-mains" wires for coupling the fixed oscillator to the detector (for which a special shielded channel was built) was allowed to go underneath.

Mullard 354V valves were used as in addition to being suitable we had already adopted these as standard in one or two other pieces of apparatus.

When the oscillator was completed, it was given a preliminary test out on batteries before connection to its eliminator unit. With the aid of milliammeters in the various anode circuits, radio-frequency oscillations in the fixed and variable oscillators were checked, and a rough idea of its performance obtained. A rather bigger frequency difference than was desirable between the two radio-frequency oscillators was at first experienced, and this was eliminated with the help of some low value fixed condensers bridged across the existing 0.0025 fixed condenser *C*10.

The fixed condenser *C*12 was next examined to see whether it tuned the filter circuit to the fundamental of the fixed frequency oscillator. In this case we were more fortunate and did not succeed in improving its value. The detector was carefully adjusted for best working conditions, and finally the low frequency amplifying valve was checked to see that the radio-frequency component which filtered through to its grid was of a small order, and that the valve was working well within the straight portion of its characteristic. When this work had been carried out, decoupling resistances throughout were revalued so that when the eliminator was connected, the conditions would not be materially altered. This may seem cruder than making exact calculations and design beforehand, but it has certain advantages, particularly as this was the first mains instrument which we had built and we were rather in the dark as to how far we might have to carry out decoupling to prevent pulling between the two radio oscillators, and smoothing to reduce ripple in the output.

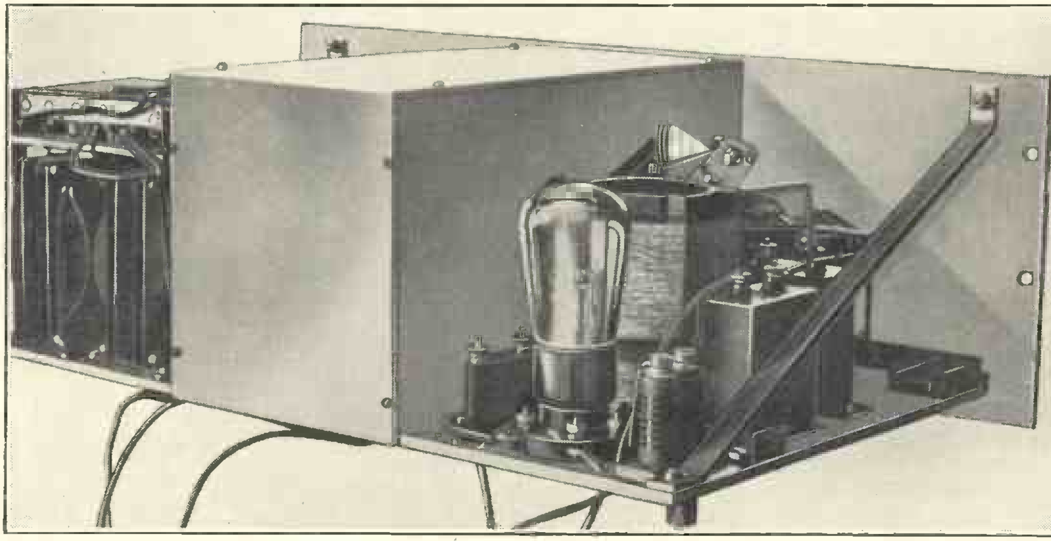


Fig. 11.—*The fixed radio-frequency oscillator.*

It was found possible to adjust the two radio oscillators so that the low frequency output was of the order of two a second. Oscillograph records made, however, showed that the wave form at this frequency was far from sinusoidal, and that the less said about frequencies below about fifty cycles the better.

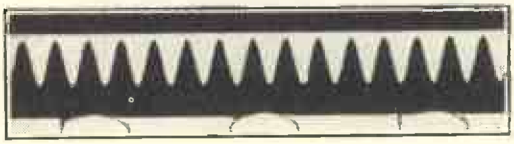
(C) Calibration

We were fortunate in having at our disposal one of the latest R.C.A. Photophone

Recording Cameras, which greatly simplified calibration in our case. The main condenser was set to even readings and records made of the resulting outputs. The distance between the wave peaks was then measured

(*Above*) Fig. 12.—*Wave form of 50-cycle note.*

(*Below*) Fig. 13.—*Wave form of 500 cycles.*



with the help of a measuring microscope taking average values for the higher frequencies over several complete oscillations.

Error due to mains supply fluctuations affecting the supply of the synchronous recorder camera motor would not exceed two per cent. As in most cases the distance apart of the peaks was derived from a section of anything up to twelve complete oscillations, the error of measurement also should not greatly exceed two per cent. The points were plotted on a curve, and dial settings for even frequencies obtained. A random setting of the oscillator at the value for 5,000 cycles obtained in this way was made some weeks after calibration, the output recorded as before, and remeasured, and a result of 4,950 obtained. Other frequencies checked in this way showed a proportional error.

(D) Performance

The output curves of the oscillator are given in Fig. 6. At 500 cycles per second, the line output when measured across a 500 ohm non-reactive load was just about 2 volts (r.m.s.) with the gain control at its maximum setting.

The falling off in response below 100 cycles is mainly due to the shunted inductances of the choke and primary winding of the output transformer in Curve *A* being on the small side, and in Curve *B* to that of the output choke. For talking picture purposes, curves are seldom plotted much below 100 cycles, and many mixing panels and amplifiers are fitted with high pass filters suppressing frequencies below this value. In any case, this loss being known, it is a simple matter to apply a correction when curves are required in the extreme bass.

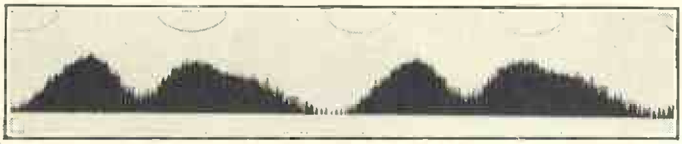


Fig. 14.—*Wave form of rectified mains hum.*

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A Method of Measuring the Self-capacitance of Coils*

By M. G. Scroggie, B.Sc., A.M.I.E.E.

Abstract

THE limitations of existing methods of measuring the self-capacitance of coils are explained, and a new method described in which the only reading required is that of a difference in capacitance three times as great as that being measured. A difference-calibrated condenser of quite ordinary accuracy is therefore adequate.

The apparatus is simple and may be used for the simultaneous measurement of the inductance also. The coil is tuned in turn to the second harmonic and fundamental of an oscillator by means of two equal condensers in series and parallel respectively; the difference required to accomplish this exactly being taken up by adjustment of one of the condensers. A special device is described for minimising the error due to stray capacitances.

Existing Methods

Although Howe† simplified the problem by showing that the distributed capacitance of a coil could, for most practical purposes, be regarded as equivalent to a constant concentrated capacitance, proposed methods of measuring this quantity have entailed certain difficulties and objections.

The usual "intercept" method, which consists of plotting added capacitance against the square of the wavelength and producing the resulting straight line to meet the capacitance axis, is simple and straightforward, and has the merit of showing up gross errors in observation by the failure of the points to lie on a straight line; but in practice it requires standards of both capacitance and wavelength which are exceedingly accurate over a fairly wide range, in order to obtain a very moderate accuracy in the result. It is quite usual for the percentage error in the result to be about 100 times as great as that in the observations. It is practically impossible to know the absolute values of *small* added capacitance with great accuracy and therefore in order to obtain a reliable straight line large values (of the order of several hundred micromicrofarads) of added capacitance are desirable; the quantity being measured is then small in comparison, and accuracy is lost in this way.

The Meissner method,* in which the coil is immersed in a liquid, usually oil, of known permittivity, is very ingenious and overcomes the above difficulties, as only a *difference* in capacitance is to be observed; but unfortunately the method is inapplicable in substantially all cases owing to the presence of supporting and insulating materials other than air.

Griffiths† has described a modification of the intercept method in which the values of added capacitance required to tune the coil to a number of harmonics of an oscillator are observed. As it is possible, by well-known methods, to compare resonant frequencies to any degree of precision, the wavelength errors are eliminated. If C_s is the self-capacitance, n the order of the harmonic, and C_n the added capacitance at resonance

$$C_s = \frac{n^2C_n - (n+1)^2C_{n+1}}{2n+1}$$

With a single pair of observations the result is given by the difference between two much larger quantities and error is thus multiplied. Moreover, the absolute values of added capacitance are required, whereas it is a sound principle to depend on difference values only where small quantities are concerned.

But by including a sufficient number of harmonics, and dealing with the results in the usual way for obtaining the best mean value, very accurate determinations may be

* MS. received by the Editor, December, 1932.
† *Proc. Phys. Soc.*, Vol. 24, p. 251 (1912).

* *Jahrbuch der d. Tel.*, Vol. 3 (1909).
† *E.W. and W.E.*, Vol. 5, p. 452 (1928).

made. The work involved is more than most people care to tackle, however, and standards of capacitance reliable to one part in several thousands are not always available, so for these reasons the following method may be found useful.

Principle of New Method

In principle it is extremely simple. In Fig. 1 L is the coil of which the self-capacitance C_s is to be measured; C_2 is any fixed capacitance, which need not be known but is conveniently of the order of 100 $\mu\mu$F.; and C_1 is a variable somewhat greater than C_2, of which only a difference calibration is necessary. An uncalibrated oscillator is also required.

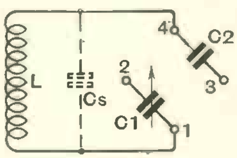


Fig. 1.

Terminals 3–1 are first joined, and the oscillator set to resonance. This link is then removed and placed across 2–4, and C_1 adjusted to resonate with the oscillator. C_1 and C_2 are then equal. Next 2–3 are joined, and the oscillator frequency shifted so that its second harmonic resonates. Lastly, 1–3 and 2–4 are both joined (2–3 being open). If there were no self-capacitance the circuit would now be in tune with the fundamental, the capacitance being four times as great as when adjusted to the harmonic. Actually an increase, δC, in C_1 is required to bring this about. C_s is equal to one-third of δC.

As C_s is usually of the order of only a few $\mu\mu$F. stray capacitances in the measuring apparatus would lead to large errors if not taken into account. One may consider six stray capacitances between the terminals and associated leads. Of these C_{1-2} and C_{3-4} are included in C_1 and C_2 respectively, and as it is a *difference* observation that is made they cause no complication. By screening the two condensers to terminals 1 and 4 respectively, C_{1-3} and C_{2-4} may be eliminated, and by placing 2 and 3 far enough apart for the stray between them to be very small, but not so far apart that the link 2–3 has appreciable capacitance to 1 or 4, the total effective stray can be reduced to that between 1 and 4, in parallel with C_s. Terminal 1 would normally be earthed.

Practical Procedure

In order to adjust the oscillator to resonance it is almost essential in practice to cause the test circuit also to oscillate, and this is best done by means of a dynatron valve. The anode-screen capacitance of the valve is then added to C_s and C_{1-4}. The same apparatus can be used to determine this initial capacitance in parallel with C_s, by connecting L, or any suitable coil, across 1–2, and noting the difference in C_1 required to restore the original frequency after the total capacitance has been increased by joining 2–4. For this test either another valve may be used for setting up oscillation in the test circuit, or the latter may be set to exact resonance by means of the well-known "N-curve" effect.* As the valve and other stray capacitance must be subtracted to get the result, it is obviously necessary in the interests of accuracy to reduce these quantities to a minimum.

If such measurements are required frequently, it is advisable to make up a permanent assembly comprising C_1 and C_2, the arrangement of terminals, rigid leads for connecting the coils sufficiently far away from the rest of the apparatus to avoid stray effects thereto, and a dynatron valve. A

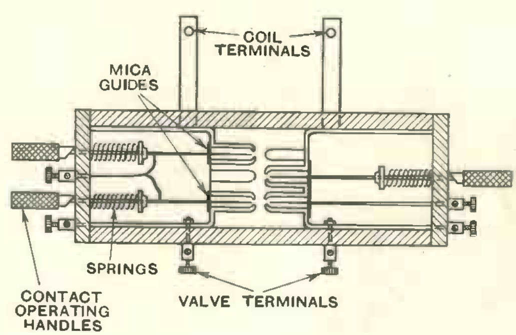


Fig. 2.

Mullard S4VB, although not a very lively oscillator, has a particularly low and stable effective capacitance, of the order of 5 $\mu\mu$F. The frequency shift introduced by the resistance of the valve, if adjusted to the threshold of oscillation in every case, is small and in any case largely cancels out.

* W. D. Oliphant, *Jour. Sci. Inst.*, Vol. 9, p. 121 (1932). For detailed information on the technique of adjusting to resonance, see F. M. Colebrook, *Jour. I.E.E.*, Vol. 69, p. 497 (1931).

Screened Connector Device

The arrangement used by the author for minimising the effects of stray capacitances is shown in Fig. 2, and consists of two pot-shaped screens held at a fixed distance apart by ebonite side cheeks. Each pot is provided with three projections consisting either of tubular or solid extensions of the screens.

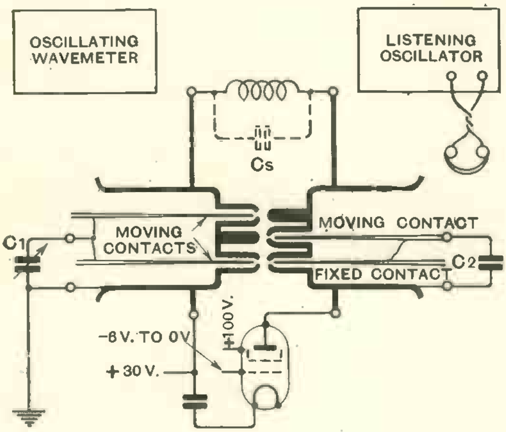


Fig. 3.

The tubular extensions resemble a wasp's sting, being provided with sharp-pointed rods which are held by strong springs so that they project through small holes in the ends of the tubes and make contact with one another or with the opposing solid extensions. The other ends of the rods are provided with handles which enable the rods to be retracted by twisting them through a half-turn. (This motion also serves to ensure a clean contact.) The capacitance of the points of these rods to the opposing screens and to one another is then extremely small, but by releasing them they can be used to make the contacts necessary for the test. The other features are shown in a diagrammatic view of the general layout, in Fig. 3.

The inductance of the leads is in general negligible except at frequencies of the order of 10 megahertz and upwards, but for extreme precision and at very high frequencies it would be possible to modify the arrangement slightly to permit the inductance of the leads to be readily calculable, or alternatively the leads could be shortened by enclosing the condensers in the screens.

The procedure for obtaining a high-precision difference calibration of C_1 is described in the article by Griffiths already referred to. Actually, owing to the method by which the value of C_s is derived, quite a rough calibration of C_1 is adequate for most purposes, and special care is necessary only in avoiding undesirable stray capacitances.

Inductance

Usually the inductance also of the coil is required to be found. If $\frac{\omega}{2\pi}$ is the fundamental frequency of the oscillator at the end of the test,

$$L = \frac{1}{2\omega^2\left(C_2 + \frac{2}{3}\delta C\right)}$$

If C_2 is not already known it can be found in terms of the difference calibration of C_1 by disconnecting it and observing the increase in C_1 necessary to compensate. Thus the inductance is known in terms of one frequency and the difference calibration of a condenser.

Although, in explaining the principle of measurement, the fundamental and second harmonic of the oscillator were mentioned, it is usually more convenient to use the second and fourth harmonics, in order to avoid an excessive disparity in the strengths of the two signals.

A Note on Demodulation Under Practical Conditions *

By M. V. Callendar, B.A.

(Research Department, Lissen, Ltd.)

THE *theory* of "demodulation" (or better, depression by a strong carrier of apparent modulation of a weak transmission) for an idealised linear rectifier is well known, and there is no reason to doubt the exact validity of the formulae which have been arrived at by Butterworth, Appleton and others[1] by different methods. There is, however, still considerable doubt as to how far the question is modified by the departure of any *practical* detector from the particular ideal type assumed in the original analyses.

To start with, the normal practical rectifier (whether grid, anode bend, or diode) has as an effective load a resistance R shunted by a condenser C; in this case it has been shown[2] that, if we take the logical limiting case where the rectified voltage is equal to the peak volts input (*i.e.*, R is very large compared with ρ_g the valve grid to filament resistance in the pass direction), there will be no demodulation for values of frequency difference ($\triangle f$) between the two stations greater than the highest modulation frequency to which the detector will respond in virtue of the time constant of the load (CR). However, in the *Proc. I.R.E.* paper referred to above, the author suggested that in practice the demodulation will never completely disappear owing to the always appreciable value of ρ_g/R: finally, Mr. Lewis in a recent letter[3] has taken this point farther. On the basis of his detector theory[4], which assumed a static rectifier characteristic showing an infinite (or constant high) resistance in one direction, and a constant low resistance ρ_g in the other, he works out some examples showing that there should be no appreciable reduction in demodulation effect even for large values of $\triangle f$ and C: he considers the condition of R/ρ_g large to be quite abnormal and even undesirable, in spite of the well-known practical advantages of increased sensitivity, and decreased damping.

However, even these two corrections to the original theory do not take us far enough to predict quantitatively the results under any practical conditions except possibly when working at large inputs with a diode. There is still the residual non-linearity of the best power detector to take into account: moreover, the practical grid or anode current curve does not correspond to Mr. Lewis's ideal static characteristic except for large inputs (say > 2 volts) nor can any exact value for the practical ρ_g be defined. We may, therefore, expect the degree of demodulation to vary in practice:

(i) With value of the product $CR \times \triangle f$ for a given valve and grid leak.

(ii) With ratio of R/ρ_g, even for constant $CR \triangle f$.

(iii) With input to the detector.

The only experimental results available appear to be one from Appleton (*loc. cit*) where the input is not stated, and a few in the author's *Proc. I.R.E.* paper (q.v.). It was therefore thought worth while to put the matter on an experimental basis by examining the variation in the demodulation factor with variation in the factors mentioned above over a range covering most values likely to be met with in practice.

The experimental circuit was as shown in Fig. 1: we can here notice only a few of the most important points:

(i) In order to avoid extra capacitive or resistive load on the detector grid, the input voltmeter was connected across the tuned circuit, and the volts drop in the grid condenser determined by a separate series of experiments.

(ii) It was necessary to use a two-stage filter when measuring the modulated output to make certain that the heterodyne note $\triangle f$ could not affect the output readings.

(iii) The 7 kc. frequency difference was adjusted by a 7 kc. tuned circuit which could

* MS. received by the Editor, March, 1933.

be switched in place of the 400 cy. filter, and the 25 kc. was set by a specially calibrated vernier on one of the standard signal generators.

cathode, which was approximately $18\mu\mu F$ in this case.

The results of experiments on a conventional power grid detector, having a

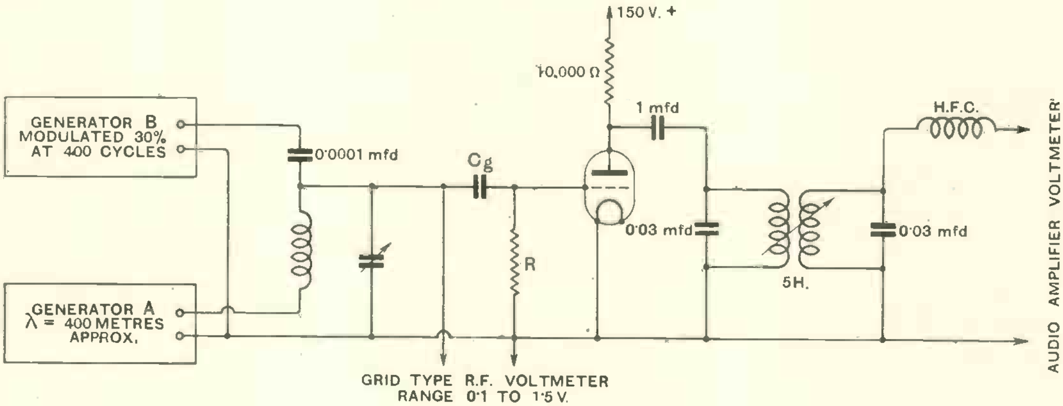


Fig. 1.

(iv) The effective value of C in the above discussion will not be exactly equal to the grid cond^r. Cg, but will also include the valve and stray capacity C' from grid to rectification characteristic as shown in Fig. 2, are given in Table I, which should be read in conjunction with the remarks above upon the three factors expected to determine the

TABLE I.

Demodulation Ratio for Power Grid Detector (Figs. 1 and 2).

Input A.	R.	Cg.	Δf.	$2\pi.\Delta f.R.C.$	Ratio B/A.	Demod. Ratio.	Remarks.
0.5 V.	0.5 MΩ	130 $\mu\mu$F.	7 kc.	3·3	1.0	0.60	Standard conditions for 7 kc. Shows variation with B/A (not unexpected).
0.5 ,,	0.5 ,,	130 ,,	7 ,,	3·3	0.5	0.38	
0.5 ,,	0.5 ,,	130 ,,	7 ,,	3·3	0.33	0.28	
0.5 ,,	0.5 ,,	130 ,,	7 ,,	3·3	0.25	0.22	
0.5 ,,	0.5 ,,	130 ,,	7 ,,	3·3	0.20	0.18	
0.5 ,,	0.5 ,,	130 ,,	7 ,,	3·3	0.166	0.16	
1.5 V.	0.5 MΩ	130 $\mu\mu$F.	7 kc.	3·3	0.33	0.10	Variation with input (effect of overloading).
0.25,,	0.5 ,,	130 ,,	7 ,,	3·3	0.33	0.42	
0.5 V.	2.0 MΩ	22 $\mu\mu$F.	7 kc.	3·4	0.33	0.44	Variation with R/ρ_o (as anticipated).
0.5 ,,	0.15 ,,	480 ,,	7 ,,	3·3	0.33	0.21	
0.5 V.	0.5 MΩ	130 $\mu\mu$F.	7 kc.	3·3	0.33	0.26	Results for const. $C\Delta f$. (unexpected).
0.5 ,,	0.5 ,,	22 ,,	25 ,,	3.6	0.33	0·33	
0.5 ,,	0.5 ,,	480 ,,	7 ,,	11.0	0.33	0.48	
0.5 ,,	0.5 ,,	130 ,,	25 ,,	11.8	0.33	0·73	
0.5 V.	0.5 MΩ	130 $\mu\mu$F.	25 kc.	11.8	1.0	0.80	Standard conditions for 25 kc. (Showing spurious demodulation due to overloading).
					0.25	0.70	
1.0 ,,	0.5 ,,	130 ,,	25 ,,	11.8	1.0	0.65	
					0.25	0.55	

demodulation ratio (ratio of audio volts from B with A on to that with A not on).

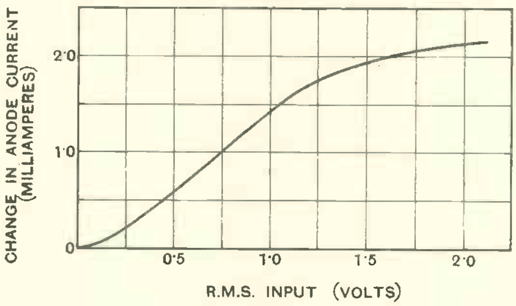


Fig. 2.

The Table is to be taken primarily as giving examples of practical demodulation ratios: secondarily, however, it is of interest to see whether the values obtained are actually incompatible with previous theory. Provided that it is realised that there are too many indeterminate factors here to expect quantitative results, we can say that there are only two unexpected features in the Table—

(*a*) It is seen that the demodulation for large inputs is even more drastic than that calculated by Butterworth. The reason for this is best seen from the last results given (for $\triangle f = 25$ kc), where the *true* demodulation effect (*e.g.*, for $B/A = \frac{1}{4}$) is very small while there is an *apparent* effect which is roughly constant for any ratio of B/A: it is evident that when the large input from A is put on, the detector gives the usual anode bend overloading, and the sensitivity for the B transmission is reduced.

(*b*) The demodulation ratio did not remain constant for different values of $\triangle f$ even when $C\triangle f$ was kept constant: this result, which was definitely reproducible, seems only explicable in terms of the Miller capacitive and resistive load on the detector grid: thus, considering the equivalent circuit for the component of frequency $\triangle f$, the exact value of C will include the reflected capacity C'' as well as the stray C', and this C'' will vary with the value of $\triangle f$: similarly, the correct value of R should take the reflected resistive load R'' into account. This effect should be more pronounced in most practical cases than in these experiments owing to the smaller by-pass normally used, and might well repay a detailed theoretical and practical investigation, which is outside the scope of this short note.

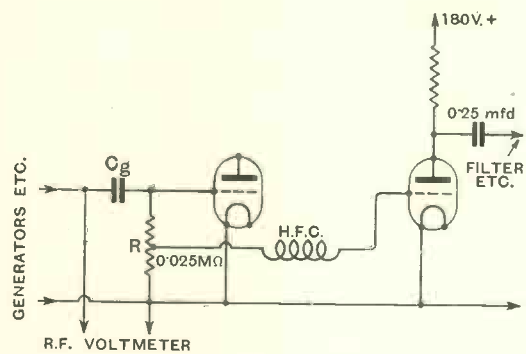


Fig. 3.

Some further experiments were therefore made, using the grid of the same valve as a diode, and tapping off only a small portion of the grid leak to avoid any possible load

TABLE II.

Demodulation Ratio for Diode Detector, at 1 volt R.M.S. Input from "A" (Fig. 3).

R.	Cg.	$\triangle f$.	$2\pi\triangle f.R.C.$	Demod. $B/A = 1$.	Ratio $B/A = 1/3$.	Remarks.
0.5 MΩ	130 μμF.	7 kc.	3.3	0.76	0.41	Results for const. $C\triangle f$ (discrepancies not present).
0.5 ,,	22 ,,	25 ,,	3.6	0.72	0.39	
0.5 ,,	480 ,,	7 ,,	11.0	0.83	0.73	
0.5 ,,	130 ,,	25 ,,	11.8	0.81	0.72	
0.1 MΩ	22 μμF.	25 kc.	0.63	—	0.14	Variation with R/ρ_g: also variation with $C\triangle f$.
0.1 ,,	130 ,,	25 ,,	2.3	0.74	0.26	
0.1 ,,	480 ,,	25 ,,	7.8	0.78	0.66	
2.0 ,,	130 ,,	25 ,,	47	0.95	0.92	
2.0 ,,	480 ,,	25 ,,	155	1.0	1.0	

(see Fig. 3): the results are given in Table II, where the previous discrepancies are absent, thus lending qualitative if not quantitative support to the explanations suggested above. Even here, however, the demodulation effect is less than anticipated from Mr. Lewis's letter: this must be attributed to the lack of strict linearity in the practical detector, as mentioned above (Para. 3).

Broadly speaking, then, we see that in practice the demodulation ratio may easily have any value between half the theoretical ($B/2A$ approx.) and unity. Let us take as the best representative case an input of 0.5V. to an *AC/HL* grid detector having $Cg = 0.0001\ \mu F$ and $Rg = 0.5\ M\Omega$: this detector will show a demodulation ratio of the order of B/A for an interfering station on an adjacent channel ($\triangle f = 9$ kc.) and will thus here give about the same audio ratio (B^2/A^2) of desired to undesired signals as would a parabolic detector: for larger values of $\triangle f$, however, the demodulation effect will progressively diminish until at some 30 kc. it will cease to contribute noticeably to the selectivity. With conditions unchanged except for the use of a lower value of Rg (approx. 0.2 Ω), or smaller Cg (approx. 20 $\mu\mu F$), the selectivity may be expected to remain roughly parabolic up to some 30 kc. off tune. It is worth noting that many types of battery valve exhibit a higher value of ρ_g than the A.C. valve considered above, and thus the values of Rg mentioned may be increased to nearly double when applied to such cases.

In conclusion, the author desires to acknowledge his indebtedness to Mr. G. M. Wells for assistance with the experimental work, and to Messrs. Lissen Limited for permission to publish the results of work done in their laboratory.

[1] Butterworth, *Wireless Engineer*, Nov., 1929: Aiken, *Proc. I.R.E.*, Jan., 1931: Appleton, *W.E.*, March, 1932.

[2] Appleton letters to *W.E.*, April and July, 1932: Callendar, *Proc. Inst. Rad. Eng.*, September, 1932.

[3] Letter to *W.E.*, November, 1932.

[4] The Detector, *W.E.*, September, 1932.

OLYMPIA RADIO SHOW, 1933

A general view of the Main Hall, Olympia, on the opening day of the Radio Show. An illustrated report on matters of technical interest exhibited will appear in our next issue.

The Use of the Cathode-ray Oscillograph at Ultra-high Frequencies

By Dr. H. E. Hollmann

(Heinrich-Hertz Institute for High-frequency Research, Berlin)

II. PHASE DISPLACEMENT BETWEEN THE CO-ORDINATES

IN Part I (*W.E. & E.W.*, August, 1933) the relations in only a single deflection field were dealt with. In order, however, to study the comparative courses of two deflecting voltages, two deflecting fields at 90° to each other are, as is well known, employed; *i.e.*, two pairs of deflecting plates, each pair deflecting the ray along one of two rectangular co-ordinates. To protect both deflecting systems from mutual interaction, and to obtain deflecting fields as uniform as possible, the four plates are not arranged in one common radial plane; the two pairs are spaced, along the direction of the ray, by a gap d, as shown in Fig. 6. As a consequence of this and of the fact that here, again, the ray requires a definite time to pass from one pair to the other, there occurs between the deflections along the two co-ordinates a delay time of the amount $\tau = d/v_0$, or expressed as a phase angle, $\psi = \omega\tau = \omega d/v_0$. If the two deflecting systems are subjected to a.c. voltages which are of the same phase—if, for instance, they are directly connected to each other—the screen will show a straight line inclined at an angle of 45° to the co-ordinates; the introduction of phase-difference between the deflecting voltages will draw this straight line out into an ellipse or circle.

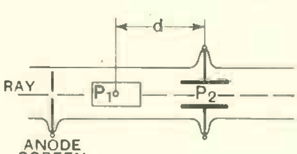


Fig. 6.

But at ultra-high frequencies the phase displacement ψ originating in the tube itself produces a similar distortion of the straight line which would otherwise be given by voltages of the same phase. It is only when this effect, which is proportional to $\sin\psi$, is again equal to zero that the tube can work true to phase and therefore can be used for the investigation of short-wave processes. This condition is always fulfilled whenever

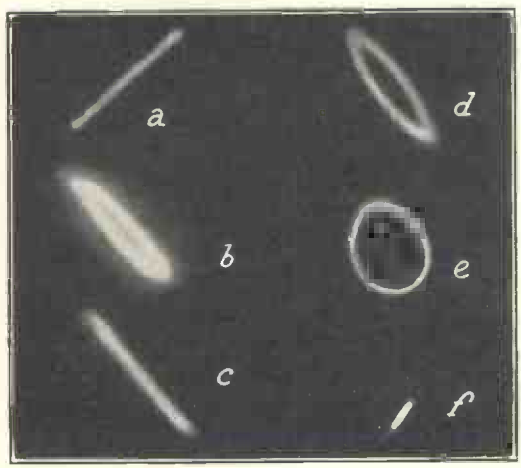


Fig. 7.

ψ passes through a multiple of 180°, so that the condition for phase fidelity is

$$\psi = \omega\tau = \omega d/v_0 = n\pi \qquad .. \quad (10)$$

As in Part I., if ω is expressed in terms of λ, and τ in terms of the gap d between the two pairs of plates and the ray velocity v_0, it follows that the above condition is given by

$$2\pi\, c/\lambda \,.\, d/v_0 = n\pi, \text{ so that } d = n \,.\, v_0/c \,.\, \lambda/2 \,.\, (11)$$

Thus we find for phase compensation a similar condition to that previously established for the optimum plate length (equation 9), namely that the interval between the two pairs of plates should be a whole multiple of the half-wavelength reduced in the ratio of v_0/c. Here also we see that, for a given tube and for a given frequency, fidelity of phase can be obtained by adjusting the anode potential, so that an analysis of the figures obtained at high frequencies is made possible. In Fig. 7 some records, made with an ordinary tube, with in-phase deflecting voltages, are reproduced. First of all (*a*) shows the static calibration curve of the tube, taken at 50 c/s. The remaining figures were taken with a wavelength of 84 cm. (*b*) corresponds to the maximum anode potential of 1 500 v; it shows that not only is the sense of direction rotated with regard to the static characteristic (*a*), but also that the line is drawn out into a narrow ellipse. At 1 200 v the straight line is restored, as shown in (*c*); the phase displacement has been compensated at 180°, so that the line is rotated 90° with respect to the static characteristic. At still lower potentials the trace, as it rotates, passes again through the form of an ellipse; then of a circle; till finally, in (*f*), it becomes at 230 v again a straight line, agreeing in direction with the static characteristic (*a*), and giving once more fidelity of phase. In agreement with the theory developed in Part I., the records show that as the anode voltage decreases from 1 500 v there is at first a slight increase of sensitivity followed by a steady decrease, till at about 200 v no deflection at all can be seen. At this voltage, in fact, the first minimum of Fig. 5 is reached.

In practical work with a cathode-ray tube over a given frequency range it is, however, an undesirable complication to have to compensate for phase displacement by adjusting the anode potential, which would have to be done over again whenever the frequency was changed. For this reason the plate system shown in Fig. 8 was developed, giving an automatic compensation of phase rotation which is quite independent of frequency and anode voltage.

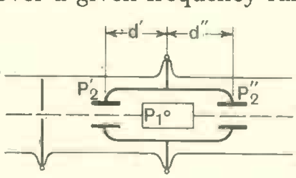


Fig. 8.

In this system one pair of plates (P_2 in Fig. 6) is divided into two parts, P_2' and P_2'', equally spaced by the gaps d' and d'' on either side of the other plate system P_1. The two components P_2' and P_2'' are directly connected together so that they are subjected to potentials of the same phase. The compensation of phase rotation takes places as follows: in the passage through the length d' a rotation occurs equal to the angle $\psi' = \omega d'/v_0$; then, in passing over the length d'', an equal but opposite rotation $\psi'' = -\omega d''/v_0 = -\psi'$ is produced, which neutralises the first rotation and makes the tube function true to phase under all conditions. Fig. 9 is a photograph of the new plate system in the practical form evolved in the Von Ardenne Laboratory.

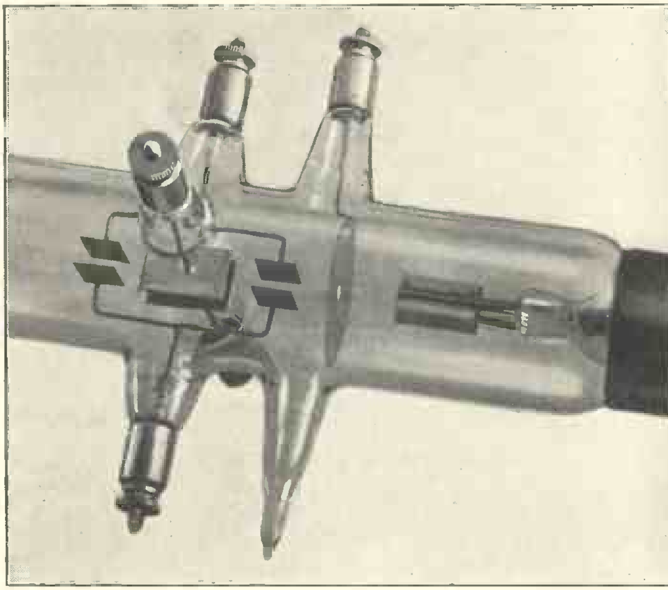


Fig. 9.

Tests with this tube, with the plates directly connected, gave in every case a perfectly linear movement of the fluorescent spot, so that the tube can be used for error-free investigations even in the zone of decimetre waves. If, at first sight, the use of a cathode-ray tube at such high frequencies appears to present little interest, it must be remembered that in many applications, *e.g.* in television, with a large number of picture elements, the frequencies and harmonics are high enough to produce troublesome phase distortions, which can to a very great extent be avoided by the new design.

III. GAS CONCENTRATION AT VERY HIGH RECORDING SPEEDS

The above considerations naturally hold good for any cathode-ray tube, so long as the electron path-times and the deflecting frequency bear such a relation as has been discussed. Since, during the last year or two, low-voltage cathode-ray tubes with ray concentration by ionised residual gas, such as have been used in the present investigations, have come into very general use, we will conclude with some remarks on the subject of gas concentration in the particular frequency range with which this paper deals.

As is well known, the formation time of the space charge surrounding the cathode ray, and impeding the natural diffusion of the electrons, is of the order of 10^{-6} sec., so that at very high recording velocities the effect of gas concentration is bound to diminish, since the short time in which a path-curve is passed over is not enough for a fresh building up of a concentrating field. But on the other hand the recombination time, in which the space charge dwindles to zero and the gas becomes again completely neutral, is of the same order of magnitude. Accordingly with the high frequencies here considered the concentrating space-charge field need not have completely vanished when, after a whole or half period, the ray passes over the same path. According to this conception, the space charge is pictured as forming a kind of conical envelope in the gas-filled space, within which the ray rotates with very high speed. Unfortunately it has at present not been possible to decide experimentally whether the concentration takes place not only in the radial direction (as can be seen from the figure on the screen) but also in the direction of the recording motion, or whether here the failing-space-charge field makes itself evident in a blurring of the ray throughout its conical zone of motion. It may, however, be expected that further researches with decimetre waves will lead to interesting information as to the mechanism of gas concentration.

Man-made Static

The Post Office Display at Olympia

THE one encouraging feature in connection with the prevalence of electrical interference with radio reception is the energy and determination with which the difficulty is being tackled. It is increasingly realised that interference of this kind is no "act of God" but a contingency of human origin, to be countered by human effort. This is the spirit in which the General Post Office laudably concentrated its display at the Olympia Radio Show on the subject of interference suppression; first by showing the public how the difficulties could be overcome and then by encouraging offenders to take the simple and necessary steps.

By way of an object-lesson, the Post Office stand held an array of seemingly innocuous domestic appliances, such as a vacuum cleaner, refrigerator, electric sewing machine, electric fan, as well as such acknowledged nuisances (in the radio sense) as an electric sign, and a mercury arc rectifier—all warranted to disturb reception in their near neighbourhood. The visitor was then shown the proper manner in which the interference could be overcome, either by adjustment of the offending machine itself, or by the incorporation of the appropriate chokes and condensers in the listener's set.

It is known that many listeners are unable to recognise man-made static when they hear it, or, alternatively, are at a loss as to how to deal with the situation when it arises. At Olympia the Post Office pointed the way. Anti-interference forms were made available to the public, enabling anyone troubled with or suspecting local interference to place his complaint before the Post Office engineers.

This official effort represented one more step in a campaign the necessity for which has been so insistently advocated by our sister journal, *The Wireless World*.

Tone Correcting Amplifiers*

By G. Priechenfried

(Engineer, British Radiostat Corporation)

TONE correction, as such, is not new, and has been used practically since the time when long distance telegraphy and telephony were introduced. It was then found that lines of any appreciable length (particularly underground lines) were introducing distortion, and it was soon appreciated that it was necessary to compensate for this distortion in order to obtain a satisfactory reproduction of the transmitted signals.

Particularly on submarine cables, and during the last few years also on long distance telephone lines, tone correction was used extensively ; the advent of broadcasting made this even more necessary because for satisfactory transmission of music the characteristic of the telephone line has to be substantially level from 50 to 5,000 cycles.

It should be noted, however, that in all these cases tone correction was used in order to compensate for some *undesirable effect* or deficiency produced by the associated circuits.

This was also the case for the reception of modulated waves. Here it had been suggested by some people that in case the selectivity of a circuit had accidentally been made too high, it would be possible to correct for the attenuation of the upper sidebands, or upper modulation frequencies, by compensating in the low frequency circuit. For instance, in the use of reaction circuits, reaction might have been taken so far that the high notes were attenuated to such an extent as to make the reception of the modulated waves unsatisfactory. The suggestions for tone correction had thus the purpose in mind to correct for what was considered an inherent disadvantage of a circuit.

Dr. Robinson, however, in introducing the "Stenode," looked upon such high frequency distortion as desirable, and not as a nuisance. From the point of view of overcoming interference from neighbouring stations, it was essential to concentrate on very high selectivity. In fact, the state of the art had become such that it was considered impossible to use very highly selective circuits for the reception of modulated waves. The first step taken by Dr. Robinson was to show that no matter how high the selectivity may be it is possible to receive modulated waves. When such highly selective circuits are employed, correction becomes an essential process.

Another belief before the introduction of the "Stenode" was that no advantage was to be gained by deliberately making a circuit highly selective if tone correction were to be later employed. Because it was thought that when a tone correcting amplifier is employed it will bring back the interfering signals in the same way in which it restores the quality of the desired signals.

It has been shown conclusively that the use of high selectivity with tone correction has a large advantage in this respect : in so far as it restores the desired modulations, but does not restore the direct interfering programme. From this point of view it is desirable to use a circuit of as high a selectivity as is practicable because the higher the selectivity the less is the direct interference from a neighbouring station.

Other advantages are introduced by the use of highly selective circuits. Dr. Robinson worked out the formula for the percentage modulation of signals after they have passed through a highly selective device ; this formula being :—

$$m' = m \frac{n}{p} \frac{\delta}{2\pi}$$

m' = percentage modulation of the output
m = percentage modulation of the input
n = High frequency
p = Modulation frequency
δ = Logarithmic decrement.

This formula shows that high selectivity reduced the percentage modulation of the waves, and it is well known that detector distortion is thereby reduced. More than this, it enables perfect rectification to be obtained.

Whilst the "Stenode" has a beneficial effect on the elimination of a direct interfering programme, it does not remove effects of a heterodyne nature. For instance, the heterodyne effects between carrier waves still remain. More than this, heterodyne effects occur between interfering sidebands and the desired carrier wave, and these also are not removed by circuits of high selectivity. However, it is noteworthy that when stations of equal field strength are placed so close together that their sidebands overlap, and when ordinary modulations are employed, the effect of sideband heterodyning is negligible. The reason for this is believed to lie in the free vibrations introduced by the highly selective circuit.

Tests have been made with a receiver giving almost perfect reproduction up to 4,500 cycles, when stations are separated by 5,000 c.p.s. It was found that when the field strengths were identical the interfering modulations could not be distinguished. The interfering sideband heterodyne effect could not be distinguished until one station was five times as strong as the other. Thus, in the normal course of events, the "Stenode" enables stations which are 5,000 c.p.s. apart to be received without appreciable interference. Naturally, in these circumstances the heterodyne note between the carriers is not audible as the low frequency response is small at 5,000 cycles.

Another advantage of this type of receiver is that it is easier to design, produce and service than the Band Pass receiver (I am referring here to true-band-pass and not what is commonly called band-pass, without deserving this name). The

* A paper read before the Radio Designers' Association, January, 1933.

reason for this is that all selective circuits are peaked to one frequency, and that the coupling between these circuits is not critical provided that it is below a certain value. The initial alignment of the selective circuits is therefore very simple and can be effected without the use of Cathode Ray Oscillographs and similar instruments. It is obvious that this also simplifies the servicing considerably.

Summarising, we find that receivers employing very high selectivity and tone correction possess the following advantages :—

(*a*) It is possible to remove all direct interference completely.

(*b*) The percentage modulation is greatly reduced, which makes perfect rectification possible, and so reduces detector distortion.

(*c*) Heterodyne interference of a *steady* character (caused by tonic train modulation) is not removed. It is believed that the heterodyne interference caused by the *transient* modulations of the undesired carrier is considerably reduced owing to the free vibrations of the low damped receiving circuits.

(*d*) The design, production and servicing of receivers of this type is much simpler than of those designed on band-pass principles.

As it is very seldom possible, however, to get something for nothing, we expect to find that " Stenode " circuits have also inherent disadvantages. Although these disadvantages are present, we find that some of them are actually compensated for by similar advantages, and others are of no great importance and can be overcome without great difficulty or cost.

It has been said, for instance, that transmitting stations do not retain their frequency sufficiently constant to permit the use of very high selectivity. This problem to-day is not of very great importance, as great progress is being made towards keeping the frequencies of transmitters constant. However, even if the transmitting frequency does vary a little, a practical method of dealing with it is to make the resonance curve of a very narrow band-pass, say, 500 or 1,000 cycles in width. (250 to 500 cycles on either side.)

Another criticism has been that the low frequency correction is of such a nature that it tends to emphasise any detector distortion. However, this criticism is more than outweighed by the fact that the percentage modulation is low, and therefore there is less chance of producing detector distortion.

Actually, it has been shown that there is a balance in favour of the " Stenode " from the point of view of harmonic distortion.

The reduction of percentage modulation usually means, however, that less audio output is obtained from the detector, and that as a rule more low frequency amplification is required.

This is not of very great importance as by the use of a screened grid detector it is usually possible to load the output valve fully even when tone correction is employed. It is also possible when using transformer coupling to use a very much higher step-up ratio owing to reasons which will be given later.

Again, it has been stated that the tone correction valve will handle less energy without distortion owing to the low value of the load impedance, but as correction is usually applied in the anode circuit of the detector, or the subsequent grid circuit, this again is of little importance owing to the very small modulation components.

I hope to have given you in as few words as possible a fair account of what receivers employing high selectivity and tone correction, or, simpler, " Stenode " receivers, will do or not do.

I am afraid I cannot go into further details as I want to discuss the design problems introduced by tone correction. If you would like, however, to study this matter more fully I would refer you to a report made by the Department of Scientific and Industrial Research. Following the controversy on the " Stenode," this department appointed a special committee to investigate the subject of highly selective circuits, and a very comprehensive report has been issued (Radio Research Special Report, No. 12) entitled " A Theoretical and Experimental Investigation of High Selectivity Tone-Corrected Receiving Circuits."

What problems occur in the design of amplifiers to compensate for sideband attenuation ?

Before replying to this question we have to define more clearly what a tone correcting amplifier is. This is fairly simple. If we plot the gain of an amplifier against frequency we get a certain curve which may or may not be a straight line parallel to the frequency axis. If it is, we call it a straight or normal amplifier. If not, then it is a tone correcting amplifier.

Before designing an amplifier of this type we must obviously know what kind of curve we require, and it is therefore necessary to find out first of all what kind of law the input voltages to the amplifier follow. Once we know this, we find the desired low frequency amplifier curve by taking the reciprocal values of the input voltages and plotting them against frequency. In other words, if we want to get perfect reproduction the low frequency amplifier curve will have to be as near as possible the inverse of the high frequency resonance curve of the receiver.

It is clear that we shall now have to consider the various means for obtaining high selectivity. Obviously, this can be done in numerous ways, but three types stand out quite clearly :—

(1) The single tuned circuit of very low damping. This case is represented by

(*a*) a single circuit with reaction adjusted to the critical point, and,

(*b*) by the quartz resonator.

(2) A chain of tuned circuits of medium damping, with the coupling between these circuits adjusted below the critical value, so that single peaking is obtained. This type is really nothing but a band-pass circuit with very narrow band widths, say 1 kc. A similar circuit is being used in the ordinary " Stenode " receivers.

(3) The true-band-pass type. This can be obtained in two different ways. First of all by a combination of multi-staged low pass and high pass filters. This type has to my knowledge never been used in this country except for the reception of commercial telephony, and need therefore, not be considered, although it is the only type which

can give as close an approximation to the rectangular resonance curve as desired. In this case, tone correction is, of course, unnecessary.

The second way of obtaining the band-pass effect is by increasing the coupling between the tuned circuits above the critical value, which in turn produces double humping. This method is employed in certain modern superheterodynes, but it very seldom produces anything near the desired rectangular curve. In order to obtain absolute 9 kc separation, it is necessary to keep the coupling fairly loose, and this means that the band widths will usually have to be much narrower than that required for the perfect reproduction of high notes. Therefore, even in this case tone correction is desirable.

When speaking of absolute 9 kc separation, I am thinking of a resonance curve which is at least 1,000 times down at 9 kc in order to be able to separate two adjacant stations, even when the field strength of the unwanted one is 50 to 100 times higher than that of the wanted station. This high degree of selectivity can in my opinion only be obtained in superheterodynes, and even then it is necessary to use very low damped intermediate frequency circuits, or else a very low value of intermediate frequency. The latter has the disadvantage that it makes elimination of the image frequency fairly difficult. It is, therefore, advisable to keep the intermediate frequency at a value near the conventional 110 to 126 kc, and to make the intermediate circuits as low damped as possible. This can be done by reducing the inductance of the I.F. coils, down to somewhere around 6 millihenries, and, in addition, by winding the coils with litz wire. It is very probable that the new type of iron cored inductances, now being advertised, will play an important part in this connection.

Having discussed the various means of obtaining high selectivity, let us now consider how we can apply tone correction to compensate for the different forms of distortion introduced by the different types of selective circuits. One thing is common to all methods of tone correction : it should be applied as soon after the detector as possible, in order to avoid harmonic distortion and overloading of the low frequency valves. For this reason it is best to apply it in the anode circuit of the detector valve, or the subsequent grid circuit.

The simplest case of tone correction is given by the single low decrement circuit, whether it be a reaction circuit or a quartz resonator. In this case, we can apply the demodulation formula :—

$$m' = m \frac{n}{p} \frac{\delta}{2\pi}$$

and we find that the low frequency output from the detector is inversely proportional to the modulation frequency, and the correcting amplifier will therefore have to give amplification which rises linear with the frequency.

This can be realised in practice by providing the tone correcting valve with a load the impedance of which is proportional to the frequency and is equivalent to the valve impedance for the highest wanted frequency. This condition is fulfilled by an inductance L of such a value that it satisfies the equation $2\pi \cdot p_{max.} \cdot L = R$.

It is of no importance whether choke or transformer coupling is employed, provided, of course, that the leakage resonance is equal to or higher than $p_{max.}$ If a transformer is used it is possible to use a very high step-up ratio owing to the low value of primary inductance required, and here we have one way of compensating for the loss of audio output from the detector.

In this connection, we have to consider one more point. If we make $2\pi p_{max.} L = R$, then we obtain a correction curve that rises proportionally to the frequency until $p_{max.}$ is reached, and remains constant after this. This means that all frequencies above $p_{max.}$ will be amplified to the same extent as $p_{max.}$, although they are undesired and would result in an increase of heterodyne interference.

What is really required is an amplifier which follows the desired law up to $p_{max.}$ and then cuts off as rapidly as possible. Although it is possible to obtain this effect by the combination of correcting amplifier and a low pass filter, with a cut-off frequency of $p_{max.}$, this would increase the production cost of the receiver considerably, if a fairly sharp cut-off were required.

It is possible, however, to get a good approximation by the simple expedient of making the load inductance rather smaller than that given by the equation

$$2\pi \times p_{max.} \times L = R$$

and then tuning it to $p_{max.}$ This does not change the shape of the correction curve appreciably, except for frequencies just below $p_{max.}$, but it produces a fairly sharp cut-off above this frequency.

It is thus possible, by combining very high selectivity with tuned tone correction circuits, to obtain almost the ideal rectangular band-pass curve as far as the low frequency output of the receiver is concerned, and still retain all the advantages of high selectivity.

The degree of tone correction can be made adjustable by connecting a variable resistance in series with the inductance in the case of choke coupling. This method cannot be applied to transformer coupling without making certain modifications. In this case it is necessary to use a transformer with a primary inductance of normal value, and then shunt the primary with the correction choke in series with a variable resistance. This method, I believe, is used in at least one of the commercial correction transformers obtainable on the market.

The effect of this series resistance is to maintain the amplification constant for all frequencies below a certain value, and this value, which may be called $p_{min.}$, is given by the equation

$$p_{min.} = \frac{R'}{2\pi L}$$

R' = the value of the tone control resistance. This equation shows that an increase of the resistance raises the bass response and therefore in effect reduces the amount of tone correction. A tone control of this type is essential in a tone corrected reaction receiver where the shape of the resonance curve is variable, and depends on the amount of reaction applied.

So far we have only considered the design of tone correcting amplifiers which have to be used in conjunction with single tuned circuits of very low damping. This represents the simplest case, as the correction amplifier has to follow a very simple law.

Things are rather more complicated when more than one tuned circuit is employed. In this case the tone correction amplifier has to follow a more complex law ; according to the number of selective circuits employed, it might be anything from the second power law upwards, but the most common case is represented by something approaching the fourth power law, providing that the coupling between circuits is below the critical value. The law is of a still more complex nature if definite band-passing is aimed at.

In spite of this, it is fortunately possible to employ exactly the same methods as in the case of single tuned circuits. It is only necessary to choose the inductance and resistance values very carefully, and in this case the use of tuned tone correction is essential.

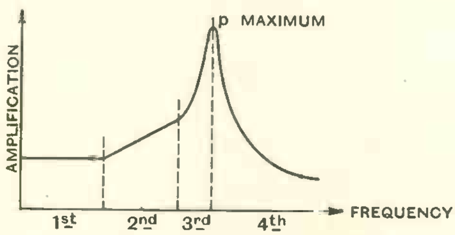


Diagram of correction curve divided into sections which are discussed in the text.

Although the desired correction curve is rather complicated and differs for practically every type of receiver, it is possible to obtain a fairly close approximation by dividing it into four distinct regions.

The first region is given by a straight line parallel to the frequency axis, and is in practice provided by the resistance in series with the correction choke.

The second part can again be looked upon as a straight line, which is, however, not parallel to the frequency axis. The angle depends on the high frequency band width of the receiver, and it can be said to be directly proportional to the band width. By band width I mean the band of frequencies which is passed without appreciable attenuation.

This part of the curve can be realised by the low inductance choke, and the angle can be changed by altering the inductance value.

The third region is characterised by an increase of the gain with frequency much faster than given by the linear law, until the peak frequency $p_{max.}$ is reached. This part of the curve can be approximated by a hyperbolical law and can easily be realised in practice by tuning the correction choke to $p_{max.}$ as suggested before.

The fourth and last part of the correction curve should, of course, drop down as fast as possible with the frequency, but if a low pass filter is not employed it will simply follow the same law as the third region, *i.e.*, the amplification will fall according to the resonance curve of the tuned correction choke.

Experiments carried out in the Radiostat laboratories have shown that it is possible to obtain almost any desired shape of correction curve by using the very simple circuits which I have described. In some cases where a very high amount of correction is desired it is necessary to apply correction in *two* stages and thus multiply the effects obtainable in each stage, but in most cases one stage is sufficient.

The accuracy with which any desired shape of correction curve can be obtained is proved by the fact that one of the receivers constructed on " Stenode " principles has an overall response curve which is virtually flat from 30 to 4,500 cycles ; the deviation from the straight line nowhere exceeds plus or minus 2 decibels.

It is, of course, possible to apply tone correction in very many different ways, but it will be found that the fundamental principles employed are always the same and identical to those described. The same remark applies to the tone correction devices now obtainable on the market. They usually consist of an ordinary L.F. transformer which has a low inductance choke shunted across one winding, in series with a resistance, which may or may not be adjustable. In one particular make, one primary and two secondaries are being used, one of which is tuned to the highest desired frequency and the other to a fairly low frequency. A potentiometer allows either the high or the low notes to be emphasised by tapping off more energy from one secondary or the other.

The fact that quite a number of different types of commercial tone correction devices are now available shows that the importance of high selectivity, coupled with tone correction, is being more and more appreciated by the general public as well as by the technical people, and it is therefore safe to assume that this principle will in future play a very important part in the design of broadcast receivers. This particularly in view of the continuous increase in the power of European broadcasting stations, which calls for the highest possible selectivity.

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.

Laminated or Non-laminated High-frequency Cores?

To the Editor, The Wireless Engineer.

SIR,—With reference to the Editorial of Prof. Howe in the June number and the letter of Herr Nissen in the same issue, it seems necessary to discuss once more the question "Laminated or non-laminated cores" and the theory of capacitive eddy currents.

Basing his investigation on physical assumptions made by Herr Nissen in his letter, Prof. Howe calculates the capacitive losses and comes to the conclusion that the objections of Herr Nissen *re* the capacitive losses seem justified and that although capacitive losses may exist in principle they seem of no practical importance, being extremely small in comparison with hysteresis losses.

However, the researches with Ferrocart tend to prove the contrary. Indeed, it is very difficult to comprehend theoretically the conditions in such compound cores of complicated structure and to reduce them to simple schematical conceptions or even to base a calculation on such an abstract and simplified idea of the complicated phenomena. How problematical the matter is can best be proved by the literature, and especially the patents, on compound cores for loading coils, where similar conditions prevail. In spite of the many years of practical experience gained in this technique, the statements in many patent specifications are quite contradictory to each other.

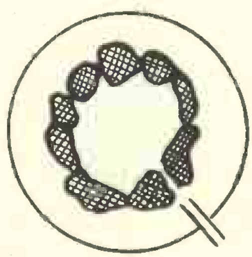
Whenever the results of practical experiment do not agree with the theoretical calculations, it is more probable that the calculations, ingenious and correct though they may be in themselves, are based on wrong or imperfect assumptions than that the experiments are misleading.

Herr Nissen assumes that the many little particles form a circular chain of condensers and he reduces the capacity of the series to the capacity of a single condenser, the plate distance of which corresponds to the sum of the plate distances of all the single condensers. He calculates this total plate distance in a very neat manner from the specific permeability, assuming it to be equal to the sum of all air gaps between the particles, which determines the resulting specific permeability of the material. He thus obtains an approximate figure of the core capacity which he considers as a parallel capacity to the coil, reduced, however, in its effect by the ratio of the one quasi winding of the core to the number of turns of the coil. It is obvious that in the case of such a purely capacitive propagation of the eddy currents throughout the core, the resulting capacity values and losses must be very small; but is one actually justified in assuming purely capacitive propagation?

Perhaps the short explanations *re* capacitive effects in my article in your April number were not detailed enough and obviously they have been misunderstood. Therefore, some supplementary explanations may be necessary to explain more fully the theory of capacitive losses in the core and the observations which led to the assumption of such losses.

When measuring the specific ohmic resistance of non-laminated compound cores a very high resistance was found, which seemed to prove, that the insulation of the particles was a good one. Nevertheless, the losses were very high and in particular showed a rapid increase between 300 and 200 m wavelength, which was higher than could have been expected from the higher copper losses and stronger inductive effects in the core. It was found out, however, that the specific resistance of the core was varying at different spots. Therefore it is probable that the particle structure and the insulation between the particles is not homogeneous over the whole core, but the particles are partly in electrical contact with each other. We may imagine that the eddy current path is perfectly interrupted at a few incidental points only, while at most touching points, though having a fairly high resistance, it is not perfectly interrupted.

I have tried to give a scheme of such a core structure in the figure. The perfect interruption which accidentally has formed would suffice to prevent galvanic eddy currents. In fact, such irregular interruptions are sufficient at long waves. With decreasing wavelength, however, the interruptions are overbridged by capacitive coupling and a considerable loss current flows over the whole core, mostly on the galvanic way, and on the capacitive one at a few points of perfect interruption. Especially due to the irregular and accidental character of these interruptions, cores of this kind do not show at all the necessary uniformity in losses. It will be obvious from these considerations that the calculation method of Herr Nissen is based on imperfect ideas of the physical conditions and I am sorry that Prof. Howe has in vain taken the trouble of calculating the losses in another way, but based on similar presumptions. If we imagine that only at a few points purely capacitive conductance is present, while the preponderating part of the eddy current path is formed by galvanic conductance, that is metallic contact between the edges and points of the particles or a semi-conductor effect of the insulating material between the particles, it is quite possible that relatively high capacities may result, which render possible capacitive propagation of the eddy currents at the interrupted points without considerably weakening the current.



Unfortunately it is impossible to calculate these losses even approximately, for any theoretical abstraction would be misleading; *e.g.*, it is not admissible to equalise the sum of all air gaps between the particles (calculated from the specific permeability of the compound core) and the total plate distance of the quasi condenser, for galvanic conductance due to contact of the points and semiconductor effects may result even where magnetic conductance is non-existent. The same holds good regarding calculations based on the space factor. I may emphasise once more that the conditions in such compound cores are too complicated by far to get a reliable figure of the losses by simplified calculations.

However, experiment so far has proved the assumptions *re* capacitive effects. It has been ascertained that by arranging intermediate paper layers and furrows the losses were reduced much more than would have been expected from the increase of the specific resistance of the material. Even the thickness and dielectric constant of the paper was of influence.

I have hitherto been unable to see any other explanation of these effects but capacitive coupling. In fact, the theory of capacitive losses did not result from theoretical calculations, but from observations in the laboratory. As long as another explanation of the phenomena is not found, I don't think it right to reject capacitive effects as being absurd, even though the ideas of their functions may still be imperfect and not capable of proof by calculations.

Another question is whether the method adopted in the case of Ferrocart is the only way of preventing capacitive coupling. It will be obvious from the above that this is substantially a question of uniformity. Any method which warrants uniform and perfect insulation throughout the core and uniform structure regarding arrangement of the particles will be suitable to make a core of uniform permeability and losses, for if the eddy current path is everywhere galvanically interrupted, the capacitive resistance will be so high that no losses of any practical importance could result.

The methods of obtaining such uniformity have all been carefully studied by Hans Vogt and are described in a number of patent specifications. The Ferrocart process has been definitely adopted for industrial manufacture because it is the most reliable one, offering the advantage of greatest uniformity in permeability and losses due to its particular nature. In addition, the material made by this process has high constancy against influences of time and temperature and—an important practical feature—it can be worked, in particular stamped like metal, so that a core can be built up of stampings in the same way as a transformer core, without necessitating a particular mould as is necessary in the case of non-laminated cores.

The statement of Herr Nissen, that the paper considerably reduces the permeability, so that an advance of 50 per cent. in permeability (I think permeability is meant by performance) is possible by eliminating the paper, is not at all correct. As can be easily measured, the paper has a thickness of only 12μ as compared with 260μ of the magnetic layer. Therefore, the space factor is reduced by 5 per cent. only in maximum. On the other hand, due to the additional insulation the particles can be packed more tightly so that the small reductions in permeability are practically compensated.

An increase in permeability of 50 per cent. is not obtained by leaving out the paper, as maintained by Herr Nissen, but is only possible by more tight packing which leads to higher losses. The object is not to obtain the maximum of permeability but to obtain the optimum proportion of permeability and losses, otherwise the reduction in copper losses would be outweighed by higher losses. Non-laminated cores as Herr Nissen proposes to use have already been made some time ago by Polydoroff, an American inventor (*see* R. H. Langley, Proc. of the Radio Club of America, April, 1932), but the practical difficulties of uniformity in losses were obviously not overcome, for this development did not find industrial application. The question from an engineer's point of view is always whether such a core will show the necessary uniformity in industrial production. It is one thing to make a few good cores in the laboratory under special precautionary measures, but it is quite another matter to get the same result in mass production.

As regards the magnetic alignment, I wonder on what considerations Herr Nissen bases his statements *re* the impossibility of practicably applying this method. I feel that Herr Nissen would be rather embarrassed if he were asked to prove his statements. The importance of the aligning method is demonstrated already by the patent literature, proposing magnetic alignment of compound cores in different manners for Pupin coils, etc. As a matter of fact, further important applications of the method of magnetic alignment in the production of high-frequency cores exist which may be discussed in another article.

Berlin. ALFRED SCHNEIDER.

Abstracts and References

To the Editor, The Wireless Engineer

SIR,—We have been interested to note references which have appeared in your journal in 1932 Abstracts, page 535, and 1933 Abstracts, page 212, dealing with glow discharge tube coupling. In these references the invention of this method of coupling is attributed to H. Peek who first published his account of it in *Archiv für Electrotechnik*, dated June 17th, 1932.

If reference is made to British Patent No. 369,578, application date December 20th, 1930 (see *Wireless Engineer*, September, 1932, patents abstracts), it will be seen that the glow discharge coupling was discovered by us and patented by the Admiralty in England nearly two years before any accounts appeared in the foreign Press.

H. SMITH, B.A., D.Sc.
E. E. HILL, Ph.D., M.Sc., F.Inst.P.

[It should be noted that the "Abstracts and References" published in this journal are strictly non-critical, expressing no opinions except those contained in the paper or article under abstraction. —ED.]

Abstracts and References

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PROPAGATION OF WAVES

Über die Dämpfung von Kurzwellen durch leitende Wände (The Damping of [Ultra-] Short Waves by Conductive Walls).—H. Zuhrt. (*Hochf:tech. u. Elek:akus.*, June, 1933, Vol. 41, No. 6, pp. 205–207.)

A marked absorption by conductive walls is often encountered in tests with 3- to 10-metre waves. In order to get an idea of the amount of such damping, the writer considers a plane wave-train of constant amplitude falling with normal incidence on a conductive wall thin in comparison with its distance from the transmitter. He thus obtains equation 14 for the ratio of the electrical field strengths after and before the passage through the wall. From this, by introducing numerical values, he derives the curves of Fig. 3, where the abscissae represent the " numerical wall-thickness " (*i.e.* the ratio of actual thickness to wavelength in air) and the ordinates represent the field-strength ratio ; the loss angle of the wall material serves as parameter, while the dielectric constant is taken as 4, so that the velocity in the wall is half that outside it. He then discusses these curves, beginning with the case where the wall is loss-free, so that $\phi = 0$. Since field strengths are all compared with the undistorted field strength in front of the wall, the waves reflected back at the front surface are neglected. The waves penetrating into the wall are partly passed out and partly reflected by the back surface, but those which are reflected are turned again by the front wall and accompany fresh waves entering the wall. Since the transition from wall to air is similar to reflection at the open end of a line, the potential wave is reflected without change of phase. If therefore the wall thickness is equal to $\lambda/4$, $\lambda/2$, $3\lambda/4$ . . . (where λ is the wavelength in air), the reflected waves reinforce the penetrating waves, while if it is equal to $\lambda/8$, $3\lambda/8$ . . . they oppose them. In the first case the transmitted wave will be a maximum, in the second case a minimum, in agreement with Fig. 3 ($\phi = 0$).

If ohmic losses occur in the wall, increasing thickness produces increasing damping, as is seen in the curves for $\phi = \pi/16$, $\pi/8$ and $\pi/4$. The first of these still clearly shows the maxima and minima due to reflection ; the second less clearly, while with high damping ($\phi = \pi/4$) they have disappeared. These calculated curves, therefore, show that a conductive wall can produce considerable absorption (1) if the thickness of the wall is of the same order as the wavelength, which may often happen with ultra-short waves, and (2) if tan ϕ is fairly large. For the values of brickwork-conductivity arrived at by l.f. measurements, ϕ works out at only a fraction of a degree. The writer, however, points out that Strutt has found the conductivity of the ground to increase sharply at ultra-high frequencies (1932 Abstracts, pp. 27–28 and 454, r-h col.) and that, since this increase must also apply to brickwork, it is quite possible for the observed absorptions to agree with the calculations.

Radiocomunicazioni con Onde cortissime (Radio Communications by Ultra-Short [Micro-] Waves).—G. Marconi. (*Alta Frequenza*, March 1933, Vol. 2, No. 1, pp. 5–24.)

Version in Italian of the R.I. discourse dealt with in May Abstracts, pp. 266 (r-h col.) and 267 (l-h col.).

Considerazioni sulla Propagazione delle Onde ultracorte e delle Microonde (Considerations on the Propagation of Ultra-Short and Micro-Waves.)—G. Pession. (*Alta Frequenza*, Dec., 1932, Vol. 1, No. 4, pp. 485–499.)

The " ultra-short wave " service on a 10-metre wave between Italy and Sardinia (Fiumicino/Golfo Aranci, 250 km) is first discussed, and curves are given showing some of the results during the period 1930/32 ; variations of the quality of the service with the seasons are indicated. Marconi's " micro-wave " tests are then outlined, leading to the well-known Rocca di Papa/Capo Figari results (55-cm waves, distance 268 km). The two cases are then compared from the propagation point of view, and it is found that while the 10-m results can be explained by diffraction phenomena according to the formulae of Watson and T. L. Eckersley, the micro-waves, according to these formulae, would have given insufficient signal strength even if the power at the transmitter had been the same as for the ultra-short waves. Some explanation other than diffraction is therefore needed for the micro-wave results. Jouaust's hypothesis of optical refraction due to the presence of the atmosphere (made in connection with the Corsica 3.5-metre results—1931 Abstracts, p. 317, l-h col.) is examined quantitatively, but is found to demand, for the explanation of the results obtained with the 55-cm waves, an improbable gradient of temperature, particularly in view of the 750 and 350 metres' elevation of the transmitter and receiver above the sea. The writer considers that the true explanation is *a practically straight-line propagation of part of the transmitted energy towards the horizon*, followed by effects due to pronounced positive temperature gradients in the atmospheric strata close to the surface of the sea, which result in part of the energy following the earth's curvature, part detaching itself from it; the two portions re-uniting in a very attenuated condition at the receiver.

"ULTRA-SHORTS" FROM THE AIR [Transmissions from an Aeroplane: Occurrence of Shadows cast by Banks of Cloud or Rain ?]:—Morgan. (*See* under "Stations, Design and Operation.")

EXPERIMENTS WITH ULTRA-SHORT WAVES: DEMONSTRATION [on 65-cm Wavelength: including Imitation of Fading].—N. L. Yates-Fish. (*Proc. Phys. Soc.*, 1st May, 1933, Vol. 45, Part 3, No. 248, pp. 482–484.)

RECHERCHES EXPÉRIMENTALES SUR LA RÉFLEXION TOTALE DES ONDES HERTZIENNES (Experimental Researches on the Total Reflection of Hertzian Waves [and the Study of a Radiometer suitable for these Waves. Part I. Introduction and Theory]).—G. Beauvais. (*L'Onde Élec.*, April, 1933, Vol. 12, No. 136, pp. 161–179.)

For a *Comptes Rendus* Note on these researches *see* March Abstracts, p. 150, l-h col., and for a similar Note on a radiometer, 1932 Abstracts, pp. 474–475.

FERMAT'S PRINCIPLE [Theoretical Discussion].—L. Natanson. (*Phil. Mag.*, July, 1933, Series 7, Vol. 16, No. 103, pp. 178–192.)

THE IONOSPHERE—PROFESSOR APPLETON'S ADDRESS TO THE ROYAL SOCIETY.—E. V. Appleton. (*Electrician*, 30th June, 1933, Vol. 110, No. 2874, p. 857.)

At the meeting on 22nd June. The summary includes the following points: "The noon ionisation in the upper Region F is usually $3\frac{1}{2}$ to 4 times that in the lower Region E, average (equinox) values being 6.1×10^5 and 1.8×10^5 electrons/cm³ respectively. Neither the diurnal nor seasonal variation of Region F is as marked as that of Region E, a difference probably accounted for by the difference in the pressures at the two atmospheric levels in question. There can be little doubt that the maximum of Region E ionisation is reached at a height of about 100 km above the ground. The height of the corresponding Region F maximum is much more difficult to estimate, but a figure of 180 km is probably not greatly in error.

"Experiments carried out within the last twelve months at Slough, England, have brought to light further details concerning what may be called the fine-structure of the ionosphere. The intermediate region between Regions E and F has been shown not to be devoid of ionisation, and, on relatively infrequent occasions, evidence has been found of another maximum of ionisation there. But it is not usual in England at noon for this intermediate region to be as strongly ionised as Region E. Evidence has also been found of the existence of a protuberance or ledge on the under-side of Region F, the maximum ionisation of which increases with solar altitude. It may not be superfluous to point out that any region higher than Region F, but of lower ionisation, would not be detected by the usual wireless methods of exploration." The picture now presented of the structure of the ionosphere is that there are two main regions, each of which is probably made up of two elements during the day-time. Probably the four components are associated with ionisation potentials of different atmospheric constituents, atomic and molecular.

The experimental ratio of summer noon to winter noon ionisation for Region F is given as from about 1.5 to 1.8, compared with 2.2 for Region E (*see* next abstract). Undisturbed noon ionisation in Region E appears to be 50-60% greater at sunspot maximum than at sunspot minimum. "An important matter yet to be settled is whether this variation is to be attributed to an 11-year cycle in the intensity of ultra-violet light from the sun." In dealing with recurrence tendencies and irregularities the writer says: "It is not yet certain that the world's thunderstorms do not act, to some extent, as an intermediary mechanism in providing the charged particles which cause phenomena exhibiting the 27-day recurrence tendency, and it would be a matter of great interest to examine the thunderstorm data for such a tendency and also for an 11-year period." Regarding the nature of the ionisation he recalls that what is estimated in wireless exploration is the sum of the ratios N_e/m_e and N_i/m_i: polarisation measurements have demonstrated that the former (electron) ratio is greater than the latter (ion) ratio. The splitting of a pulse into a doublet, as a result of the action of the earth's magnetic field on the ionosphere, is only to be expected if the refractive process is effected mainly by electrons, and the relation between observed polarisation and the direction of propagation relative to the magnetic field shows that the effective electrical charges are of negative sign. Regarding the processes of electron-capture (studied by measurements of the steady night decay of electron content) the evidence is still conflicting, Eckersley's results fitting in with the usual recombination law for electrons and positive ions, whereas the writer has found that the law describing the attachment of electrons to uncharged atoms gives a better agreement with his observations.

WEEKLY MEASUREMENTS OF UPPER-ATMOSPHERIC IONISATION [Variation in Region E over Sunspot Cycle: Thunderstorms as Subsidiary Ionising Agency: etc.].—E. V. Appleton and R. Naismith. (*Proc. Phys. Soc.*, 1st May, 1933, Vol. 45, Part 3, No. 248, pp. 389–398.)

Continuation of the work dealt with in 1932 Abstracts, p. 575, l-h col. The weekly estimates here discussed extended from January, 1931, to November, 1932. Assessed from the general trend of the curve, instead of by averaging, the ratio of summer-noon to winter-noon ionisation is found to be of the order of 2.2. The general level is lower in 1932 than in 1931, the diminution being of the order of 10 to 15%. This is probably due to the approach of the sunspot minimum: "if work in future years confirms this variation with the sunspot cycle, and we are able to ascribe it even only in part to the ultra-violet light from the sun, it will follow that such radiation varies with solar activity over a wider range than does the so-called solar constant." An *International Research Council* paper by Appleton is referred to in which he interpreted Austin and Wymore's results on Nauen signals (1928 Abstracts, p. 221, l-h col.) as indicating that the conductivity of the lower reflecting layer is 1.6 times as great at sunspot maximum as at sunspot minimum.

The latter part of the paper deals with the causes of the abnormal ionisation so often encountered in summer. "Although it is clear that the major source of daytime ionisation for the lower region is ultra-violet light, evidence has been steadily accumulating which indicates that it is necessary to take other possible causes into account to explain departures of the ionisation from the normal seasonal and diurnal values." C. T. R. Wilson's 1924 argument that thunderclouds contribute ionisation to the atmospheric conducting layer is referred to and is developed in greater detail in an Appendix, together with his suggestion that the ionisation current between the layer and the upper part of the cloud will be augmented by ionisation by collision; and Lutkin's work, on the correlation of thunderstorm activity with the writer's data and other observations, is discussed. Also a case observed at the Radio Research Station, Slough, is mentioned, when a thunderstorm area reaching the great circle between Slough and St. Assise produced so pronounced an absorption that the reflected wave was undetectable.

As regards a possible correlation between magnetic storms and abnormally high ionisation, "we can only say that if there is a very big magnetic storm the ionisation in region E is increased." When such an increase occurs from any cause (*e.g.* magnetic storm or thunderstorm) there is not usually a corresponding increase in region F; in fact, sometimes the E ionisation is greater than that in F region; so that the agency or agencies which cause such abnormal ionisation in E "is not the same as the agency (*i.e.*, ultra-violet light) which ionises both E and F regions in the normal manner" (*cf.* next abstract). Although the weekly ionisation values give a slight suggestion of a recurrence tendency with a period of 27 days (solar rotation-period), daily readings will be necessary before this result can be accepted with confidence. In the Discussion, Chapman mentions that the estimate of the variation of E-layer ionisation with the sunspot-cycle is of the same order as the sunspot-cycle variation in amplitude of the solar diurnal variation of terrestrial magnetism. Lutkin suggests that some at least of the seasonal variation of ionisation may be explained by the seasonal variation of thunderstorm activity.

An Automatic Recording Method for Wireless Investigations of the Ionosphere [and a Discussion of Some Results: Thunder- and Shower-Clouds as the Cause of Abnormal E-Layer Ionisation].—J. A. Ratcliffe and E. L. C. White. (*Proc. Phys. Soc.*, 1st May, 1933, Vol. 45, Part 3, No. 248, pp. 399–413.)

A preliminary letter on the method here described was dealt with in 1932 Abstracts, p. 400; for the visual method from which it was developed *see* 1931 Abstracts, p. 606, r-h col. Attention is directed to a common abnormal occurrence of increase in the E-region ionisation during the hours of darkness, without a corresponding increase in the F region (*cf.* preceding abstract). Either the abnormal E region is ionised by some influence from outside the atmosphere which can pass through the F region without ionising it, or else the ionisation is produced by a terrestrial source. A stream of charged particles from the sun, deviated to the dark side of the earth, would be a possible cause in the first case; but then it would seem reasonable to expect some correlation between magnetic storms and the occurrence of the midnight E region; over the present limited period of the tests no such correlation has been found. Wilson's thunder-cloud theory, as a likely explanation along the lines of the second case, is discussed, and it is pointed out that Wilson stressed the fact that the electric field of a large rain cloud, which would not be regarded as a thunder-cloud, may be strong enough to cause discharge in the atmosphere above it; also that all thunder-clouds within a considerable area will contribute to the vertical electric force at a point.

Ranzi's observations (Abstracts, 1932, p. 632, r-h col.) are mentioned: "our results entirely confirm his observations and seem to show an even closer correlation with thunderstorms and heavy rainfall." The echo from the abnormal E region in the night is much less absorbed than that from the normal daytime E region: one of two explanations suggested, namely, that the ionisation distribution changes at night so that there is less ionisation in an absorbing region below the deviating region, would agree with a suggestion made, on quite different evidence, by Appleton and Ratcliffe (1930, p. 561, l-h col.).

The Magneto-Ionic Theory.—J. A. Ratcliffe. (*Wireless Engineer*, July, 1933, Vol. 10, No. 118, pp. 354–363.)

The writer concludes:—"The final results of the magneto-ionic theory with frictional collision neglected are summarised in Figs. 8 to 14. The results will be valid for the ionosphere in the following practical cases. The curves for μ (Figs. 9–13) will probably hold for wavelengths less than 1 800 m. The curves for R, the polarisation, will hold approximately where $\nu < p$, that is, they will hold, for waves of length less than 1 800 m, in the deviating portions of the ionosphere (*i.e.*, where μ departs appreciably from unity; in not very exact language, we may say 'in the layer itself'). Near the ground they will not hold at all; in fact, both waves received at the ground will be circularly polarised."

IONISATION IN THE UPPER ATMOSPHERE AT ABOUT 200 KM ABOVE SEA LEVEL.—E. O. Hulburt. (*Physics*, May, 1933, Vol. 4, No. 5, pp. 196–201.)

Author's summary :—" From the skip distances of radio waves measured in temperate latitudes during 1927 and 1928 the average day ionisation is calculated to be at about 200 km above sea level with a maximum electron density of 7.5×10^5 and 5.6×10^5 for a summer and winter day respectively, which agree with the observed virtual heights from radio echo experiments and the longest wave which at normal incidence pierces through the ionised layer. The ratio 1.33 of summer to winter day electron density agrees with the ratio 1.42 calculated from ionisation by the ultra-violet light of the sun. An average night ionisation of 2.5×10^5 and 1×10^5 for summer and winter at 160 km is in rough accord with the radio facts as they are known, but within limits a more dense ionisation at a higher level, or a less dense at a lower level, would accord equally well. The average day ionisation for 1927 and 1928 is 6.5×10^5 electrons.cm^{-3} which, when compared with the value 4.3×10^5 calculated from the skip distances of 1923 and 1924, shows that *the ionisation increased by about 50% from minimum to maximum solar activity*."

The writer concludes his paper as follows :—" If the foregoing discussion is correct it follows that the daytime virtual heights from the echo experiments are pretty close to the true height of the upper layer of ionisation and that the night virtual heights are not close at all but are much greater than the true height. As a theorist I find no objection to this conclusion, but as an experimenter when I look at curves such as Fig. 2, 3 and 4, I wonder if the theorist is correct. Thus we close with a note of uncertainty which only future experiment can dispel."

METINGEN VAN DE HOOGTE DER HEAVISIDE-LAAG (Measurements of the Height of the Heaviside Layer).—G. J. Elias, C. G. A. von Lindern and G. de Vries. (*Tijdschr. Nederl. Radiogen.*, May, 1933, Vol. 6, No. 3, pp. 53–64.)

This paper gives the results of observations on the reflection from the ionosphere of pulses on a carrier frequency of 4Mc/s, emitted at the rate of 80 per sec. The duration of the emitted pulses was 10^{-4} sec. ; the method of production is not described. Reception took place some hundred metres from the emitter—the receiving aerial is not specified ; the received signal, after h.f. amplification, heterodyning and i.f. amplification, was split into two parts, of which one passed through an i.f. amplifier, a detector, a l.f. amplifier and a limiting device on to one pair of plates of a cathode-ray oscillograph ; the other part passed through a detector and l.f. amplifier on to the grid of a triode whose anode was connected to a condenser and high resistance in parallel, forming a linear time base across the other pair of plates, so that the signal produced automatic synchronisation of the time base and the displacement perpendicular to it due to the ground wave and echoes. The limiting device caused the maximum heights of the echoes to lie along a slit and a continuous record was obtained by photographing this.

Specimens of the records obtained are reproduced ; the writers distinguish three reflecting layers which they call I, II and III. " Layer I " occurred in all observations during the day ; its height during the autumn of 1932 was 200 km, in the spring of 1933 about 250 km. Multiple reflections from it were observed shortly before sunset and shortly after sunrise. The height was greater in the evening and morning than during the middle of the day. In the autumn of 1932 there was a time interval of about 2 hours between sunrise at a height of 200 km and the appearance of the layer. This time difference decreased in the early months of 1933. A lag of the same order of magnitude occurred between sunset at a height of 200 km and the disappearance of the layer.

Multiple echoes allow the reflection coefficient ρ_1 of Layer I to be calculated ; taking into account the reflection coefficient ρ_2 of the earth (0.83 for this frequency), ρ_1 just before sunset was found to lie between 0.92 and 1.0, which the writers consider to agree well with values earlier deduced from interference observations (Abstracts, 1932, p. 396) in which the height of the layer was assumed to be 120 km and the observations were taken an hour after noon, when the reflection coefficient is about eight times less than just before sunset. Split echoes were also observed. " Layer II " occurred occasionally during the night in the autumn of 1932, more frequently in the spring of 1933. Its height was about 400 km. A graphical representation is given of the total number of hours during which it was observed. Its thickness appeared to be greater than that of " Layer I " ; scattering was observed and the occurrence of " ionic clouds " was presumed. " Layer III " occurs occasionally at a uniform height of 100 km for short periods during the day or night.

In their discussion of the physical causes of these layers the writers find that " Layer I " is caused by direct ultra-violet radiation from the sun. From calculations given in former papers (1931, pp. 373 and 373–374) and the time lag mentioned above for " Layer I," an estimate of the recombination coefficient can be obtained and also of the density of the atmosphere at the height where reflection takes place [these estimates, however, are not actually given]. The absolute temperature at the reflection height for " Layer I " is thence found to be 400° or 500° C. " Layer II " is thought to be caused by charged corpuscles radiated from the sun, as also " Layer III," which is probably the same as Appleton's " E " region (1930, pp. 446–447) while " Layer I " is probably Appleton's " F " region.

RECORDS OF THE EFFECTIVE HEIGHT OF THE KENNELLY-HEAVISIDE LAYER [Frequencies 2 050 and 4 095 kc/s].—G. W. Kenrick. (*Physics*, May, 1933, Vol. 4, No. 5, pp. 194–195.)

Results during the winter of 1932–3 with the equipment previously described (July Abstracts, pp. 386–387). Among points mentioned, " in the case of nearly all the records a tendency to decreased effective heights and stronger reflections shortly after midnight but long before dawn is noted. . . . This sometimes results in a minimum height at approximately 3 or 4 a.m., and sometimes E layers appear at this period. . . . While several explanations of these phenomena (which are apparently rather consistently observable) are possible, they seem to indicate a definite increase in ionisation between midnight and dawn. The 4 095 kc records clearly show a number of multiple reflections at the dawn and sunrise periods. Marked ' splits ' are also to be noted at such times, which may be attributable to double refraction phenomena. The tendency of the effective height on 4 095 kc to reach a minimum at times approximating those at which the E layer becomes ' critical ' for 2 050 kc is also clearly marked. . . ."

SELECTIVE FADING PHENOMENA AND HEIGHT MEASUREMENTS OF THE IONOSPHERE.—P. von Handel and H. Plendl. (*Hochf:tech. u. Elek:akus.*, April, 1933, Vol. 41, No. 4, pp. 141–147.) A very full summary, by Plendl, of the paper dealt with in July Abstracts, pp. 383–384.

LAYER HEIGHT MEASUREMENT: A PULSE-GENERATING CIRCUIT USING THE INTERMITTENT DISCHARGE THROUGH A GAS-FILLED TRIODE.—Verman and Mahomed. (*Electrotechnics, Bangalore*, April, 1933, No. 6, p. 9.)

" A new method of generating short-period pulses of 0.0001 sec. duration and 150-cycle frequency, which is simpler than the methods used hitherto. . . ." No details are given.

A GENERAL THEORY OF THE PROPAGATION OF RADIO WAVES IN THE IONISED LAYER OF THE UPPER ATMOSPHERE.—S. Namba. (*Rep. of Rad. Res. and Works in Japan*, Dec., 1932, Vol. 2, No. 3, pp. 303–328.) *See* May Abstracts, p. 265, r-h column.

SOME LONG-DISTANCE TRANSMISSION PHENOMENA OF LOW-FREQUENCY WAVES.—E. Yokoyama and I. Tanimura. (*Ibid.*, pp. 329–336.) *See* May Abstracts, p. 264, l-h column.

THE OPTICAL BEHAVIOUR OF THE GROUND FOR SHORT RADIO WAVES.—C. B. Feldman. (*Proc. Inst. Rad. Eng.*, June, 1933, Vol. 21, No. 6, pp. 764–801.)

Author's summary :—The rôle of the ground in radio transmission is first considered generally. In short-wave propagation taking place *via* the Kennelly-Heaviside layer only the ground in the vicinity of the antennas is involved, and its effect may be included in antenna directivity. The utility of so ascribing the ground effect exclusively to the terminals of a radio circuit rests on the applicability of simple wave reflection theory in which the distance between the terminals does not appear. For this purpose reflection equations, similar to Fresnel's equations for a non-conducting dielectric, are employed with a complex index of refraction.

The paper describes experiments undertaken to determine the limits of applicability of these optical reflection equations, and discusses the results. Particular emphasis is placed on the identification of direct and reflected waves. The existence of a surface wave, foreign to simple reflection theory, is recognised with vertical antennas, when the incident wave is not sufficiently plane. At angles of incidence between grazing and the pseudo-Brewster value the requirements of planeness are severe. The relation of optics to Sommerfeld's theory is discussed. The experiments include tests made with the aid of an airplane.

For short-wave communication *via* the Kennelly-Heaviside layer, use of the modified Fresnel equations is shown to be justified. These equations fail only at substantially grazing incidence and then merge into the Sommerfeld ground wave solution. The ground effect is always to discriminate against radiation or reception at very low angles.

Two methods of determining the electrical constants of the ground are described. One comprises measurements of the elliptical polarisation of the ground wave, and is based on Sommerfeld's propagation theory. The other is a method of measuring, at radio frequencies, the conductivity and dielectric constant of samples of ground removed from the natural state. Suitable agreement between the two methods is found if the non-uniformity and stratification of natural ground is considered. The sample method is also used to determine the conductivity of ocean water.

THE INFLUENCE OF THE EARTH IN RADIO COMMUNICATION.—R. L. Smith-Rose. (*World-Radio*, 30th June, 14th and 21st July, 1933, Vols. 16 and 17, Nos. 414, 416 and 417, pp. 861 and 863, 46, and 77.)

KORTE-GOLF OMROEP IN NEDERLANDSCH-INDIË (Short-Wave Broadcasting in the Dutch East Indies).—W. G. Kuyck. (*Tijdschr. Nederl. Radiogen.*, May, 1933, Vol. 6, No. 3, pp. 65–72.)

Diagrams are given combining observations of field strength, atmospheric disturbance and fading on wavelengths of 49.5, 31.3 and 19.56 metres emitted during 1931 from an experimental sender at Tandjong Priok. The observations were made at 210 stations scattered over the whole of the East Indies. No effect of the form of the emitting antenna on the observations was detected.

NUAGES DANS LA STRATOSPHERE (Clouds in the Stratosphere).—C. Störmer. (*Comptes Rendus*, 12th June, 1933, Vol. 196, No. 24, pp. 1824–1825.)

" Southern Norway possessing a series of stations linked by telephone and provided with special apparatus for photographing the aurora borealis, we have succeeded in obtaining not only thousands of photographs of aurora but also several hundred photographs of very remarkable clouds situated in the stratosphere. There are two essentially different types of these : first, the luminous night clouds at a height of about 82 km, and second, beautiful mother-of-pearl clouds situated 20 to 30 km [especially 23 to 29 km] above the ground." 1932 was particularly rich in such clouds and it has been possible to make exact determinations of their height and velocity : a typical value for the latter, in the case of the luminous night cloud, was 50 m/sec. Clouds of this first type were seen only during the summer; the mother-of-pearl type almost exclusively during the winter, at times of deep depressions in Northern Europe. Observations on moon-lit mother-of-pearl clouds lead to the conclusion that their particles do not exceed 0.0025 mm in diameter. "The next time these mother-of-pearl clouds show themselves, it will be of great importance to sound the upper atmosphere with balloons provided with recording instruments, to determine the nature of these remarkable clouds."

THE ABSORPTION OF OXYGEN IN THE ULTRA-VIOLET [and the Existence of an O_4 Molecule].—L. Herman. (*Comptes Rendus*, 19th June, 1933, Vol. 196, No. 25, pp. 1877–1880.)

IONISATION OF AIR AND HYDROGEN IN THE HIGH-FREQUENCY DISCHARGE.—Th. V. Jonescu and Irène Mihul. (*Comptes Rendus*, 19th June, 1933, Vol. 196, No. 25, pp. 1873–1875.)

Further development of the work dealt with in August Abstracts, pp. 439–440.

SUR LA DÉCHARGE EN HAUTE FRÉQUENCE (The High-Frequency Discharge [and the Formation of "Plasmoids" at the Mid-Points of the Internodes of the Standing Waves)].—M. Chenot: Wood. (*Comptes Rendus*, 26th June, 1933, Vol. 196, No. 26, pp. 1973–1975.)

Further development of the work dealt with in May Abstracts, p. 266 (Gutton and Chenot) and back references, which also deal with Wood's "plasmoidal discharges."

METALLREFLEXION. IV. ELEKTRISCHE WELLEN IN DER KURVE (Metallic Reflection. IV. Propagation of Electromagnetic Waves along Curved Wires).—I. Ebeling. (*Zeitschr. f. Physik*, 1933, Vol. 83, No. 9/10, pp. 669–683.)

Former papers in this series appeared in *Zeitschr. f. Physik*, 1925, Vol. 32, p. 489, and 1929, Vol. 58, p. 333. The experimental investigations described in this paper lead to the conclusion that the wavelength of electromagnetic oscillations impressed on a Lecher system whose wires are partly straight and partly curved may be considerably greater than those of a system of straight wires. The periodic time is however found to be the same. Thus the velocity of the waves along curved wires appears to be greater than the velocity of light.

LUMINOUS DISCHARGE BETWEEN LECHER WIRES IN A PARTIALLY EVACUATED TUBE.—W. D. Hershberger, H. A. Zahl and M. J. E. Golay. (*Phys. Review*, 15th June, 1933, Series 2, Vol. 43, p. 1042.)

Abstract only. A luminous discharge took place between the voltage loops on Lecher wires coupled to a Barkhausen-Kurz oscillator generating undamped 65-cm waves, and enabled a visual study to be made of the changes in potential distribution as various circuit adjustments were made.

DIELEKTRISCHE POLARISATION IN FESTEN KÖRPERN (Dielectric Polarisation in Solid Bodies).—J. Errera. (*Physik. Zeitschr. der Sowietunion*, No. 5, Vol. 3, 1933, pp. 443–468.)

A survey of the writer's prolonged researches, some of which have been dealt with in 1931 Abstracts, pp. 205 and 435, r-h columns.

ZUR THEORIE DES SKINEFFEKTS (The Theory of the Skin Effect).—E. Rothe. (*Zeitschr. f. Physik*, 1933, Vol. 83, No. 3/4, pp. 184–186.)

An integral equation is found for the skin effect for cylindrical conductors of any shape, using only Maxwell's equations and the usual boundary conditions, with Sommerfeld's radiation condition.

ELECTROMAGNETIC-WAVE PROSPECTING IN U.S.S.R. [and the Theory of Propagation in Semi-Conducting Media].—Petrowsky. (*See* under "Miscellaneous.")

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

RELATIONS BETWEEN THE COMBINATION COEFFICIENTS OF ATMOSPHERIC IONS.—F. J. W. Whipple. (*Proc. Phys. Soc.*, 1st May, 1933, Vol. 45, Part 3, No. 248, pp. 367–380.)

Author's abstract:—The principal object of the paper is to put forward for consideration a formula, $\eta_{12} - \eta_{10} = 4\pi e w_1$, which indicates that the combination coefficient η_{12} for small ions and large ions of the opposite sign exceeds the coefficient η_{10} for small ions and uncharged nuclei, and further that the difference between the two coefficients depends on the mobility w_1 of the small ions. The experimental evidence for the formula is discussed, as well as possible applications.

RADIO IMPULSES FOUND COMING FROM HEART OF MILKY WAY.—K. G. Jansky. (*Sci. News Letter*, 3rd June, 1933, Vol. 23, No. 634, p. 339.)

See August Abstracts, p. 441, r-h col. Using an extremely sensitive receiver tuned to 20 600 kc/s, the author detected a particular kind of static, concerning which he states that it was "always a little stronger coming from one direction than from all other directions, and that this direction of maximum static hiss was continually rotating around the horizon, approximately once a day." This rotation period corresponded exactly with the stellar rotation period. It appears that there is a stream of radio impulses coming from a definite point in the heavens located very near the centre of the Milky Way.

HYPOTHESIS ON THE SOURCE OF ELECTROSTATIC AND MAGNETIC FIELDS OF THE EARTH.—K. Machihara. (*Journ. I.E.E. Japan*, March, 1933, Vol. 53 [No. 3], No. 536: English summary pp. 18–19.)

PRECAUTION AGAINST DISTURBANCES CAUSED BY THUNDERSTORMS ON ELECTRIC POWER TRANSMISSION LINES [Thunderstorm Observations and Warnings in Tokyo and Yokohama].—K. Takasawa. (*Journ. I.E.E. Japan*, Jan., 1933, Vol. 53 [No. 1], No. 534: English summary pp. 8–9.)

INVESTIGATION OF THE ACTION OF THE KLYDONOGRAPH.—E. Wilkinson. (*E.T.Z.*, 29th June, 1933, Vol. 54, No. 26, pp. 627–629.)

SPARK DISCHARGE IN THE AIR, PART III.—Y. Asami. (*Journ. I.E.E. Japan*, Jan., 1933, Vol. 53 [No. 1], No. 534: English summary, pp. 4–7.)

Continuation of the work referred to in 1932 Abstracts, p. 577, r-h col.

STUDY OF THE ELECTRIC DISCHARGE [Velocity and Properties of Second Negative Streamer]. —Y. Toriyama and U. Shinohara. (*Ibid.*, Feb., 1933, Vol. 53 [No. 2], No. 535: English summary pp. 11–13.)

PRINCIPLES OF STATISTICAL ANALYSIS OCCASIONALLY OVERLOOKED [Application to Cosmic Ray Data].—A. G. McNish. (*Journ. Franklin Inst.*, June, 1933, Vol. 215, No. 6, pp. 697–703.)

"Seven frequently overlooked sources of error in the statistical analysis of periodicities are discussed and illustrations of them are drawn from recent published discussions of cosmic-ray observations."

ANALYSIS OF THE ABSORPTION CURVE OF COSMIC RADIATION.—E. Lenz: Regener. (*Zeitschr. f. Physik*, 1933, Vol. 83, No. 3/4, pp. 194–213.)

Values are found for the absorption coefficients of the various components of cosmic radiation as measured by Regener (April and August Abstracts, pp. 209 and 442.)

INVESTIGATION OF COSMIC RADIATION IN THE WILSON CHAMBER.—P. Kunze. (*Zeitschr. f. Physik*, 1933, Vol. 83, No. 1/2, pp. 1–18.)

Further development of the work dealt with in February and May Abstracts, pp. 94 (r-h) and 268 (l-h column). The directional distribution of the tracks at the earth's surface, projected on the plane of the chamber, is found to be similar to a $\sin^2$-curve. The nature of the double tracks obtained is discussed and calculations are given for a two-body impact on relativistic lines. The specific ionisation is treated by counting the drops in the track.

ON THE NATURE OF THE PRIMARY COSMIC RADIATION.—W. F. G. Swann. (*Phys. Review*, 1st June, 1933, Series 2, Vol. 43, No. 11, pp. 945–946.)

The writer of this letter has deduced from the classical and from the wave mechanical theories an equation which shows that ionisation by charged particles should become inappreciable when their energy is about 10^{10} volts. The primary positive cosmic ray particles entering the earth's atmosphere may be assumed to have energies of this order and to generate secondaries with energies of about 10^9 volts, which are the particles observed experimentally. The primary energy of 10^{10} volts is necessary in order that the particles, coming from distances many times the earth's radius, may reach it at the low latitudes at which radiation is observed.

THE ABSORPTION OF COSMIC RADIATION.—B. Gross. (*Zeitschr. f. Physik*, 1933, Vol. 83, No. 3/4, pp. 214–221.)

A simple relation is given for the determination of the intensity for perpendicular incidence, from the intensity values experimentally determined for radiation incident from all sides.

THE AZIMUTHAL ASYMMETRY OF THE COSMIC RADIATION IN MEXICO CITY.—T. H. Johnson. (*Journ. Franklin Inst.*, June, 1933, Vol. 215, No. 6, pp. 749–753.)

A note on work already referred to in August Abstracts, pp. 442–443.

ANGULAR DISTRIBUTION OF COSMIC-RAY PARTICLES. —J. C. Stearns and R. D. Bennett. (*Phys. Review*, 15th June, 1933, Series 2, Vol. 43, pp. 1038–1039.)

Experimental results indicate a maximum intensity in the vertical direction at Denver, in agreement with the theory of Vallarta and Lemaitre (*see* Johnson, August Abstracts, pp. 442–443).

A NEW METHOD OF DIRECT DETERMINATION OF THE NATURAL ANGULAR DISTRIBUTION OF COSMIC RAYS [Rotatable System of Tube Counters of Varying Lengths].—L. Tuwim. (*Comptes Rendus*, 8th May, 1933, Vol. 196, No. 19, pp. 1431–1433.)

ÜBER DIE EIGENSCHAFTEN DER DURCHDRINGENDEN KORPUSKULARSTRAHLUNG IM MEERESNIVEAU (The Properties of the Penetrating Corpuscular Radiation at Sea-Level).—B. Rossi. (*Zeitschr. f. Physik*, 1933, Vol. 82, No. 3/4, pp. 151–178.)

This paper contains a description and discussion of all the author's work on the penetrating power of cosmic rays; most of the results have already been published (*cf.* Abstracts, 1931, pp. 264, 377, 552, 609; 1932, pp. 90, 401, 456; 1933, p. 95; *see* also July, p. 388, l-h col.). The coincidence method was used for measurements of absorption in lead up to a thickness of 101 cm: the results agreed with those to be expected if the primary cosmic radiation was corpuscular in nature. The production of secondary particles in the matter penetrated by the cosmic radiation was directly shown; they were able to penetrate 1 cm thickness of lead. The percentage of secondary radiation was found to increase with the angle of incidence.

USE OF ARGON IN THE IONISATION METHOD OF MEASURING COSMIC RAYS AND GAMMA RAYS.—J. J. Hopfield. (*Phys. Review*, 1st May, 1933, Series 2, Vol. 43, No. 9, pp. 675–686.)

The writer compares pressure–ionisation curves for argon and for air and finds that argon is about twice as sensitive as air for use in cosmic and gamma-ray ionisation chambers. The ratio of the intensity of cosmic rays to gamma rays is found to be lower for argon than for air in the ionisation chamber at the same pressure.

Detection of the Ionisation by Individual Cosmic Rays.—W. F. G. Swann. (*Phys. Review*, 1st May, 1933, Series 2, Vol. 43, No. 9, p. 775 : abstract only.)

The writer finds a value of the ionisation as about 200 ions per cm of path per atmosphere at 4 atmospheres.

A Lens for Cosmic-Ray Electrons.—W. F. G. Swann and W. E. Danforth, Jr. (*Phys. Review*, 1st May, 1933, Series 2, Vol. 43, No. 9, p. 778 : abstract only.)

Two vertical concentric tubes are used, between which a p.d. is maintained. Rays passing through one counter may be focused so as to pass through the other. The construction of the tubes is described.

Measurements of Cosmic Rays with a New Type of Counter Tube [and the Action of the Rays on Chemical Elements : Ionisation (Extranuclear Electrons) and Absorption (Nuclei)].—L. Tuwim. (*Comptes Rendus*, 3rd July, 1933, Vol. 197, No. 1, pp. 79–81). Using the very rarified counter tube referred to in July Abstracts, p. 388, l-h column.

Remarks on the Problem of Cosmic Rays [Generation of "Positive Electrons" by Impact on Matter].—H. Kallmann. (*Naturwiss.*, 19th May, 1933, Vol. 21, No. 20, pp. 365–366.)

Production of Secondaries by Cosmic Rays.—J. C. Street. (*Phys. Review*, 15th June, 1933, Series 2, Vol. 43, p. 1055 : abstract only.)

Secondary Effects of Cosmic Radiation.—E. Fünfer. (*Zeitschr. f. Physik*, 1933, Vol. 83, No. 1/2, pp. 92–103.)

PROPERTIES OF CIRCUITS

Building-Up of a Self-Oscillation in an Oscillation Circuit including a Periodically Varying Inductance [H.F. Alternator of Inductor Type].—Y. Watanabe, T. Saito, and Y. Kaito. (*Journ. I.E.E. Japan*, March, 1933, Vol. 53 [No. 3], No. 536 : English summary p. 21.)

A special case of the phenomenon investigated by Winter-Günther (1931 Abstracts, p. 437). The writers obtained an output of several hundred watts.

Über den gedämpften Resonanzkreis mit eisenhaltiger Induktivität (The Damped Resonance Circuit with Iron-Cored Inductance [Graphical Determination of Stationary Conditions]).—W. Diesendorf. (*Elektrot. u. Masch : bau*, No. 5, Vol. 51, 1933, pp. 57–59.)

Transients in Negative Constant Series Circuits.—L. C. Verman. (*Journ. Indian Inst. Sci.*, Vol. 15 B, Part III, pp. 33–42.)

Continuation of the work dealt with in Abstracts, 1931, p. 379, r-h col. The Mathes and Dudley negative impedance circuits (Crisson, 1931, p. 627, r-h col.) can be treated as negative impedances for transient as well as steady state currents, just like the Bartlett type. Charts are given for transient solutions of series combinations of positive and negative circuit constants. For circuits containing only negative constants, the transient currents die out after a certain time, as they do in circuits containing only positive constants ; but in circuits containing combinations of positive and negative constants they increase with time, until a limit is reached where the negative constants lose their pure negative character. What happens then depends on the particular circuit employed to obtain the negative constant.

Method of Calculating the Attenuation in a Band-Pass Filter arbitrarily composed of Inductances, Resistances, Capacities, Transformers.—H. Pleijel. (*L'Onde Élec.*, April, 1933, Vol. 12, No. 136, p. 15 A : summary only.)

"If the propagation constant of the filter is determined, neglecting the resistances, the latter can easily be allowed for on the supposition that they are small compared with the reactances : it is sufficient to regard them as *real* additions to the *imaginary* impedances : the increase of the propagation constant is then obtained as a differential."

Discussion on "A Practical Analysis of Parallel Resonance."—W. J. Seeley : Lee. (*Proc. Inst. Rad. Eng.*, June, 1933, Vol. 21, No. 6, pp. 875–876.)

For Lee's paper *see* May Abstracts, p. 269. In his reply to Seeley the writer agrees that a definition of parallel resonance must distinguish not only between unity power factor and maximum impedance but also between the kinds of resonance arrived at by tuning with different circuit elements : "if inductance is used for tuning, the definition must further state whether the resistance generally in series with the inductance varies or not, and if it varies, in what way . . . A suitably phrased set of definitions might do a great deal to clarify the situation."

High-Frequency Amplifier with Series Resonant Circuit [as Plate Load instead of Usual Parallel Resonant Circuit : Improved Results in Amplification and Stability, *e.g.* in I.F. Amplifier of Superheterodyne Receiver].—E. Iso. (Summary only in *Rep. of Rad. Res. and Works in Japan*, Dec., 1932, Vol. 2, No. 3, Abstracts and References Section, pp. 16–17.)

The Balancing and Stabilising of H.F. Amplifiers.—Ure, Grainger and Cantelo. (*See* under "Transmission.")

Decoupling Efficiency [and a Convenient Alignment Chart].—W. A. Barclay. (*Wireless Engineer*, June, 1933, Vol. 10, No. 117, pp. 307–309.)

An Example of a Complete Analogy between Electrical and Mechanical Oscillation.—C. Ramsauer. (*Physik. Zeitschr.*, 1st June, 1933, Vol. 34, No. 11, pp. 459–461.)

A complete analogy for an electrical oscillating circuit is found in two equal hollow spheres containing air, connected by a tube with a small turbine in the middle. The air oscillates between the two spheres and the volume of each sphere is the mechanical equivalent of the capacity of the condenser in the electrical circuit.

TRANSMISSION

I TRIODI A RISCALDAMENTO INDIRETTO QUALI GENERATORI DI MICROONDE (The Indirectly Heated Triode as Generator of Micro-Waves). —A. Giacomini. (*Alta Frequenza*, Dec., 1932, Vol. 1, No. 4, pp. 500–508.)

See also 1932 Abstracts, p. 581, r-h col. Among the results obtained, it was found that for constant potentials applied to the valve, λ varied linearly with the length l of the Lecher system connected to grid and anode; that an increase of grid or anode potential caused a displacement of the range of oscillation towards shorter or longer wavelengths respectively; that in spite of the dependence of λ on l, if l was kept constant small variations of λ could be obtained by the variation, within wide limits, of the anode or grid voltages; and that a law of the type $\lambda = f(V_g)$ could be established on the condition that every value of V_g was associated with that value for l, and for λ, which corresponded to a maximum amplitude of oscillation. Fig. 4 shows the variation, with emission current, of the zone of oscillation, and finally Fig. 5 gives a comparison between the wavelengths measured, as a function of the grid voltage, and those calculated from Scheibe's formula.

The wavelengths and received e.m.fs were measured by an electro-acoustic method which has several advantages. A third Lecher wire system with movable discs is loosely coupled to the generating circuit. The r.f. current is rectified by a zincite-tellurium contact, and instead of being passed through a galvanometer is periodically interrupted by a 200 c/s tuning-fork contact and sent through a transformer and amplifier to a loud speaker. Thus the nodes and antinodes are conveniently indicated. A potentiometer and cell circuit, with a milliammeter in series, is included in the arrangement (Fig. 2), and by adjusting the potentiometer till the loud speaker is silent an indication is obtained of the mean value of the e.m.f. across the rectifying contact.

STUDIES ON RADIOTELEPHONE TRANSMITTERS AND RECEIVERS FOR ULTRA-SHORT WAVES.—H. Ataka. (*Journ. I.E.E. Japan*, April, 1933, Vol. 53 [No. 4], No. 537: English summary pp. 27–28.)

Characteristics of the Mesny push-pull oscillator are discussed: oscillating current I_0 increases almost linearly with plate voltage, which must exceed a certain value in order to start an oscillation; there is an approximate relation $I_0 = RI_g/(R_g + R_0)$ where R_g is the grid resistance and R and R_0 are constants; I_0 is maximum for an optimum value of R_g almost independent of plate voltage; if R_g is small the oscillator is unstable at high negative grid-bias voltage (hence plate modulation is better than grid modulation).

The receiver is super-regenerative; the writer finds that an ordinary regenerative circuit, if properly designed (Fig. 3), gives the same effect as a super-regenerative circuit: "the sensitivity of the receiver increases as the plate voltage increases, and for the best receiving condition the receiver is found to be in a state of free oscillation, the amplitude of which is fairly strong": this is explained by the production of a l.f. oscillation (owing to the presence of the grid condenser) which quenches the u.s.w. oscillation as in a super-regenerative receiver.

ON THE INTENSITY OF ELECTRON OSCILLATION IN A TRIODE.—K. Morita. (*Rep. of Rad. Res. and Works in Japan*, Dec., 1932, Vol. 2, No. 3, pp. 211–282.)

English version of the paper dealt with in March Abstracts, p. 154.

ON THE PRODUCTION OF ULTRA-SHORT-WAVE OSCILLATION WITH A COLD-CATHODE DISCHARGE TUBE [and Strong Magnetic Field].—K. Okabe. (*Journ. I.E.E. Japan*, May, 1933, Vol. 53 [No. 5], No. 538: English summary p. 33.)

THE GENERATION OF ULTRA-SHORT WAVES BY MAGNETRON OSCILLATORS WITH MULTIPLE FILAMENTS.—S. Uda, N. Ochiai and T. Seki. (*Journ. I.E.E. Japan*, May, 1933, Vol. 53 [No. 5], No. 538, pp. 365–368: in Japanese, with diagrams.)

COMPARISON BETWEEN PUSH-PULL CONNECTED AND PARALLEL CONNECTED TYPES OF ELECTRON OSCILLATION [Ultra-Short-Wave] CIRCUITS. —K. Yamauchi. (*Journ. I.E.E. Japan*, March, 1933, Vol. 53 [No. 3], No. 536, pp. 236–239: in Japanese, with numerous diagrams).

EIN NEUER FUNKENOSZILLATOR FÜR DEZIMETERWELLEN (A New Spark Oscillator for Decimetre Waves [Concentric Tube Circuit Design, for Greatly Increased Powers]).—L. Rohde and H. Schwarz. (*Hochf:tech. u. Elek:akus.*, June, 1933, Vol. 41, No. 6, pp. 207–210.)

The writers begin by stating that with spark oscillators with quasi-stationary circuits the maximum outputs in accordance with theory have already been attained and no further increase seems possible. In discussing their grounds for this statement they refer to the work of Busse and of Haupt (Abstracts, 1928, pp. 408–409: 1931, p. 612); the former's announcement of 50 watts radiated energy at 30 cm appears to them inexplicable. They themselves have obtained, with such circuits, values of some tenths of a watt—about what they would expect from their calculations.

In order to exceed such outputs, large capacities must be used. This involves reducing the inductances to correspond, and this cannot be done beyond a certain extent without losing the quasi-stationary conditions. Pupp's breaking-down plate condenser (1930, p. 43) was on such lines, but its current distribution was unfavourable to the production of high outputs. The writers then describe their own design of oscillator, enormous compared with the typical quasi-stationary circuit (for a comparison *see* Fig. 2), and consisting of a length of concentric tubing, open at both ends, whose inner and outer tubes form a capacity which is charged by a transformer to 5000 v r.m.s. and discharged through a central spark gap. A standing wave is produced along the tubes, and a coupling loop connected to two points on the inner tube, symmetrical as regards this wave, serves to bring out the energy. This coupling loop, like one spark-gap lead and one transformer lead, passes through holes in the outer tube in order to reach the inner tube.

Details of the apparatus are given. For an 80-cm wave the outer tube is 40 cm long and 3 cm in diameter, with a capacity of some 125 cms (compared with about 2 cms in an ordinary quasi-stationary circuit). If it is desired to radiate the energy, the simplest plan is to prolong the inner tube by $\lambda/4$ at each end. Fig. 5 shows such an arrangement (for a 20-cm wave) combined with a parabolic reflector of rods. The shortest wave-length demonstrably obtained was 14 cm. With an 80-cm wave the power measured in a secondary circuit was from 3–5 watts. Constancy of output within 2–3% can be maintained over several hours.

THE BALANCING AND STABILISING OF HIGH-FREQUENCY AMPLIFIERS, WITH SPECIAL REFERENCE TO POWER AMPLIFIERS FOR RADIO TRANSMITTERS [for Naval Ship Use].—W. Ure, E. J. Grainger and H. R. Cantelo. (*Journ. I.E.E.*, June, 1933, Vol. 72, No. 438, pp. 528–546.)

The full paper, a *Wireless Engineer* summary of which was dealt with in August Abstracts, p. 446, l-h column.

AUMENTO DELLA MODULAZIONE NEI TRASMETTITORI RADIOTELEFONICI (Increase of Modulation in Radiotelephonic Transmitters).—F. Marietti. (*Alta Frequenza*, Dec., 1932, Vol. 1, No. 4, pp. 516–539.)

Author's summary :—The principles of radiotelephonic modulation are recalled and the advantages presented by a high percentage of modulation at the transmitter are brought out. Methods of raising this percentage to 100% in old transmitters are then discussed, the problem being treated differently according to whether the modulation occurs in an intermediate or in the final stage. The procedure for calculating the modifications necessary for obtaining 100% modulation is given for the former case, and the steps to take to raise the percentage in the second case are indicated. As a practical example a description is given of the complex modulation system of the Turin transmitter, in which the degree of modulation has recently been raised from 70% to 100%. An appendix gives a résumé of the various types of amplification in use [American "Classes A, B and C" and English "Classes I, II, III and IV"].

TELEPHONY BY CARRIER AND ONE SIDE BAND.—S. P. Chakravarti. (*Journ. Indian Inst. Sci.*, Vol. 15 B, Part IV, pp. 43–48.)

Apart from the usual transmission methods (single side band : carrier and both side bands) there should be a third, employing the carrier and one side band, which should have the advantages of requiring no carrier replacement at the receiver, as in the first system, and a width of filter only half that required by the second system. The writer examines the theory of such a third system and describes his experimental confirmation of his conclusions. An additional advantage is that the reproduced speech does not suffer from phase distortion as in the suppressed carrier method. A disadvantage is that the speech band cannot be amplified by supplying a carrier of large amplitude at the receiver, but has to be amplified by voice-frequency amplifiers.

THEORETICAL AND EXPERIMENTAL STUDIES ON THE FREQUENCY STABILISATION OF THE DYNATRON-TYPE OSCILLATOR [including the Use of an Additional Inductance in the Dynode Circuit].—T. Hayasi. (*Journ. I.E.E. Japan*, May, 1933, Vol. 53 [No. 5], No. 538 : English summary p. 35, Japanese paper with diagrams pp. 389–394.)

The additional inductance L' is coupled electromagnetically to the inductance L in the oscillation circuit. Equation 15 is derived for the oscillation frequency, from which it is seen that when $L' = L$ the frequency is unaffected by changes of d.c. power-supply voltages or secondary circuit constants. Experimental confirmation is given. The condition for the maintenance of oscillation in a dynatron circuit is discussed in detail : the condition derived by Hull and others is seen to be the simplest special case of the generalised equation here developed.

The absolute value of the effective negative resistance is shown to decrease when the additional resistance in series with L' takes a comparatively large value. Finally a method is given of stabilising by means of a quartz resonator, making use of the "Ziehen" phenomenon.

A MORE STABLE CRYSTAL OSCILLATOR OF HIGH HARMONIC OUTPUT [Screen-Grid Valve with Tuned Circuit between Cathode and Earth, Crystal between Grid and Cathode].—J. J. Lamb. (*QST*, June, 1933, Vol. 17, No. 6, pp. 30–32.)

MORE ON TRANSMISSION-LINE ["Impedance-Line"] INTERSTAGE COUPLING [between Exciter and Power Amplifier].—(*QST*, June, 1933, Vol. 17, No. 6, p. 34.)

CIRCUITS WITHIN CIRCUITS : A DISCUSSION OF PARASITIC OSCILLATIONS IN NEUTRALISED AMPLIFIERS.—G. Grammer. (*QST*, June, 1933, Vol. 17, No. 6, pp. 11–15.)

NEW RADIO TELEPHONE EQUIPMENT FOR TRANSPORT AIRPLANES ; *and* A THREE-FREQUENCY RADIO TELEPHONE TRANSMITTER FOR AIRPLANES.—D. K. Martin : W. C. Tinus. (*Bell Lab. Record*, May, 1933, Vol. 11, No. 9, pp. 262–266 and 267–272.)

DUPLEX PORTABLES [Portable Self-Contained "Transceivers" for Transmission and Reception, weighing 23 Pounds].—F. P. Keefer and L. E. Grant. (*QST*, June, 1933, Vol. 17, No. 6, pp. 8–10 and 35.)

RECEPTION

RADDRIZZAMENTO DI TENSIONI ALTERNATIVE AD ALTISSIMA FREQUENZA (10^9 Hertz) MEDIANTE DIODI (The Rectification of Alternating Voltages at Ultra-High Frequencies by means of Diodes [Micro-Wave Detection]).—N. Carrara. (*Alta Frequenza*, Dec., 1932, Vol. 1, No. 4, pp. 509–515.)

The writer's researches on micro-wave detection by triodes have already been published (January Abstracts, p. 38, r-h column). The present paper describes how these researches led to the detection of the 50-cm waves by diodes. The receiving dipole was connected through a concentric feeder, ending in a parallel-wire pair of variable length and spacing, to the grid and the negative end of the filament of the Métal T.M.C. triode which had been found so suitable for micro-wave reception. The plate was either left insulated or connected to the grid. The grid and the negative end of the filament were connected through a microammeter.

The theory of the process is considered and compared with that for rectification at ordinary radio frequencies (10^5 c/s). It is concluded that when the potentials are very small it is no longer possible to neglect the initial velocities of the electrons and the effect of the space charge, and that this explains the fact that for fairly large distances between transmitting and receiving aerials it is no longer possible to rectify micro-waves by the circuit described, whereas the usual arrangement of triode (strongly positive grid, feeder connected to plate and filament) still functions well.

STUDIES ON RADIOTELEPHONE TRANSMITTERS AND RECEIVERS FOR ULTRA-SHORT WAVES [and the Super-regenerative Action of an ordinary Regenerative Receiver].—Ataka. (*See* under " Transmission.")

ÜBER SCHNELLTELEGRAPHIE-EMPFANG IM DRAHTLOSEN ÜBERSEEVERKEHR AUF KURZWELLEN (High-Speed Telegraphic Reception on Short-Wave Transoceanic Services [with particular reference to the " Double Undulator " System for Combating Fading and Atmospherics]).—H. Mögel. (*E.N.T.*, June, 1933, Vol. 10, No. 6, pp. 237–241.)

After a general survey, the writer describes the " double recorder " or " double undulator " system of reception, in which two separate recorders work on a common tape, rather wider than the usual; these two recorders are supplied by two independent receivers whose multiple-aerial systems are spaced at least 15–20 wavelengths apart, and each recording system has its own regulating and limiting appliances controlled from the operating desk. The effect of fading can be thus reduced to 1–2% and the service improved over 100%; in many cases the speed can be multiplied by eight. The writer compares the system with the RCA method using three similar aperiodic aerial systems with three similar receivers automatically regulated together. " Since, with the Double Undulator, each of the recording systems possesses its own limiting and regulating arrangements, not only can fading compensation be accomplished, but also a decrease of the effects of atmospherics—a result of special importance with the longer short waves. For this purpose the one amplitude is limited rather more downwards, the other rather more upwards. Aerials and receivers need not be of the same type: it is not necessary for the l.f. outputs to be of the same order of magnitude. . . . If a combination of receivers at two stations more than 10 km apart is employed, local disturbances from unavoidable switching processes or thunderstorms may be almost completely eliminated."

DER EINFLUSS DER ANPASSUNG AUF VERSTÄRKUNG UND SELEKTIVITÄT IN ABGESTIMMTEN HOCHFREQUENZVERSTÄRKERN (The Influence of Matching [Circuits with Valves] on the Amplification and Selectivity of Tuned R.F. Amplifiers).—H. G. Baerwald. (*E.N.T.*, June, 1933, Vol. 10, No. 6, pp. 258–276.)

The writer remarks that in broadcast receivers with r.f. amplification too little attention is often given to matching the oscillatory circuits with the valves; he therefore examines the subject in order to bring out clearly and quantitatively the effect which such matching has on the amplification and selectivity, taking first the simple practical example of the popular two-circuit receiver with a screen-grid r.f. stage followed by a detector with retroaction coupling, usually by a tuned rejector circuit. Incidentally, he refutes the common idea that such a coupling gives the same wide adjustment of amplification and selectivity as is given by the retroactive audion circuit with variable aerial coupling, so that it is in fact considered to be nearly equivalent to an additional r.f. stage. " This idea is erroneous on grounds of matching: a resonance damping decrease can only lead to a marked heightening of amplification and selectivity when combined with a corresponding coupling variation leading to good matching; whereas the coupling by the rejector circuit is rigid."

He then investigates the rôle played by matching in the design of multi-circuit r.f. amplifiers, where the urgency lies in the attainment not of the greatest amplification but of the greatest selectivity; the matching and detuning of the various circuits must be arranged to give the nearest approximation to the ideal square-topped resonance curve. The degree of such approximation, as a function of the number of circuits, is given in Fig. 12 for some typical cases; here the ordinates represent a figure of merit (" Güte ") which the writer introduces for the purpose. This figure of merit g is the ratio of the detuning which reduces amplitudes to 50% to the detuning which reduces them to 1%. Finally, he discusses the relative merits of such a series of r.f. amplifier circuits and of the band-pass filter circuits of Cauer and Jaumann (Abstracts, April, p. 228, and 1932, p. 537, r-h columns), ending by comparing the resonance curves of the 4-stage amplifier series (given in Fig. 10 for three different conditions of matching and detuning) with the curve of a Jaumann 4-stage filter (curve *J* of Fig. 10). Fig. 14 gives another comparison of the same two arrangements.

THE OPTIMUM DECREMENT OF TUNED CIRCUITS FOR THE RECEPTION OF TELEPHONY [with Channels spaced 9 kc/s].—D. A. Bell. (*Wireless Engineer*, July, 1933, Vol. 10, No 118, pp. 371–374.)

" When selectivity was normally only required to separate stations some 40 kc/s apart, it was natural to think of the desired transmission as occupying the peak of the resonance curve, which was more or less flat-topped, and interfering signals away on the skirt of the curve. With this picture in one's mind it seemed obvious that selectivity could always be improved by pushing up the peak of the curve. Under present-day conditions, with powerful stations only 9 kc/s apart, the side bands of the desired transmission and interfering signals merge into one another, so that selectivity is largely governed by the slope of a particular portion of the curve. With this new point of view we must reconsider the whole question from first principles." It is assumed that tone-correction can be provided to an unlimited extent, and with any desired frequency characteristic.

THE THEORY AND PRACTICE OF TONE CORRECTION: ERRATA.—F. M. Colebrook. (*Wireless Engineer*, June, 1933, Vol. 10, No. 117, p. 315.)

In Figs. 4 and 7 of the article dealt with in March Abstracts, p. 156, "μH" should read "mH."

REMARKS ON "A NOTE ON THE THEORY AND PRACTICE OF TONE-CORRECTION" [Additional Method depending on Series Resonant Circuit consisting of Choke in Grid Lead, Its Input Capacity, and the A.C. Resistance of Preceding Valve].—W. F. Cope: Colebrook. (*Wireless Engineer*, July, 1933, Vol. 10, No. 118, p. 370.)

TRANSFORMERLESS PLATE SUPPLIES [for Receiver Valves].—(*QST*, June, 1933, Vol. 17, No. 6, pp. 24 and 72.)

DECOUPLING EFFICIENCY [and a Convenient Alignment Chart].—W. A. Barclay. (*Wireless Engineer*, June, 1933, Vol. 10, No. 117, pp. 307–309.)

RECEIVING SETS FOR THE TROPICS: A PLEA FOR STUDY OF THE EASTERN MARKET.—(*World-Radio*, 23rd June, 1933, Vol. 16, No. 413, p. 825.)

From a Malaya correspondent. Among various points mentioned are the following:—Troubles are usually to be traced to the breakdown of insulation and unsatisfactory methods of wiring. Components should be marketed in sealed, evacuated tins. There is an ever-growing demand for a really good medium- and short-wave radio-gramophone.

PRACTICAL HINTS ON Q. P. P.—R. W. Hallows. (*World-Radio*, 14th and 21st July, 1933, Vol. 17, Nos. 416 and 417, pp. 47 and 78–79.)

HIGH-FREQUENCY AMPLIFIER WITH SERIES RESONANT CIRCUIT [as Plate Load instead of Usual Parallel Resonant Circuit: Improved Results in Amplification and Stability, *e.g.* in I.F. Amplifier of Superheterodyne Receiver].—E. Iso. (Summary only in *Rep. of Rad. Res. and Works in Japan*, Dec., 1932, Vol. 2, No. 3, Abstracts and References Section, pp. 16–17.)

BRIDGE-TYPE PUSH-PULL AMPLIFIERS [to avoid Hum induced in Coupling Transformer].—L. Tulauskas. (*Electronics*, May, 1933, Vol. 6, No. 5, pp. 134–135.)

SQUARE-TOP FILTERS [especially for the I.F. Circuits of Superheterodyne Receivers].—Piesch. (*Electronics*, May, 1933, Vol. 6, No. 5, pp. 136–137.) Based on Piesch's article dealt with in April Abstracts, pp. 211–212.

A NOTE ON INTERFERENCE TONES IN SUPERHETERODYNE RECEIVERS.—W. F. Floyd. (*Proc. Phys. Soc.*, 1st July, 1933, Vol. 45, Part 4, No. 249, pp. 610–616.)

Author's abstract:—The question of interference tones, in the case of a superheterodyne receiver, presents certain features not encountered in the case of non-heterodyne types of receivers. Briefly, the problem involves (1) the reception of at least three signals, (2) double detection, and (3) a filter action between the two detectors. In the case of rectification by detectors with generalised characteristics, quantitative analysis is extremely complex. The form of the result, however, shows how large is the number of possible sources of interference tones. The specific case of square-law rectification is considered also.

THE PENTAGRID CONVERTER [Combined Oscillator-Detector for Superheterodyne Receivers].—C. L. Lyons. (*Wireless Engineer*, July, 1933, Vol. 10, No. 118, pp. 364–369.)

See also July Abstracts, p. 394, r-h column. "The 2A7 and 6A7 valves mark a definite step forward in the simplification of the most popular type of receiver which, to-day, seems to be the superheterodyne."

NEW IDEAS FOR THE SUPERHETERODYNE [including the Pentagrid Valve as Frequency Changer].—W. T. Cocking. (*Wireless World*, 14th July, 1933, Vol. 33, pp. 20–21.)

THE NEW MONODIAL SUPER.—W. T. Cocking. (*Wireless World*, 21st and 28th July, 1933, Vol. 33, pp. 34–37 and 52–56.)

A seven-valve a.c. mains-operated superheterodyne receiver for the amateur constructor. The principal features are a single-valve frequency changer, employing the new Pentagrid valve, and a double-diode pentode which serves as the second detector, the A.V.C. valve and the tone corrector.

CONVERTING STANDARD SUPERHETS TO S.S. ["Single Signal"] RECEIVERS.—J. J. Lamb. (*QST*, June, 1933, Vol. 17, No. 6, pp. 25–26 and 72, 74.)

Continuing the series of articles referred to in August Abstracts, p. 446, r-h column.

A CRYSTAL CONTROL SUPERHETERODYNE RECEIVER [for Aeroplanes: Western Electric 12A Receiver].—H. B. Fischer. (*Bell Lab. Record*, May, 1933, Vol. 11, No. 9, pp. 273–278.)

A "National" Two-Valve Receiver with "Free-Swinging" Loud Speaker, costing 76 RM.—(*E.T.Z.*, 29th June, 1933, Vol. 54, No. 26, p. 638.)

At the request of the Ministry of Propaganda, the Radio industry in Germany is combining to put on the market a cheap equipment to receive the local station and the Deutschlandsender. Special arrangements (*e.g.*, output of 100 000, reduced royalties and profits, etc.) are necessary to produce at the price named. *See* also *Wireless World*, 7th July, 1933, p. 7, for an interview with Leithäuser, the designer of this "Volksempfanger." The receiver must not be "too good," otherwise the listener might hesitate to buy a more expensive set even if he had the money for it!

An A.C. Short-Wave One-Valve Receiver [using a Pentode: Smooth Reaction down to 10 Metres].—(*World-Radio*, 7th July, 1933, Vol. 17, No. 415, p. 22.)

Class "B" Economy is Two-Fold.—M. G. Scroggie. (*Wireless World*, 7th July, 1933, Vol. 33, pp. 2–3.)

It is now well known that the quiescent output systems, to which Class "B" amplification belongs, afford a considerable measure of h.t. battery economy, as the current consumed is proportional to the signal strength. It is probably not so well known, however, that these quiescent methods are in themselves much more efficient than the ordinary push-pull scheme with mid-point bias. In this article the author sets forth some interesting results of efficiency measurements.

Avoidable Interference.—André L. J. Bernaert. (*Wireless World*, 7th July, 1933, Vol. 33, pp. 4–5.)

Discussing the various causes of electrical interference, with particular reference to the part played by electric wiring and metal pipes in disseminating it to points remote from its source.

The Radio Exhibitions [National and International] in Paris, 1932. (*L'Onde Élec.*, April, 1933, Vol. 12, No. 136, pp. 180–209.)

AERIALS AND AERIAL SYSTEMS

Some Notes on "Wave Canal" [Directional Aerial System for Ultra-Short Waves, using a Line of Wave Directors with Metallic Plates forming a Partial or Complete Rectangular Tube].—S. Nakamura. (*Journ. I.E.E. Japan*, March, 1933, Vol. 53 [No. 3], No. 536: English summary p. 25, Japanese paper with diagrams pp. 240–243.)

The received currents are more than 2–3 times as great as with the "ordinary wave canal" (*see* March Abstracts, p. 159, l-h column).

The Gain in Beam Antennas.—Y. Kato and H. Takeuchi. (Summary only in *Rep. of Rad. Res. and Works in Japan*, Dec., 1932, Vol. 2, No. 3, Abstracts and References Section, pp. 13–14.)

"Calculations for the gain in the Telefunken or similar type of beam antennas are given. The beam antenna is considered to be an assembly of half-wave dipoles, which are arranged in order equally at a distance of a half wavelength in both horizontal and vertical directions. . . . It is shown that by calculating the radiation resistances by the integration of the Poynting flux radiated from the antenna, the gain expressed in decibels may be given by the formula

$$g = 20 \log_{10} N + 10 \log_{10} r_{n,m} - 0.86,\text{"}$$

where $r_{n,m}$ is the sum of a number of terms involving m, n, μ, ν, etc. The effect of the reflector is also considered, the increase in gain being found to be 3 db. "Curves are given, with which the gain may be found graphically for various sizes of antennas." *Cf.* Labus, 1932 Abstracts, p. 285, l-h column.

Note on Directed Transmissions [from a Single, Greek-Pattern Array: the Production of Two Beams rotating in Opposite Directions by a Periodic Variation of Wavelength].—G. Longo. (*L'Onde Élec.*, April, 1933, Vol. 12, No. 136, pp. 210–212.)

The writer considers a single Greek-pattern array, fed at one end and having its vertical portions rather longer than the horizontal. For any wavelength between two limiting values there are two horizontal directions, symmetrical with respect to the array, for which the field strength is a maximum, being much smaller for every other horizontal direction: correspondingly, for any horizontal direction there is one wavelength between these limits, and only one, which gives a maximum in this direction. Consequently if the array is fed with a wave of periodically varying length, two beams are obtained in the horizontal plane, rotating in opposite directions with a constant angular velocity: or by a suitable modification the angle of rotation can be made to vary according to any desired function of the time.

The Resistance of Earth Electrodes [for Earthing Electrical Installations and Apparatus].—P. D. Morgan and H. G. Taylor. (*Journ. I.E.E.*, June, 1933, Vol. 72, No. 438, pp. 515–518.)

Among the score of conclusions and recommendations at the end of the paper may be mentioned:—even a very small proportion (less than ½% by weight of moisture) of common salt in the moisture of the soil may reduce the resistance of an electrode by as much as 80%, and replenishment is necessary much less frequently than is usually anticipated (once a year would meet almost all cases, and in some soils once in 3 years would suffice): "copper sulphate has certain advantages and is not much inferior, though it is probably more expensive." There is a value of moisture content which it is unnecessary to exceed: a water-logged situation is not essential to a low resistance unless the soil be sand or gravel.

[Broadcast Receiving] Aerials and Lightning.—(*World-Radio*, 30th June and 7th July, 1933, Vol. 16 and 17, Nos. 414 and 415, pp. 868 and 17.)

THEORETICAL AND EXPERIMENTAL INVESTIGATIONS OF THE VIBRATIONS IN OVERHEAD LINES.—H. Schmitt and P. Behrens. (*E.T.Z.*, 22nd June, 1933, Vol. 54, No. 25, pp. 603–605.)

VALVES AND THERMIONICS

THE INDIRECTLY-HEATED TRIODE AS GENERATOR OF MICRO-WAVES.—Giacomini. (*See* under "Transmission.")

CLASS B AMPLIFIERS CONSIDERED FROM THE CONVENTIONAL CLASS A STANDPOINT.—J. R. Nelson. (*Proc. Inst. Rad. Eng.*, June, 1933, Vol. 21, No. 6, pp. 858–874.)

Author's summary :—The wave form of the output current of an ideal tube is analysed when plate current cut-off occurs between zero and 180° of the cycle. The theory thus developed is applied to practical tubes, and it is shown that one of the tubes operated in series may be represented as a hypothetical class A amplifier provided that twice the plate load resistance cuts off the plate current for the input voltage used. It is also shown that a diagram may be constructed from the characteristics of a tube for any operating condition from class A to class B with half the wave cut off. The load resistance used may then be transferred back to the characteristic. This load resistance shows conditions under which each tube is operating and explains why it is possible to obtain more than twice the power output under some conditions with two tubes than with one tube under the same conditions.

THE PENTAGRID CONVERTER [Combined Oscillator-Detector for Superheterodyne Receivers].—Lyons. (*See* under "Reception.")

HIGH-FREQUENCY PENTODES.—R. Wigand. (*Radio, B., F. für Alle*, July, 1933, pp. 315–317.)

HEXODES, A NEW TYPE OF RECEIVING VALVE.—Telefunken Company. (*E.T.Z.*, 22nd June, 1933, Vol. 54, No. 25, p. 611.) *See* also Aug. Abstracts, p. 450 (three).

ELECTRONICS AND ELECTRON TUBES. PART IV : CONTROL OF ELECTRON SPACE CURRENTS [Dynatron, Pliotron, Tetrode and Pentode, Magnetron, Axiotron]. PART V : PLIOTRON AND SCREEN-GRID TUBE APPLICATIONS.—E. D. McArthur. (*Gen. Elec. Review*, June and July, 1933, Vol. 36, Nos. 6 and 7, pp. 282–289 and 330–336.)

IMPORTED VALVES—APPLICATION FOR MARKING ORDER UNDER THE MERCHANDISE ACT.—(*Electrician*, 23rd June, 1933, Vol. 110, No. 2873, p. 834.)

THE RADIO EXHIBITIONS IN PARIS, 1932 [including Transmitting and Receiving Valves].—(*L'Onde Élec.*, April, 1933, Vol. 12, No. 136, pp. 180–209.)

DYNAMIC MEASUREMENT OF ELECTRON TUBE COEFFICIENTS.—W. N. Tuttle. (*Proc. Inst. Rad. Eng.*, June, 1933, Vol. 21, No. 6, pp. 844–857.)

Large errors in dynamic measurements are possible in the case of modern valves with high plate resistance, if the currents through the inter-electrode capacitances are not compensated. It is also desirable to minimise the effect of the measuring apparatus impedance, and to permit the measurement of negative as well as positive values of the coefficients. The writer, after an analysis of the necessary circuits, describes a single test instrument for the measurement of the three usual coefficients, over wide ranges of values, in which all these requirements are satisfied.

THE DIAL-CODED UNIVERSAL TUBE CHECKER AND CIRCUIT ANALYSER.—C. B. De Soto. (*QST*, June, 1933, Vol. 17, No. 6, pp. 21–23.)

THEORY OF THERMIONIC VACUUM TUBES.—E. L. Chaffee. (Book Review in *Wireless Engineer*, July, 1933, Vol. 10, No. 118, p. 380.)

ÜBER DAS VERHALTEN VON SCHIRMGITTERRÖHREN BEI ANWESENHEIT VON SEKUNDÄRELEKTRONEN (The Behaviour of Screen-Grid Valves in the Presence of Secondary Electrons).—J. Herweg and G. Ulbricht. (*Hochf:tech. u. Elek:akus.*, June, 1933, Vol. 41, No. 6, pp. 189–194.)

The characteristic curves of the screen-grid and anode currents, for varying anode voltages, are first examined. With control-grid potential as parameter, the falling part of the anode-current curve slopes more steeply as this grid potential is increased, so that the curves radiate out from each other (Fig. 1). This phenomenon was referred to in an earlier paper (1932 Abstracts, pp. 417–418) and was made use of for an asymmetrical "trip" circuit for a cathode-ray oscillograph. The reason for it is here investigated. Tests on a number of valves with cylindrical electrodes show how small variations in the construction may easily give anomalies, due to secondary electrons, in the characteristic curves. The anomalies shown in Fig. 5 are caused by the following effect : for a certain potential distribution in the valve, when the anode voltage is not very different from the s.g. voltage, the secondary electrons set free at the anode fly back to the anode and in so doing may pass through the screen grid (Fig. 6a), thus increasing the anode current and decreasing the s.g. current. Such an effect can only occur with cylindrical electrodes. A similar anomaly is that of Fig. 7, where the sum of the anode and s.g. currents increases suddenly when the anode and s.g. potentials are equal : this is due to some of the secondary electrons set free at the anode reaching the control grid instead of the screen grid (Fig. 6b).

The rest of the paper deals with the penetration coefficient ("durchgriff.") Reference to Fig. 1, discussed above, shows that the penetration coefficient, which is given by the horizontal distances between the curves, cannot be constant as the anode voltage changes, but must take on all values positive and negative [in this connection it is pointed out that though, with s.g. valves, there are two "durchgriffs," one for constant anode current and one for constant emission current ($i_a + i_{sg} + i_g$), only the former is important]. Fig. 8 is a curve of the penetration coefficient as the anode voltage is increased: it shows two high peaks, for $V_a = 0$ and $V_a = V_{sg}$; the latter peak rises to 300%, so that at this point a small variation of anode potential will change the anode current 300 times as much as an equal change in control-grid potential (assuming constant s.g. potential). These peaks are due to space charges. When $V_a = 0$ (or more strictly when $V_a = -0.1/0.2$ volt, allowing for the initial velocities of the electrons) the electrons reverse before reaching the anode; when $V_a = V_{sg}$ the secondary electrons at anode and screen grid form a cloud in unstable equilibrium, so that the least change in the potential of either electrode produces a very large effect. Fig. 8 also shows that as long as the anode characteristic (labelled J_a) is falling, the penetration coefficient is negative.

Die Sekundäremission in Elektronenröhren, namentlich Schirmgitterröhren (Secondary Emission in Thermionic, particularly Screen-Grid, Valves [with Special Reference to H.F. Transmitting Valves]).—C. J. de L. de la Sablonière. (*Hochf:tech. u. Elek:akus.*, June, 1933, Vol. 41, No. 6, pp. 195–202.)

From the Philips' laboratories. In a.f. output valves the effects of secondary emission can be overcome by the use of a third grid, at filament potential; the difficulty is greater in r.f. transmitting valves, since here the screen grid has also to function as an electrostatic screen. For this purpose the grid must be made of fine-meshed gauze, so that the s.g. current (at the expense of anode current) is rather large. Under these conditions, secondary emission has a favourable effect (so long as the anode alternating potential amplitude remains less than the difference between the anode and s.g. d.c. potentials) in rendering the s.g. current smaller and the anode current larger. The present paper deals with measurements, by an extension of the methods used for triodes by Lange and others, on the Philips' s.g. transmitting valves dealt with in an earlier paper (1932 Abstracts, pp. 527–528). These measurements bring out clearly various phenomena concerning the current distribution in s.g. valves. Thus equations 19 and 20 define two coefficients γ_1 and γ_2, referring to secondary emission at screen grid and anode respectively, which can be represented as functions of the velocity of the primary electrons for various ratios of anode and control-grid voltages (Fig. 13). Each coefficient is the product of two factors, the effective reflection coefficient (giving the number of secondary electrons set free by one primary electron) and the saturation coefficient (giving the percentage of these electrons actually reaching the screen grid and anode).

Die Bestimmung des Schirmgitterverlustes einer gesteuerten Schirmgitter-Senderöhre (The Measurement of the Screen-Grid Loss of a Driven S.G. Transmitting Valve).—C. J. de L. de la Sablonière. (*Ibid.*, pp. 202–203.)

In a previous paper (1932 Abstracts, pp. 527–528) the writer gave an approximate formula for this loss in terms of screen-grid d.c. voltage and mean *primary* s.g. current. Making use of results obtained in the paper just dealt with in the preceding abstract, he now obtains a new formula, containing only factors which are directly given by the d.c. voltmeter and ammeter, and thus capable of being a practical help in avoiding over-loading of the screen grid. This formula is

$$W_{sg} \approx p V_{sg}(I_{sg} + I_a),$$

where p is a valve constant, V_{sg} is the s.g. d.c. potential, and the two currents are the average values.

Der innere Widerstand von Schirmgitterröhren (The Internal Resistance of Screen-Grid Valves).—C. J. de L. de la Sablonière. (*Ibid.*, pp. 204–205.)

Making use of the results and data of the two papers dealt with above, together with a new measurement, the writer investigates the internal resistance of the Philips' s.g. transmitting valve Type QC 05/15. The conductance is given by the sum of the "ideal" internal conductance, the conductance resulting from the variation of the primary electron distribution over screen grid and anode, and the conductance resulting from the gradually occurring saturation of the secondary s.g. current. For an anode voltage of 500 v, s.g. voltage of 120 v and control grid voltage of -6 v, these three conductances are found to be 88×10^{-8}, 8.4×10^{-8}, and 273×10^{-8} respectively, so that their sum is 370×10^{-8}: the internal resistance, the reciprocal of this, is thus about 270 000 ohms. A direct measurement gives about 200 000 ohms: this agreement is satisfactory in view of the nature of the data, and is at least sufficient to show that for this valve type it is the gradual saturation of the secondary s.g. current which is the main hindrance to an approach to the "ideal" resistance, here over a million ohms.

Thermal and Photoelectric Emission from Caesium–Caesium Oxide Cathodes, and the Influence Exerted on Emission by Inclusion of Caesium Atoms in the Dielectric.—de Boer & Teves. (*Zeitschr. f. Physik*, 1933, Vol. 83, No. 7/8, pp. 521–533.)

Effect of High Series Resistance on Cold Emission.—R. W. Mebs. (*Phys. Review*, 15th June, 1933, Series 2, Vol. 43, pp. 1058–1059.)

Abstract only. "Breakdown due to disruption of the cathode surface is not produced by the electric stresses due to the field, but instead is a function of the current."

The Effect of Temperature on the Emission of Electron Field Currents from Molybdenum and Tungsten.—A. J. Ahearn. (*Phys. Review*, 15th June, 1933, Series 2, Vol. 43, p. 1058: abstract only.)

Thermionic and Adsorption Characteristics of Platinum on Tungsten.—R. W. Sears and J. A. Becker. (*Phys. Review*, 15th June, 1933, Series 2, Vol. 43, p. 1058: abstract only.)

A New Method of Determining Thermionic Work Functions of Metals, and Its Application to Nickel.—G. W. Fox and R. M. Bowie. (*Phys. Review*, 15th June, 1933, Series 2, Vol. 43, p. 1057: abstract only.)

Note on Contact Potential Difference [and Thermionic Work Functions].—A. T. Waterman. (*Phys. Review*, 15th June, 1933, Series 2, Vol. 43, p. 1048: abstract only.)

The Temperature Dependence of the Work Function for Composite Surfaces.—W. H. Brattain and J. A. Becker. (*Phys. Review*, 15th June, 1933, Series 2, Vol. 43, p. 1058: abstract only.)

The Dependence of Adsorbed Ions on Temperature.—J. A. Becker and W. H. Brattain. (*Ibid.*, p. 1058: abstract only.)

DIRECTIONAL WIRELESS

A Radio Range Beacon Free from Night Effects [by the Use of Ultra-Short Waves]. —H. A. Chinn. (*Proc. Inst. Rad. Eng.*, June, 1933, Vol. 21, No. 6, pp. 802–807.)

Including a short account of tests with a four-course beacon (crossed loops) working on 34.6 Mc/s, the transmitter consisting of a 75 w oscillator operating on 17.3 Mc/s and two 75 w tetrodes, with grids in parallel, acting as frequency doublers. Continuous day and night observations over several months failed to reveal any variations; "the 'on-course' position remained fixed at all times in the direction it was orientated." Ground tests were confined to within 35 miles of the transmitter; "flight tests (over great distances) indicate that the range over which the signals can be used is greatly in excess of that which the quasi-optical relationship would suggest"; this also held good for transmission entirely over sea. Vertical transmitting aerials instead of loops would have been much more efficient. The vertical aerials used on aeroplanes for radio range reception would be particularly suitable for use with such u.s.w. beacons.

On the Solution of the Problem of Night Effects with the Radio Range Beacon System [the "Transmission Line" Antenna System: Adcock Principle].—H. Diamond. (*Proc. Inst. Rad. Eng.*, June, 1933, Vol. 21, No. 6, pp. 808–832.)

See also March Abstracts, p. 162. Experimental data are included comparing the performances of the "T-L" antenna system and the old loop antenna system under nearly identical conditions. With the former, "the beacon course is satisfactory through its entire distance range, the night effects becoming negligible."

Blind Landing of Aircraft.—(*Bur. of Stds. Tech. News Bull.*, May, 1933, No. 193, pp. 53–54: *Journ. Franklin Inst.*, June, 1933, Vol. 215, No. 6, pp. 742–744.)

Notes on demonstrations and service tests, since 15th March, 1933, of the radio system of landing aids at Newark Airport (August Abstracts, p. 451, r-h column).

The Production of Two Horizontal Beams rotating in Opposite Directions, by feeding a Single Greek-Pattern Array at one End with a Periodically Varying Wavelength.—Longo. (*See* abstract under "Aerials and Aerial Systems.")

ACOUSTICS AND AUDIO-FREQUENCIES

Un Résonateur piézo-électrique à Réponse uniforme pour une Gamme donnée de Fréquences (A Piezoelectric Resonator with Uniform Response over a Given Range of Frequencies [and Its Use as Electro-Optical Relay, Microphone, etc.]).—A. Guerbilsky. (*Comptes Rendus*, 19th June, 1933, Vol. 196, No. 25, pp. 1871–1873.)

For a resonator of natural frequency f to be modulated without distortion at frequencies between 0 and f', its resonance curve must have a horizontal part of width $2f'$. The usual quartz plate with parallel faces has a resonance peak of a width of the order of $f \times 10^{-4}$; for a resonance frequency of 5×10^6 c/s this width corresponds to 500 c/s, so that the maximum modulation frequency is only 250 c/s. If, however, the quartz plate is so constructed that its thickness varies from one spot to another, taking the values corresponding to the frequencies between $f - f' - a$ and $f + f' + a$ (where a is a small quantity representing the width of the localised vibrating portion), the resonance curve will have the shape required for distortionless modulation at frequencies between 0 and f'.

The writer has thus constructed electro-optical relays (using polarised light) giving an equal response for modulation frequencies up to and beyond 16 000 c/s. He has also made two types of microphone: in the first type, the oscillations of a high-frequency circuit are maintained by the quartz; since the damping of the quartz depends on the density of the surrounding medium, the amplitude of the h.f. current also depends on this density and therefore follows the variations produced by the sound wave, so that the rectified h.f. current can be used as an ordinary microphone current. In the second type, the quartz is connected in parallel with a coil and a variable condenser: the coil is coupled to a heterodyne generator and the whole circuit tuned to the mean crystal frequency, so that the corresponding point on the resonance curve lies in the "crevasse" produced by the energy absorption due to the quartz vibrations. The depth of this "crevasse" varies with the damping of the crystal and is therefore controlled by the sound wave.

On the Determination of Some of the Elastic Constants of Rochelle Salt [Piezoelectric Resonators] by a Dynamical Method.—R. M. Davies. (*Phil. Mag.*, July, 1933, Series 7, Vol. 16, No. 103, pp. 97–124.)

An Acoustic Illusion Telephonically Achieved [Microphones set into Cheek-Bones of Tailor's Dummy and connected by Separate Leads to Head-Gear Receivers: "Binaural" Reception compared with Loud Speaker Reproduction].—Harvey Fletcher. (*Bell Lab. Record*, June, 1933, Vol. 11, No. 10, pp. 286–289.)

The dummy not only supports the microphones at the proper distance apart but also modifies the sound field near them as it would be modified by the human head; the result is a complete acoustical transportation of the listener to the position of the dummy. Other tests on true "binaural" reception (two microphones, suitably separated; two lines; two separate earphones), as compared with loud-speaker reception, showed that "even the inconvenience of wearing head receivers does not prevent most observers from preferring the binaural system." Even when all frequencies over about 2 800 c/s were suppressed in the binaural system, more than a third of the observers preferred it.

ÜBER FREQUENZKURVEN VON TONABNEHMERN (The Frequency Characteristics of Electrical Gramophone Pick-Ups [and Their Dependence on the Load and on the Type of Needle]).—H. Emde and O. Vierling. (*Hochf:tech. u. Elek:akus.*, June, 1933, Vol. 41, No. 6, pp. 210–212.)

Authors' summary:—The recording of frequency curves by means of a test record [50–7 000 c/s, with indicating gaps at various intervals] and ink writer enables long series of measurements to be made in a short time, owing to the simplicity of operation. The investigation of pick-ups by this method shows the marked dependence of the frequency characteristic, and thus of the merit of the pick-up, on the needle used and on the load. It would therefore be very desirable if manufacturers of pick-ups would specify the type of needle which gave the best characteristic. It would moreover be advantageous for the regulating resistance to be built into the tone arm, so that the optimum loading might be ensured.

ELECTRO-ACOUSTIC PROPERTIES OF FLAMES [Experiments with a View to developing a New Microphone].—Verman. (*Electrotechnics, Bangalore*, April, 1933, No. 6, p. 9.)

EINIGE BEMERKUNGEN ZUR KLASSIFIKATION DER MIKROPHONE (Some Remarks on the Classification of Microphones).—A. Charkewitsch: Schuster. (*E.N.T.*, May, 1933, Vol. 10, No. 5, pp. 195–198.)

Prompted by Schuster's paper (1932 Abstracts, p. 589, l-h column).

ON THE AMPLITUDE OF LOUD SPEAKER DIAPHRAGMS AT LOW FREQUENCIES.—N. W. McLachlan. (*Wireless Engineer*, July, 1933, Vol. 10, No. 118, pp. 375–380.)

"The question arises as to the maximum amplitude permissible before alien frequencies [caused as described] become aurally disconcerting. This can only be settled properly by experiment. In the meantime, therefore, we shall approach the problem by computing the amplitudes likely to occur in the operation of loud speakers." The sections deal in succession with the amplitude to radiate 1 watt of acoustic power, the amplitude in the average case, the resonance of the diaphragm on its surround, the amplitude at resonance, the calculation of I_2/I'_2, the optimum power and amplitude at resonance [and the advantages given by an intense magnetic field] and the relationship between amplitude and loudness [with curves of "isobels" for pure tones from a loud speaker diaphragm of 10 cm radius operating in an infinite baffle in free space].

VIBRATIONS OF A COIL-DRIVEN PAPER CONE: CORRESPONDENCE.—H. F. O. Benecke: P. O. Pedersen: Strafford. (*Wireless Engineer*, May and June, 1933, Vol. 10, Nos. 116 and 117, pp. 257 and 313.)

Referring to Strafford's results (June Abstracts, p. 332, l-h col.) Benecke mentions that these "auxiliary frequencies" have given considerable trouble to loud speaker manufacturers, as they were supposed to be due to faults in the coil, diaphragm, surround, etc. Finally they were recognised as a natural and quite general peculiarity of the cones, due to an effect resembling that involved in Melde's tuning-fork and stretched string experiment, and corresponding to a Mathieu differential equation, one of whose solutions is a frequency half of the exciting frequency. Pedersen refers to mathematical and experimental researches of his own on these "sub-harmonics in forced oscillations" and quotes the inequality representing the conditions under which they may occur. He mentions that these sub-harmonics may further arise in a system where the acting force, besides being a function of the time, is also a function of the displacement (*e.g.* the case of a moving coil in an inhomogeneous magnetic field—*cf.* McLachlan, under Strafford, *loc. cit.*).

A SHORTED-TURN INDICATOR [*e.g.* for Testing Voice Coils of M.C. Loud Speakers].—C. G. Seright. (*Electronics*, May, 1933, Vol. 6, No. 5, p. 136.)

DER TEILNEHMER-ENDVERSTÄRKER (The Subscriber Output Amplifier).—R. Winzheimer and H. Reppisch. (*Hochf:tech. u. Elek:akus.*, April, 1933, Vol. 41, No. 4, pp. 129–138.)

Final part of the paper referred to in 1932 Abstracts, pp. 465 and 590, l-h columns.

SOUND FILM RECORDING [particularly the RCA Photophone System].—M. Federici. (*Alta Frequenza*, March, 1933, Vol. 2, No. 1, pp. 46–73.)

DAS TONLAMPENBRUMMEN IN LICHTTONANLAGEN (The Hum due to the Sound-Reproducing Lamp in Sound-Film Equipments [and its Dependence on the Filament-Current Alternating or Ripple Frequency and on the Nature of the Photoelectric Cell]).—P. Kotowski. (*Zeitschr. f. tech. Phys.*, No. 7, Vol. 14, 1933, pp. 270–274.)

AMPLIFICATION OF TRANSIENTS.—C. H. Smith. (*Wireless Engineer*, June, 1933, Vol. 10, No. 117, pp. 296–298.)

"A mathematical analysis which indicates discrepancies between the response of a receiver to steady tones and to transient waves, and suggests possible lines for fruitful experimental investigation." The decrement of the exponentially damped sine wave is unchanged, but the amplification obtained is greater for the damped wave train than for the undamped, particularly for those frequencies at which, owing to the presence of reactances in the coupling units, a reduction in the amplification of steady tones occurs.

A Method of Tone Control.—W. F. Cope: Colebrook. (*See* reference under "Reception.")

The Theory and Practice of Tone Correction: Errata.—Colebrook. (*See* under "Reception.")

Interpreting Distortion Data.—M. G. Scroggie: Massa. (*World-Radio*, 16th June, 1933, Vol. 16, No. 412, p. 802.)

An article on Massa's work dealt with in July Abstracts, p. 397, l-h column.

Zwei Integralgesetze des Hörens. Lautstärke und Hördauer eines Schallimpulses (Two Integral Laws of Acoustics. Loudness and Audibility Time of an Acoustic Impulse).—S. Lifschitz. (*Zeitschr. f. Physik*, 1933, Vol. 83, No. 1/2, pp. 123–128.)

The conclusion is reached that, if a musical programme is to be of artistic value, the time during which a sound is audible (which depends on the resonance of the concert hall) must be constant under all circumstances.

On Reverberation Time in Broadcasting Studios [including Sound Absorption by Artists themselves, etc.].—K. Hoshi. (*Rep. of Rad. Res. and Works in Japan*, Dec., 1932, Vol. 2, No. 3, pp. 291–301.)

Author's summary:—This is a report on the oscillographic measurements of reverberation time in broadcasting studios. The decay of sound in a studio is on the whole logarithmic, but the actual history of the decay on the oscillograms is not always regular, depending on the sound interference of the room and the directional properties of both microphone and loud speaker. To eliminate these effects, a warbling tone is necessary for the sound source. Microphones and loud speakers should be non-directional.

As the sound absorption by the artists themselves is considerable in a small broadcasting studio, a somewhat longer reverberation time is desirable when the room is devoid of occupants. The optimum reverberation time in broadcasting studios is a little shorter than in ordinary auditoriums. It has a nearly fixed value irrespective of volume. From experiments we know that they are 0.2 sec. for lectures and speeches and from 0.6 to 1.0 sec. for orchestras.

Theorie der Schallabsorption in porösen Wänden (The Theory of Sound Absorption in Porous Walls).—L. Cremer. (*E.N.T.*, June, 1933, Vol. 10, No. 6, pp. 242–251.)

The Tactual Perception of Musical Intervals.—L. D. Goodfellow. (*Journ. Franklin Inst.*, June, 1933, Vol. 215, No. 6, pp. 731–736.)

"This paper is a report of the ability of persons to recognise musical intervals by touch."

Absolute Metingen der Geluidsintensiteit ter Bepaling van het Minimum audibile (Absolute Measurements of the Loudness of Sound in the Region of the Threshold of Audibility).—H. C. Huizing. (*Ann. des P.T.T.*, April, 1933, Vol. 22, No. 4, pp. 369–370: summary only.)

The writer's two methods, for intensities of the order of 10^{-10} ergs/cm² sec., are a microscopical examination of the diaphragm and a capacity-variation ultra-micrometric method (movements of 0.001 micron). Among other results his tests on the sensitivity curve of the ear give a maximum of 10^{-9} ergs/cm² sec. in the neighbourhood of a frequency of 800 c/s.

Objektive Lautstärkemessungen (Objective Measurements of Sound Intensity [Survey]).—F. Trendelenburg. (*Elektrot. u. Masch:bau*, No. 14/15, Vol. 51, 1933, pp. 232–236.)

Die Lautstärke von Geräuschen (The Loudness of Noises [a New Theory and the Failure of the Old]).—H. Barkhausen and U. Steudel. (*Hochf:tech. u. Elek:akus.*, April, 1933, Vol. 41, No. 4, pp. 115–116.)

The original Barkhausen law, that the loudness of a non-sinusoidal sound is determined by the subjectively loudest partial tone given by Fourier analysis and the ear-sensitivity curve, provided the neighbouring partial tones differ in frequency by more than 20%, has been found to fail in certain cases when tested by means of the frequency-independent electro-dynamic telephone; the discrepancies increased as louder and louder sounds were measured. The reasons for the failure are discussed, and the note leads up to the long paper by Steudel dealt with below.

Über Empfindung und Messung der Lautstärke (The Perception and Measurement of the Loudness [of Noises and Musical Notes]).—U. Steudel. (*Ibid.*, pp. 116–128.)

See Barkhausen, above. The results of measurements on the loudness of various types of noise, chiefly clicks, single and periodic, are discussed. Some of these were made, with the help of the Barkhausen noise-meter operated by nine different observers, by direct comparison with a 1 000 c/s note; it is concluded that it is not always desirable to employ quite unpractised observers. The remaining measurements were made indirectly by means of a calibrated noise.

A number of conclusions are drawn from these tests:—(1) the human ear reacts only to changes in air pressure, which must be rapid enough (a 10 c/s note is inaudible) and must not be effaced by equal and opposite changes following too quickly (10 000 c/s note); (3) the loudness of periodically repeated clicks increases, if the repetition of the pressure impulses follow each other more than 50 times per second, to about 10 phons compared with a single click; above 50 times per second the loudness no longer increases, so that a noise of clicks following each other more than 50 times per second may be regarded as producing a continuous excitation of the ear; (4) in contrast to the very small time of 0.3 msec. for that first part of the pressure curve which determines the loudness, the decay time is of the order of 0.5 sec.; (5) it varies to some extent with the duration of the previous excitation (thus curve *c* of Fig. 12 shows an increased rate of decay for a periodic series of clicks, compared with curve *b* for notes of 480, 850 and 1 850 c/s). A footnote here reads: "That the decrease of loudness is independent of frequency is somewhat contradictory to the fact that quicker fluctuations can be heard in high notes than in low. On the other hand, very high notes seem to persist a long time." In a section on the physiological processes of sound perception it is mentioned that results (3), (4) and (5) also hold good for the eye; perception of loudness corresponds to perception of brightness, whereas perception of tone corresponds to image perception.

In addition to these conclusions, the first part of the paper gives a new formula (2) which corresponds, for single clicks, to the standard formula for a continuous 1 000 c/s note, namely, $L = 20 \log p/p_0$, where $p_0 = 3.2 \times 10^{-4}$ bar_{eff} ($1\ \text{bar}_{\text{eff}} = 70$ phons). This new formula involves what the writer names the "impulse time" of 0.3 msec. referred to in (4) above.

Part II first discusses the possible development of an objective loudness-meter which would give a direct reading of the surface area represented by formula (2). Such an apparatus would be extraordinarily difficult to construct, and the writer therefore goes on to describe an improved equipment on more orthodox lines. He gives his reasons for choosing peak-value rather than effective-value recording: the latter in some cases gives completely erroneous results, being really only suitable for musical sounds and certain types of noise in little-damped halls. But even the peak-value method, in its simple form, gives wrong results in certain cases; to allow for the asymmetrical pressure curves so often encountered, full-wave rectification is essential, and in the equipment described this rectifying stage (four rectifiers in bridge connection) is supplemented by a second stage (peak-rectifying audion) for the sake of very sharply peaked noises such as those from motorcycles. The paper ends with examples of the use of the equipment and a comparison (Fig. 24) of its results with those given by other systems of sound measurement.

A Valve Voltmeter for Audio-Frequencies, Calibrated by Direct Current [using a Triode with Grid and Anode connected].—(*Wireless Engineer*, June, 1933, Vol. 10, No. 117, pp. 310–312.)

Calibration of Low Audio-Frequencies [using an Ordinary Electric-Mains Clock and the Output Stage of a Radio Receiver].—E. R. Meissner. (*Electronics*, May, 1933, Vol. 6, No. 5, p. 137.)

A Machine which generates a Modulated Frequency Band [Carrier Frequency of 500 c/s already modulated with a 25 c/s Note: for Long-Distance Telephone Calling].—W. Dornig. (*E.T.Z.*, 29th June, 1933, Vol. 54, No. 26, pp. 623–625.)

Standard Audio-Frequency Oscillator [20 to 10 000 c/s, Power Output 20 mw].—Standard Telephones & Cables, Ltd. (*Wireless Engineer*, July, 1933, Vol. 10, No. 118, p. 363.)

The Velocity of Sound in Gases in Tubes.—G. W. C. Kaye and G. G. Sherratt. (*Proc. Roy. Soc.*, 3rd July, 1933, Vol. 141, No. A 843, pp. 123–143.)

The experiments described in this paper form a continuation of work in which one resonating tube only was used (1931 Abstracts, p. 390, l-h column). Here six tubes were used, of various diameters and of three different materials—glass, copper and carbon. Two temperatures (18° C and 100° C) and six different gases were employed. A valve-oscillator system controlled by a vibrating quartz crystal, which also served as a resonance detector, provided a series of frequencies from 500 to 27 000 c/s. Free space velocities for the pure dry gases used are given. "The results indicate that for all the gases the Helmholtz-Kirchhoff formula is quantitatively correct in its statement of the influence of tube diameter and frequency on the velocity."

The Absorption of Sound in Air and Water Vapour.—V. O. Knudsen. (*Phys. Review*, 15th June, 1933, Series 2, Vol. 43, p. 1051: abstract only.)

The Transfer of Vibrational Energy between Molecules.—H. O. Kneser. (*Phys. Review*, 15th June, 1933, Series 2, Vol. 43, p. 1051: abstract only.)

Heterodyne Detection of Super-Audible Acoustic Waves in Air.—H. Yagi and S. Matsuo. (*Rep. of Rad. Res. and Works in Japan*, Dec., 1932, Vol. 2, No. 3, pp. 287–290.)

Authors' abstract:—"At the transmitter, a super-audible acoustic wave is produced by a magnetostriction oscillator. At the receiver, a feeble wave is produced by means of the Johnson-Rahbek phenomenon, or by some other method whereby the frequency may be continuously varied. Although a heterodyne beat is obtained, the ear is still unable to detect it. Close to the nozzle of a pipe, an air-jet is blown in a slanting direction. The jet, besides causing a rectifying action of the acoustic wave, causes at the same time a sort of super-regenerative amplification. Audible sounds of the beat frequency are then picked up and amplified." The distance covered was about 200 metres, using a UX201A valve oscillator. "It should be noted that beam signalling by acoustic waves is usually very liable to excessive fading."

Locating Fish by Submarine Echoes.—(*Electronics*, May, 1933, Vol. 6, No. 5, p. 132.)

A Measurement of the Fundamental Sound Generated by the Airscrew of an Aeroplane in Flight: *and* The Propagation of Sound along the Slipstream of an Airscrew.—E. T. Paris. (*Phil. Mag.*, July, 1933, Series 7, Vol. 16, No. 103, pp. 50–61: 61–64.

PHOTOTELEGRAPHY AND TELEVISION

Theoretical Notes on Certain Features of Television Receiving Circuits [including Correction of Resistance-Coupled Amplifiers by Addition of Small Amounts of Inductance].—G. D. Robinson. (*Proc. Inst. Rad. Eng.*, June, 1933, Vol. 21, No. 6, pp. 833–843.)

" While on the one hand we see published characteristics of single stages of resistance-coupled amplifiers indicating that a solution has not been provided, on the other hand we have demonstrations of operation of television equipment which show that some sort of a solution has been provided. The conclusion that should be drawn from this apparent contradiction is thought to be that no *simple* and accurate solutions to the problems of television amplification have been published." The writer deals in turn with the determination of the $C \times R$ value required to keep the distortion for a single stage below a certain percentage ; the addition of small amounts of inductance to decrease the variation in amplification and the phase shift at relatively high frequencies (curves for practical use are given) ; and the employment of a pair of detector valves with push-pull input and simple parallel output, to eliminate the usual r.f. by-pass condenser with its danger of by-passing useful high frequencies, and to give a more favourable ratio of resistance to capacity. " Somewhat similar results should be obtainable with the Wunderlich tube, except that it is not available for plate detection."

Reception of Television : How the Cathode-Ray Oscillograph can be Utilised.—R. Hardy. (*Electrician*, 30th June, 1933, Vol. 110, No. 2874, pp. 854–856.)

A Note on the Kerr Cell [and the Distortion due to the Curvature of Its Characteristic].—E. E. Wright. (*Proc. Phys. Soc.*, 1st May, 1933, Vol. 45, Part 3, No. 248, pp. 469–473.)

Author's abstract :—The distortion due to the curvature of the light/voltage characteristic of a Kerr cell is discussed, and an expression giving the amplitudes of the Fourier components of the light-variation due to a pure alternating potential applied to the cell is obtained. Sets of curves showing the variation of percentage of second and third harmonic with bias and amplitude of the applied alternating potential are given. The working conditions for minimum distortion obtained from these curves agree with those used in practice.

Betrachtungen zur neuzeitlichen Erzeugung von Licht (Considerations on the Latest Methods of Generating Light [including the Sodium Vapour Lamp for Television, etc.]).—M. Pirani. (*Elektrot. u. Masch:bau*, No. 14/15, Vol. 51, 1933, pp. 222–227.)

An Electro-Optical Relay using a Quartz Resonator with Uniform Response over a Wide Range of Frequencies.—Guerbilsky. (*See* abstract under " Acoustics and Audio-frequencies.")

The Bernheim Photoelectric Cell, functioning without Current Amplification.—Bernheim : G. Mazo Company. (*Génie Civil*, 10th June, 1933, Vol. 102, No. 23, p. 549.)

Externally, the cell consists of a silver-gray metallic disc about 4 cm in diameter, mounted on ebonite and provided with two side terminals. " This cell, which functions as a photoelectric element [by the Becquerel effect], is composed of crystals of rare metals in combination with rare earths : the whole thus forms photoactive, oriented elements, the upper layer serving as cathode and the support as anode." The current given is proportional to the intensity of the incident luminous flux, there being no " dark " current. A 50 candle-power lamp placed 1 metre from the cell produces an output of 12 μA ; sunlight easily gives 40 mA. The cell should be especially useful for photometric and colorimetric measurements, as its sensitivity maximum coincides with that of the eye. Its sensitivity also extends into the infra-red and ultra-violet regions, it is insensitive to temperature variations, and has practically no inertia.

The Copper-Cuprous-Oxide Rectifier and Photo-electric Cell.—Grondahl. (*See* under " Subsidiary Apparatus and Materials.")

Report on the Theory of Semi-Conductors [including Sections on Internal Photo-Effects, Contact Theory, etc.].—Fowler. (*See* under " Subsidiary Apparatus and Materials.")

MEASUREMENTS AND STANDARDS

Verlustwinkelmessung mit Hochfrequenz an Kondensatoren (The Measurement at High Frequencies [above 1 Mc/s] of the Loss Angles of Condensers).—L. Rohde and W. Schlegelmilch. (*E.T.Z.*, 15th June, 1933, Vol. 54, No. 24, pp. 580–584.)

After a short discussion of the problem, the writers first describe the procedure and equipment used for wavelengths of 300–20 metres, on the substitution principle. The testing circuit is loosely coupled to the three-point, interchangeable-coil generating circuit, and is perfectly symmetrical. A special valve voltmeter is used, with a diode with small internal capacity and an almost " point " filament (Abstracts, 1931, p. 393) ; the d.c. potential is measured on an electrostatic instrument such as a thread electrometer. The wavelength of the generator is measured by the Rohde and Schwarz wavemeter (January, p. 49) ; since this combines a wide-range circuit (giving about 0.3 w) and a precision circuit, it is often used as the generator itself. With this equipment, tan δ can be measured within $\pm 3\%$, a measurement on one wave taking about 1 minute for small loss angles. For values over 10^{-2} a slightly different procedure is necessary, giving a similar accuracy but taking about 15 minutes. The above equipment is excellent down to a 20 m wave. For a 6 m wave a second equipment is employed (Figs. 4 and 5), the procedure being a combination of damping measurement and amplitude comparison.

The rest of the paper gives the result of tests, on wavelengths of 300, 150, 75, 25 and 6 metres, on a number of natural and artificial dielectrics, including many of the ceramic type.

A Method of Measuring High Insulation Resistances [Loss of Charge Principle with Constant Applied Voltage].—P. J. Higgs. (*Journ. Scient. Instr.*, June, 1933, Vol. 10, No. 6, pp. 169–174.)

An Instrument for the Measurement of Dielectric Loss in Insulations [for Rapid Routine Testing Purposes: using Gold-Leaf Electrometer in a Null Method].—G. R. R. Bray. (*Journ. Scient. Instr.*, June, 1933, Vol. 10, No. 6, pp. 183–184.)

Sur la Définition et la Mesure de la Résistance d'une Prise de Terre (The Definition and Measurement of the Resistance of an Earth Connection).—R. Bigorgne and P. Marzin. (*Ann. des P.T.T.*, April, 1933, Vol. 22, No. 4, pp. 313–340.)

There are many methods and instruments for measuring the resistance of an earth connection; often they lead to results which differ, giving grounds for thinking that such a resistance is a badly defined quantity. "The object of the researches here described was to obtain an exact definition of the resistance of an earth connection, to study the conditions of its measurement, and to determine the influence exerted by certain factors [length of base, frequency, measuring current intensity, etc.] on the result obtained."

The Resistance of Earth Electrodes.—Morgan and Taylor. (*See* under "Aerials and Aerial Systems.")

A Geophysical Earth Tester [Modification of "Megger" Earth Tester to give a Second Range of 0–0.3 Ohms].—(*Journ. Scient. Instr.*, June, 1933, Vol. 10, No. 6, pp. 185–187.)

The Measurement of the Resistance of Earths by the Mocquard Apparatus.—Bridoux: Mocquard. (*Génie Civil*, 22nd July, 1933, Vol. 103, No. 4, p. 95.) *See* also 1931 Abstracts, p. 163, l-h column.

Accidental Errors in A.C. Bridges [with Special Earthing Devices to secure Perfect Balances: Reduction of Errors by a "Method of Repetition."]—K. Ogawa. (*Journ. I.E.E. Japan*, April, 1933, Vol. 53 [No. 4], No. 537: English summary p. 29.)

The capacity of the condenser under test is subtracted several times from the known capacity, by the substitution method; the final remainder is measured and from this the required value is determined.

Universal Alternating-Current Bridges.—K. Ogawa. (*Journ. I.E.E. Japan*, June, 1933, Vol. 53 [No. 6,] No. 539: English summary pp. 42–32.)

The wide range, without altering bridge connections, is obtained with some sacrifice of accuracy. Any impedance between 1 and 10^7 ohms, within a frequency range of 1 to 50 kc/s, can be measured; also "the earth capacities at both terminals of any impedance if they are not so large."

On the A.C. Bridge with Instrument Transformers, and Characteristics of Each of its Elements.—M. Kuriyama. (*Journ. I.E.E. Japan*, Jan., 1933, Vol. 53 [No. 1], No. 534: English abstract pp. 1–3.)

Direct-Reading Modulation Meter [using a Detector Valve with nearly Parabolic Characteristic].—H. Wada and M. Goto. (Summary only in *Rep. of Rad. Res. and Works in Japan*, Dec., 1932, Vol. 2, No. 3, Abstracts and References Section, p. 16.)

Sur un Voltmètre amplificateur (An Amplifying Voltmeter [using a Two-Grid Valve to generate A.F. Current with Amplitude depending on D.C. Voltage to be measured: Milliammeter reads Changes of 2×10^{-5} Volt]).—J. Roulleau. (*Comptes Rendus*, 12th June, 1933, Vol. 196, No. 24, pp. 1786–1787.)

Dynamic Measurement of Electron Tube Coefficients.—Tuttle. (*See* under "Valves and Thermionics.")

The Measurement of Peak Values of Alternating Currents and Voltages by means of a Thyratron [using the Relationship between Grid Voltage and Minimum Striking Voltage on Anode].—E. Hughes. (*Journ. Scient. Instr.*, June, 1933, Vol. 10, No. 6, pp. 180–182.)

Two Simple Methods of Absolute Measurement of Electrical Resistance in Terms of Inductance and Frequency.—H. R. Nettleton and E. G. Balls. (*Proc. Phys. Soc.*, 1st July, 1933, Vol. 45, Part 4, No. 249, pp. 545–554.)

The first method depends on the fact that in an a.c. transformer there is a simple relation between the resistance of the secondary, the mutual inductance, the self-inductance of the secondary, and the frequency, if the primary and secondary currents are exactly equal; this equality is judged with the help of a metal rectifier. The second method also uses the adjustment to equality of the primary and secondary currents: these are further adjusted to be in quadrature, and a simple arrangement is thereby derived which enables Campbell's two-phase a.c. method of measuring resistance to be employed.

Eine neue Kompensations-Messeinrichtung zur Bestimmung des Übertragungsmasses an Vierpolen (A New "Compensator" Measuring Equipment for the Determination of the Transmission Equivalent of Quadripoles [including Quadripoles with Negative Damping, *i.e.*, Amplifiers]).—H. Piesch. (*E.N.T.*, June, 1933, Vol. 10, No. 6, pp. 251–257.)

The diagram of the "compensator" is given in Fig. 2. The two pairs of terminals of the symmetrical quadripole under test are connected in turn to the compensator, and damping and phase-angle compensation are adjusted to give a minimum in the telephones. As an example, the voltage diagram of a 3-stage filter chain with a cut-off frequency of 2 070 c/s is given (Fig. 8). The procedure for the measurement of unsymmetrical dipoles, much less often required, is more complicated.

MISURE SIMULTANEE DI CORRENTE, TENSIONE E FASE ALLE ALTE FREQUENZE (Simultaneous Measurement of Current, Voltage and Phase at High Frequencies [up to Tens of Megacycles per Second]).—U. Ruelle. (*Alta Frequenza*, March, 1933, Vol. 2. No. 1, pp. 25–45.)

The use of modern thermoammeters enables the classic "three ammeters" procedure to be applied at high radio-frequencies. An experimental equipment for this purpose is described, together with examples of its use. As an example of a complex system which may be investigated in this way the writer takes a coupling bridge such as is used to connect an aerial to its feeder.

THE SIMPLIFICATION OF ACCURATE MEASUREMENT OF RADIO-FREQUENCY [Argument on Comparative Merits of Crystal-Controlled and Fork-Controlled Multivibrators].—L. Hartshorn: Griffiths. (*Wireless Engineer*, July, 1933, Vol. 10, No. 118, p. 369.)

Correspondence on a statement in the paper by Griffiths dealt with in August Abstracts, p. 456, r-h column.

A PIEZOELECTRIC RESONATOR WITH UNIFORM RESPONSE OVER A GIVEN RANGE OF FREQUENCIES.—Guerbilsky. (*See* under "Acoustics and Audio-frequencies.")

THE RESEARCHES OF THE LATE DR. D. W. DYE ON THE VIBRATIONS OF QUARTZ.—E. H. Rayner. (*Journ. I.E.E.*, June, 1933, Vo. 72, No. 438, pp. 519–527.)

The full paper, a *Wireless Engineer* summary of which was referred to in June Abstracts, p. 338, l-h column.

A QUARTZ PLATE OF MINIMUM FREQUENCY VARIATION.—S. Matsumura and S. Kanzaki. (*Monthly Bibliographical References of the Union Radio-Scientifique Internationale*, May, 1933, p. 10: summary only.)

Authors' summary:—"A method for obtaining a very small temperature coefficient of the frequency of *Y*-wave in *X*-cut quartz plate is indicated. It consists in cutting a rectangular plate in *YZ*-plane with its length direction tilted at a proper angle from the geometrical axis toward the optic axis so as to leave the longitudinal oscillation in the direction of the minimum Young's modulus. The lowest value of the temperature coefficient thus obtained is about -3×10^{-7} Further explanation is given on the most suitable method for fixing the plate in its holder." *See* also Abstracts, 1932, p. 533, r-h column; Straubel, 1931, pp. 568–569, and March, p. 171, l-h column; also next abstract.

TEMPERATURE COEFFICIENT OF FREQUENCY OF *X*-CUT RECTANGULAR QUARTZ PLATES.—S. Matsumura and S. Kanzaki. (*Ibid.*, p. 10.)

Authors' summary:—"The temperature coefficient of the oscillation frequency of quartz plates is investigated with the ordinary *X*-cut rectangular plates whose dimensional ratios of the length measured along the optic axis to that along the geometrical axis are from 1 to 3. The result shows that the coefficient takes different values with different dimensional ratios." *See* also preceding abstract.

EFFECT OF TEMPERATURE UPON PIEZOELECTRIC VIBRATION OF TOURMALINE PLATES.—S. Matsumura, S. Ishikawa and M. Goto. (*Ibid.*, p. 10.)

Authors' summary:—"The effects of temperature upon the piezoelectric properties of tourmaline are investigated with the aid of its piezoelectric vibration of the so-called *Z*-cut plate. The experiment reveals the fact that the piezoelectric properties of tourmaline are scarcely affected by change in temperature even if it is raised as high as about 600° C."

RELATIONS BETWEEN ETCH FIGURES AND PIEZOELECTRIC PROPERTIES OF TOURMALINE.—S. Matsumura and M. Goto. (*Ibid.*, p. 11.)

Authors' summary:—"Etching on the crystal faces of tourmaline is produced by immersing the crystal into sodium hydroxide fusion, and the characteristic patterns of the figures thus etched are shown to indicate the crystallographic axes as well as its piezoelectric properties." *Cf.* Kao, 1932 Abstracts, p. 49, l-h col., for hydrofluoric etching of quartz.

ON THE VARIATION OF THE ELECTRICAL CONDUCTIVITY OF QUARTZ, TRIDYMITE, AND CRISTOBALITE WITH TEMPERATURE.—S. Shimizu. (*Journ. I.E.E. Japan*, May, 1933, Vol. 53 [No. 5], No. 538: English summary pp. 35–36.)

OPTISCHE DEMONSTRATION DES "ZIEHENS" EINES QUARZES (Optical Demonstration of the "Ziehen" [Oscillation-Hysteresis] Effect in a Quartz Crystal).—E. Hiedemann and H. R. Asbach. (*Physik. Zeitschr.*, 15th June, 1933, Vol. 34, No. 12, p. 494.)

THE MOVEMENTS OF A QUARTZ CRYSTAL IN AN ELECTROSTATIC FIELD.—de Gramont. (*See* under "Miscellaneous.")

ÜBER HYSTERESISERSCHEINUNGEN BEIM REZIPROKEN MAGNETOSTRIKTIONSEFFEKT (Hysteresis Phenomena in the Reciprocal Magnetostrictive Effect).—E. A. Kopilowitsch. (*Physik Zeitschr. der Sowietunion*, No. 5, Vol. 3, 1933, pp. 542–544.) Further investigation of the results dealt with in 1932 Abstracts, p. 355, r-h column.

METALLIC REFLECTION: PROPAGATION OF ELECTROMAGNETIC WAVES ALONG CURVED WIRES [Experiments on Partly Curved Lecher System].—Ebeling. (*See* under "Propagation of Waves.")

LUMINOUS DISCHARGE BETWEEN LECHER WIRES IN A PARTIALLY EVACUATED TUBE.—Hershberger, Zahl and Golay. (*See* under "Propagation of Waves.")

THEORETICAL AND EXPERIMENTAL STUDIES ON THE FREQUENCY STABILISATION OF THE DYNATRON-TYPE OSCILLATOR.—Hayasi. (*See* under "Transmission.")

ÉTUDES SUR LA TRANSMISSION DES SIGNAUX HORAIRES (Studies of the Transmission of Time Signals [and the Determination of Delay Times]).—R. Jouaust. (*Ann. des P.T.T.*, May, 1933, Vol. 22, No. 5, pp. 373–396.) *See* also Stoyko and Jouaust, August Abstracts, p. 457, l-h column.

SUBSIDIARY APPARATUS AND MATERIALS

REMARKS ON "IRON CORES FOR HIGH-FREQUENCY COILS" [Vogt Iron (Ferrocart)].—G. Nissen : G.W.O.H. : Schneider. (*Wireless Engineer*, June, 1933, Vol. 10, No. 117, pp. 313–315 and 293–295.)

Referring to Schneider's article dealt with in July Abstracts, p. 403, Nissen contests at considerable length the idea that the "capacitive eddy currents" discovered by Vogt (and combated, as an additional source of loss, by the paper layers introduced in the manufacture of Ferrocart) can have any importance whatever. G.W.O.H., in an editorial, makes a more direct rough calculation of the losses in the dielectric material of the core, comes to the conclusion that Nissen's criticism is justified, but remarks that the Ferrocart coils may nevertheless do all that is claimed for them: "an invention is often much better than the inventor's theory of its operation."

FERROCART.—A. Schneider. (*Electrician*, 30th June and 7th July, 1933, Vols. 110 and 111, Nos. 2874 and 2875, pp. 849 and 851, and 9.) *See* also Abstracts, January, p. 39 (Sowerby); February, p. 100 (Olvenstedt); March, p. 173 (G.W.O.H.); May, p. 281, and July, p. 403 (Schneider); 1932, p. 640 (Vogt). *Cf.* also Polydoroff, July, p. 393.

ON THE STRUCTURE OF THE NICKEL-IRON ALLOYS.—W. Broniewski and J. Smolinski. (*Comptes Rendus*, 12th June, 1933, Vol. 196, No. 24, pp. 1793–1796.)

MAGNETISATION OF IRON BY THE SUPERPOSITION OF AN A.C. FIELD ON A CONSTANT MAGNETIC FIELD.—St. Procopiu. (*Comptes Rendus*, 26th June, 1933, Vol. 196, No. 26, pp. 1976–1979.)

CALCOLO APPROSSIMATO DELLE INDUTTANZE A NUCLEO DI FERRO (The Approximate Calculation of Iron-Cored Inductances).—G. Someda : Marocchi. (*Alta Frequenza*, March, 1933, Vol. 2, No. 1, pp. 94–98.)

Someda refers to Marocchi's method (April Abstracts, p. 226, l-h col.) and suggests a second method: Marocchi, in his reply, shows that the two give results which are in very good agreement.

TAYLOR'S FREQUENCY TRIPLER [Three Saturated Choke Coils combined with an Unsaturated Transformer with Three Primaries: Explanation of Action].—P. R. Pillai and F. N. Mowdawalla. (*Journ. Indian Inst. Sci.*, Vol. 16 B, Part I, pp. 1–18.)

THE DESIGN OF AN "ERROR-FREE" CURRENT TRANSFORMER [Constant Permeability by use of Two Magnetic Circuits working respectively on the Concave and Convex Parts of Their Magnetisation Curves].—A. C. Schwager. (*E.T.Z.*, 25th May, 1933, Vol. 54, No. 21, p. 503: summary only.)

A NOTE ON THE MAGNETIC SUSCEPTIBILITIES OF CUPROUS OXIDE FILMS.—S. S. Bhatnagar and N. G. Mitra. (*Current Science, Bangalore*, May, 1933, Vol. 1, No. 11, pp. 343–344.)

THE COPPER-CUPROUS-OXIDE RECTIFIER AND PHOTOELECTRIC CELL.—L. O. Grondahl. (*Reviews of Mod. Phys.*, April, 1933, Vol. 5, No. 2, pp. 141–168.)

Including long lists of literature references up to about the end of 1932. "Many of the experimental results [Union Switch and Signal Company laboratories] are published here for the first time."

THERMO- UND VOLTASPANNUNG DES KUPFEROXYDULS (Thermo- and Voltaic E.M.F. of Cuprous Oxide [Preliminary Note]).—G. Mönch. (*Naturwiss.*, 19th May, 1933, Vol. 21, No. 20, p. 367.)

THE DISCONTINUITIES OF POTENTIAL AT THE CONTACT OF A SEMI-CONDUCTOR AND A METALLIC ELECTRODE.—G. Déchène. (*Comptes Rendus*, 22nd May, 1933, Vol. 196, No. 21, pp. 1577–1579.)

REPORT ON THE THEORY OF SEMI-CONDUCTORS.—R. H. Fowler. (*Physik. Zeitschr. der Sowietunion*, No. 5, Vol. 3, 1933, pp. 507–528: in English.)

Including sections on the Hall effect and the number of impurities, the change of resistance in a magnetic field, Volta contact potentials and thermionic work functions, inner photo-effects (and the crystal photo-effect of Dember), rectifying contacts, and difficulties in the Contact Theory.

THE SELENIUM RECTIFIER [Comparison with Copper-Oxide Type: Temperature and High-Voltage Fatigue: Efficiency 67%].—M. Fukuda and Y. Saito. (*Journ. I.E.E. Japan*, March, 1933, Vol. 53 [No. 3], No. 536: English summary p. 17.)

[The Construction of] THE TANTALUM RECTIFIER FOR BATTERY CHARGING.—F. M. Colebrook. (*World-Radio*, 26th May, 1933, Vol. 16, No. 409, pp. 705 and 707: to be continued.)

GITTERGESTEUERTE GASENTLADUNG ALS REGELBARER WECHSELSTROMWIDERSTAND (Grid-Controlled Gas Discharge [Thyratron] as Alternating Current Resistance which can be Regulated).—P. Lenz. (*Archiv f. Elektrot.*, 1st July, 1933, Vol. 27, No. 7, pp. 497–504.)

Author's summary :—The strength of the current in an a.c. circuit can be regulated with practically no loss by altering the reactance of a transformer in series with the load by means of a grid-controlled valve. The corresponding equations are derived and experimentally confirmed.

THE THEORY OF THE SKIN EFFECT.—Rothe. (*See* under "Propagation of Waves.")

STROMVERDRÄNGUNG BEI GLEICHSTROM (Skin Effect with Direct Current [Theoretical and Experimental Demonstration of Its Existence and Practical Importance : Preliminary Communication]).—E. Weber. (*Elektrot. u. Masch:bau*, No. 14/15, Vol. 51, 1933, pp. 238–240.)

STUDY OF THE ELECTRICAL PROPERTIES OF THIN FILMS OF PLATINUM OBTAINED BY CATHODE SPUTTERING.—A. Féry. (*Ann. de Physique*, May–June, 1933, Vol. 19, pp. 421–507.)

THE CRYSTALLINE STATE OF THIN SPLUTTERED FILMS OF PLATINUM.—G. P. Thomson, N. Stuart and C. A. Murison. (*Proc. Phys. Soc.*, 1st May, 1933, Vol. 45, Part 3, No. 248, pp. 381–388.)

A NEW INDUSTRIAL INSULATING MATERIAL : THE LAMBERT INSULATING CONCRETE.—P. Ferrier. (*Rev. Gén. de l'Élec.*, 3rd June, 1933, Vol. 33, No. 22, pp. 731–733.)

A SYMPOSIUM ON INSULATING MATERIALS AND THEIR USES. (*E.T.Z.*, 8th June, 1933, Vol. 54, No. 23, pp. 537–572.)

Including papers by various writers on mica and mica products (Schroeder) ; porcelain and ceramic products (Weicker : Calit, Calan, Frequentit and Frequenta, Sipa, Ardostan, Thermisol, Magnesolit, etc.) ; materials in the Steatite group (Albers-Schönberg : including the first four materials dealt with by Weicker, above) ; glass as an insulating material (Hänlein) ; foliated and composite materials (Senst : micanite, presspan, etc.) ; rubberless compressed materials (Schramm : trolitul, polystyrol, bakelite, synthetic resin, phenoplastic materials, micalex, etc.) ; the classification of rubberless compressed materials (Schob) ; insulating materials in communication engineering (Moench) ; the present position of research (Vieweg and Pfestorf) ; and others.

COMMERCIAL DIELECTRICS : THE FACTORS CONCERNED IN THEIR DIELECTRIC LOSSES : ELECTRO-OSMOTIC MECHANISM AND SEMI-PERMEABILITY : INTENSE POLARISATION RETAINED BY A DIELECTRIC SOLIDIFIED IN AN ELECTRIC FIELD : ETC.—J. Lahousse. (*Rev. Gén. de l'Élec.*, 13th May, 1933, Vol. 33, No. 19, p. 644 : summary only.)

CRITICAL REMARKS ON SOME NEW RESEARCHES ON THE BREAKDOWN OF SOLID INSULATORS.—L. Inge, A. Walther and B. Wul. (*Physik. Zeitschr. der Sowjetunion*, No. 3, Vol. 3, 1933, pp. 284–303.)

Recent theories involving a tearing of the crystal lattice, ionisation by collision, and the growth of "dendrites," are examined in turn and found wanting.

THE MEASUREMENT AT HIGH FREQUENCIES [above 1 Mc/s] OF THE LOSS ANGLES OF CONDENSERS [and of Various Natural and Artificial Insulating Materials].—Rohde and Schlegelmilch. (*See* under "Measurement and Standards.")

AIR-TYPE ALIGNMENT CONDENSERS FOR PLUG-IN COILS [replacing Mica-Type "Trimmers" for Increased Stability, particularly for "Single Signal" Superheterodyne Receivers]. (*QST*, June, 1933, Vol. 17, No. 6, p. 32.)

COMPARISON BETWEEN CASCADES OF TUNED R.F AMPLIFIERS AND THE BAND-PASS FILTERS OF CAUER AND OF JAUMANN.—Baerwald. (*See* abstract under "Reception.")

OPERATING CONSTANTS FOR DIRECT-CURRENT THERMIONIC AMPLIFIERS.—P. A. Macdonald and T. W. Tweed. (*Physics*, May, 1933, Vol. 4, No. 5, pp. 178–183.)

Authors' summary :—The sensitivity to voltage, measured in volts per mm scale deflection, of a direct-current thermionic amplifier (simple circuit) is taken as inversely proportional to the mutual conductance divided by the plate current of the valve employed. The mutual conductance is found to decrease less rapidly than the plate current, as the filament and plate potentials are lowered. The most sensitive operating value of the plate potential of a UX 222 is found to be 1.5 volts, giving a voltage sensitivity of 8×10^{-4} volt/mm in the simple circuit with no plate current compensation. By suitable use of the screen grid, a grid-filament resistance of 10^{14} ohms may be obtained, giving a current sensitivity of 8×10^{-15} amp./mm with an input resistor of 10^{11} ohms.

A DIRECT-CURRENT AMPLIFIER CIRCUIT.—L. A. Turner. (*Phys. Review*, 15th June, 1933, Series 2, Vol. 43, p. 1050 : abstract only.)

THE CATHODE-RAY OSCILLOGRAPH IN RADIO RESEARCH.—G. W. O. H. : Watson Watt, Herd and Bainbridge-Bell. (*Wireless Engineer*, July, 1933, Vol. 10, No. 118, pp. 351–353.)

Editorial on the book referred to in July Abstracts, p. 402, r-h column.

ZUR KATHODENOSZILLOGRAPHIE (Cathode-Ray Oscillography [Survey of Cold-Cathode Oscillograph Developments, including the Use of Permanent Magnets ; Multiple-Ray Tubes ; 500-Volt Tubes ; the Use of the Accelerating System as Electron Lens ; etc.]).—W. Rogowski. (*Elektrot. u. Masch:bau*, No. 17, Vol. 51, 1933, pp. 249–254.) *See* also May and July Abstracts, pp. 283 and 402 ; 1932, p. 418, l-h col. ; and elsewhere.

DIE GRENZLEISTUNG DES KATHODENOSZILLOGRAPHEN BEI LINSENSCHRIFT (The Limiting Efficiency of the Cathode-Ray Oscillograph with Lens Recording).—J. M. Dodds. (*Archiv f. Elektrot.*, 1st July, 1933, Vol. 27, No. 7, pp. 531–538.)

Cf. Rogowski, 1932 Abstracts, p. 418, r-h col. Author's summary:—" It is shown that, with a cold cathode oscillograph of suitable construction, all phenomena can be photographically recorded with *external* lens and camera, up to the limit of distortion defined by the finite velocity of the electrons. The maximum velocity of the trace on the fluorescent screen which can be externally recorded is more than 0.1 times the velocity of light."

ÜBER DIE ABHÄNGIGKEIT DER ELEKTRONENSTRAHL-KONZENTRATION VON DER GASART (The Dependence of Electron Beam Concentration on the Kind of Gas).—E. F. Richter. (*Physik. Zeitschr.*, 1st June, 1933, Vol. 34, No. 11, pp. 457–458.)

The region of pressure in which a filamentary beam occurs is 10^{-1} mm Hg in helium and 10^{-3} mm Hg in xenon.

THEORIE DES ELEKTRONENMIKROSKOPES (Theory of the Electron Microscope).—W. Glaser. (*Zeitschr. f. Physik*, 1933, Vol. 83, No. 1/2, pp. 104–122.)

This paper discusses the Gaussian dioptrics and the theory of errors in the optical images formed by electron beams in an axially symmetrical field.

DIE ABBILDUNG DURCHSTRAHLTER FOLIEN IM ELEKTRONENMIKROSKOP (The Delineation of Irradiated Films in the Electron Microscope).—B. von Borries and E. Ruska. (*Zeitschr. f. Physik*, 1933, Vol. 83, No. 3/4, pp. 187–193.)

DIE ELEKTRONENMIKROSKOPISCHE ABBILDUNG ELEKTRONENBESTRAHLTER OBERFLÄCHEN (Formation by the Electron Microscope of Images of Surfaces irradiated by Electrons).—E. Ruska. (*Zeitschr. f. Physik*, 1933, Vol. 83, No. 7/8, pp. 492–497.)

ZUR FOKUSSIERBARKEIT VON KATHODENSTRAHLBÜNDELN GROSSER AUSGANGSQUERSCHNITTE (The Possibility of Focusing Cathode-Ray Beams of Large Initial Cross-Section).—E. Ruska. (*Zeitschr. f. Physik*, 1933, Vol. 83, No. 9/10, pp. 684–697.)

The focusing properties of various geometrical forms of the electrodes in a cathode-ray tube are theoretically considered.

THE SPURIOUS RING EXHIBITED BY FLUORESCENT SCREENS [due to Total Internal Reflection].—J. V. Hughes. (*Proc. Phys. Soc.*, 1st May, 1933, Vol. 45, Part 3, No. 248, pp. 434–440.)

ON EXPERIENCE WITH THE USE OF BROMIDE PAPER FOR [Internal] CATHODE-RAY OSCILLOGRAMS.—T. Hayakawa and T. Hishiyama. (*Journ. I.E.E. Japan*, June, 1933, Vol. 53 [No. 6], No. 539: English summary, p. 39.)

Cf. Förster, 1932 Abstracts, p. 596, l-h col. The writer finds that by using an oscillograph of recent design and by taking certain precautions, he obtains oscillograms with the following advantages: they are distinct, and positive; the paper is cheap; manipulation is simple and development easy. A disadvantage is that more time is required for evacuation: the pumps are operated for 30 minutes with 12 sheets of paper inside the camera, without phosphoric anhydride; the latter is then introduced and evacuation continued for another 5 minutes. Results are quite distinct up to a spot velocity of 2 cm/μs and a sweeping velocity of 0.5 cm/μs, with a cathode voltage over 60 kv.

THE MOST IMPORTANT PHOTOTECHNICAL PROPERTIES OF 32 COMMERCIAL TYPES OF FILM.—U. Schmieschek. (*Zeitschr. f. tech. Phys.*, No. 7, Vol. 14, 1933, pp. 284–288.)

NEW INSTRUMENTS FOR MECHANICAL INTEGRATION, DIFFERENTIATION, AND HARMONIC ANALYSIS, ON THE PRINCIPLE OF " ROLLED-UP " ABSCISSAE [Preliminary Communication].—P. Boisseau. (*Comptes Rendus*, 19th June, 1933, Vol. 196, No. 25, pp. 1863–1864.) *See* also *ibid.*, 3rd July, 1933, Vol. 197, No. 1, pp. 23–24.

AN APPARATUS FOR TRACING THE MEAN DERIVATIVE OF A FUNCTION REPRESENTED BY ITS CURVE IN CARTESIAN CO-ORDINATES.—F. E. Myard. (*Ibid.*, pp. 1865–1866.)

HARMONIC ANALYSIS OF OSCILLATORY PHENOMENA (Mathematical Processes: Methods of Pichelmayer and Schruttka and of Zipperer).—J. Krönert. (*Alta Frequenza*, March, 1933, Vol. 2, No. 1, pp. 108–110: summary only.)

DECIBEL AND DECINEPER CHARTS [for Simplifying Calculations of Power Gain and Loss in Transmission Lines and Radio Amplifiers].—L. B. Sklar. (*Elec. Engineering*, July, 1933, Vol. 52, No. 7, pp. 509–510.)

A SHORTED-TURN INDICATOR [*e.g.* for Testing Voice Coils of M.C. Loud Speakers].—C. G. Seright. (*Electronics*, May, 1933, Vol. 6, No. 5, p. 136.)

STATIONS, DESIGN AND OPERATION

COMPARISON BETWEEN 10-METRE AND 55-CENTIMETRE SERVICES (between Italy and Sardinia).—Pession. (*See* abstract under " Propagation of Waves.")

" ULTRA-SHORTS " FROM THE AIR.—S. G. Morgan. (*Wireless World*, 21st July, 1933, Vol. 33, pp. 44–45.)

The author gives an account of his experiences in making certain experimental five-metre transmissions from an aeroplane flying between London and Liverpool. " No signals were reported from soon after the time at which we ran into heavy weather. This suggests the possibility that thick banks of cloud or rain cast ' shadows ' or act as effective blankets to ultra-short waves. Several reports mention the fact that signals fluctuated wildly soon after this weather was encountered, which again lends force to this theory. These effects may, however, have been due to the failure of the modulator at this critical period."

Short-Wave Broadcasting in the Dutch East Indies.—Kuyck. (*See* under "Propagation of Waves.")

A Broadcasting Service for Portugal: Establishment of a State Monopoly.—(*World-Radio*, 30th June, 1933, Vol. 16, No. 414, p. 852.)

New European Wavelengths Plan: the Lucerne Convention.—(*World-Radio*, 30th June, 1933, Vol. 16, No. 414, pp. 848–850.)

Lucerne Wave Plan: Some Continental Opinions.—(*World-Radio*, 14th July, 1933, Vol. 17, No. 416, p. 32.)

The Lucerne Wave Allocation Plan.—H. Giess. (*E.T.Z.*, 6th July, 1933, Vol. 54, No. 27, pp. 660–662.)

The Madrid Conference and the Regulation of Radio Communication [with Field Strength Curves for Sea and Land].—(*Alta Frequenza*, March, 1933, Vol. 2, No. 1, pp. 84–93.)

The International Radiotelegraphic and Telegraphic Conference, Madrid, 1932—H. Pfeuffer. (*Elektrot. u. Masch:bau*, No. 11, Vol. 51, 1933, pp. 134–137.)

GENERAL PHYSICAL ARTICLES.

Potential Distribution about an Electrode on the Surface of the Earth [Analytical Treatment, including the case of a Many-Layer Earth].—M. Muskat. (*Physics*, April, 1933, Vol. 4, No. 4, pp. 129–147.) *See* also May Abstracts, p. 286, for a paper by King covering some of the same ground.

Experiments to Determine the Total Intensity of the Earth's Magnetic Field from the Time of Rotation of Slow Electrons.—K. H. Stehberger. (*Ann. der Physik*, 1933, Series 5, Vol. 17, No. 3, pp. 278–292.)

Non-Canonical Transformations and the Electromagnetic Field.—G. Rumer. (*Zeitschr. f. Physik*, 1933, Vol. 83, No. 5/6, pp. 351–353.)

On Dirac's New Theory of the Electromagnetic Field.—S. Schubin. (*Physik. Zeitschr. der Sowietunion*, No. 4, Vol. 3, 1933, pp. 338–350: in English.)

Positive Electrons and the Existence of Protons [Dirac's Theory of the Holes: the Proton as a "Hole with a Neutron"].—H. Mandel. (*Physik. Zeitschr. der Sowietunion*, No. 5, Vol. 3, 1933, pp. 551–553: in English.)

The Origin of the Positive Electrons.—I. Curie and F. Joliot. (*Comptes Rendus*. 22nd May, 1933, Vol. 196, No. 21, pp 1581–1583.)

The Mass of the Neutron [consisting of One Proton and One Electron of Negative Energy].—J. J. Placinteanu. (*Comptes Rendus*, 15th May, 1933, Vol. 196, No. 20, pp. 1474–1476.)

The Diffusion of Electrons by Atoms.—J. Winter. (*Comptes Rendus*, 1st May, 1933. Vol. 196, No. 18, pp. 1299–1301.)

On Quantum Electrodynamics.—Dirac, Fock and Podolsky. (*Physik. Zeitschr. der Sowietunion*, No. 6, Vol. 2, 1932, pp. 468–479.)

Probability and the Exponential Laws of Physics [Derivation from Poisson's Probability Equation].—M. C. Holmes. (*Journ. Franklin Inst.*, March, 1933, Vol. 215, No. 3, pp. 281–285.)

The Principle of Indefiniteness.—K. K. Darrow. (*Review Scient. Instr.*, April, 1933, Vol. 4, No. 4, pp. 188–192.)

The Definition of the Magnetic Field [Thompson's Formulae more practical than Maxwell's].—H. Abraham. (*Comptes Rendus*, 27th March, 1933, Vol. 196, No. 13, pp. 908–910.)

MISCELLANEOUS

The Movements of a Quartz Crystal in an Electrostatic Field [Cylinder, 2 cm in diameter, rotating at 2–3 000 r.p.m. for an Oscillating Exciting Potential of 30 Volts: 2 gm Parallelepiped at 20 000 r.p.m.]—A. de Gramont. (*Comptes Rendus*, 6th June, 1933, Vol. 196, No. 23, pp. 1705–1707.)

Discussing the case of the cylindrical crystal, the writer mentions that by replacing the single pair of electrodes by two pairs at 90° or three at 120°, fed with suitably phased sinusoidal potentials, two- or three-phase "motors" are obtained which are self-starting and of definite direction of rotation. If the crystal is kept from turning, a transformer action occurs, and the 30 volts across the "primary" electrodes will give potentials of several thousands of volts across the "secondary" electrodes. In the case of the "high speed" parallelepiped crystals, the crystals were cut in such a way that the electric charges produced forces which were dissymmetrical and inclined with respect to the electrodes.

Mechanical Vibration of Conductor due to D.C. Corona Discharge.—S. Kumagai and J. Nagaya. (*Journ. I.E.E. Japan*, June, 1933, Vol. 53 [No. 6], No. 539: English summary pp. 40–41.)

The summary concludes:—"The vibration . . . is similar to its natural vibration. . . . It is suggested that the vibration . . . is caused by the irregular succession of mechanical impulses due to the motion of ions. A mathematical analysis shows that the natural vibration of an elastic wire is caused by such an irregular succession of impulses acting upon it."

On a New Type of Reasoning and Some of Its Possible Consequences [Principle of Flexibility of Scientific Truth as Secured by Measurements]: *and* Remarks on the Preceding Note on Many-Valued Truths.—F. Zwicky: E. T. Bell. (*Phys. Review*, 15th June, 1933, Series 2, Vol. 43, pp. 1031–1033: 1033.)

Notes on Relations between Elliptic Integrals and Schlömilch Series [in connection with the Calculation of Modulation Products].—W. R. Bennett. (*Bell Tel. System Monograph B*-718, 5 pp.) By-product of the work dealt with in July Abstracts, p. 389, r-h column.

The Rôle of Statistical Method in Economic Standardisation.—W. A. Shewhart. (*Bell Tel. System Monograph B*-721, 13 pp.)

Probability, Statistics, and the Theory of Errors.—H. Jeffreys. (*Proc. Roy. Soc.*, 1st June, 1933, Vol. 140, No. A 842, pp. 523–535.)

Principles of Statistical Analysis Occasionally Overlooked.—McNish. (*See* under "Atmospherics and Atmospheric Electricity.")

The Ultra-Short Electromagnetic Waves, with particular regard to Military Applications.—F. Gatta. (*Bibliografia Italiana*, June, 1933, Vol. 6, No. 5–6, p. 15: contents only.)

An Example of a Complete Analogy between Electrical and Mechanical Oscillation.—Ramsauer. (*See* under "Properties of Circuits.")

Radio Engineering.—F. E. Terman. (Book Review, *Wireless Engineer*, June, 1933, p. 316.)

Skin Effect with Direct Current [Theoretical and Experimental Demonstration of Its Existence and Practical Importance: Preliminary Communication].—E. Weber. (*Elektrot. u. Masch:bau*, No. 14/15, Vol. 51, 1933, pp. 238–240.)

Iron Tube filled with Metallic Sodium as Overhead Conductor for Large Currents.—R. H. Boundy. (*E.T.Z.*, 29th June, 1933, Vol. 54, No. 26, p. 626: summary only.)

Elimination of the Troubles in Telephone Circuits produced by Mercury-Vapour Rectifiers.— –. Collet. (*Ann. des P.T.T.*, June, 1933, Vol. 22, No. 6, pp. 551–562.)

Inductive Interference from Fault Currents on E.H.T. Power Lines.—A. J. Jackman. (*P.O. Elec. Eng. Journ.*, July, 1933, Vol. 26, Part 2, pp. 97–106.)

Electromagnetic-Wave Prospecting in the U.S.S.R.—A. Petrowsky. (*Sci. Abstracts, Sec. A.*, June, 1933, Vol. 36, No. 426, pp. 563–564.)

In addition to practical details, the theory of propagation in semi-conducting media is dealt with. "It is shown that not only are the speed of propagation and the coefficient of absorption A dependent on the specific resistivity of the medium, but that the amplitude of the electric force also depends upon it, so that the diminution of the wave with increasing distance r does not depend upon the factor e^{-Ar} alone. The formulae are employed to deduce what distance of penetration in air the transmitter must have in order that the waves may penetrate a distance r in rock, and it follows that a smaller power suffices when the receiver can detect the magnetic force; hence the use of a frame aerial in the receiver. It is also shown that, provided the wavelength does not exceed the distance between transmitter and receiver, it is theoretically advantageous to use as long waves as possible." The wavelengths employed ranged from 50 to 500 metres.

During the work there appeared evidence of interference phenomena resulting in a minimum of signal strength when the wavelength happened to be about four times the average height of the neighbouring trees.

Correspondence on "The Principles of Electromagnetism."—C. L. Fortescue: B. Freudenberg: Moullin. (*Wireless Engineer*, June, 1933, Vol. 10, No. 117, pp. 315–316.) *See* August Abstracts, p. 462, l-h column.

Ultra-Micrometric Method of Measuring the Temperature of Metal Container in Calorimetric Processes.—Esser and Grass. (*Electronics*, May, 1933, Vol. 6, No. 5, p. 141.)

Improvements in Prytherch's Capacity Dilatometer.—J. L. Haughton and F. Adcock: Prytherch. (*Journ. Scient. Instr.*, June, 1933, Vol. 10, No. 6, pp. 178–180.) *See* 1932 Abstracts, p. 480, r-h column.

The Automatic Timing of the Ostwald Viscometer by means of a Photoelectric Cell [eliminating Psychological Errors].—Grinnell Jones and S. K. Talley. (*Physics*, June, 1933, Vol. 4, No. 6, pp. 215–224.)

Photoelectric Colour-Measuring Instruments.—H. Neustadt, Jr. (*Electronics*, May, 1933, Vol. 6, No. 5, pp. 128–131.)

The Bernheim Photoelectric Cell, requiring No Amplification, with Sensitivity Maximum agreeing with that of the Eye.—Bernheim. (*See* abstract under "Phototelegraphy and Television.")

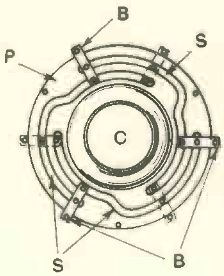
Some Recent Patents

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.

LOUD SPEAKERS

Application date, 5th February, 1932. No. 387127

To secure a measure of tone control, *i.e.*, of the frequencies to which the speaker responds most readily, the end of the cylinder *C* on which the moving coil is wound is flared out to form a slightly "dished" plate *P* in which slots *S* are cut as shown. The slots are provided with movable bridge-pieces *B*, the position of which controls the effective stiffness of the plate, its movement relative to the coil, and therefore its effective response to treble and bass notes. The plate *P* is connected in any suitable way to the diaphragm proper.



No. 387127

Patent issued to The General Electric Co., Ltd. and D. A. Oliver.

ELECTROSTATIC SPEAKERS

Application date, 15th February, 1932. No. 385776

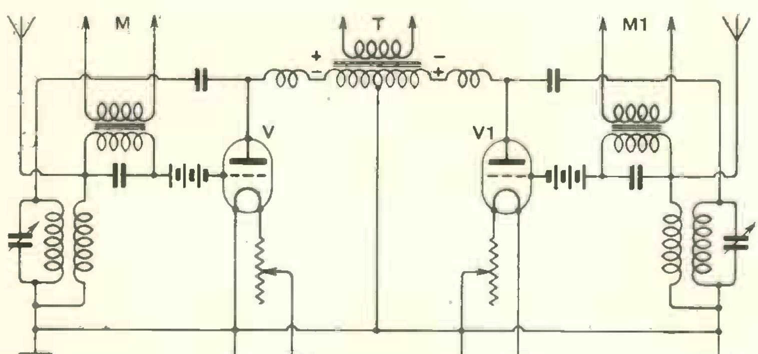
For the sake of compactness, the diaphragm of an electrostatic type of loud speaker is utilised to form one or more of the walls or panels of the cabinet of a wireless receiver. The other electrode may be suitably decorated to give an ornamental effect.

Patent issued to B. J. Grigsby.

MULTIPLEX SIGNALLING

Convention date (France), 23rd January, 1931. No. 387114

The simultaneous transmission and reception of different messages is effected by energising the valves at each station by supersonic and synchronised currents in such a way that one transmiting valve and one receiving valve are simultaneously operative at rapidly recurring intervals, whilst during intervening periods a second pair of transmitting and receiving valves are in operation. The Figure illustrates the invention as applied to a transmitting station. The two valves *V*, *V1* are supplied from a transformer *T* so that when the anode of *V* is positive, and signals are being transmitted, the anode of *V1* is negative so that the valve is inoperative, and *vice versa*. Signals are applied through microphones *M*, *M1*. A similar arrangement is used at the receiving station except that the microphones are replaced by telephones. Synchronising is effected through the electric mains, when both stations are on the same supply; otherwise a special synchronising wave is radiated.



No. 387114

Patent issued to W. A. Loth and A. J. Givelet.

TELEVISION SYSTEMS

Convention date (Germany), 22nd December, 1930. No. 387087

To remove the "striped" effect from the received picture, particularly in cathode-ray systems, the line-deflecting voltage is so arranged that it is not an integral multiple of the image frequency. This causes the scanning control to commence say at the beginning of the top line in the first picture and at a point within the top line in the second picture, and so on, the displacement resulting in a completely-uniform effect free from the undesired bands.

Patent issued to M. von Ardenne.

"FILM" TELEVISION

Convention date (France), 28th August, 1931. No. 387592

To simplify synchronisation between the transmitter and receiver in a system for televising from a kinematographic film, the "phase" is controlled at the transmitting end by means of an electro-mechanical transmission comprising a differential gear. This enables the film to be driven at a constant speed with relation to the scanning apparatus, but allows of a certain degree of phase acceleration or retardation, which can be adjusted at will.

Patent issued to Compagnie pour la Fabrication des Compteurs et Materiel d'Usines à Gaz.

ELIMINATING PARASITIC OSCILLATIONS

Application date, 18th August, 1931. *No.* 388067

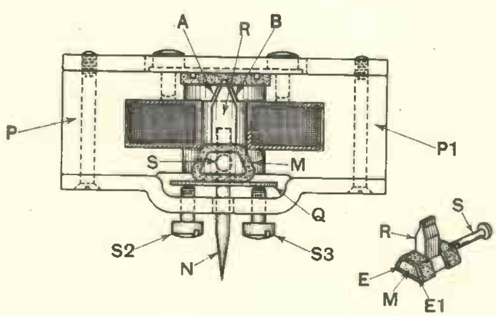
Parasitic oscillations tend to occur in short-wave amplifiers and generators, at a frequency which is a harmonic of the main or desired oscillation frequency, and arrangements are known for inserting damping resistances to eliminate or reduce their effect. As an alternative remedy, the local circuits forming the seat of the parasitic oscillations—which usually pass through one or other of the inter-electrode capacities of the valve—are identified and adjustable impedances are inserted in order deliberately to detune these circuits so that they cannot resonate to a harmonic of the working frequency.

Patent issued to Marconi's Wireless Telegraph Co., Ltd., E. Green and F. G. Robb.

GRAMOPHONE PICK-UPS

Application date, 28th June, 1932. *No.* 386882

The armature consists of (*a*) a reed part *R* with two sloping faces, which lie between sloping abutments *A*, *B* on the pole-pieces, and (*b*) a truncated base-piece *M* fitted with rubber sleeves and resting on a non-magnetic plate *Q*. The needle *N* is held by a screw *S*. The gap between armature and poles is adjusted by screw *S2*, *S3*, the top of the armature projecting into a strip of spongy rubber. In operation the armature does not oscillate about a central axis but rocks about the two edges *E*, *E1*, compressing the rubber sleeves as it does so.



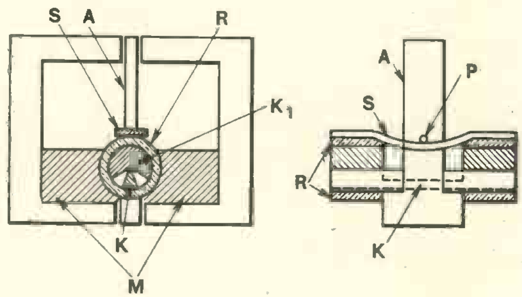
(a) (b)

No. 386882

Patent issued to C. Collard and Collard, Ltd.

Convention date (Germany), 23rd November, 1931. *No.* 387974

The known form of knife-edge bearings for the armature of a pick-up tends to produce both a low-pitched resonance effect due to the tone-arm and a higher-pitched resonance determined by the elasticity of the securing means and the mass of the armature. According to the invention both sources of distortion are eliminated by enclosing the knife-edge bearings *K*, *K1* in a rubber tube *R* which imparts a certain degree of resilience in a direction at right-angles to the axis of the armature *A*. The rubber tube is held in supports *M* secured to the pole pieces. A pin *P* on the armature bears against the centre part of a leaf-spring *S* the two ends of which are carried by the rubber tube.



No. 387974

Patent issued to C. Lindström Akt.

PRE-SET CONDENSERS

Application date, 11th November, 1931. *No.* 388130

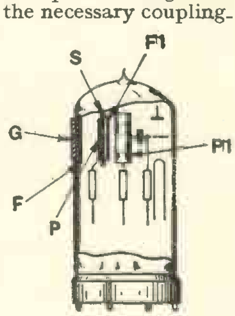
A condenser is designed to be pre-set to one or other of several accurately-determined capacity values. Several pairs of plates or electrodes are arranged to have different predetermined capacities, provision being made for final " trimming." One or more earthed plates are then moved to screen all the electrodes except the particular pair having the capacity value which it is desired to bring into circuit. Locking-nuts are provided to keep the setting rigid once the required adjustment has been made.

Patent issued to British Thomson Houston Co., Ltd., and T. H. Kinman.

MULTI-STAGE AMPLIFIERS

Convention date (Germany), 9th September, 1930. *No.* 387413

The electrodes for three separate stages of amplification, together with the necessary coupling impedances, are contained in a single glass bulb. The control grid *G* of the first set of electrodes is mounted, as shown, outside the glass bulb in close proximity to the filament *F*. The plate *P* of the first stage is also made to serve as the control grid of the second set of electrodes, which include the filament *F1* and plate *P1*. A glass screen *S* shields the electrode *P* from receiving electrons directly from the filament *F1*. The third or final set of amplifying electrodes is shown in conventional form.



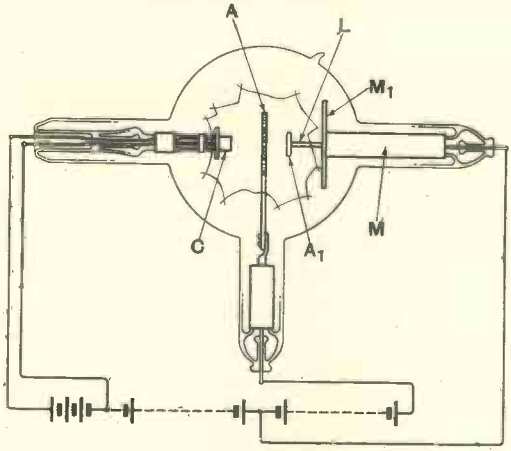
No. 387413

Patent issued to M. von Ardenne.

ULTRA SHORT-WAVE GENERATORS

Convention date (U.S.A.), 27th August, 1930
No. 387697

In generating "centimetre" waves, secondary emission from the electrode *A*1 is utilised to impulse a resonant structure *M*, which is housed wholly or in part inside the glass bulb. Electrons from the cathode *C* pass through a highly positive anode *A* on to the electrode *A*1, which is at a lower positive potential. The resonant structure comprises a disc *M*1 connected to the electrode *A*1 by a rod *L*, and a tubular portion *M*. Tuning is determined partly by the capacity between the discs *A*1 and *M*1,



No. 387697

and partly by the inductance of the connecting rod *L*. The parts *A*1 and *L* may in fact be regarded as a radiating antenna, the tubular portion *M* serving as a capacity counterpoise.

Patent issued to The British Thomson Houston Co., Ltd.

PORTABLE OR FIELD SETS

Convention date (Germany), 6th March, 1931.
No. 387715

In a portable short-wave transmitter or receiver designed for field work, difficulties may arise in operation owing to the effect of the leads which connect the elevated dipole aerial to the H.F. tuning circuits, since the latter must always be readily accessible to the operator. According to the invention the dipole and set are coupled through a flexible conductor having a length equal to, or an exact multiple of, the operating wavelength.

Patent issued to C. Lorenz Akt.

MIRROR-DRUMS FOR TELEVISION

Application date, 29th April, 1932. No. 387881

The body of the drum, or web extending between the central boss and the outer rim, is tapered outwards to decrease the moment of inertia. The rim is made of greater thickness and is provided with a series of flat facets, to each of which a mirror or reflector is directly secured by means of a central screw tapped into the metal of the rim. The mirrors may be of silvered glass, polished or silvered steel, or speculum metal, and may be either plane or curved.

Patent issued to W. W. Jacomb and Baird Television, Ltd.

RECTIFYING VALVES

Application date, 12th August, 1932. No. 387944.

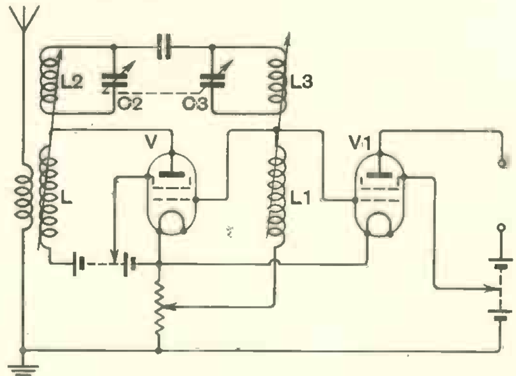
A double-diode rectifier, suitable for full-wave operation, is characterised by a construction in which each anode is fitted with and supported by a cooling-fin having end-radiators. A separate cathode is provided for each anode, and all the electrodes are held rigidly in position, as a unitary structure, by a common insulating member. Three pairs of electrodes may be assembled in the same bulb to form a tri-phase rectifier.

Patent issued to Standard Telephones and Cables, Ltd., and F. D. Goodchild.

BAND-PASS TUNING

Convention date (U.S.A.), 10th May, 1930.
No. 387683

To increase selectivity and to improve "cut-off," the incoming signals are made to pass twice in succession through the filter circuits. The aerial is coupled to a coil *L* connected across the anode and screen-grid of the first H.F. amplifier *V*. Another coil *L*1 is connected between the control grid and filament. The band-pass circuits *L*2, *C*2 and *L*3, *C*3 are coupled to the coils *L* and *L*1 respectively as shown. Incoming signals are transferred from the coil *L* to the coil *L*2, and, after passing once through the band filter, are fed to the coil *L*1 which is in the input circuit of both the valves *V* and *V*1. Part at least of the signal



No. 387683

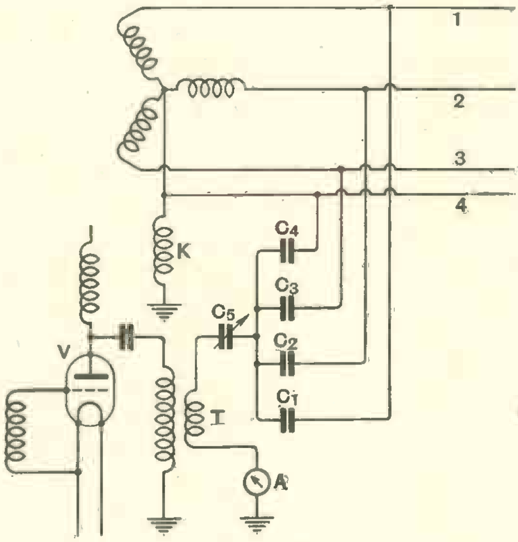
energy is therefore transferred in amplified form (and by a sort of feed-back action) through the valve *V* to the coil *L*, where it again traverses the band-filter circuits before finally passing on to the next amplifier valve *V*1.

Patent issued to Dubilier Condenser Co., Ltd

WIRED-WIRELESS RELAYS

Application date, 22nd October, 1931. *No.* 388480

Broadcast programmes are distributed in high-frequency form to a circle of subscribers over a three-phase electric-light or power-supply network,



No. 388480

the neutral conductor being connected to earth through an impedance which insulates the high-frequency signalling currents though it has negligible impedance to the low-frequency power currents. The power-supply lines 1, 2, 3 and the neutral conductor 4 are all connected through condensers *C*1, *C*2, *C*3, *C*4 to the secondary of a high-frequency transformer *T* in the output circuit of the transmitting valve *V*. Ammeters may be provided in each line, or, as shown the lines may be connected through a common condenser *C*5 to a single ammeter *A*. When a plurality of different programmes are distributed simultaneously, a choke *K* is inserted in the normal earthing lead, but when only one programme is concerned this is replaced by a wavetrap tuned to the carrier frequency used.

Patent issued to P. P. Eckersley, W. T. Sanderson and R. Blackburn.

L.F. AMPLIFIERS

Convention date (Holland), 26th April, 1932. *No.* 388292

High efficiency in amplification is dependent upon keeping the alternating-current portion at as high a ratio as possible to the total anode dissipation. Accordingly a variable voltage is derived from the signal input and is applied to cut down the direct current component by increasing the negative bias applied to the grid of the amplifier. The bias so applied varies with the signal voltage in such a way as to maintain the sum of the signal and biasing voltages practically constant.

Patent issued to N. V. Philip's Gloeilampenfabrieken.

MOVING-COIL SPEAKERS

Convention date (U.S.A.), 2nd September, 1930. *No.* 388448

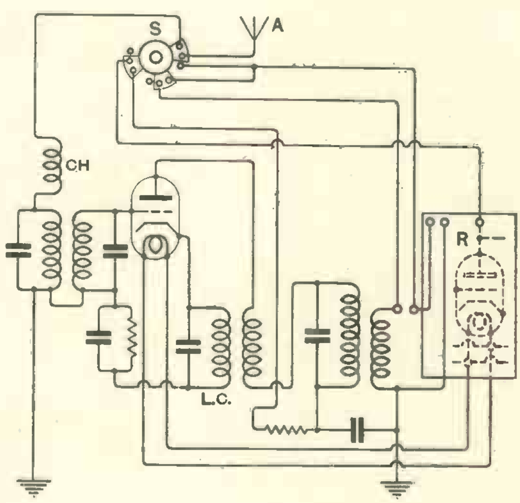
In order to reduce the size of the air-gap, and to facilitate centring, the speech coil is fixed but influences an associated conductor which extends into the air-gap of a separate field-coil. The field-coil is situated near the apex of the cone, and the speech coil is wound separately on a fixed transformer core. The fluctuating speech-currents vary the field through the core, and so induce a corresponding current in the associated member, the far end of which enters the field gap and is vibrated accordingly to drive the diaphragm.

Patent issued to The Magnavox Co.

WAVE-BAND ADAPTERS

Convention date (France), 3rd April, 1931. *No.* 388235

A frequency-changing unit is connected between the aerial *A* and an existing receiver *R* to extend the effective wave-band range of the latter. The switch *S* allows the aerial to be connected either directly to the input terminal of the receiver *R*, or through a choke *CH* to the input of the frequency-changing valve *V* of the adapter. This valve is back-coupled as shown, the main oscillating circuit *LC* being connected to the cathode, instead of to the grid, so as to prevent re-radiation from the aerial. If the receiver *R* will normally tune up to 500 kc., and it is desired to receive, say 150 kc., the input circuit is tuned to the latter frequency



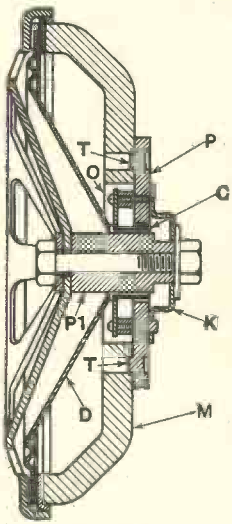
No. 388235

and the local oscillator circuit *LC* to 650 kc. The adapter valve *V* is arranged to be energised from the same current source as that supplying the receiver *R*.

Patent issued to I. Diaz.

PERMANENT-MAGNET SPEAKERS

Convention date (*U.S.A.*), 18*th May*, 1931.
No. 387673



No. 387673

The main magnet M is made in the form of a bar with a circular opening O at the centre. The bar is magnetised so that its opposite ends are of the same polarity, whilst the part around the central pole is of opposite polarity. An annular pole-piece P is mounted over the central aperture and co-operates with a centre pole-piece $P1$ to form an annular air-gap for the speech-coil C which drives the diaphragm D. The annular pole-piece P is centred in position by means of projections T which take into apertures formed in the main magnet, and also by a spacing-collar K of non-magnetic material.

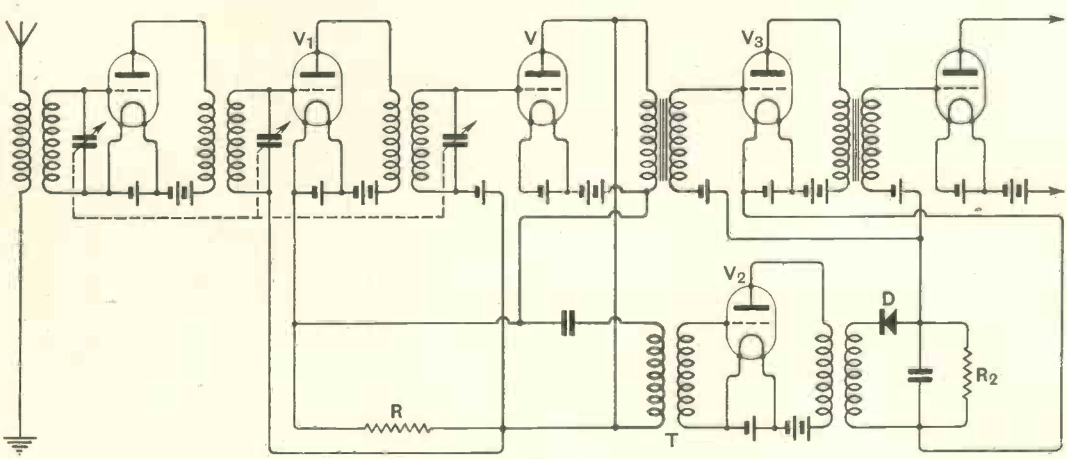
Patent issued to The Magnavox Co.

AUTOMATIC VOLUME CONTROL

Convention date (*U.S.A.*), 1*st May*, 1931.
No. 388601

In order to suppress "background" noise in the absence of a definite signal, one of the low-frequency amplifiers is given a paralysing bias so that it functions to prevent the operation of the loud speaker during tuning operations until such time as a signal of predetermined strength is received. As shown a resistance R in the output of the detector valve V is used to control the bias of the high-frequency amplifier $V1$. A transformer coupling T, also in the output circuit of the detector valve, transfers the radio-frequency output from that valve through an amplifier $V2$ to a rectifier D, which supplies biasing voltage through a resistance $R2$ to the grid of a low-frequency valve $V3$. The last-mentioned valve is initially paralysed by a prohibitive bias until the incoming signal produces a sufficiently strong counter-bias across the resistance $R2$ to reduce the resultant grid voltage to normal.

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



No. 388601

Convention date (*U.S.A.*), 24*th January*, 1931.
No. 388122

In order to secure a more rapid response to any fluctuation of input strength, an auxiliary control valve of the screen-grid type—as distinct from the known arrangement of using a triode—is connected in parallel with the detector valve. The rectified voltage developed in the anode circuit of the S-G valve is fed back to impose a variable bias on the grids of one or more of the preceding high-frequency stages.

Patent issued to United American Bosch Corporation.

ELECTROLYTIC CONDENSERS

Convention date (*U.S.A.*), 19*th June*, 1930.
No. 388395

A durable condenser, capable of taking high voltages, is characterised by the use as an electrolyte of the reaction products formed by heating together ethylene glycol and a film-maintaining electrolyte consisting of ammonium borate and boric acid. The composition is spread on an open-meshed fibre cloth impregnated with paraffin and laid between two sheets or electrodes of aluminium. The plates are lacquered to prevent creeping and surface corrosion.

Patent issued to S. Ruben.

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