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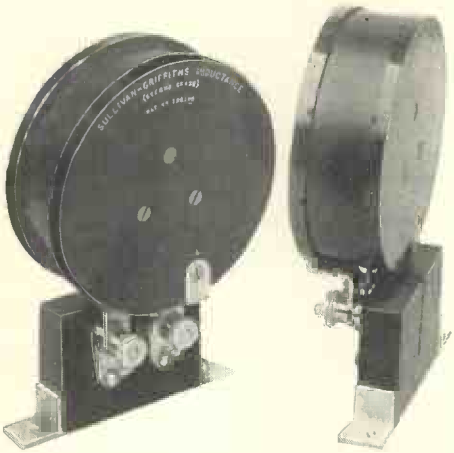

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The

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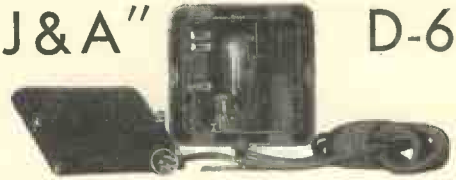

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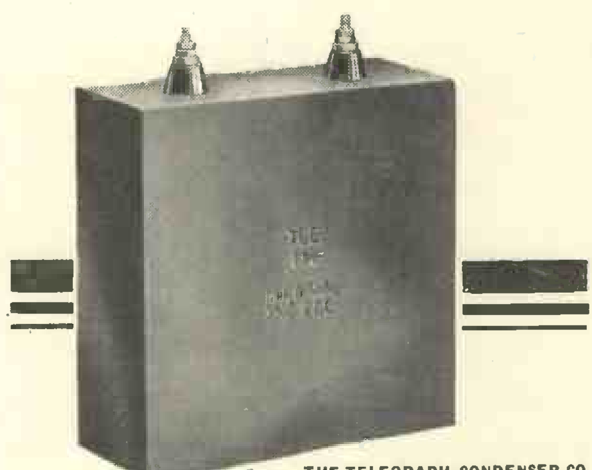

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THE

WIRELESS ENGINEER

AND

EXPERIMENTAL WIRELESS

VOL. X. MARCH, 1933. No. 114

Editorial

UNTIL the beginning of last year long-distance radio-telegraphy in Germany was conducted by a private company, the "Transradio A.G. für drahtlosen Ubersee-Verkehr," an offshoot of the Telefunken Company, but on 1st January, 1932, the stations were taken over by the Postal Department of the German Government, which thus became possessed of the historic Nauen station, in addition to the receiving stations at Geltow and Beelitz and the associated Telegraph Offices in Berlin and Hamburg. We do not know what connection, if any, the Telefunken Company still maintains with the stations thus taken over, but we notice that the *Telefunken Zeitung*—a journal of which any firm might justifiably be proud—still retains its triple heading, Telefunken-Transradio-Debeg, the last-named being the marine operating company.

The history of Nauen goes back to the year 1906 when the Telefunken Co. installed there an experimental 10 kW spark set, which was soon replaced by a 100 kW. quenched-spark transmitter. In 1913 experiments were made with high-frequency alternators and frequency-multiplying transformers, with which radio telephonic communication with Vienna and radio-telegraphic communication with Sayville near New York were found possible. Towards the end of the war the station was considerably enlarged and equipped with 2 sets of 400 kW. and 2 sets of 150 kW., a new company being formed which in 1923 adopted the name "Transradio." At first the company leased the station to the Government, but in 1921 the company obtained from the Government a concession, and took over the transmission of all overseas radio-communication. By the recent decision this has all reverted to the Government.

With the development of short-wave communication, much of the older long-wave equipment has become superfluous. At Nauen only the two 400 kW. machine sets are now used, but these still carry a large part of the long-distance telegraphic business. The Eilvese station, with its four Goldschmidt machines, which was also operated by the Transradio Company, was closed down some years ago and has now been dismantled.

At the present time, 16 telegraphy channels are being worked from Nauen; they are as follows:—

United States resumed in ..	1919
Egypt opened in	1923
Argentine; North China ..	1924
Dutch East Indies	1925
Brazil; Japan	1926

Philippines	1927
Chile ; Mexico ; Siam	1929
Cuba ; Persia ; Shanghai ..	1930
Syria ; Venezuela	1931

In addition to this, telephony is being worked on the following channels :—

Argentine since	1928
East Indies	1929

Brazil, Chile and Uruguay since 1930, Siam and Venezuela since 1931, and Egypt since 1932.

Picture transmission is carried out on two channels, viz., South America since 1930 and North America since 1932.

The wavelengths employed are, generally speaking, from 15 to 20 metres during the day and from 30 to 60 metres during the night. The type of beam aerial favoured by the Telefunken Company is the array of horizontal dipoles or half-wave aerials, with a vertical separation of half a wavelength. The reflector is a similar array placed a quarter of a wavelength behind the first. By changing over the connections to the two arrays the direction of maximum radiation is reversed. This is very convenient as it enables the same aerial to be used for transmission in either direction around a grand circle, thus, for example, permitting the same aerial to serve either the South American or the Japanese channel.

In many respects, the station at Nauen resembles that at Rugby ; there are the giant steel lattice towers supporting the long-wave aerials, standing in dignified symmetry and surrounded in all directions by a mushroom growth of pygmy masts and short-wave aerials scattered about in apparent disorder. At Nauen the high towers support two aerials, each operated from one of the high-frequency machines, one at a wavelength of 18,130 metres and the other at 13,000 metres. There are 30 short-wave aerials, 15 of them with reflectors and 15 without. They vary in size from 4 dipoles to 96 dipoles. There are, however, only 12 short-wave transmitters, each crystal controlled and capable of delivering 20 to 25 kW. to the aerials. Six of the sets have their anode current supplied from high voltage D.C. dynamos and six from rectified alternating current. The power required by the whole station is taken from a 15,000 volts 3-phase public supply, but a 1,000 H.P. Diesel set has recently been installed as a reserve in case of failure of the public supply.

The receiving station, which was formerly situated at Geltow near Potsdam, has now been transferred to Beelitz. For long-wave reception there are two aerials, each consisting of crossed frames carried on 60 metre steel towers. These can be connected in different ways to five long-wave receiving sets. For short-wave reception there are a large number of aerials of the same type as at the transmitter, in addition to experimental aerials of the Beverage and other types. The receiver rooms contain 35 short-wave receivers. To overcome the effects of fading several aerials and receivers are sometimes used simultaneously on the same channel. Nearly all the receiving aerials have reflectors to make them insensitive to signals arriving in the reverse direction.

Both Nauen and Beelitz are connected with the Central Telegraph Office in Berlin, the former by a 50 pair and the latter by a 55 pair cable. These cables have 7 or 8 pairs with the high cut off frequency of 36,000 for picture transmission ; of the remaining pairs, some have a cut off frequency of 16,000, some 3,500, and some 2,700. The pairs intended for telephony branch off to the Berlin exchange. All the transmission keying and reception recording is carried out in Berlin.

G. W. O. H.

Some Notes on the Use of a Diode as a Cumulative Grid Rectifier*

By E. A. Biedermann, B.Sc., A.M.I.E.E.

Introduction

THE use of a diode as a cumulative grid rectifier in broadcast receivers possesses several outstanding advantages to which attention was drawn some time ago by Mr. F. M. Colebrook†, and more recently by Mr. H. L. Kirke.‡. It appears that it is possible to obtain practically perfect rectification with any R.F. input voltage exceeding a fraction of a volt. If, then, by the use of an R.F. filter it can be ensured that only a small fraction of the R.F. voltage applied to the rectifier is passed on to the succeeding L.F. amplifier, the full capacity of the latter is available for amplification of the L.F. voltage. When, however, the functions of rectification and L.F. amplification are combined in one valve, as in the case of the ordinary grid detector, the maximum L.F. grid swing which the detector can handle without reverse anode-current rectification and consequent distortion occurring is limited by the fact that the valve has also to deal with the full R.F. voltage. Conversely, when the L.F. amplifier has only to deal with the L.F. voltage, a given grid swing can be accommodated with a smaller mean anode current. This is a great advantage when mains voltage is limited, since adequate de-coupling can then

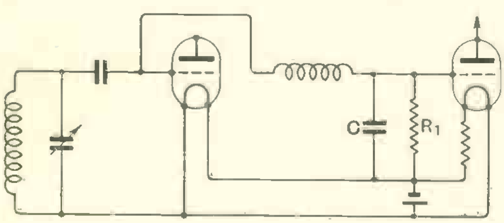


Fig. 1.

be effected irrespective of the method of coupling the amplifier to the succeeding valve.

* MS. received by the Editor, June, 1932.
† *Wireless World*, June 10th, 1931.
‡ *Wireless World*, February 3rd, 1932.

Since the last-mentioned advantage will only be obtained in full measure, provided the R.F. voltage passed on to the amplifier is but a small part of that applied to the rectifier, it seems desirable to examine what are the best conditions for ensuring this.

Direct- and Indirectly-coupled Rectifier

The arrangement put forward by Mr. H. L. Kirke is illustrated in Fig. 1, while that sug-

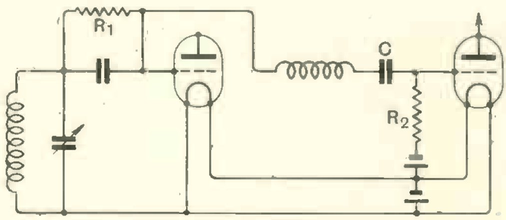


Fig. 2.

gested by Mr. F. M. Colebrook is essentially as shown in Fig. 2. In the former arrangement the diode is directly connected to the L.F. amplifier, the resistance R_1 serving the dual purpose of grid leak and coupling resistance, while the condenser C in parallel augments the filtering effect of the R.F. choke. In Mr. Colebrook's arrangement the grid leak R_1 is in the usual position, a separate resistance R_2 being used to couple the rectifier to the amplifier, the latter being isolated from the former by the blocking condenser C_2, thus enabling grid bias to be applied to the amplifier through the coupling resistance R_2.

At first sight there seems to be no really essential difference between the two methods, but it will appear later that the use of the indirect coupling may under some conditions materially influence the action of the rectifier. For the immediate purpose of examining the effect of the R.F. filter the two methods can, however, be considered as substantially the same.

R.F. Voltage Applied to Amplifier

The extent of the filtering effected by the

R.F. choke is, of course, as much dependent on the R.F. input impedance of the amplifier as on the efficiency of the choke. In the case of an L.F. amplifier the anode circuit R.F. load is essentially capacitive and in these circumstances the R.F. input impedance consists of a resistance R_g in parallel with a capacity C_g whose magnitudes are given by the expressions

$$\frac{1}{R_g} = \frac{x}{(1+x^2)}\left(\mu\frac{R_0}{R_a} + \frac{C_{ga}}{C_a}\right)\omega C_{ga} \quad .. \quad (1)$$

$$C_g = \frac{1}{(1+x^2)}\left\{\left(\mu\frac{R_0}{R_a} + 1\right) + x^2\frac{(C_a - C_{ga})}{C_a}\right\}C_{ga} + C_{gf} \quad .. \quad (2)$$

where

C_{ga} = anode-grid capacity.

C_{gf} = grid-filament capacity

C_a = effective capacity of anode circuit including the capacity C_{ga}

and $x = R_0\omega C_a$ where R_0 denotes the resultant of the A.C. resistance R_a of the valve and any resistance which may be used for coupling the succeeding valve to the amplifier.

C_{ga}/C_a will invariably be quite small compared with $\mu R_0/R_a$, so that approximately

$$\frac{1}{R_g} = \frac{x}{(1+x^2)}\mu\frac{R_0}{R_a}\omega C_{ga} \quad .. \quad (3)$$

Also, if C_{gf} is taken as approximately equal to C_{ga} and the very small capacity

$$\frac{x^2}{(1+x^2)}\frac{C_{ga}}{C_a}C_{ga}$$

is neglected,

$$C_g = \left\{\frac{1}{(1+x^2)}\mu\frac{R_0}{R_a} + 2\right\}C_{ga} \quad .. \quad (4)$$

From (3) and (4) the R.F. input impedance of the amplifier is then given approximately by

$$Z_g = \frac{(1+x^2)^{\frac{1}{2}}}{2\left\{\left(\frac{\mu}{2}\frac{R_0}{R_a} + 1\right)^2 + x^2\right\}^{\frac{1}{2}}\omega C_{ga}} \quad (5)$$

The quantity $x = R_0\omega C_a$ will vary over a wide range of values, from something less than unity to 100 or more, according to circumstances, but for any given valve and given arrangement for coupling this to the succeeding valve, it will depend only on the product ωC_a. At any given wavelength, therefore, the value of the input impedance can be controlled only by the effective anode circuit capacity C_a. This can be given quite a wide range of values by the use of different by-pass condensers and, if necessary, by employing a R.F. choke in the anode circuit.

It is easily shown that the coefficient of $1/\omega C_{ga}$ in (5), for given values of μ and R_0/R_a, is always smaller the smaller the value of x, while the smaller Z_g in relation to the impedance of the R.F. choke preceding the amplifier the less will be the R.F. voltage acting on the amplifier for any given voltage applied to the rectifier. It appears, therefore, that in order to reduce the R.F. voltage on the amplifier to a minimum, the effective anode circuit capacity should be made as small as possible. This means that no by-pass condenser should be used in the anode circuit of the amplifier and that a R.F. choke should also be connected in the anode circuit to prevent any appreciable part of the capacity arising from the following part of the receiver being effective at the anode of the amplifier. It should be noted, however, that it may not be found possible in some cases to dispense entirely with a by-pass condenser, as the use of R.F. chokes in both grid and anode circuits of the amplifier may lead to instability. For this reason the resonant wavelength of the anode circuit

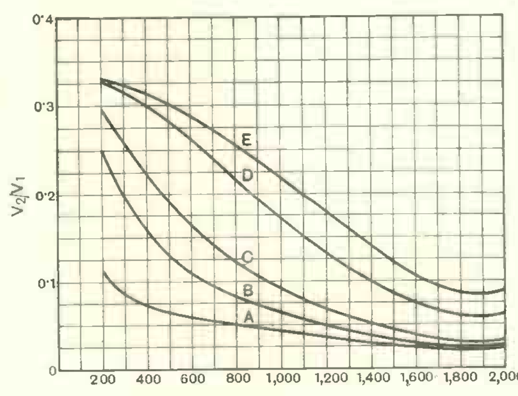


Fig. 3.—$\frac{V_2}{V_1} = \frac{\textit{Amplifier Voltage}}{\textit{Rectifier Voltage}}$.
Curve A—C_a = 20 $\mu\mu F$., B—C_a = 70 $\mu\mu F$., C—C_a = 120 $\mu\mu F$., D—C_a = 320 $\mu\mu F$., E—C_a = 520 $\mu\mu F$.

choke should be at least as great as that of the choke in the grid circuit.

Again, with any given value of C_a, the value of x will decrease as the wavelength increases. Thus the coefficient of $1/\omega C_{ga}$ in (5) decreases with increasing wavelength while the impedance of the choke rises at first in direct proportion to the wavelength and subsequently more rapidly, until the resonant wavelength of the choke is approached. It follows, therefore, that with increasing wavelength the fraction of the rectifier voltage which is passed on to the amplifier should steadily decrease till the above resonant wavelength is approached.

The above two general conclusions are illustrated and confirmed by the curves of Fig. 3. These show the variation of the ratio V_2/V_1, with wavelength for various values of the effective anode circuit capacity C_a, V_1 denoting the R.F. voltage applied to the rectifier and V_2 that which is effective at the grid of the amplifier. These curves relate to a typical battery valve with an amplification factor of 15 and an A.C. resistance of 10,000 ohms, transformer-coupled to the succeeding valve. The anode-grid and grid-filament capacities were assumed to be 5 $\mu\mu$F. and as the rectifier was supposed to be indirectly-coupled to the amplifier, a coupling resistance of half a megohm was allowed for, though the effect of this is very small. The R.F. choke in the grid circuit of the amplifier was assumed to have an inductance of 200,000 $\mu\mu$H. and a self-capacity of 5 $\mu\mu$F. with a maximum impedance of 540,000 ohms at a resonant wavelength of about 1,900 metres.

It will be seen that under these assumed conditions the filtering of the R.F. voltage at the shortest wavelengths is very ineffective except when the effective anode circuit capacity is reduced to a very small value. Even when this capacity is only 70 $\mu\mu$F. the R.F. voltage at the amplifier rises, at a wavelength of 200 metres, to 25 per cent. of that applied to the rectifier.

It is evident from (5) that in the case of a valve, *e.g.*, a mains valve, having a considerably greater amplification factor, the values of Z_g would be correspondingly lower and the filtering consequently more effective. On the other hand, the effect of any stray capacity across the choke has been neglected and the effect of any such capacity would clearly be to reduce the filtering effect of the choke. It is clear, therefore, that it must not be too readily assumed that the use of a R.F. choke alone in the grid circuit of the amplifier will always ensure adequate filtering of the R.F. voltage, even from the point of view only of its effect on the amplifier. From this point of view it appears that it is advisable to keep the effective anode circuit capacity as low as possible.

R.F. Voltage in Anode Circuit of Amplifier

Even though the R.F. voltage on the grid of the amplifier be adequately reduced so far as its effect on the functioning of this valve is concerned, it will again be magnified by the valve, with the result that a R.F. voltage comparable with that applied to the rectifier may still appear in the anode circuit of the amplifier. The amplification due to the valve is given very closely by

$$\frac{V_a}{V_2} = \frac{\mu}{(1 + x^2)^{\frac{1}{2}}} \quad \ldots \quad \ldots \quad (6)$$

where V_a denotes the R.F. voltage developed between anode and filament and V_2, as before, that between grid and filament of the amplifier. Now when Z_g is small compared with the impedance of the choke in the grid circuit of the amplifier, V_2 is approximately proportional to Z_g for any given voltage V_1 applied to the rectifier and given impedance of R.F. choke. It follows from (5) and (6) that V_a/V_1 is proportional to

$$\mu \Big/ \left\{\left(\frac{\mu}{2}\frac{R_0}{R_a} + 1\right)^2 + x^2\right\}^{\frac{1}{2}} \omega C_{ga}$$

Since $x = R_0 \omega C_a$, V_a/V_1 will, for given values of the various constants, be at all wavelengths greater the smaller the value assigned to C_a, so that the condition which was found to be the best from the point of view of reducing the R.F. voltage on the grid of the amplifier becomes the worst when the voltage developed in the anode circuit is considered. The shorter the wavelength the more marked is the effect of varying C_a, since, for any given value of C_a, x has relatively large values at the shorter wavelengths.

The curves of Fig. 4 show the variation of V_a/V_1 with wavelength in the particular case used previously to illustrate the variation of V_2/V_1. It will be seen that, when C_a has the small value 20 $\mu\mu$F., the voltage developed in the anode circuit of the ampli-

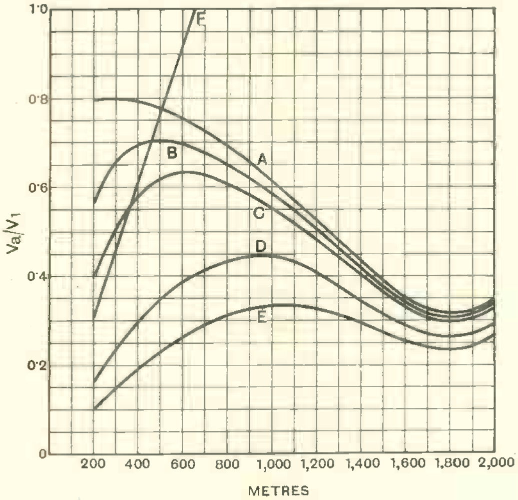


Fig. 4.—$\frac{V_a}{V_1} = \frac{\textit{Anode Voltage}}{\textit{Rectifier Voltage}}$.
Curve A—C_a = 20 $\mu\mu$*F.*, B—C_a = 70 $\mu\mu$*F.*, C—C_a = 120 $\mu\mu$*F.*, D—C_a = 320 $\mu\mu$*F.*, E—C_a = 520 $\mu\mu$*F.*, F—C_a = $\mu\mu$*F.*, *choke omitted.*

fier rises to as much as 80 per cent. of that applied to the rectifier, when the wavelength is 200 metres. The curve F is given for the purpose of comparison. It shows the values V_a/V_1 would have, when $C_a = 520$ $\mu\mu$F., were the grid circuit choke omitted, and thus corresponds to the case of the single-valve grid detector.

Possible Methods of Improving the R.F. Filter

Two possible methods of rendering the R.F. filter more effective are obvious. One is to connect a capacity between the grid and filament of the amplifier. Since such a capacity is, for modulation frequencies, effectively in parallel with the grid condenser in the input circuit of the rectifier, as well as with the input capacity of the amplifier, it would be necessary, if high note loss is not to be increased, to reduce the value of the grid condenser by the amount of the parallel capacity thus added. This method is, in fact, that used by Mr. Kirke in his arrangement of the direct-connected diode shown in Fig. 1. Thus instead of the commonly used 100 $\mu\mu$F. grid condenser, this could be reduced to 50 $\mu\mu$F. and an equal capacity be connected in parallel with the amplifier.

It is one advantage of the use of a diode as a rectifier that the absence of any reaction effect makes its R.F. impedance relatively high and the use of the smaller grid condenser does not lead to any material reduction of the R.F. voltage applied to the rectifier in relation to that developed across the tuned circuit.

The effect of the above modification in the same typical case is illustrated by curves I and II of Fig. 5. The factor β given by these curves represents the ratio in which the previous values of both V_2/V_1 and V_a/V_1 are reduced by the addition of the parallel capacity. Curve I is for an effective anode circuit capacity of 20 $\mu\mu$F. and curve II for a capacity of 520 $\mu\mu$F.

While the improvement effected is much greater with the greater value of C_a, the actual values of V_2/V_1 with this value of C_a are still greater than those obtained when $C_a = 20$ $\mu\mu$F. As, however, with both values of C_a the greatest value of V_2 at any wavelength is now less than 7 per cent. of V_1, it is immaterial from the point of view of the satisfactory functioning of the amplifier what value of C_a is used. From the point of view of the R.F. voltage in the anode circuit it is now clearly better to use

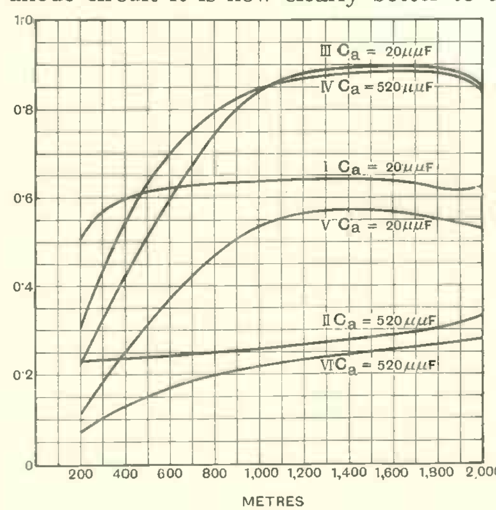


Fig. 5.

a relatively large value of C_a, since not only is the improvement effected by the parallel capacity then greatest, but the original values of V_a/V_1 are then smallest, as shown by the curves of Fig. 4. With $C_a = 520$ $\mu\mu$F., V_a is reduced to less than 10 per cent. of V_1 at all wavelengths.

A second obvious method of improving the R.F. filter would be to connect a resistance in series with the R.F. choke. This would effect some considerable improvement at the shortest wavelengths, where the impedance of the choke is relatively low. This is shown by the curves III and IV of Fig. 5, which show the values of β which would be obtained in the same particular case by the use of 100,000 ohm resistance having negligible capacity. Unfortunately the improvement effected by this means is only marked at the shortest wavelengths. Thus in the above typical case it would still be necessary to keep the value of C_a fairly low if V_2 is to be reduced to something less than 10 per cent. of V_1 over the whole range of wavelengths.

The use of resistance in the above manner clearly involves some loss of modulation voltage. This would be particularly so in the case of the directly-connected rectifier where the additional resistance would be in series with the grid leak, which cannot be given a very high value without unduly accentuating high note loss. With the indirectly-coupled arrangement, however, the additional resistance is in series only with the coupling resistance and this can be given a relatively high value without any increase of high note loss, since for modulation frequencies it is effectively in parallel with the grid leak. If this coupling resistance were 1 megohm, for example, the loss of modulation voltage due to the addition of 100,000 ohms in series with the R.F. choke would not be serious.

The above two methods of added parallel capacity and series resistance could, of course, be combined and the resulting improvement is then as indicated by curves V and VI in Fig. 5. It would in this case be quite practicable to make use of a relatively large value of C_a since the R.F. voltage on the grid of the amplifier would be adequately reduced at all wavelengths, and comparison of curves II and VI shows that some considerable further reduction of the anode circuit voltage would be effected at the shorter wavelengths by the combination of the two methods.

Alternative Method of Coupling Rectifier and Amplifier

By adopting a somewhat different method of coupling the rectifier and amplifier, it is possible to effect some considerable improvement in the filtering of the R.F. voltage. The arrangement, which is equally applicable with direct, or indirect, coupling of rectifier and amplifier, is shown in Fig. 6 for the latter case. It will be seen that the grid leak and condenser, instead of being connected in the usual manner between the tuned input circuit and the grid of the

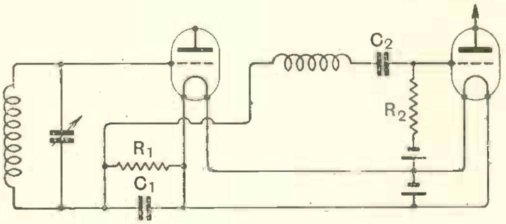


Fig. 6.

rectifier, are inserted between the low-potential end of the tuned circuit and the rectifier filament, an arrangement which, of course, necessitates insulating the low potential side of the tuning condenser. The R.F. choke feeding the grid of the amplifier is then connected to the junction of the tuned circuit and the grid leak, grid condenser combination. For direct coupling of rectifier and amplifier the R.F. choke would be inserted in series with the grid leak, the latter serving as a coupling resistance as before.

By the above means the choke filter has applied to it only the relatively small R.F. voltage developed across the grid condenser, instead of the whole R.F. voltage applied to the rectifier. In fact, an additional filter stage has been introduced, the resistance of the grid-filament path of the rectifier, in parallel with its grid-filament capacity, forming the high-impedance element of the filter and the grid condenser, or grid leak and condenser in parallel, forming the low-impedance element. Unfortunately, for reasons which will probably be obvious, this alternative method of coupling rectifier and amplifier is only applicable where the tuned input circuit is coupled to the preceding R.F. amplifier inductively, either by transformer or band-pass filter.

With the values usually employed for the grid leak and condenser the former has a practically negligible effect on the impedance of the combination for R.F. currents. Similarly the R.F. choke filter, which is also in parallel with the grid condenser, will also be negligible in its effect on the resultant R.F. impedance existing between the low-potential end of the tuned circuit and the filament of the rectifier. This impedance will, therefore, be substantially that due to the capacity C_1 of the grid condenser. In these circumstances, if C denote the grid filament capacity of the rectifier and R the effective resistance of its grid-filament path, the R.F. voltage V_0 developed across the grid condenser in relation to that V_1 applied between grid and filament of the rectifier is given by

$$\beta = \frac{V_0}{V_1} = \frac{(1 + R^2\omega^2C^2)^{\frac{1}{2}}}{R\omega C_1} \quad .. \quad (7)$$

The variation of β with wavelength, when the grid condenser has a value of 100 $\mu\mu$F. and the grid-filament path an effective resistance

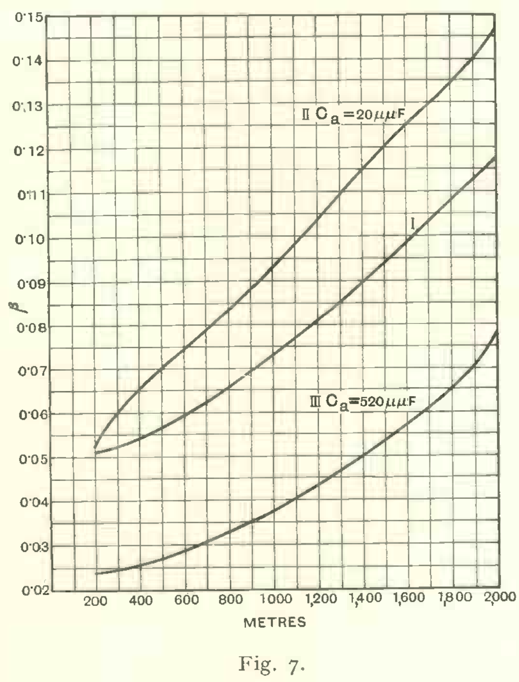


Fig. 7.

of 100,000 ohms, is shown by curve I of Fig. 7. The values found for V_2/V_1 and V_a/V_1 in the particular case discussed in the preceding sections would, with this alternative arrangement, be the values of V_2/V_0 and V_a/V_0 and the resulting values of V_2/V_1 and V_a/V_1 are, therefore, obtained by multiplying the previous values by the values of the factor β. The result is that, without making use of either of the modifications mentioned above, V_2 is now reduced to less than 2 per cent. of V_1 at all wavelengths even when C_a has the relatively large value 520 $\mu\mu$F., which is the least favourable case. There is thus no need for C_a to be small and with the above value V_a is reduced to some 3 per cent. of V_1, or less, at all wavelengths. Even with the small value 20 $\mu\mu$F. for C_a, V_a is less than 5 per cent. of V_1. If now the capacity of the grid condenser be reduced to 50 $\mu\mu$F. and a capacity of equal value be added in parallel with the amplifier, the overall improvement on the curves of Figs. 3 and 4 is represented by the values of the factor β given by curves II and III of Fig. 7. With $C_a = 20$ $\mu\mu$F. the overall filtering is now not as good as with the 100 $\mu\mu$F. grid condenser, but with $C_a = 520$ $\mu\mu$F. it is better. With this latter value of C_a, V_a is reduced to 2 per cent. of V_1, or less, at all wavelengths. With some intermediate values for C_a it would be practically immaterial whether the grid circuit capacity were used wholly as a grid condenser or partly as such and partly as a capacity connected directly in parallel with the grid and filament of the amplifier.

Some General Conclusions regarding the R.F. Filter

While it is dangerous to draw too general conclusions from examination of a particular case, it seems fairly safe to say that, without making use of the alternative arrangement last discussed, the R.F. voltage on the grid of the amplifier could usually be reduced, by the other methods discussed, to a sufficiently small value to prevent distortion occurring in the amplifier, but that the degree of filtering obtained is unlikely to be adequate from the point of view of the R.F. voltage in the anode circuit of the amplifier. Thus a further R.F. filter in the anode circuit of the amplifier would usually be necessary, as has been pointed out by Mr. H. L. Kirke.*

* *Wireless World*, April 20th, 1932.

With the alternative method of coupling suggested, it would seem that not only could the R.F. voltage on the grid of the amplifier invariably be reduced to a quite negligible fraction of that applied to the rectifier, and this without the aid of the other modifications, but the R.F. voltage in the anode circuit of the amplifier would generally be adequately eliminated without the aid of any further filter other than that provided by a by-pass condenser of 100–500 $\mu\mu$F.

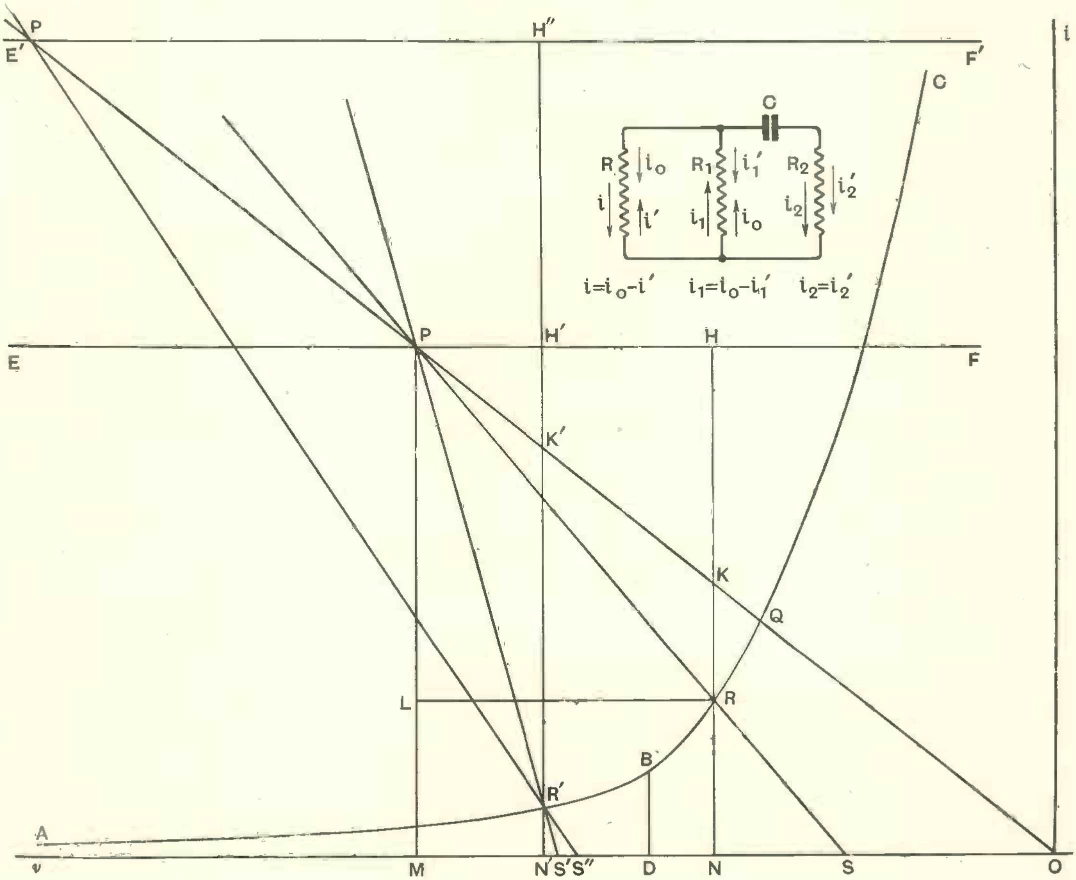


Fig. 8.

Effect of Indirect Coupling on Rectifier.

At first sight it might appear that there could be no essential difference in the functioning of the diode rectifier whether coupled directly, or indirectly, to the amplifier. Closer examination, however, reveals that indirect coupling may in some circumstances materially modify the action of the rectifier and lead to some distortion when the modulation percentage is high. Mr. H. L. Kirke has, in fact, apparently obtained some experimental evidence of this, as indicated in a recent article in *The Wireless World*.* The following analysis of the matter may be of some interest, though it differs in some respects from the theory put forward by Mr. Kirke in the article referred to.

In Fig. 8, *ABC* represents the grid current characteristic of the rectifier, while in the inset diagram R represents the effective resistance of the rectifier for currents of modulation frequency, R_1 the grid leak and R_2 the coupling resistance, the coupling condenser C being supposed to have a

* *Ibid.*

negligible impedance relative to R_2 at modulation frequencies. OP represents the load line for the grid leak R_1 alone and P is supposed to be the operating point for the carrier value of a modulated R.F. input voltage when the coupling resistance and amplifier are disconnected. With 100 per cent. modulation the representative point would then move from P to Q and back during the positive half of the modulation cycle. When the coupling resistance and amplifier are connected it is obvious that the representative point must move on a new load line. This new load line will still be a straight line* on the above assumption as to the relatively negligible impedance of the capacity C, and its slope will be determined by the resultant of the two resistances R_1 and R_2 in parallel. Thus, for example, if $R_2 = 2R_1$, the new load line will have a slope 50 per cent. greater than OP. Again, it is clear, since the circuit comprises only resistances, that the current i_2 of modulation frequency which will now flow through R_2 must be in phase with the modulation of the R.F. input voltage and hence this current must pass through its zero value when the R F. input voltage passes through its carrier value. At this instant in the modulation cycle, therefore, the current through the rectifier and the mean grid potential must be the same as if the coupling resistance and amplifier were disconnected. Thus the new load line also passes through the point P, so that for the particular relation $R_2 = 2R_1$ the load line is SP where $OS = \frac{1}{3}OM$.

The point of intersection R of SP with the grid current characteristic must now correspond to that instant in the modulation cycle at which the R.F. input voltage, supposed modulated 100 per cent., momentarily vanishes, for at this point, and this point only, the grid current has the value which it would have at the corresponding grid potential in the absence of any R.F. voltage. Thus with 100 per cent. modulation the representative point now moves from P to R and back during the positive half of the modulation cycle.

The current i through the rectifier can be regarded as consisting of a DC component i_0, the value for the carrier voltage, with a superposed modulated component of instantaneous value i' which, during the positive half of the modulation cycle flows in the opposite direction to i_0, so that at any instant $i = (i_0 - i')$. Thus in Fig. 8 PM represents i_0 while i' is represented by the intercepts between the horizontal line EPF and the new load line PR, HR thus representing the maximum value of i'.

Similarly, the current i_1 through the grid leak R_1 consists of the same DC component i_0 and a superposed modulated component i_1' which also flows in the opposite direction to i_0 during the positive half cycle, so that $i_1 = (i_0 - i_1')$. Also, since the total modulation current flowing through R_1 and R_2 in parallel is equal to the modulated component i' through the rectifier, and $R_2 = 2R_1$, it follows that $i_1' = \frac{2}{3}i'$ and $i_2' = \frac{1}{3}i'$, where i_2' denotes the modulated, and only, current through R_2. The current i_1' is therefore represented by the intercepts between EPF and the load line PQ corresponding to the grid leak alone, while the current i_2' is represented by the intercepts between PQ and the new load line PR.

The conditions at the instant of maximum positive voltage in the modulation cycle are of particular interest. At this instant the representative point is at R, the R.F. input voltage is momentarily nil and there is no rectified current flowing through the rectifier, but only the static component represented by RN. In the grid leak R_1, however, the total current at this instant is that represented by KN, made up of the static component RN and a rectified component KR, both flowing from filament to grid, while the current through the coupling resistance R_2 is also that represented by KR, but flowing from grid to filament. Thus at this particular instant, so far as currents arising from *rectification* are concerned, there is simply a circulation of current through the grid leak R_1 and coupling resistance R_2. The conditions at this particular instant have been stressed because they help to make clear what may happen in some circumstances.

Under the particular conditions assumed above there appears to be no reason why the indirectly-coupled rectifier should not function in exactly the same way as the directly-coupled rectifier, even with 100 per cent. modulation, except, of course, that the modulation voltage will be somewhat less

* The effect of the capacity of the grid condenser and amplifier is here neglected.

for a given R.F. input voltage. Any distortion, or increase of distortion, occurring under these conditions could only be attributed to a possible increase of curvature at the foot of the rectification characteristic and it is quite possible that such an increased curvature might occur, partly as a result of the increased slope of the load line and partly owing to the shifting from Q to R of the point of intersection of this line with the grid current characteristic.

The case is quite different, however, if the coupling resistance is given such a low value in relation to that of the grid leak as to result in a load line such as $PR'S'$, or if, without reducing the coupling resistance to such an extent as this, the carrier voltage is greater, so that a load line such as $P'R'S''$ is obtained. For the various load lines to have such large slopes as those shown in Fig. 8, the scale for the grid current must be greatly magnified, so that a point such as B may be regarded as the point at which grid current would be said to cease. Whether the grid current actually does cease suddenly at a certain negative grid potential, or merely becomes negligibly small at more negative potentials, will subsequently be seen to be immaterial. For the moment it will be supposed that it does not cease entirely at the point B but only becomes negligibly small at that point.

The analysis of the various currents given above then still holds good in every detail and, in particular, it is still true that at the instant when the representative point is at R' the point of intersection of either of the assumed new load lines with the grid current characteristic, the rectified current through the rectifier and the R.F. input voltage momentarily vanish, while a rectified current, now represented by $K'R'$, circulates through R_1 and R_2. But, since grid current is supposed to be negligibly small over the part BR' of the characteristic, it also follows that only a negligible rectified current flows through the rectifier during that part of the modulation cycle for which the peak R.F. voltage is less than that represented by $N'D$. During this period, therefore, the representative point remains almost stationary close to the point R' and the mean grid potential remains almost constant. This in turn means that, during this period, there must be a practically constant circulation of current through R_1 and R_2, of magnitude represented by $K'R'$. At first sight this seems impossible, but it is not so. The explanation lies in the assumption that the impedance of the blocking condenser C at modulation frequencies is negligible compared with the resistance R_2, in which case it may also be considered negligible compared with $(R_1 + R_2)$. Thus $1/\omega C$, or $T/2\pi C$ is negligible compared with $(R_1 + R_2)$, where T is the period, so that $(R_1 + R_2)C$ is very large compared with $T/2\pi$. But $(R_1 + R_2)C$ is the time constant of the circuit consisting of R_1, R_2 and C, so that this condition means that even for a considerable part of a modulation cycle the condenser can maintain a practically constant current with but a negligible change of grid potential. The condenser will be recharged when the R.F. input voltage again increases sufficiently to cause rectification and there must, of course, be some slight distortion of the load line in consequence of this discharge and recharge of the condenser, but this distortion of the *load line* will be negligibly small if the impedance of C is sufficiently small. On the other hand, it is clear that in these circumstances, there must be very marked distortion of the *wave-form* of the modulated grid current and voltage as soon as the modulation percentage is sufficiently great for the peak R.F. voltage to fall below the value represented by $N'D$, since the mean grid potential then remains substantially constant for that part of the modulation cycle during which the peak R.F. voltage remains below this value.

It follows, therefore, that the maximum percentage modulation with which the indirectly-coupled rectifier can deal without distortion must be reduced whenever the load line is such as to intersect the grid current characteristic at a point of greater negative potential than that at which grid current becomes negligibly small. It is also obvious that the same argument will still apply if, as a limiting case, it is supposed that grid current actually ceases entirely at a point such as B in Fig. 8, which point would then coincide with the point D. Briefly it can be then said that to prevent appreciable distortion with 100 per cent. modulation, the load line must intersect the grid current characteristic. It will easily be seen that whether intersection occurs, or not, will depend not only on the relative values of the grid leak and coupling resistance, but also on the magnitude of the former and equally on the magnitude of the R.F. carrier voltage and on the value of the negative potential at which grid current ceases, or becomes negligible. In fact, if V_0 denote the numerical value of this potential and V that of the mean negative potential produced by a given R.F. carrier voltage, then, assuming that no grid bias is applied to the rectifier, the condition that the load line shall intersect the grid current characteristic is

$$\frac{R_2}{R_1} \geqq \frac{(V - V_0)}{V_0} \quad \ldots \quad \ldots \quad (8)$$

With a mains valve grid current usually ceases at a negative potential of about 1 volt. In this case if the carrier voltage were such as to give a mean negative grid potential of 2 volts, R_2 should be at least equal to R_1, while if the grid potential due to the carrier were 10 volts, R_2 would have to be at least nine times R_1. If the grid leak were $\frac{1}{4}$ megohm even the latter condition could be met by the use of a coupling resistance of between 2 and 3 megohms.

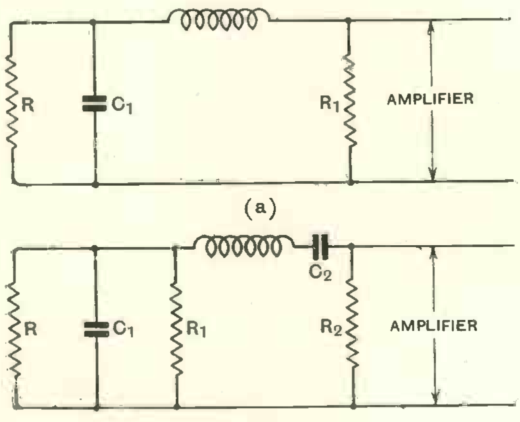


Fig. 9.

The considerations outlined above do not enable any certain conclusions to be drawn as to whether a greater curvature is caused at the foot of the rectification characteristic by the use of the indirect coupling between rectifier and amplifier even when matters are so adjusted that the load line does intersect the grid current characteristic. Experimental information on this point would be of considerable interest. It will be seen that the use of an indirect coupling has two effects. Not only is the slope of the load line increased, but the effect is the same as if a negative grid bias were applied to the rectifier. It would seem, therefore, that the rectification characteristic for a modulated input might be experimentally determined by using a series of values of unmodulated input voltages corresponding to different instantaneous values in the modulation cycle. The grid leak used would, of course, have to be of the same value as the load in the modulated case and the appropriate value of negative grid bias, corresponding to the value assumed for the carrier voltage, would have to be applied.

Volume Control with the Diode

The use of a diode as a rectifier, whether directly, or indirectly, coupled to the amplifier, lends itself particularly well to the application of post-rectifier volume control. One of the chief reasons for the use of a predetector volume control is the prevention of overloading of the detector. It is true that the possibility of overloading of screen-grid valves, with consequent cross-modulation, has to be considered, but with the advent of the variable-mu valve considerably greater voltages can be handled in the R.F. stages. Now it appears that, when a diode is used as a cumulative grid rectifier, there is no fear of its being overloaded ;* distortion is likely to occur only with underloading, and a post-rectifier form of volume control appears, therefore, to be particularly suitable.

There are various ways in which this could be effected. For currents of modulation frequency, the circuits of the directly- and indirectly-coupled rectifier are effectively as shown at (*a*) and (*b*) respectively in Fig. 9, R representing the grid-filament resistance of the rectifier, C_1 the grid condenser, R_1 the grid leak and R_2 the coupling resistance. It is evident that volume control could be effected in the first case by varying the grid leak R_1 and in the second case by varying either R_1 or R_2. Variation of the grid leak, however, seems undesirable for several reasons. Considerable reduction of volume by this means would involve very low values

* It is assumed here that in the case of indirect coupling the conditions laid down in the previous section are satisfied.

of R_1, and this tends to increase the curvature at the foot of the rectification characteristic, to increase considerably the damping of the input circuit due to grid current and—what is important when ganged tuning condensers are used—to affect the tuning of the input circuit. Variation of the coupling resistance R_2 in the case of the indirectly-coupled rectifier would have none of these effects, but again considerable volume reduction would mean that this resistance would be reduced to a comparatively small value and the impedance of the blocking condenser C_2 would no longer be relatively negligible unless it were given an excessively large capacity. Consequently reproduction of low modulation frequencies would suffer.

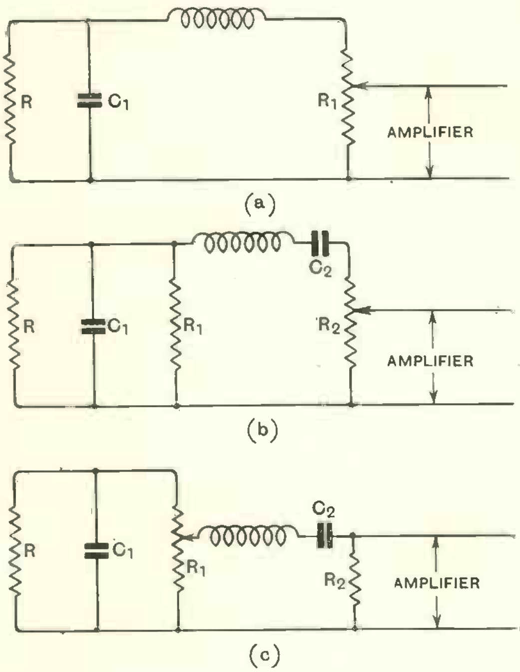


Fig. 10.

The use of a variable potentiometer resistance has, however, none of the above drawbacks. With the directly-coupled rectifier the grid leak R_1 could take this form, as shown at (*a*) in Fig. 10. With the indirectly-coupled arrangement either R_2 or R_1 could be made to serve the purpose, as shown at (*b*) and (*c*) respectively in Fig. 10. Of these two alternatives the second is probably to be preferred, since, for the reasons given in the last section, R_2 may in some cases require to be of a comparatively high value, whereas half a megohm is probably about the maximum convenient value for a variable resistance.

Provided the potentiometer resistance has only negligible capacity, reduction of volume will be accompanied by increased filtering of the R.F. voltage, thus more or less compensating for the larger R.F. input to the rectifier on account of which volume is being reduced.

Incidentally also it can be shown that reduction of volume will be accompanied by progressive reduction in the amount of high note loss. The latter is to a considerable extent caused by the capacitive load added by the amplifier, and the smaller the part of R_1 or R_2 across which the amplifier is connected, the smaller will be the capacitive load across the grid leak and rectifier arising from the input capacity of the amplifier.

These methods of obtaining volume control are, of course, equally applicable in the case of the alternative arrangement of rectifier and amplifier suggested.

A Multi-range Mains Operated Valve Voltmeter

By C. N. Smyth, B.Sc. (Eng.)

(Research Laboratories of the General Electric Co., Ltd., Wembley, England)

ABSTRACT.—The design and behaviour of a multi-range anode-bend valve voltmeter are described. The valve voltmeter derives its supplies from the A.C. mains, covers a range of from 0.5 to 150 volts and, having a very high effective shunt impedance, is suitable for use up to radio frequencies.

Introductory

VALVE voltmeters, which form so necessary a part of the equipment of every radio laboratory, often suffer from a number of inconveniences which are not inherent in the principle of the instrument. The chief of these are the use of battery supplies, the lack of portability, the limited range, and the high damping imposed on the test circuit when making measurements at radio frequencies.

The object of the design described below is to overcome as many of these drawbacks as possible, and to produce at a moderate cost a valve voltmeter independent of battery supplies, portable, suitable for use at high frequencies and at the same time covering a wide range of voltages. An instrument constructed in the following way has been found to be entirely satisfactory and data referring to it are given at the end of this article.

Description of Instrument

The voltmeter is of the anode-bend self-biased type* and is run in conjunction with an eliminator of normal design. The complete circuits are shown in Fig. 1. The voltmeter and eliminator are housed in two separate boxes, and connected together by a length of four-wire copper braided cable, so that they may be used some distance apart. The eliminator for convenience can be kept beneath the bench, thereby avoiding any trouble which might arise due to its stray magnetic fields. Both components are carefully screened mag-

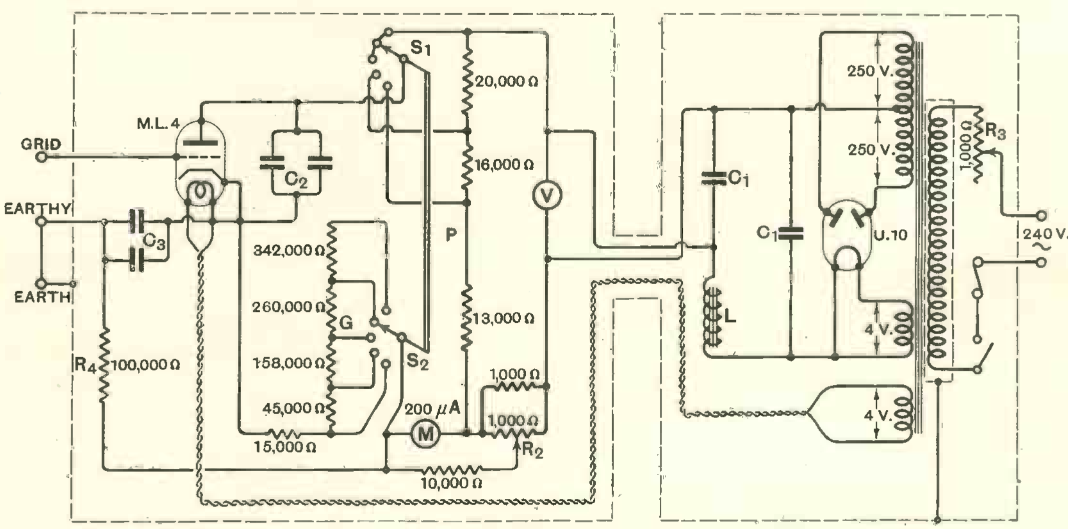


Fig. 1.—*The complete circuit.*

* W. B. Medlam and U. A. Oschwald. Further notes on the Reflex Voltmeter. *E.W. & W.E.*, February, 1928, Vol. 5, p. 56.

netically and electrostatically and no errors have been detected from stray couplings. The valve which was selected by experiment as possessing the most suitable characteristics and which gave the most linear calibration to the voltmeter was an Osram M.L.4. It had a mutual conductance of 3.6 and an internal impedance of 3,000 ohms. The valve was designed for use as a small power amplifier and had an indirectly heated cathode.

Fig. 2.—*Multi-range mains operated valve voltmeter.*

If the constants of the valve used differ appreciably from these values slight adjustment of the resistances will be necessary in order to obtain the exact ranges. The general layout and construction can be seen from Figs. 2 and 3.

Details of Components

(Referring to Fig. 1 for symbols.)

R_2 and R_3 are 1,000 ohm variable resistances of the small wire-wound rotary type.

R_4 is a 100,000 ohm decoupling resistance of the grid leak type.

P is a wire-wound potentiometer—wound of Eureka wire in 16 slots on an ebonite rod—having a number of tappings so that the H.T. can be readily adjusted.

G are resistances of the grid leak type and should be specially chosen with regard to permanence and ability to carry currents of 500 microamperes for an indefinite period. For the larger values it is advantageous to connect a number of smaller resistances in series.

C_2 and C_3 are the by-pass condensers. For this purpose 2 μF paper condensers, of the non-inductive type, are connected in parallel with 0.1 μF mica condensers. (The 2 μF paper condensers alone may have a high impedance at radio frequencies, and the 0.1 μF condensers are added as a precautionary measure.)

M is an Elliott 200 microampere meter, and V is a Ferranti miniature electrostatic voltmeter having a range of 450 volts, and a very open scale at 270 volts.

The condensers C_1 are Dubilier 8 μF 450 volt working, dry type, electrolytic condensers.

L is a choke with a nominal rating of 30 henrys when carrying a d.c. current of 10 milliamperes. The eliminator transformer is wound with 8 turns per volt on Stalloy laminations, having a core area of 1 sq. in. The primary winding is wound with No. 36 S.W.G. D.S.C. copper, the secondary with No. 38, and the filament windings with No. 20. The eliminator delivers d.c. at 270 volts, the voltage being checked on the electrostatic voltmeter, and a.c. at 4 volts for the valve filaments.

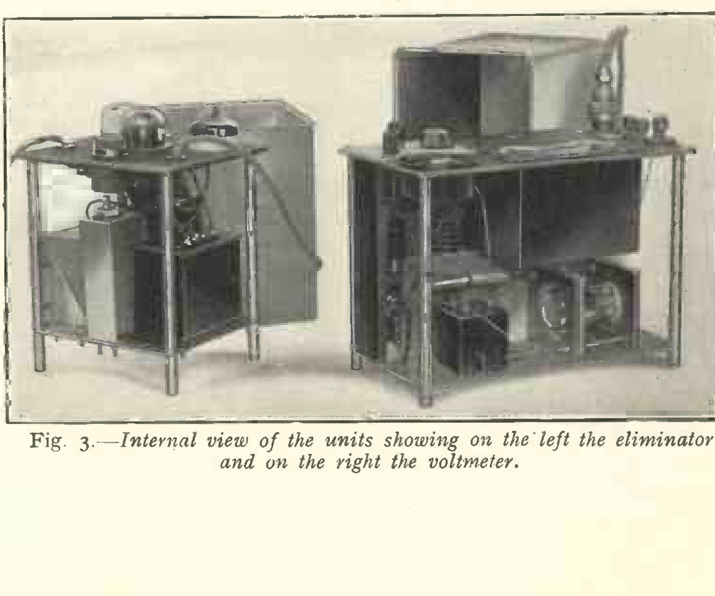


Fig. 3.—*Internal view of the units showing on the left the eliminator and on the right the voltmeter.*

Assembly Details

The two switches S_1 and S_2 which alter the H.T. and grid biasing resistance respectively both have to be operated to change the range, and therefore they are ganged together on a common spindle. The arms of the two switches are slightly staggered relatively to one another so that the grid bias is always increased before the anode voltage rises, and therefore large anode currents are avoided.

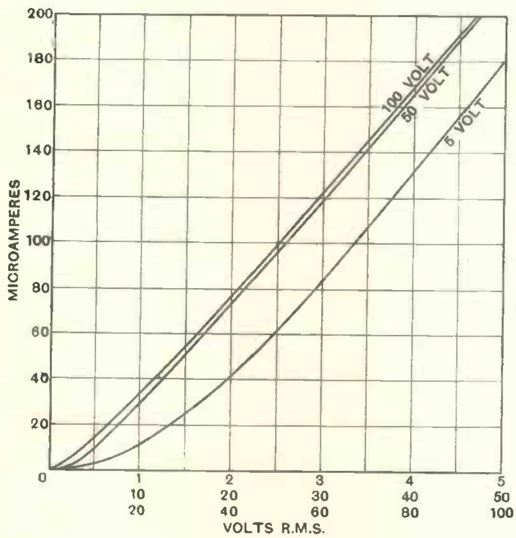


Fig. 4.—*Calibration of instrument on 5, 50 and 100 volt ranges.*

The small initial current taken by the valve is backed-off in the meter circuit by current obtained from a tapping on the H.T. potentiometer. The backing-off current has to be slightly adjusted by means of a small resistance when changing the range, but this can be accomplished very speedily.

The valve is decapped and mounted in a rubber seating between two Keramot cheeks. The lead from the grid terminal to the valve is made as short and kept as far away from any other metal as possible; while the grid terminal itself is mounted in a quartz disc. These precautions are taken in order to make the effective shunt impedance high. While changing the range and setting the instrument correctly on zero it is necessary to earth the grid of the valve. This can be accomplished by means of an earthing plug or short flexible lead connected to the low potential input terminal.

A small additional switch not shown in Fig. 3 has with advantage been fitted to more recent models. It eliminates the need for disconnecting or for short-circuiting the test voltage whilst changing the range. This switch is shown in Fig. 6; it makes no appreciable difference to the input impedance of the instrument since the insulation is quartz and the additional capacity to earth is less than 1 $\mu\mu$F. The switch is adjusted so as to leave the grid free for only a fraction of a second when changing over.

All the components in each part are secured to brass top panels. These panels stand on brass legs which are screwed to the bottoms of the boxes by screws from outside. Tinned iron screens fit tightly over the assembled parts, while within these screens the transformer and choke are housed in separate iron cases. The eliminator and voltmeter both fit into teak cases which are fitted with removable lids and leather straps for carrying purposes.

Action of the Voltmeter

The Voltmeter is of the anode-bend self-biased type. For small signals on each range the bias is small and the anode current flows over the whole of the cycle, the valve behaving as a normal anode-

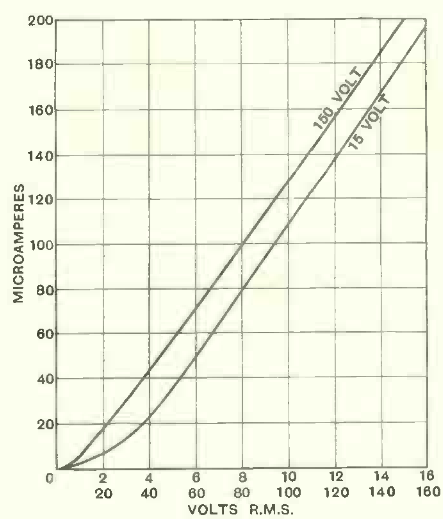


Fig. 5.—*Calibration of instrument on 15 and 150 volt ranges.*

bend rectifier working on the curvature of the valve characteristic. For large signals the bias is greatly increased and the valve only takes current over the positive peak of the applied voltage wave; the action then approximates to a peak voltmeter.

The instrument is calibrated in R.M.S.

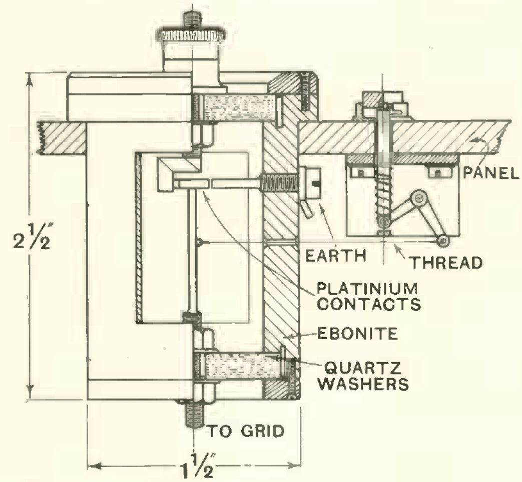


Fig. 6.—*Low-capacity and low-loss earthing switch.*

voltages on a sinusoidal supply and will read correctly R.M.S. values if the wave form of the applied voltage is pure.

The instrument was carefully examined for grid current on all the ranges but none was detected. This was tested by connecting a 4 megohm grid leak in series with the grid lead, applying a constant low-frequency voltage to the voltmeter, and noticing if the instrument varied when the grid leak was short-circuited. Any change in measured voltage would have been due to the voltage dropped in the grid leak itself when carrying grid current.

Further tests were also made to verify that no interference was present from the 50 cycle supply mains. For this purpose a voltage derived from the same mains supply was applied to the grid through a reversing switch, and when the phase was reversed no change in the measured voltage was observed. The instrument was then connected across the output of a heterodyne oscillator and the pointer carefully observed at frequencies a fraction of a cycle on either side of 50 and 100 cycles per second. This procedure would detect any beats which might be formed between the 50 cycle supply and the test voltage, but the pointer was found not to waver at all.

Constants of the Voltmeter

Shunt capacity 15 $\mu\mu$F.

Effective shunt resistance	
at 1.2×10^6 cycles/second	7 megohms,
at 0.6×10^6 cycles/second	too high to measure certainly over 12 megohms.

Ranges 0–5, 0–15, 0–50, 0–100, 0–150 volts R.M.S.

Suitable for use from power to radio frequencies.

In the worst case an 8 per cent. variation in mains voltage causes a 1 per cent. change in instrument calibration. A small variable resistance is fixed in the eliminator, in series with the primary of the transformer, which will compensate for mains voltage variations up to 20 per cent.

If desired the voltmeter may be run from battery supplies.

Book Reviews

Atmospheric Electricity

By B. F. J. Schonland, O.B.E., M.A., Ph.D. Pp. 100+viii, with 25 diagrams. Methuen and Co., Ltd., London. Price 2s. 6d.

The literature—at least the English literature—of "Atmospheric Electricity" is in a singularly uncollected form, and the book under notice is to be commended as giving a very comprehensive review of the subject in a single volume. It is one of the latest addition to Messrs. Methuen's series of monographs on physical subjects.

It is perhaps a criticism of the work that—from a wireless point of view—it deals to only a very small extent with the ionisation of the upper atmosphere (i.e., the Kennelly, Heaviside and Appleton layers) that is of such importance in radio communication. While this is brought under review in its relation to the general subject of atmospheric ionisations at all levels, wireless readers might be inclined to imagine that the subject was worthy of more extensive treatment. Apart from this criticism the amount of information contained in the book is remarkable for a volume of its size.

Starting with the ionisation of the atmosphere, the author traces the various factors that contribute to this condition, including that described as "the penetrating ionisation." This agency is considered of sufficient importance to receive the next section to itself, with a review of the methods which have been used to measure it, with an account of the nature and origin of the radiation. The third section deals with electric fields and electric currents in the atmosphere, particularly with the potential gradient in the neighbourhood of the earth's surface, closing with a discussion of the mechanism by which the earth's charge is maintained. The last section of the book is devoted to discussion of thunderstorms and gives an account of the fields and field-charges due to thunderstorms, the electrical quantities involved, the formation of thunderclouds and the mechanism of the discharge.

J. F. H.

Short-Wave Wireless Communication

By A. W. Ladner and C. R. Stoner. 360 pp. + x. 214 Figs. Chapman and Hall. 15s.

The authors are both thoroughly conversant with the development of short-wave communication and have written a very useful and timely book on this important subject. Mr. Ladner is Superintendent of Instruction at the Marconi Co., and Mr. Stoner was until recently a member of their research staff. The book is not confined to a consideration of the work of the Marconi Company, but describes and illustrates the work of other companies. The first four of the seventeen chapters deals with historical development and the fundamental principles of electro-magnetic waves; the succeeding chapters cover the whole subject of the generation, modulation, radiation and reception of the waves, both for telegraphy and telephony. Special attention is devoted to high frequency feeders and aerial arrays. The final chapter is devoted to ultra-short waves.

The most difficult task for the authors of such a book is in presenting a clear and not-too-mathematical exposition of the fundamental principles of electro-magnetic wave propagation, and the chapters in which the authors attempt this are the least satisfactory in the book. The explanations are often vague and loosely worded; as, for example, on page 23, where it is stated that a sphere which is expanding and contracting will produce a series of compressions and rarefactions, forming *rings* round the body and that the pressure and displacement along any radius will *vary with distance as a sine curve.* We were pleased to see that the authors use the analogy between mechanical stress and strain, magnetic force and induction, and electric force and displacement to give their readers a more concrete conception of these magnitudes, although they always refer to the electric strain σ and never to the displacement D.

On page 25 it is stated that two *such* units placed 1 cm. apart would *attract;* this should be *repel*, and a few lines further down when stating that 4π lines leave *every* north pole, it would have been better to say every *unit* north pole. It should perhaps have been made clearer when speaking of the density of lines whether the reference was to lines of force or lines of induction, or, to use their mechanical analogy, lines of stress or lines of strain. The number per square cm. cannot represent both stress and strain. The statement that "one electrostatic line starts out from every positive unit electric charge" shows at once that we are dealing with lines of displacement or strain and not lines of force, since $4\pi/K$ lines of force are associated with unit charge.

The authors are careful to use only lines of electric displacement and lines of magnetic induction, and never lines of force, and this point might have been emphasised with advantage.

To say of electrons, that, whilst they are not all vibrating at the same frequency, yet there is a mean frequency *at which the majority of them vibrate*, is to give an entirely wrong conception. The alleged proof of the reduction of dielectric constant due to ionisation is the worst section of the book, for if it proves anything it is that the authors were quite out of their depth. Again, in describing the radiation from a dipole the statement that the *magnetic lines* may be imagined as meeting lines travelling outward as a result of the succeeding cycle of current, "and hence a *closed loop* is formed," is quite wrong. It is a great pity that the authors did not obtain some competent guidance when writing these theoretical chapters.

The English is rather weak in places, for instance, "which (if the conductor *was* a perfect one) would be equal in amplitude," and "several types working on this *principal* have been developed." We wonder if "unusuable" signifies "usually unusable"; it looks a queer hybrid.

One is used to seeing liberties taken with foreign names, but there is no need to misspell Dellinger or Kennelly. The latter is sometimes Kenelley, sometimes Kenneley, and sometimes correct.

The general style of the book as regards type and diagrams is excellent, but a connection is missing in Fig. 55; this diagram needs much more explanation than is given, as it contains several unusual features such as the use of two variable condensers in series where one would do.

Notwithstanding these adverse criticisms, the book is one which can be recommended to anyone interested in short-wave radio-communication. It gives a very good account of the development and present state of the subject, and anyone who has read this review will be forewarned when he meets difficulties in the theoretical treatment.

G. W. O. H.

Einführung in die Schwingungslehre (Introduction to the Theory of Oscillations)

By Dr. Barkhausen. vii + 128 pp. 118 Figs. S. Hirzel, Leipzig. 5 Marks (unbound), or 6.50 Marks (bound).

Professor Barkhausen is Director of the Institute for weak-current electrical engineering at Dresden and is a well-known authority on the subject. One can rely upon anything he writes being accurate and clearly presented. The present little book is an elementary discussion of oscillations of all kinds, mechanical, electrical, and acoustical. It goes fully into natural and forced oscillations, damping, beats, resonance, stationary and progressive waves, etc. They are all clearly described and illustrated by examples of organ pipes, violin strings, diaphragms, etc. It is a book to be recommended to all who can read the language.

G. W. O. H.

Attenuation of Transmission Lines*

Simple Method of Measuring

By Dr. M. J. O. Strutt

(Physical Laboratory, N. V. Philips' Gloeilampenfabrieken, Eindhoven, Holland)

I.—Five different known methods of measuring the attenuation of transmission lines

IN the use of transmission lines for any purpose (telephone, carrier-telephone, feeders) two constants are of primary importance: the *wave-impedance* and the *attenuation*. The first one gives the impedance, to which a line of any length should be connected, in order to prevent reflection at the end and hence to ensure the most efficient transfer of energy along the line. The second one gives the quotient of the output voltage V_2 over the input voltage V_1, if the line is connected at its output to a load with the aforesaid wave-impedance Z.

Several methods of measuring the attenuation:

$$e^{-\alpha x} = \frac{V_2}{V_1} \quad \ldots \quad \ldots \quad (1)$$

where commonly x is in km. and α is given in *Nepers per km.*, have been described.

One method makes use of the above definition. The transmission line is terminated over the wave-impedance Z and V_2 and V_1 are measured. Then α can be found from eq. (1). The difficulty in applying this method is, that the wave-impedance must be known or otherwise must be found by trial and error.†

A second method also makes use of this equation (1), but takes a line so long that no reflection from the far end can be observed at the input. The voltage is measured along the line with a high-impedance voltmeter. Plotting this voltage distribution logarithmically, the constant α may be found by (1). This method is successful with long lines or with lines which have an excessive attenuation. It has, *e.g.*, been applied in determining the soil constants at radio frequencies.‡

A third method makes use of a special property of transmission lines. The wavelength of an electromagnetic wave in the free air is found by dividing the velocity of light by the frequency. The wavelength along transmission lines is shorter, partly owing to the dielectric and magnetic properties of the medium in which it is embedded, and partly owing to the attenuation. If the line consists of bare wire in air, the shortening is only due to the attenuation and by a known formula; § the attenuation may be calculated from the measured wavelength on the line. This method cannot be applied to lines embedded in insulating material, *e.g.*, cables, unless the dielectric constant is known.

A fourth method, successfully applied in measuring feeders,‖ may be used with lines of length comparable with the wavelength and of no excessive attenuation. The output end is left open and the voltage distribution along the line measured. If the line had no attenuation, the voltage would be zero at the nodes. Owing to attenuation, however, no zero voltage is found at the nodes, but a finite value, due to the energy necessary to supply the line loss. From the voltage distribution at the minima the attenuation may be calculated. The latter three methods are only applicable to lines which are accessible to voltage measurements over considerable lengths. They fail, *e.g.*, with cables, unless special holes, etc., are made.

A fifth method consists in measuring the input impedance of a line, first with the far end short-circuited and then with it open. From these two impedances all constants of the line, and thence also the attenuation, may be calculated by known formulae.¶ This method, however, necessitates rather complicated calculations, owing to the intricate formulae.

II.—Principles of the new method

It is well known that if V_2 is the voltage at the open far end of a line, the voltage at

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

† L. Sokolow, *Ann. d. Phys.*, **83**, 1136, 1927.

‡ Strutt, *Elektr. Nachr. Technik*, **7**, 1930.

§ Bergmann Holtlöhner, *Ann. d. Phys.*, **87** (1928), 653–676.

‖ Roosenstein, *Exp. Wireless*, 1931, p. 294.

¶ Comp. Fränkel, *Theorie der Wechselströme*, p. 188. Hund, *Sc. Papers Bureau Standards*, Vol. 19, p. 487, 1923–1924.

any point distant x from it is given by the equation

$$V = V_2 \cosh nx \quad \ldots \quad (2)$$

where $n = \alpha + j\beta$

At the input of the line, with length l, the voltage is

$$V_1 = V_2 \cosh nl = V_2 (\cosh \alpha l \cos \beta l + j \sinh \alpha l \sin \beta l) \quad \ldots \quad (3)$$

We now determine the values of l which make V_1 a maximum :

$$\frac{d\left|\frac{V_1}{V_2}\right|^2}{dl} = 0 = \cosh \alpha l \cos \beta l(\alpha l \sinh \alpha l \cos \beta l - \beta l \cosh \alpha l \sin \beta l) + \sinh \alpha l \sin \beta l(\alpha l \cosh \alpha l \sin \beta l + \beta l \sinh \alpha l \cos \beta l) \quad \ldots \quad (4)$$

If $\alpha l << 1$, the right-hand side equals $\alpha l \sinh \alpha l \cosh \alpha l = (\alpha l)^2$ approximately, if we take $\beta l = k\pi$, where $k = 1, 2, 3 \ldots$ Hence in this case (4) is *almost* satisfied by taking $\beta l = k\pi$, the difference being small of second order. As a fact, $\beta l = k\pi$ satisfies (4) *exactly*, if $\alpha = 0$. This solution of (4) :

$$\beta l = k\pi \; ; \; k = 1, 2, 3 \ldots \quad \ldots \quad (5)$$

holds good for transmission lines, in which we have *small attenuation*. It is easy to find l from (4) exactly for any attenuation.

Taking (5), we get from (3) :

$$\left|\frac{V_1}{V_2}\right| = \cosh \alpha l \quad \ldots \quad (6)$$

Hence α may be determined by measuring the ratio of V_1 to V_2.

In practice we do not vary l, but the frequency. Now, βl is proportional to the frequency, or at least very nearly so, whereas αl is not a strongly varying function of the frequency in most cases. Hence in practice, the result (6) will also hold good, in cases of not too great αl, compared with unity, if we vary the frequency instead of the length l, until V_1/V_2 is a maximum.

The general case of any attenuation and varying frequency may also be dealt with starting by (3). However, no practical case, in which this would be necessary, is known to the author.

III.—Measurements of attenuation along transmission lines by the new method

The method, based on the above principles, works as follows. On the input and output of the cable are placed voltmeters with internal impedance, very large, as compared with the wave-impedance Z (*e.g.*, Moullinmeters). The output is otherwise non-connected. Then the frequency is varied, until the line is an entire number of half wavelengths long, *viz.*, eq. (5). If this condition is satisfied, the attenuation α may be found by the simple eq. (6).

TABLE I

Fre. kilocycles.	Ratio Output volts. / Input volts.
25	1.07
27.5	1.55
30	1.24
32.5	0.89
35	0.89
40	1.28
42.5	0.97
45	0.79
47.5	0.83
50	1.04
52.5	1.00
55	0.80
57.5	0.72
60	0.81
62.5	0.90
65	0.83

This method has been successfully applied to cables as used for carrier waves and to telephone lines. With one of the former cables the ratio (6), as a function of frequency, gave the curve of Table I. From this curve, using (6), we get :

TABLE II

Frequency kilocycles.	α Nepers/km.	ϵ Dielectr. constant of cable isolation.
34	0.090	4.0
46	0.108	3.87
58	0.130	3.85

As ϵ is presumably constant, the last column of Table I indicates that the error in these measurements is some per cents.

With this same cable α was also determined according to the fifth method of section I. This gave :

TABLE III

Frequency kilocycles.	α Nepers/km.
34	0.095
46	0.115
58	0.137

As a control, the second method of section I was also applied at one frequency. It gave a result in accordance with Tables II and III.

The above method may, of course, be easily applied to short wave feeders for antennae.

Vibrations of a Coil-driven Paper Cone*

By F. R. W. Strafford

ABOUT two years ago the writer was testing a moving-coil loud speaker over the audible frequency spectrum by means of a beat frequency oscillator, and noticed that when the input was sufficiently strong certain critical frequencies were found at which the diaphragm produced a steady additional note of considerably lower tone.

A number of recent experiments regarding this phenomenon have established some interesting facts, details of which are given in the following notes.

A moving-coil loud speaker was set up and driven by the steady state output of a carefully calibrated audio-frequency oscillator, capable of dissipating some 4 watts of electrical power in the speech coil and with inappreciable harmonic content.

The diaphragm of the loud speaker was of the moulded paper type with integral corrugated surround.

Since this type of diaphragm possesses no join on the surface its transmission qualities were assumed to be reasonably uniform.

The first auxiliary vibration occurred when the fundamental frequency was 900 ~, and by means of tuning forks was found to be 450 ~.

It was found impossible to produce the auxiliary vibration until a certain critical threshold value was reached, when it suddenly built up and maintained an intensity which did not appear to be much affected by any increase of input power.

A change in frequency of about 20 cycles per second on either side of the fundamental frequency was sufficient to cause the auxiliary vibration to cease abruptly.

By exploring the surface of the diaphragm with a surgical stethoscope, suitably modified at the entrance, a perfect set of radial nodes, extending to the cone apex, were found while the auxiliary vibration was maintained; but these vanished directly the latter ceased, and only the fundamental remained.

The next auxiliary vibration was produced when the input frequency was raised to 1,100 ~, and was again found to have a frequency exactly half that of the fundamental.

Further exploration revealed that the phenomenon occurred at regular frequency intervals, and also that the number of radial nodes uniformly increased with frequency.

The following table shows the relationships established.

Input Frequency in Cycles/Sec.	Auxiliary Frequency.	Number of Radial Nodes.
900	450	12
1,100	550	14
1,300	650	16
1,500	750	18

Above 2,150 cycles per second the phenomenon ceased, possibly due to the intensity of the vibrations at the fundamental frequency being less than the critical threshold value required to produce the effect.

The cause of these spurious vibrations is obscure. If they were due to non-linearity of the restoring force component on the system, one would expect them to be more easily established at the lower frequencies, where the displacement of the system is greatest.

That is was impossible to produce them at frequencies below 900 ~ was proved, in this particular system, by very careful investigation.

The same argument applies with regard to any possibility of the magnetic flux in the gap being asymmetrical, and, therefore, producing a non-linear driving force on the system.

A form of mechanical resonance of the diaphragm material is indicated; but why the condition should be sustained only at a number of equally spaced frequencies is difficult to appreciate without further investigation.

In the writer's opinion the subject is interesting and opens considerable scope for further investigation, particularly for one bold enough to analyse the phenomenon mathematically.

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

Electronic Oscillations and the Magnetron Short-wave Oscillator

Papers by E. C. S. Megaw, B.Sc., read before the Wireless Section, I.E.E., on 4th January, 1933.

Abstract.

THE papers are communications from the Staff of the Research Laboratories of the G.E.C., Ltd., Wembley. The first paper on "Electronic Oscillations" gives a critical summary of the existing knowledge of electronic oscillations and of their production in triode, diode and magnetron circuits. The second paper is "An Investigation of the Magnetron Short Wave Oscillator," and indicates the possible methods of utilising magnetrons to generate short-wave oscillations, together with the more important results of previous workers on this subject.

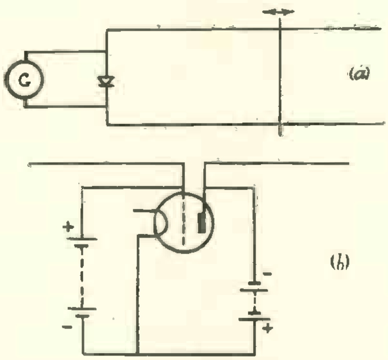


Fig. 1.—*Barkhausen-Kurz oscillator and Lecher-wire wavemeter.* (a) *Wavemeter.* (b) *Oscillator.*

The discovery of electronic oscillations is usually attributed to Barkhausen and Kurz in 1919, when it was found that on applying a positive potential to the grid and a small negative potential to the anode there occurred (*a*) an anode current in the opposite sense to that for positive ions; (*b*) indications of oscillations in a Lecher parallel wire system with a crystal detector and galvanometer when brought near the valve as in Fig. 1.* The explanation given by Barkhausen and Kurz is that electrons are accelerated from the filament to the positive grid through which some of them pass. These are retarded in the grid-anode space and turn back to the grid. Those which pass the grid again reach the neighbourhood of the filament and are once more accelerated to the grid and so the process is repeated.

More recently another mechanism has been suggested when the anode diameter is considerably greater than the grid diameter and the anode is at filament potential. Space charge saturation can then occur in the grid anode while the filament-grid space is still unsaturated. It is suggested that successive "rarefactions" and "compressions" of space-charge traverse the grid-anode space so that oscillations can be maintained in a circuit whose oscillation period is twice the time of electron-transit from grid to anode. It is believed that the two mechanisms can sometimes exist in the same valve but not simultaneously.

* The author's original figure numbers are adhered to in this abstract.

For the satisfactory production of oscillations in a triode the electrode system is subject to certain conditions in addition to that imposed by the dependence of wavelength on grid diameter. An optimum ratio of anode to grid diameter appears to be 2.5 to 3. The electrode length does not appear to be important, provided it is not comparable with the wavelength. The best grid construction appears to be a close spiral of fine wire; for anode construction a grid-form is preferable to a full cylinder, both on account of efficiency and to improve heat radiation from the grid. The grid should be designed to withstand high power dissipation, and for maximum output electrodes should be accurately constructed and aligned.

If the length of a Lecher-wire system forming the external circuit of a triode electronic oscillator is varied it is found, in general, that both the amplitude and frequency of the oscillations are varied. The variations repeat at intervals of half a wavelength on the wire owing to the successive harmonic modes of oscillation of the circuit. The wavelength decreases as the negative anode voltage is increased to an optimum value. In the region of maximum output the wavelength varies with circuit length and is nearly independent of anode and grid voltages. In the region of low output the wavelength is independent of the circuit but varies with anode and grid voltages. The effects are shown qualitatively in Fig. 4. The main peaks of oscillation occur at the circuit lengths which give

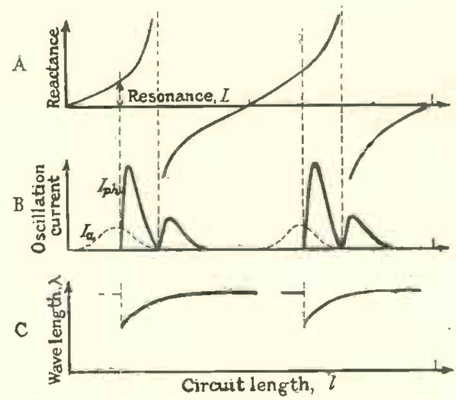


Fig. 4.—*Theoretical tuning curves* (*Möller*).

an inductive reactance that resonates with the effective inter-electrode capacity. Weaker oscillations occur when the impedance is capacitative (length $> \frac{1}{4} \lambda$).

In the case of diodes, it can be shown that the expressions for conductance and susceptance (of the charged particles in an electric field) reveal the existence of negative conductance ranges capable of giving electronic oscillation. Attempts to produce oscillation in gas-free cylindrical diodes have been uniformly unsuccessful, but oscillations have been obtained in a system consisting of a straight filament and a cylindrical grid. The wavelength was practically independent of circuit length, and increased slowly with grid voltage.

Oscillations have also been produced by means of diodes in which anode and cathode consisted of straight parallel wires. The diode is connected in a Lecher-wire system extending from both ends of the tube, and the length of the oscillatory system as well as the position of the diode in it is determined by the position of two adjustable bridges. The oscillations produced were shown to have all the known characteristics of electronic oscillations.

The magnetron oscillator is essentially a diode with a magnetic field applied in the direction of the electrode axis. If the magnetic field strength is less than a certain critical value the characteristics are those of an ordinary diode. As the field is increased past this critical value the anode current falls to a value approaching zero. The original magnetron (of Hull and Elder) made use of the negative rate of change of anode current with field strength in the cut off region, but this system was applicable to longer waves. For short-wave purposes the name of magnetron is applied to oscillations whose frequency and mechanism of maintenance are dependent on periodic electron motion. Oscillations of this type have been produced in a cylindrical diode (with axial magnetic field) in a parallel-wire circuit connected to anode and filament. In such case the space charge distribution with field-strength near a critical value is similar to that in the triode electronic oscillator, the electrons moving approximately in circles, in planes perpendicular to the filament, from filament to anode and back. If a cylindrical anode is divided into two segments, a negative-resistance characteristic results for a p.d applied between opposite segments when the magnetic field exceeds a critical value. Oscillations can be maintained in a circuit connected between the anode segments (or between cathode and any one segment) by virtue of this quasi "dynatron" characteristic.

The second paper is devoted to magnetrons both of the purely electronic type and of the dynatron type. After a theoretical discussion a considerable part of the paper is devoted to an experimental investigation to discover the nature of the fundamental relations in these two types, and to compare these relations with the indications of theory, also to apply this knowledge to the production of sufficient power to be technically useful at the shortest possible wavelength.

For oscillations of the electronic type it is found that the experimental results are entirely in agreement with theory in so far as it is applicable. In particular it is confirmed that the strength of the electronic oscillations is greatest at the critical relation between anode voltage and magnetic field, and that the wavelength of the optimum oscillation is inversely proportional to the field. Apparently anomalous results can be explained by taking account of stray capacities, due in particular to the glasswork of the valve, across the oscillatory circuit. The greatest output is not, in general,

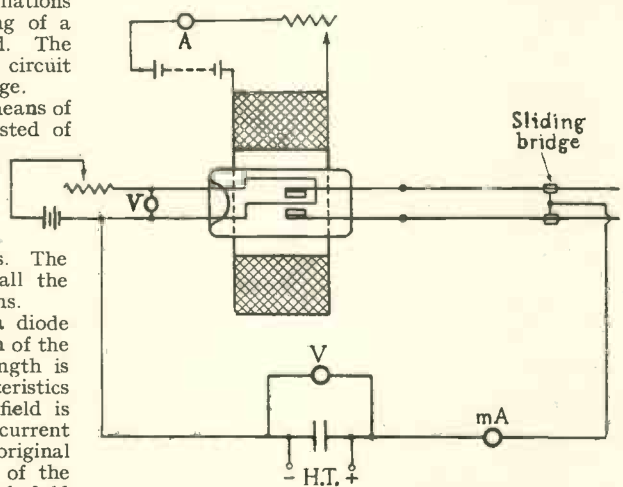


Fig. 4.—*Split-anode magnetron circuit.*

obtained with the magnetic field exactly in the direction of the electrode axis. The existence of an optimum angle is found to be due to the resultant spiral motion of the electrons balancing out the effect of cathode potential-drop for electrons arriving at part of the anode surface in such a way as to increase the number of oscillating electrons. By utilising an internal resonance effect and suitably adjusting the angle of the field, an output of 1.5 watts has been obtained at about 24 cms. wavelength.

In the investigation of the "dynatron" oscillations static characteristics are obtained showing the negative-resistance effect. From these curves the operating characteristics of the valve are calculated and checked by comparison with a set of measured values, good agreement being obtained. The energy of the dynatron type of oscillation starts to fall off rapidly at a wavelength which is about four times the electronic-oscillation wavelength corresponding to the anode voltage used. During oscillation the anode current may exceed the original total emission. This is probably due to bombardment of the filament by electrons which return to it with considerable velocity. By minimising this effect it has been found possible to obtain an output of 60 watts from a relatively small valve at about 2 m. wavelength. The shortest wavelength obtained by means of dynatron oscillations was about 30 cm., with a power of about 0.1 watt. The author concludes that for wavelengths below 50 cm. electronic oscillations give the greater output.

The last section of the first paper is devoted to a brief discussion of the application of electronic oscillators to purposes of communication. The technique of their application to transmission and reception is still in a comparatively undeveloped state. Existing data appear to indicate that frequency stability is not much worse than that of reaction oscillators at slightly longer wavelengths, provided the circuit is operated so as to minimise the effects of varying valve voltages. In the case of the triode (electronic) oscillator modulation is best effected by anode-voltage variation. In some cases nearly 100 per cent. modulation can be obtained without serious non-linearity. For telegraphic keying, the anode lead seems to be the best point, and the preferable arrangement is one which alters the anode bias by a definite amount. For the magnetron, anode-voltage modulation is again satisfactory, but a larger audio-frequency signal is required than in the triode case. Modulation and keying can alternatively be effected by varying the magnetic field. Electronic oscillators can be used for reception and give better results than the conventional circuits at wavelengths less than 1 metre. A super-regenerative receiver is illustrated in Fig. 8.

The author concludes that electronic oscillators in conjunction with suitable aerial systems are capable of providing communication up to the limit of range set by conditions intervening between transmitter and receiver.

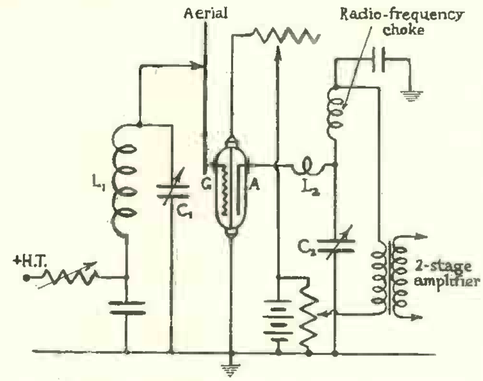
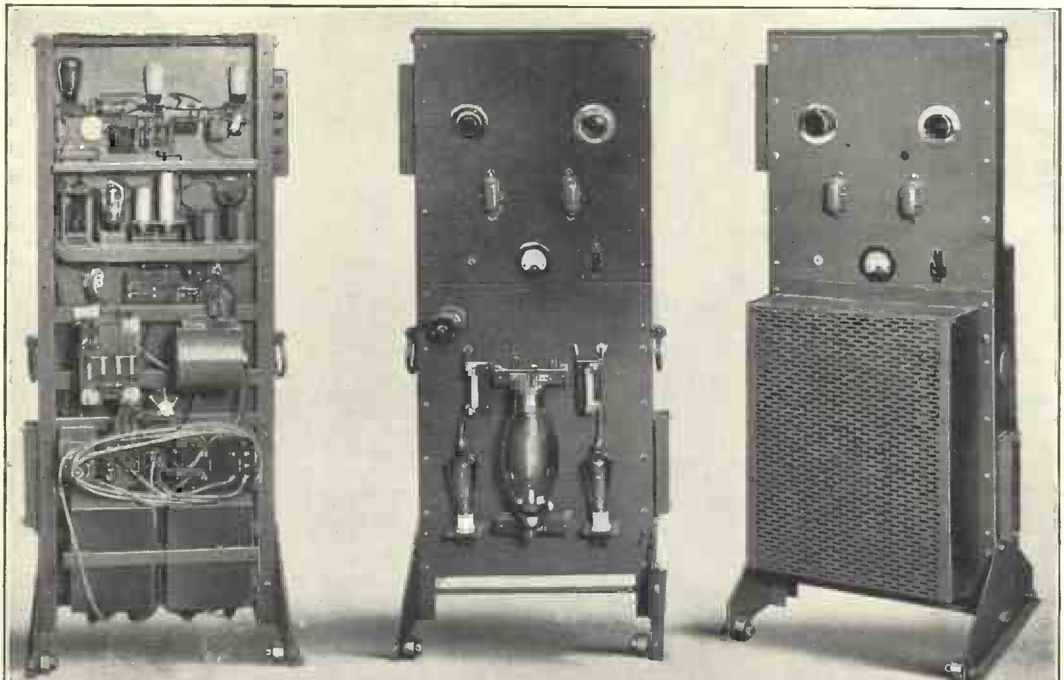


Fig. 8.—*Circuit diagram of super-regenerative receiver using electronic oscillations.*

A NEW 250-WATT AMPLIFIER



The new amplifier designed for use at the recent Scottish National Radio Exhibition and since completed by the designers, The Edison Swan Electric Company, Ltd., and standardised for Public Address and similar work. The early stage resistance-coupled amplifier has an undistorted output of 1 watt and employs Mazda AC.2/HL, AC/HL and AC/P.1 valves. All grid and anode circuits are adequately decoupled, and power is provided by means of a built-in eliminator. An Ediswan ES/250 M valve, operating at 2,000 volts (150 mA. output) and fed from Ediswan ESU.40 rectifiers, is used in the output stage. The smoothing in this stage consists of a 50-henry heavy-duty choke and two 4-mfd. 3,000-volt working condensers. Coupling to the early stage amplifier is by means of a ½-mfd. 800-volt test condenser. The equipment can be operated from either Radio, Gramophone, or Microphone, and embodies a special centre-tapped fader for control of volume.

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.

Straight Sets versus Superheterodynes

To the Editor, The Wireless Engineer.

SIR,—With reference to your Editorial in the August, 1932, issue of *The Wireless Engineer*, I have now had both the receivers mentioned working under identical conditions as to aerial, earth, power supply, etc., for long enough to enable comparison to be made. Eliminator and output stage as specified for *Wireless World* "Modern Straight Five" with a pair of Sonochorde Dual Speakers have been in use on both receiver chassis.

Let me say at the outset that I built the straight set first, as the opportunity of comparing almost every worth-while manufactured superheterodyne had not convinced me that this type of receiver was preferable to the straight set—my attitude to reception being that first and foremost I insist on high quality of reproduction, five or six stations at good quality being infinitely preferable to thousands minus that essential feature. Even now I have still to find the manufactured superheterodyne which does not cut off at the higher audio-frequencies, which does not give the so-called "mellow" reproduction, in spite of alleged "tone correctors," in addition to which many suffer from noisy background.

After much thought and comparison the *Wireless World* "Monodial" has finally convinced me that this type of receiver is definitely preferable to any other type within my experience under modern conditions, but that even so there is still room for improvement principally in the direction of greater selectivity in the H.F. and I.F. stages with a consequent wider application of tone correction, adapting intermediate frequency amplifiers to local conditions, and the eliminating of annoying spread of spark interference, which, in my case, covers the whole of the medium waveband and breaks into the lower end of the long waveband principally from the French Commercial Station at Brest.

The question of second Channel interference, it seems to me, depends a great deal on the proximity of local transmitters to the site of the receiver, and intermediate frequency choice would seem to be governed largely by the transmitting frequency. For instance, before the opening of the new local transmitter—by the way, my receiver is within four hundred yards of the output aerial—I suffered but one harmonic on the medium waveband, just below Scottish Regional, but since the additional transmitter started radiating the whole of the lower half of the medium waveband is literally full of whistles. So that it seems rather obvious that in this instance a happier choice of intermediate frequency might have been made.

Coming to the question of comparative cost it would seem that the tone-corrected superheterodyne still has something in hand, as it is not difficult to imagine that, leaving out subsequent tone correction, the attaining of equal selectivity to that obtaining in "Monodial" would add appreciably to the price of the set embodying even the advanced features of the "Modern Straight Five."

Plymouth. M. L. ELLIOTT.

Radio and Electrical Nomenclature

To the Editor, The Wireless Engineer.

SIR,—The list of terms and their derivatives used to describe electrical circuits, put forward in the Editorial of your January issue, should clarify the position so far as this group is concerned, for though the process of arriving at them is possibly repugnant to lay purists, the result is free from the irritating anomalies presented by words with pedigrees.

I venture to suggest that it is fully time for a general "cleaning up" of electrical and particularly radio nomenclature. This latest requisitioner of a new vocabulary, with the best chance of forming a uniform and co-ordinated system, appears to have been singularly unfortunate in its choice. Instead of one standard well-chosen term we too often have several alternatives, none of which properly describes the thing to which it is applied.

"Wireless" and "radio" are prominent examples, and many widely divergent definitions of these would be obtained on inquiry. Some would regard them as synonymous; others not. Some would apply them to the whole field of ether communication, some to individual branches of it. To newspapers, public address amplification, involving communication by wire, is "wireless." A broadcast receiver is "a wireless."

The term "all-electric" is used, for reasons it would surely be hard to explain, to distinguish receivers deriving power from a public supply. The alternative, "mains-driven," refers to the supply of power through a local branch line, as distinct from the main.

The function of an eliminator presumably is to eliminate. What does it eliminate? Batteries? If so, it is very unsuccessful, for there are millions more batteries in the world now than there were when the "eliminator" started its fell work.

The solecism "d.c. current" (direct current current) has become so universal that even a writer who calls for a high standard (*Wireless Engineer*, vol. 6, p. 301) makes use of it in the January issue (p. 8). How much further, then, may the lower literary strata be expected to stray. And what are we to say about "d.c. voltage"?

Valve technique has no better record. As the amplification factor of a valve is universally denoted by μ, one may be pardoned for supposing that the term "variable mu valve" refers to this property, instead of being an abbreviation of the Teutonic "variablemutualconductancevalve."

" Mutual conductance " is one expression. Others are " slope," " transconductance," " goodness," and " controlled plate conductance." There may be others.

And so on.

The official electrical engineering symbols are now practically universal, in spite of the many non-standard symbols that had gained wide currency. Would it not be possible to do the same for nomenclature ?

M. G. SCROGGIE.

Impedance Measurements

To the Editor, The Wireless Engineer.

SIR,—The note by Mr. A. T. Starr in your issue of November, 1932, on " Impedance Measurements " requires a short reply, in so far as the note comments on my paper in the *Phil. Mag.* of July, 1930.

The method shown in Mr. Starr's Fig. 3a is the method which is described in my paper in the *Phil. Mag.* The advantages mentioned by Mr. Starr are clearly set out in that paper together with the mathematical analysis corresponding thereto.

The Fig. 1b in my *Phil. Mag.* paper is obviously a mistake, as not only are the windings there shown in *parallel aiding*, whereas the text describes them as *parallel opposing* with respect to the generator across *BD*, but in *series opposing* with respect to the detector across *AC* and therefore would *short circuit the detector.*

Therefore it is clear that, as regards the figures 3a and 3b of Mr. Starr's note, not only has Fig. 3a advantages, but 3b would not work at all.

To make the matter quite clear I will explain that the error got into the *Phil. Mag.* paper in the following manner.

The actual coils used were toroids and the windings were bifilar. In the first manuscript drawings for the paper this was shown, but at the last moment the diagram was changed for simplicity, and I overlooked the fact that in changing from toroid to solenoid a " foul murder " had been committed.

It is to be noted that another similar error occurs in Fig. 11 of my paper which has no note to say that the windings of the two halves of the coil are applied in opposite directions.

Apart from these two errors the text and the diagrams of the *Phil. Mag.* paper are quite consistent, and, in view of the many high precision bridges made by the I.T.T. Laboratories on this principle since 1929, there can be no suggestion that the arrangement described is one which short circuits the detector. In view of the growing importance of this development of bridge measuring technique I wish to thank Mr. A. T. Starr for drawing attention to an error in my paper. But I feel it necessary to point out that although I " erroneously claimed " by means of a drawing error in two places (one pointed out by Mr. Starr), I correctly claimed, in the text and in diagrams throughout the paper, certain advantages for the method which is shown in Mr. Starr's note Fig. 3a ; and that Mr. Starr is himself wrong when he treats Fig. 3b as a feasible alternative.

Moscow. RAYMOND WALSH.

The Principles of Electro-Magnetism

To the Editor, The Wireless Engineer.

SIR,—Your review of Mr. E. B. Moullin's " The Principles of Electro-Magnetism " impels me to beg a little space to discuss some of the points you have put forward so forcibly.

In the first place I agree with your criticisms of the formula $f = m_1 m_2 / \mu r^2$. It is given in most elementary text books, and thousands of examination candidates are asked to state it ; but the difficulty arising from an attempt to define two quantities—permeability and pole strength—in one formula is rarely mentioned. And, as far as my experience goes, no examination candidate is ever asked to define exactly the quantities involved or to state the experimental evidence in justification of the formula (including the μ in the denominator). Even Gray's " Absolute Electrical Measurements " is not beyond criticism in this respect.

But, Sir, though I agree thus far, I cannot quite share your dislike of the idealised unit pole. After all, it is not so much the unit pole that is involved as the elementary magnetic particle of moment dM. Every source of magnetic field is assumed to be equivalent to a certain distribution of these magnetic particles, which, subject to certain laws, enable the field to be calculated. This assumption stands four-square on experiment. Gauss' measurements in the " end-on " and " broadside on " positions prove it beyond question. An idealised magnetic particle may then be used to define the magnetic moment of a magnet and the strength of a magnetic field. It does not in the least matter that this idealised particle cannot be actually made because the method of measuring M and H absolutely enables us to determine both these quantities in terms of the idealised definition, without actually using an idealised magnetic particle. The situation is somewhat analogous to that of the E.M. Unit Current. Often it is defined as the current which, when flowing in an arc 1 cm. long and 1 cm. radius, produces a magnetic field at the centre of unit strength. But though the current is defined in this way its actual realisation by means of the ampere-balance is quite another thing.

Then, Sir, with regard to your implication that all the difficulties of the non-realisation of the unit pole could be overcome by basing our definitions on the behaviour of current-carrying conductors ; is not an inverse square law necessarily involved at some point ? None of the systems of this kind provides a satisfactory substitute for Gauss' Theorem by means of which we show that $\Sigma H \mathrm{Cos}\,\epsilon\, dS$ is constant over any cross-section of a tube of force. It may perhaps be derivable by means of Laplace's law $f = \dfrac{idl \mathrm{Sin}\,\theta}{r^2}$, but this is not convincing because it is well known that this law is not necessarily the only one that could express the experimental facts, and in any case the whole of the current carrying circuit is involved and the resulting law is of little use for establishing this essential property of the tubes of force. Many people to whom I have spoken on this point *assume* this property of the tubes because obviously lines of force cannot cross. This, however, is hardly sufficient because it does not preclude the possibility of additional "lines" springing up here, there and everywhere in the field.

Finally, Sir, there is the question of the relations of H and B! At the bottom of p. 62 of your review you say "Surely we are justified in applying this analogy to form a mental concept . . ." and on p. 63 you discuss fully the use of the stress-strain analogy. And, so far, I am sure no one will disagree. A mental picture or an analogy which acts as an inspiration for further advance cannot be too greatly admired, and a great part of Faraday's genius was in the use of such analogies. But, I would submit that mental concepts and analogies are entirely different from fundamental theory. The stress-strain analogy when overdone leads to two incongruities in the case of the magnetic field. It suggests that in undisturbed space there are two magnetic phenomena related to one another in the manner of cause and effect. And yet by no possible experiment known to us at present can these phenomena be distinguished! A prominent member of the International Electrotechnical Commission remarked to me a little time ago that the introduction of μ_0 into the relation between B and H in vacuous space "at any rate provided for a distinction between the two if it were discovered in the future." But if we are to act on this policy, where are we to stop introducing letters with zero subscripts? Another difficulty also arises, namely that two measurements in a magnetic medium, one in a tunnel and one in a crevasse, give the magnitudes of two quantities which the stress-strain analogy requires to be of different dimensions, in spite of the fact that the two measurements are of an identical nature. If we survey two plots of land by means of the same instruments, should we be justified in saying that the area of one is of dimensions L^2 but that of the other—the larger plot, say—is xL^2, where x is an unknown quantity? The suggestion is absurd, but in effect it is to be found in many text books!

Both of these difficulties arise from one very important distinction to which you, Sir, make no reference in your review; namely, that stress and strain admit of *independent measurement*—the one by the load and the other by the extension—whereas in the magnetic case there is *only one possible measurement, i.e.*, the mechanical force on an elementary pole, or the torque on a magnet of known magnetic moment. It is sometimes thought that Faraday's law gives a different measure of the magnetic field, and this impression is often, perhaps, the justification for the more usual point of view. But a little consideration of the origin and proof of the law brings to light the fact that the "lines," the rate of change of which gives rise to the electromotive force, are none other than those tubes whose magnitude is defined quantitatively by $\Sigma H \cos \epsilon dS$; H being still the state measured by the force on a pole!

I would therefore submit, Sir, with all due respect, that you have been a little severe on Mr. Moullin because the logic of the situation has driven him—as it has driven others, including Physicists—to regard the stress-strain analogy strictly as an analogy and to banish it from the fundamental theory on the ground that, unlike the conception of the magnetic particle, it does not stand upon objective experiment.

City and Guilds (Engineering) College. C. L. FORTESCUE.
10th February, 1933.

Harmonic Content

To the Editor, The Wireless Engineer.

SIR,—With reference to the point raised by Mr. Kirke in your January issue that harmonic content be expressed in decibels below the fundamental, the following simple calculations apply to the case under consideration. Let the harmonic *voltage* ratio be x then for the second harmonic only.

Decibels below fundamental

$$= 20 \log_{10} \frac{1}{x}$$

$$= 26.02 \text{ db (for } x = .05)$$

For a *power* ratio of x

Decibels below fundamental

$$= 10 \log_{10} \frac{1}{x}$$

$$= 13.01 \text{ db (for } x = .05)$$

This last result indicates that a power ratio of 5 per cent. gives rise to second harmonic only 13 decibels below fundamental, which is certainly far from good commercial performance. One hopes that the amplifier to which Mr. Kirke refers was not actually as bad as the specification indicates. As far as I was aware the criterion of 5 per cent. has always been intended to refer to voltage ratio. The common method of estimating distortionless outputs is to measure the voltages developed across suitable output resistances.

In the United States a total harmonic content up to 9 per cent. for pentodes has been suggested for the new pentodes. As this figure would include considerable third harmonic, and as the frequency distortion with pentodes is always a difficulty, the output would almost certainly be of quality inferior to that obtainable from triodes, where 9 per cent. content would correspond almost entirely to second harmonic. For cases where maximum output is only likely to be required occasionally, some such figure as 9 per cent. might perhaps be adopted, at any rate for triode output. For 9 per cent. the harmonic content is just over 20 decibels below the fundamental. For the highest quality amplifiers, on the other hand, some figure like 30 decibels below fundamental might be standardised.

W. E. BENHAM.
Standard Telephones and Cables Limited.

Abstracts and References

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PROPAGATION OF WAVES

RADIO COMMUNICATION BY MEANS OF VERY SHORT ELECTRIC WAVES [around 50 Centimetres].—Marconi. (*See* under "Transmission.")

EXPERIMENTS ON ULTRA-HIGH-FREQUENCY COMMUNICATIONS [on 8.2-Metre Wave from Summit of Mt. Fuji].—Nakai, Kimura and Ueno. (*See* under "Stations, Design and Operation.")

RECENT AMERICAN AMATEUR RESULTS ON ULTRA-SHORT WAVES (56 Megacycle Band). (*QST*, Dec., 1932, Vol. 16, pp. 25–27 and 82.)

Many hundreds of stations are now using this band for ordinary routine communication "around town and over distances up to 40 or 50 miles. . . . 'Night effects,' 'freak' long-distance signals, unexpected changes in polarisation—all are reported, but none of them in sufficient detail to serve as real contributions to our knowledge. It is obvious that we have only scraped the surface of 56-mc working. More comprehensive and much more careful experimental work is needed desperately." The later pages are taken up by an account by R. G. Martin of a "five-metre" amateur expedition round San Francisco, where distances of the order of 70 miles were covered between stations on various mountains.

THE PROPAGATION OF ULTRA-SHORT WAVES.—R. L. Smith-Rose. (*World Radio*, 16th Dec., 1932, 6th, 20th and 27th Jan., 1933, pp. 1311, 20 and 22, 90 and 91, 127–128.)

Among the experiments and services referred to in the first two instalments are the Japanese 4-metre tests in two-way telephony, and it is mentioned that for communication over land it has been found possible to overcome the effect of obstacles by setting up "director" aerials at suitable points. These aerials receive the waves and re-radiate them towards the receiver, so that several straight-line paths can be joined up in series. The last two instalments deal with measurements on the attenuation of ultra-short waves by the resistance of the earth (1932 Abstracts, pp. 29–30 and 514).

ON A STUDY OF THE UPPER IONISED ATMOSPHERE IN BENGAL BY WIRELESS ECHOES OF SHORT DELAY.—S. K. Mitra and H. Rakshit. (*Phil. Mag.*, Jan., 1933, Series 7, Vol. 15, No. 96, pp. 20–32.)

This paper continues the second writer's study of the ionised upper atmosphere in the sub-tropical region of Bengal (Abstracts, 1932, p. 29) and is concerned with the heights of, and echoes from, the upper F layer. Observations were made on wave lengths of 42, 50, 75 and 80 metres and during December, 1931, and March, May and June, 1932, using the Breit and Tuve group retardation method. The pulses were produced by the method of Appleton and Builder (1931, p. 492). The emitting aerial system employed was, in December and March, of the inverted L type with a counterpoise; the wavelengths 50 and 80 metres were used and received on an outdoor inverted L type aerial. In the later observations on 42 and 75 metres a horizontal dipole was employed at the emitter and the echoes were received on a single-turn square frame aerial of side 90 cm. A cathode-ray oscillograph and linear time base were used at the receiver, which was situated at a distance of 3.8 km from the emitter in the first series of experiments. In the second series the receiver was carried inside a small motor-bus to distances up to 4 km from the emitter.

The readings obtained gave "no marked variation in the measured height [of F layer] . . . with change of wavelength within the range studied. The height changes with the season of the year and the hour of the day. The average height has a value of 250 km in the afternoon. The evening value is lower by about 20% than the midday value on any particular day."

Echoes formed by multiple reflection between the earth and the ionised layer were of frequent occurrence during sunset periods. There was no apparent regularity in the intensities of the successive echoes, though it was found that a thrice reflected echo was never stronger than a once reflected one. The number of echoes was invariably found to increase with distance from the transmitter, as was the intensity of the first reflected ray. To explain the observation that the twice reflected echo is often stronger than the once reflected one, the different places of reflection at the ionised layer are supposed to have different reflection coefficients.

THE EXISTENCE OF MORE THAN ONE IONISED LAYER IN THE UPPER ATMOSPHERE.—G. Builder. (*Wireless Engineer*, Dec., 1933, Vol. 9, No. 111, pp 667–672.)

"The chief wireless methods of investigating the electrical structure of the upper atmosphere are briefly described and compared. It is shown that the results obtained by both methods support the hypothesis of the existence of at least two layers of ionisation capable of reflecting wireless waves. The possibility of the occurrence of other strata of ionisation [Eckersley, 1931 Abstracts, p. 548] is also briefly discussed, and it is concluded that the measurements available do not require the existence of more than two simple layers of ionisation for their explanation." The writer points out that with the F layer there is no sudden jump to a higher stratum such as occurs in the case of penetration of E layer: although Appleton and Builder have obtained double echoes from the F layer on 80 metres, these are attributed to the two components, with different group velocities, produced by magneto-ionic splitting. A foot-note mentions that this hypothesis has since been confirmed.

General Theory on the Propagation of Radio Waves in the Ionised Layer of the Upper Atmosphere.—S. Namba. (*Journ. I.E.E. Japan*, Sept., 1932, Vol. 52 [No. 9], No. 530: English summary p. 103.)

The writer classifies the wireless spectrum as follows:—Low-frequency waves, $\lambda > 3\,000$ m, reflected at E layer in metallic manner by day and in dielectric manner by night (*cf.* Jan. Abstracts, p. 30); medium-frequency waves, $3\,000 \text{ m} > \lambda > 300$ m for daylight transmission, $3\,000 \text{ m} > \lambda > 1\,500$ m for night transmission, in both cases reflected at E layer with "step reflection" (a new term explained and discussed in the paper); medium-high-frequency waves, $300 \text{ m} > \lambda > 50$ m for daylight, $1500 \text{ m} > \lambda > 250$ m for night, in both cases refracted at E layer and returning to earth; high-frequency waves, $50 \text{ m} > \lambda > 20$ m for daylight, $250 \text{ m} > \lambda > 60$ m for night, in both cases refracted at F layer and returning to earth; and ultra-high-frequency waves, $\lambda < 20$ m for day, $\lambda < 60$ m for night, in both cases escaping through the layers.

The above classification is based theoretically on an angle of incidence of 70°: if this angle is about 90°, the boundary of high-frequency and ultra-high-frequency waves becomes about 8 m during daylight and about 24 m at night.

"Medium-high- and high-frequency transmissions are treated by the use of geometrical optics, giving reasons why waves of the 100 m band have bad transmission characteristics in day-time and those of the 500 m band during night-time. Propagation characteristics of the waves of the entire range of frequencies used in radio communication are seen in Table I [classification given above] and Fig. 7. Transmission characteristics of the waves of various frequencies during the magnetic storm are theoretically considered by comparing them with our experiences hitherto known."

Propagation Characteristics of High-Frequency [Short] Radio Waves, and a Method of Calculation of Their Field Strengths.—S. Namba. (*Res. Electrotech. Lab., Tokyo*, No. 336, 1932, 44 pp. and map: in Japanese.)

From author's English synopsis:—"Paths of waves travelling through the ionised medium are then calculated; thus it is shown that the characteristics of wave paths depend on the electron densities of the E and F layers, the angle of incidence, and the frequency. Next, attenuation of waves in the ionised layer is calculated, and equation 5′ obtained as a general equation of attenuation. It is pointed out that . . . the attenuation may be classified into two categories, one having the characteristic inversely proportional to ω^2 and $\cos i_0$ . . . and the other approximately proportional to ω^2 and $\cos^3 i_0$ . . . , where i_0 is the angle of projection of the ray at the transmitter. If the density of the upper atmosphere varies with height in accordance with the exponential law, the equation of the total attenuation Γ of a h.f. wave may be reduced to the simple equation $\Gamma = 1/\sqrt{f(\chi)} \cdot [k_1/\omega^2 + k_2\omega]$, where $f(\chi)$ is a certain function of χ, the zenith distance of the sun, and k_1 and k_2 are constants which are to be determined experimentally.

"Calculation is made of the decrease of the electron density in the F layer during night-time, and the recombination constant between an electron and a positive ion is determined from numerous results of h.f. field-strength observations summarised in Part 3, giving the value $\alpha_F = 1.5 \times 10^{-10}$ [sec^{-1}], where the suffix $_F$ denotes that the value is confined to the F layer. It is further pointed out that the principal controlling factor for h.f. transmission is the *attenuation* during day-time, but during night-time attenuation is not so important and the principal factor is the *escapement* of a ray to the outside of the earth's atmosphere.

"In the second part, the properties of the 'Ionisation chart of the upper atmosphere' are explained, together with the method of construction. By taking J.C.S.T. and the great circle distance from Tokyo as abscissa and ordinate respectively, the chart represents the relation between the time and the height of the sun during day-time, or the time and the electron density of the F layer during night-time, at any point on the great circle under consideration:" [a number of these charts, for various seasons and routes, are given, and the rough method of using them to obtain a field intensity curve is described: thus with the help of attenuation nomographs "the signal intensity of a h.f. transmission between Tokyo and any point on the earth can promptly be determined at any season, frequency and time"].

"In the third part the principal results of the high-frequency measurements are shown, giving discussions on several topics, such as the secular variation of the state of ionisation, effect of the magnetic disturbance, phenomenon of the 'Polar echo,' etc."

The paper ends with a long list of particulars of the principal short-wave transmitting stations of the world.

A Method of Calculation of Field Strengths in High-Frequency Transmission.—S. Namba and T. Tsukada. (*Journ. I.E.E. Japan*, Nov., 1932, Vol. 52 [No. 11], No. 532: English summary pp. 121–123.)

Covering practically the same ground as the paper dealt with in the preceding abstract.

Amateur Observations during the Total Eclipse of the Sun.—R. W. Woodward. (*QST*, Jan., 1933, Vol. 17, pp. 32–38.)

In summing up, the writer remarks that the amateur observations would seem to prove that ultra-violet light, or some radiation travelling with the speed of light, is mainly responsible for the ionisation of the upper atmosphere. "On the other hand, if Dr. Alexanderson's results [Feb. Abstracts, p. 91] are accepted . . . for the time being, at least, we still have the two theories with us," though even his results only suggest a quite small corpuscular eclipse effect compared with the optical eclipse effect.

Evidence of a Minor Effect of Corpuscular Radiation on Atmospheric Ionisation.—Burton and Boardman. (*See* abstract under "Atmospherics and Atmospheric Electricity.")

A Photometric Study of the Partial Eclipse of the Moon, 14 September, 1932 [and Deductions regarding the Ozone and Heaviside Layers].—F. Link. (*Comptes Rendus*, 19th Dec., 1932, Vol. 195, No. 25, pp. 1236–1238.)

The Note concludes :—" According to the table, the outer parts of the shadow were more transparent during the decreasing phase than during the increasing phase. The opposite occurred for the inner parts of the shadow. As M. Esclangon has pointed out, around the equinox the axis of the earth is practically in the plane of the apparent contour of the earth as seen from the moon. Consequently, different regions of the contour intervene in the illumination of the moon. In the case in point, the temperate and tropical regions of the northern hemisphere intervened during the increasing phase, and the northern polar regions during the decreasing phase.

" If an absorbing layer exists in the upper atmosphere, its effect will be the more marked at the edge of the shadow the higher its altitude. The observations may therefore be interpreted by supposing that the altitude of this layer is greater at the equator than at the pole. This is precisely the result obtained by M. Lugeon for the ozone layer and the Heaviside layer (1931 Abstracts, p. 29—two). For the latter layer the difference between the polar and equatorial regions would amount to 58 km."

The Charge of Spherical Particles in an Ionised Field.—M. Pauthenier and M. Moreau-Hanot. (*Journ. de Phys. et le Rad.*, Dec., 1932, Vol. 3, pp. 590–613.)

For *Comptes Rendus* Notes on these researches, *see* 1932 Abstracts, p. 575—two.

Theoretical Investigation on Currents through the Bridge and through the Ends of a Lecher Wire System.—Ataka. (*See* under " Measurements and Standards.")

Linearly Tapered Loaded Transmission Lines.—J. W. Arnold and R. C. Taylor. (*Proc. Inst. Rad. Eng.*, Nov., 1932, Vol. 20, pp. 1811–1817.)

Continuing the work dealt with in 1931 Abstracts p. 263 (Arnold and Bechberger). The generalised functions used in the formulae developed in the earlier paper are here expressed in terms of Bessel functions of the initial constants and the rate of taper. For the tapered loaded submarine cable the formulae are further simplified. *Cf.* Starr, 1932 Abstracts, p. 576.

Sur la Réflexion totale des Ondes hertziennes (The Total Reflection of Hertzian Waves [Experimental Confirmation, on 18-Centimetre Waves, of the Theoretical Behaviour of the Evanescent Ray, etc.]).—G. A. Beauvais. (*Comptes Rendus*, 5th Dec., 1932, Vol. 195, No. 23, pp. 1068–1070.)

Optical Dispersion : Quantum Theory of Dispersion. [Surveys].—S. A. Korff and G. Breit : G. Breit. (*Reviews of Mod. Phys.*, July, 1932, Vol. 4, No. 3, pp. 471–503 : 504–576.)

Dispersion of Light caused by Sound Waves.—Debye. (*See* under " Acoustics and Audio-frequencies.")

Sur la Diffraction de la Lumière par les Ondes élastiques (The Diffraction of Light by [Supersonic] Elastic Waves).—R. Lucas. (*Comptes Rendus*, 5th Dec., 1932, Vol. 195, No. 23, pp. 1066–1068.)

Continuation of the work referred to in January Abstracts, p. 31, and back references. According to Brillouin's theory of the interaction between light and supersonic waves, the existence of fringes of the first order would be anticipated, but not of those of higher orders such as are actually found. " We have shown [*loc. cit.*] that the hypotheses made by Debye and Sears to explain the multiplicity of fringes must be rejected. In this Note I propose to show how the existence of spectra of diverse orders can be established theoretically, and how, within a definite region of approximation, the question of their intensity can be resolved."

The Wave Equation on the Riemannian Logarithmic Surface : On a Problem in the Diffraction of Waves.—S. Soboleff : Volterra. (*Comptes Rendus*, 3rd Jan., 1933, Vol. 196, No. 1, pp. 49–51 : 9th Jan., 1933, Vol. 196, No. 2, pp. 104–105.)

A Simple Method of Producing and Projecting Mercury Ripples.—A. R. Harmon and J. B. Brinsmade. (*Review Scient. Instr.*, Dec., 1932, Vol. 3, pp. 803–809.)

The Theory of the Interpretation of Seismic Travel-Time Curves in Horizontal Structures.—L. B. Slichter. (*Physics*, Dec., 1932, Vol. 3, No. 6, pp. 273–295.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

Effects of Solar Eclipse on Audio-Frequency Atmospherics.—E. T. Burton and E. M. Boardman. (*Nature*, 21st Jan., 1933, Vol. 131, pp. 81–82.)

A record of observations of audio-frequency atmospheric intensity taken in the path of totality over a period of about 36 hours covering the time of the total solar eclipse of Aug. 31, 1932. The results " indicate an approach to night-time intensity near the period of totality. Data on resonance tone indicate an approximation to evening conditions before and during totality, followed by a condition similar to that of morning. Both the intensity and tonal data show lags of a few minutes in respect to the time of totality. These observations point to sunlight effects on the ionisation of the atmosphere." Evidence of the existence of a minor effect of corpuscular radiation was obtained.

Zur Frage der inneren Stabilität der Luftmassen verschiedenen Ursprungs (The Internal Stability of Masses of Air of Various Origins).—N. Fontell. (*Societas Scientiarum Fennica, Commentationes Physico-Mathematicae*, Vol. 6 [Nos. 1–15], 1932, No. 7, pp. 1–20.)

ELECTRIC CHARGES ON RAIN DROPS.—S. K. Banerji and S. R. Lele. (*Nature*, 31st Dec., 1932, Vol. 130, pp. 998–999.)

The writers describe an apparatus for recording the electric charge on individual drops of rain, using a Wilson tilt electroscope. They find that both positively and negatively charged drops are present in the rain received from any part of the cloud. "When the rain received during any interval is positively or negatively charged as a whole, there is an excess of positively or negatively charged drops."

BESTREBUNGEN UND VORSCHLÄGE ZUR ENTWICKLUNG DER RADIOMETEOROGRAPHISCHEN METHODEN (Attempts and Suggestions towards the Development of Radiometeorographical Methods [for Sounding Balloons]).—V. Väisälä. (*Societas Scientiarum Fennica, Commentationes Physico-Mathematicae*, Vol. 6 [Nos. 1–15], 1932, No. 2, pp. 1–10.)

THE DIURNAL COMPONENT OF THE ELECTRICAL POTENTIAL GRADIENT AT VAL-JOYEUX: VARIATIONS IN PHASE AND AMPLITUDE [Rapid and Yearly].—R. Guizonnier. (*Comptes Rendus*, 19th Dec., 1932, Vol. 195, No. 25, pp. 1299–1301.)

INTERNATIONAL ELECTRICITY CONGRESS, 1932: SUMMARIES OF PAPERS ON ATMOSPHERIC ELECTRICITY AND TERRESTRIAL MAGNETISM.—(*Rev. Gén. de l'Élec.*, 10th and 17th Dec., 1932, Vol. 32, Nos. 23 and 24, pp. 757–760 and 787–789.)

ATMOSPHERIC ELECTRICITY AND TERRESTRIAL MAGNETISM [International Electricity Congress, Paris].—(Summary in *E.T.Z.*, 29th Dec., 1932, Vol. 53, No. 52, p. 1247.)

ÜBER ELEKTRONENIONISIERUNG BEI GERINGEN UND HOHEN DRUCKEN (Electronic Ionisation at Low and High Pressures [in Nitrogen, Oxygen and Air]).—K. Masch. (*Zeitschr. f. Physik*, 1932, Vol. 79, No. 9/10, pp. 672–675.) *See* also 1932 Abstracts, p. 635.

NON-EXISTENCE OF ION MOBILITY SPECTRUM IN AIR.—R. N. Varney. (*Phys. Review*, 15th Nov., 1932, Series 2, Vol. 42, No. 4, pp. 547–555.)

MEASUREMENTS OF ULTRA-VIOLET SOLAR RADIATION IN VARIOUS LOCALITIES [at Various Heights at Various Stations in Europe, North Sea and Atlantic Ocean].—W. W. Coblentz, R. Stair and J. M. Hogue. (*Bur. of Stds. Journ. of Res.*, Jan., 1933, Vol. 10, No. 1, pp. 79–88.)

DEVELOPMENT OF ELECTRIC DISCHARGE AS AFFECTED BY THE RESIDUAL CHARGE: STUDY WITH A RESONANT WAVE, CONTINUED.—S. Mochizuki and I. Kano. (*Journ. I.E.E. Japan*, Dec., 1932, Vol. 52 [No. 12], No. 533: English summary pp. 130–131.)

Continuation of the work whose commencement was dealt with in 1931 Abstracts, p. 610.

THEORY OF SPARK DISCHARGE IN AIR [Contradiction of Townsend's Theory: Ionisation due to Electron Impact only: Importance of Rôle of Positive Ion as Space Charge].—S. Kumagai. (*Journ. I.E.E. Japan*, Oct., 1932, Vol. 52 [No. 10], No. 531: English summary pp. 108–109.)

AN EXPERIMENTAL STUDY OF ELECTRICAL DISCHARGE IN GASES AT NORMAL TEMPERATURES AND PRESSURES.—J. D. Stephenson. (*Proc. Physical Soc.*, 1st Jan., 1933, Vol. 45, Part I, No. 246, pp. 20–40.)

Author's abstract:—By an investigation based on corona discharge it is shown that there is a fixed constant, the true breakdown strength of the gas, for all types of gas discharge at normal pressures.

KNICKSTELLE IM VERLAUFE DER ANFANGSPANNUNG (Bends in the Initial Voltage Characteristic [in Spark Discharges]).—M. Toepler. (*E.T.Z.*, 22nd Dec., 1932, Vol. 53, No. 51, pp. 1219–1221.)

LIGHTNING STUDY AIDED BY A NEW INSTRUMENT [the Surge-Crest Ammeter].—W. W. Lewis. (*Gen. Elec. Review*, Dec., 1932, Vol. 35, p. 601.)

The writer begins by discussing briefly the surge-voltage recorder and lightning-stroke recorder (in which a direct photographic record of a corona splash, on the film, gives surge-crest voltage and polarity), the storm-severity meter (in which a photographic film integrates the glow from a neon tube over a fixed period of time), and the surge indicator (in which a slight spark ignites a small amount of explosive powder in a link which, when disrupted, releases an indicator target). He then refers to the surge-crest ammeter and its auxiliary magnetic link, dealt with by Foust and Kuehni—*see* next abstract.

THE SURGE-CREST AMMETER.—C. M. Foust and H. P. Kuehni. (*Gen. Elec. Review*, Dec., 1932, Vol. 35, pp. 644–648.)

Depending on the amount of residual magnetism left in a highly retentive "magnetic link" of laminated cobalt steel, which is placed so as to lie in the magnetic field produced by the surge.

AN IMPROVEMENT TO THE KLYDONOGRAPH: CORRESPONDENCE.—Müller-Hillebrand: Hartje. (*E.T.Z.*, 22nd Dec., 1932, Vol. 53, No. 51, p. 1237.)

Correspondence on Hartje's paper referred to in Jan. Abstracts, p. 33.

ON THE CAUSES OF THE PREDILECTION OF LIGHTNING FOR CERTAIN POINTS ON HIGH TENSION LINES.—Müller-Hillebrand and others: Lehmann. (*E.T.Z.*, 29th Dec., 1932, Vol. 53, No. 52, pp. 1250–1252.)

Correspondence prompted by Lehmann's paper (Feb. Abstracts, p. 93). Lehmann replies.

SPECIAL MEETING OF THE UNION OF ELECTRICITY WORKS IN SAXONY, FOR DISCUSSION OF LIGHTNING PROBLEMS.—Toepler and others. (*E.T.Z.*, 15th Dec., 1932, Vol. 53, No. 50, pp. 1206–1207.)

Deflection of Cosmic Rays by a Magnetic Field [Positive Results].—L. F. Curtiss. (*Bur. of Stds. Journ. of Res.*, Dec., 1932, Vol. 9, No. 6, pp. 815–823.)

The latest series of experiments "gives decisive evidence that a considerable fraction of an unfiltered cosmic-ray beam can be deviated by a magnetic field of 7 000 gauss." It appears that about 30% of the rays were deviated at least as much as 10^9 volt electrons would have been : for the remaining 70% the deviation, if any, was less than for those electrons. "This harder portion of the beam may contain, in addition to electrons of higher energy than 10^9 electron volts, protons of 5×10^8 electron volts and neutrons. These data indicate that the results obtained by Rossi (Abstracts, 1932, p. 401, l.h. column) and by Mott-Smith (1932, p. 278), showing no effect of the magnetic field, were affected by scattering or absorption in the iron core in which the magnetic field was produced."

Sea Level Intensity of Cosmic Rays in Certain Localities from 46° South to 68° North Latitude.—A. H. Compton. (*Phys. Review*, 15th Dec., 1932, Series 2, Vol. 42, No. 6, p. 904.)

Abstract only of measurements on the variation of intensity of cosmic radiation with locality which show "a much closer correlation of the intensity of the cosmic rays with the dip of the magnetic needle than with the geographic latitude. The differences in intensity thus seem to be due to the earth's magnetic field, which would seem to imply that the cosmic rays are electrical in character."

On Compton's Latitude Effect of Cosmic Radiation.—G. Lemaitre and M. S. Vallarta. (*Phys. Review*, 15th Dec., 1932, Series 2, Vol. 42, No. 6, p. 914.)

Abstract only. "By considering the influence of the earth's magnetic field on the motion of charged particles coming to the earth from all directions in space it is shown that the experimental variation of cosmic-ray intensity with magnetic latitude, as found by Compton and his collaborators [see above, and February Abstracts, p. 94—two], is fully accounted for." Estimates are given of the necessary energy of the charged particles.

Methods of Acquirement of Cosmic Ray Energies.—W. F. G. Swann. (*Phys. Review*, 15th Dec., 1932, Series 2, Vol. 42, No. 6, p. 914.)

Abstract only. Suggested origins of cosmic radiation are sunspots and electrostatic fields of the stars.

Cosmic Rays—Theory and Experimentation [History and Present State].—T. H. Johnson. (*Journ. Franklin Inst.*, Dec., 1932, Vol. 214, No. 6, pp. 665–689.)

Argon in the Ionisation Method of Measuring Cosmic Rays and Gamma Rays.—J. J. Hopfield. (*Phys. Review*, 15th Dec., 1932, Series 2, Vol. 42, No. 6, p. 904.)

Abstract only of paper showing "the superiority of argon over air for ionisation chambers, and the slower recombination of its ions."

General Mathematical Theory of the Vertical Tube Counter Effect of the Cosmic Radiation.—L. Tuwim. (*Journ. de Phys. et le Rad.*, Dec., 1932, Vo. 3, pp. 614–628.)

Untersuchungen zum vertikalen Zählrohreffekt der Höhenstrahlung (Investigations of the Vertical Counter Effect of Cosmic Radiation).—W. Kolhörster. (*Naturwiss.*, 9th Dec., 1932, Vol. 20, No. 50, pp. 895–899.)

An account of investigations of cosmic radiation using a counting tube. The general theory underlying the use of the counter and results so far obtained are discussed. For previous papers on the subject, which form the basis of this account, *see* 1932 Abstracts, pp. 90, 278, 634 and 635.

Vorschlag zu einheitlicher Bezeichnung der Ionisierungsstärke in Gasen (Proposal for a Uniform Notation for Strength of Gaseous Ionisation [application to Cosmic Ray Experiments]).—W. Kolhörster. (*Zeitschr. f. Physik*, 1932, Vol. 79, No. 9/10, pp. 682–683.)

PROPERTIES OF CIRCUITS

New Abnormal Oscillating Phenomena in an Oscillation Circuit including an Externally Excited Saturated Transformer.—Y. Watanabe and T. Takano. (*Journ. I.E.E. Japan*, Nov., 1932, Vol. 52 [No. 11], No. 532 : English summary pp. 116–118.)

Previous workers have dealt with the case where the core is magnetised by the current in the oscillation circuit ; the present writers consider cases in which it is excited by a current independent of the oscillatory current. In both the circuits employed, the e.m.f. induced in the secondary cancels out, so that the harmonic oscillations caused by the saturation of the iron core may be clearly observed.

Fly-Wheel and Series Circuits with Self-Excited Oscillations produced by Thermionic Valves.—Heegner. (*See* under "Transmission.")

Calculation of Output and Distortion in Symmetrical Output Systems.—J. R. Nelson. (*Proc. Inst. Rad. Eng.*, Nov., 1932, Vol. 20, pp. 1763–1773.)

Author's summary :—The conventional formula for power output is accurate when even harmonics only are present but it does not give the true power output if odd harmonics are present. It is shown that the correction factor to be applied is the square of one plus or minus the ratio of the third harmonic amplitude to that of the fundamental. Output systems are discussed in which the even harmonics are inherently low, such as those employing single pentodes or two triodes in series, either as class A or class B amplifiers.

Methods of computing the power output and distortion for each case are given together with checks between the computed and measured values. An auxiliary diagram is constructed for class A operation so that the three different output systems may be treated alike. A discussion of the point where the change from class A to B theory should be made is given for tubes connected in series.

FURTHER NOTE UPON THE PENTODE WITH CAPACITIVE COUPLING.—L. G. A. Sims. (*Wireless Engineer*, Dec., 1932, Vol. 9, No. 111, pp. 673–679.)

Continuation of the work dealt with in 1932 Abstracts, p. 456. *See* also p. 524 of same Abstracts.

DIE BETRIEBSDÄMPFUNG DER EINFACHSTEN SIEBKETTEN (The Working Attenuation of the Simplest Filter Chains).—A. Tschajanow. (*E.N.T.*, Dec., 1932, Vol. 9, pp. 473–475.)

The method adopted by Feige for determining the frequency characteristics for the working attenuation and working angle of electrical filters was to treat these quantities as functions of the characteristic impedance Z, propagation velocity g, and terminal resistance R. This method, however, leads to formulae which are complicated and inconvenient even for the simplest cases. The writer therefore uses another procedure, treating the propagation not as a function of the wave parameters Z and g but of the linear parameters of the filter, and obtains comparatively simple and practical formulae for single and double mesh low-pass and high-pass filters, which he gives in the form of a table.

ON THE ELECTRICAL CONSTANTS OF MESHED NETWORKS.—C. Ravut. (*Rev. Gén. de l'Elec.*, 24th Dec., 1932, Vol. 32, No. 25, pp. 831–844.)

REAL POWER ACCOMMODATION AND APPARENT POWER ACCOMMODATION: ERRATA.—Fischer. (*Hochf: tech. u. Elek: akus.*, Dec., 1932, Vol. 40, No. 6, p. 224.)

Corrections to the paper dealt with in January Abstracts, p. 34.

CROSSTALK AS A REFLECTION PHENOMENON: ERRATA.—Ohashi. (*E.N.T.*, Dec., 1932, Vol. 9, p. 504.)

Corrections to several errors in the paper referred to in January Abstracts, p. 35.

A SKIN-EFFECT PHENOMENON [in Concentric Pipe Feeders: Resistance of a Hollow Cylindrical Conductor may Increase if its Thickness is Increased, for Very High Frequencies].—S. A. Schelkunoff. (*Bell Lab. Record*, Dec., 1932, Vol. 11, No. 4, pp. 109–112.)

EXTENSION OF THE METHODS OF HEAVISIDE'S CALCULUS IN CALCULATION OF CIRCUITS CONTAINING PARAMETERS VARYING WITH TIME.—J. Neufeld. (*Phil. Mag.*, Jan., 1933, Series 7, Vol. 15, No. 96, pp. 170–177.)

TRANSMISSION

RADIO COMMUNICATION BY MEANS OF VERY SHORT ELECTRIC WAVES.—G. Marconi. (*World Radio*, 16th, 23rd and 30th Dec., 1932, Vol. 15, pp. 1314, 1346–1347, and 1379–1380.)

The Royal Institution lecture, a summary of which was dealt with in February Abstracts, p. 91. In his description of the Rocca di Papa–Cape Figari experiments, the writer mentions that at Cape Figari the angle of reception was investigated several times by tilting the reflector, and "it was found that the waves from the distant station reached the receiving experimental station from a horizontal direction."

During preliminary researches in reception, it was found that the successful newly-developed transmitting valves (see below) were very inefficient when used in the receiver. "In contrast with what was observed in the case of the transmitter, it was found that the plates of the valves were the active electrodes, and therefore the aerial should be connected to them instead of to the grids. Further, it was made clear that tuning was best secured by varying grid, filament, and plate potentials more or less simultaneously; and that no design would be useful commercially unless all circuits were provided with current-measuring instruments."

With regard to the development of the special transmitter for the waves of the order of 50 cm, the writer says that though the production of a special valve, with a 4 A tungsten filament and a molybdenum grid supported by electrical welding on molybdenum, led to a great improvement in power and in valve life, the inadequacy of the usual plate/grid Lecher circuit was soon apparent, and a new symmetrical 2-valve circuit was evolved, two special valves—the mirror images of one another—being made for it. The final oscillator (Fig. 1, p. 1314) has three definite tuned circuits—"inside" and "outside" filament-tuning circuits and a plate-tuning circuit. It also has a "feeder-impedance-transformer," for matching the internal resistance of the valves with that of the dipole aerial: the adjustment of this transformer is found to be rendered easier by the presence of small discs as end-capacities on the aerial. Although the conductor connecting the two anodes need only be very short to give the correct tuning (about 5 cm for a 50 cm wave) it has been found desirable to add to it another conductor one wavelength long, bent back on itself to avoid loss by radiation.

Of the inside and outside filament-tuning circuits the writer remarks that they might at first appear to be acting only as effective chokes, but that in fact both are necessary to ensure the correct distribution of potentials along and between the elements of the oscillator (Fig. 2, p. 1346). The radiating power is raised by paralleling several transmitters, with their aerials all in line and spaced to give maximum directivity: they are kept in phase by linking up, two by two, the outside filament-tuning circuits of adjacent transmitters by phasing links 1½ wavelengths long (Fig. 3, p. 1346). Plate modulation is adopted, at least for the time being, on account of its simplicity. The evolution of the "herring-bone" reflector design, and the many alternative arrangements of unit transmitters and unit reflectors, are discussed on p. 1347.

CIRCUIT FOR GENERATING ULTRA-SHORT WAVES BELOW 1 METRE WITH AN OUTPUT OF 5 WATTS AND OVER [Oscillatory Circuit between Anode and Cathode].—Westinghouse Company. (*Radio, B., F. f. Alle*, Nov., 1932, p. 494.)

In an article by Piesch on progress in America. A type of push-pull circuit is used, requiring no special valves or components: the oscillatory circuit is not connected between anode and grid as in the B.-K. circuit, but between anode and cathode. Changes of supply voltages do not alter the wavelength.

The same article mentions also a special B.-K. oscillator giving a 4.5-cm wave of small power.

ON THE INTENSITY OF ELECTRON [Ultra-Short-Wave] OSCILLATION IN A TRIODE. PART II.—K. Morita. (*Journ. I.E.E. Japan*, July, 1932, Vol. 52 [No. 7], No. 528: English summary pp. 84–85.)

Among the conclusions as to the design of triodes most suitable for strong electronic oscillations are the following:—diameter ratio about 2.5; fine spiral or net grid of thin wire; power increased by replacing plate by fine net anode. Another conclusion reached is that when the input reactance of the Lecher wires is inductive, the charge carried through the wires intensifies the possibility of maintaining electron oscillation, while in the case of capacitive reactance it suppresses the oscillation.

In Part III (*ibid.*, September, 1932, pp. 101–102) the writer describes some experiments in radiotelephony on an 80-cm wave, using the special triodes designed on the lines of Part II. The writer's special transmitting aerial system consists of three half-wave dipoles, each of which is mounted on one of the three potential loops of the standing waves in the Lecher wires: the dipoles are insulated from the wires by mica spacers 0.2 mm thick, and the wires are connected to the triode through condensers. The oscillatory current in each dipole is about 60 mA. A plane reflector, close to the triode, is provided. At the receiving end, a half-wave dipole is connected to the Lecher system close to the special receiving valve, and there is also a special reflecting dipole, insulated from the Lecher system and movable about a point roughly a quarter wavelength away from the receiving dipole. The electronic oscillations generated in the receiving system can be varied slightly in frequency by adjusting the position of this reflecting dipole. For weak signals super-regeneration is used, the quenching frequency being about 1.5 mc/s.

MAGNETOSTATIC OSCILLATORS FOR GENERATION OF ULTRA-SHORT WAVES.—G. R. Kilgore. (*Proc. Inst. Rad. Eng.*, Nov., 1932, Vol. 20, pp. 1741–1751.)

On the generators referred to in February Abstracts, pp. 98–99 (three). The experimental investigation leads to the following conclusions:—(1) From a magnetostatic tube of very simple construction, having an anode one inch in diameter, an output of several watts (up to 7 W at 42 cm) can be obtained in the wavelength range of 35 to 50 cm, with an efficiency of about 8%; (2) to obtain maximum output, the magnetic field must be somewhat greater than the "critical value" and must be inclined at a definite angle to the valve axis; (3) the frequency of such oscillators is determined primarily by the magnetic field, but is affected to a small degree by other factors such as plate voltage, plate current, etc.

SCHWUNGRADSCHALTUNG UND SERIENSCHALTUNG BEI SELBSTERREGTEN DURCH ELEKTRONENRÖHREN ERZEUGTEN SCHWINGUNGEN (Fly-Wheel and Series Circuits with Self-Excited Oscillations produced by Thermionic Valves).—K. Heegner. (*Hochf:tech. u. Elek:akus.*, Dec., 1932, Vol. 40, No. 6, pp. 198–207.)

The usual self-excited generating circuit has a fly-wheel circuit in the anode lead. The only real reason for this arrangement is to give the generator a useful efficiency. If this requirement is neglected, the writer shows that it is quite possible to design a series connection with reaction: in its simplest form (Fig. 1) this consists of a capacity C in series with an inductance L, connected between anode and cathode. The d.c. is supplied to the anode through a resistance R_a, and the closed circuit C, L, R_a forms an oscillatory system provided R_a is sufficiently small—of the order of the resistance of L. Retroaction, correct in phase, is obtained by shunting L by a very high resistance R_g in series with an inductance L_g, the latter being included in the grid/cathode lead: or this R_g, L_g shunt can be replaced by a C_g, R_g shunt, the important point in either case being that the shunt should have no natural frequency, or one greatly different from that of the series circuit.

Analysis shows, however, that such a circuit requires a valve with very steep slope. This difficulty can be avoided by replacing R_g by a second valve with high internal resistance (s.g. valve). The phase reversal introduced by this valve necessitates a transfer of C and L, giving Fig. 2; or if L_g is replaced by a suitable transformer the phase reversal can be nullified, so that C and L can remain as before. A further modification can be made as in Fig. 3, yielding a circuit which is symmetrical with respect to the two valves, each anode circuit then having a series circuit of capacity and inductance.

The rest of the paper deals with the application of the above results to maintaining constant the frequency of an oscillator; the d.c. instability of valve systems with falling characteristics (dynatrons and arcs, reactively coupled resistance amplifiers) is gone into, and oscillation-producing circuits equivalent to them are derived. It emerges that the vibrations of a piezoelectric crystal can be maintained by a dynatron circuit (Fig. 12, where C_0 is made up of the electrode capacities of crystal and valve, and L, R and C represent the crystal plate constants). The final circuit deals with a transformation to coupled circuits: this may be accomplished in the dynatron circuit by putting a fly-wheel circuit in parallel with the series circuit, or in the "dynatron-equivalent" circuit by replacing the resistance in the anode circuit of the lower valve by a fly-wheel circuit.

CRYSTAL CONTROL APPLIED TO THE DYNATRON OSCILLATOR.—K. A. MacKinnon. (*Proc. Inst. Rad. Eng.*, Nov., 1932, Vol. 20, pp. 1689–1714.)

Author's summary :—The research was suggested by the following two facts : (1) The dynatron oscillator, as compared with the feed-back oscillators, has a much better "frequency stability" (*i.e.*, its frequency is much more independent of changes in the applied electrode voltages) ; (2) The Pierce types of crystal or magnetostriction oscillators are really controlled feed-back oscillators.

One type of magnetostriction controlled, and two types of crystal controlled dynatrons were discovered. Although no stability measurements were made on the magnetostriction dynatron, it was found to have the advantage of simplicity and freedom from parasitic oscillations. Of the two crystal controlled dynatrons, one has the crystal between the screen grid and the plate, the other has the tank circuit of the ordinary dynatron replaced by the crystal. This latter has a better stability than the Pierce types, but it has the disadvantage that it is not self-starting. By inserting in this latter circuit a tuned circuit between the crystal and the plate, it is possible to get a controlled output at n or $1/n$ times the resonant frequency of the crystal, where $n = 1, 2, 3, 4, \ldots$

All the new circuits, in common with the simple dynatron, suffer from the fact that at present there is no American-made tube capable of oscillating as a dynatron over a long period of time, because of the abnormal filament emission. Some suggestions are advanced in regard to the design of a suitable tube.

Stability measurements of the Pierce crystal oscillators indicated that the grid-filament connection of the crystal was superior to either the grid-plate or the plate-filament connection. A double-beat method was utilised to measure the frequency stability of the various crystal circuits.

OPERATING MECHANISMS OF NEGATIVE RESISTANCE OSCILLATORS (IV) : INSPECTIONS ON THE AUXILIARY EQUATION OF OSCILLATION.—R. Usui. (*Journ. I.E.E. Japan*, Dec., 1932, Vol. 52 [No. 12], No. 533 : English summary pp. 135–137.)

(1) Transient and steady state solution : the "auxiliary equation" is derived, by van der Pol's transformation, from the fundamental differential equation of simple oscillator circuits. (2) Wave form and elongation of period. (3) Examples of graphical solutions. For the earlier parts *see* 1932 Abstracts, p. 459.

SECRET TELEPHONY : THE APPLICATION OF "KINEMATIC DISTORTION" IN SOUND-ON-FILM AND MAGNETIC SYSTEMS.—Podliasky. (*See* February Abstracts, pp. 104–105.)

LIMITS OF FREQUENCY STABILITY OF MODERN SHORT WAVE TRANSMITTERS.—G. Vallauri. (*Alta Frequenza*, Sept., 1932, Vol. 1, No. 3, p. 540.)

Summary of a short paper read at the International Electricity Congress, Paris.

DEVICE FOR PREVENTING BREAKDOWN OF NEUTRALISING CONDENSER IN HIGH-POWER AMPLIFIERS.—H. B. Churchill. (*QST*, Jan., 1933, Vol. 17, p. 50.)

TUNABLE HUM [from Gas and Vapour Rectifiers] : ITS CAUSE, EFFECT AND ELIMINATION.—F. S. Dellenbaugh, Jr. (*QST*, Jan., 1933, Vol. 17, pp. 46–48.)

A RADIO TRANSMITTER FOR THE ITINERANT FLYER.—J. B. Bishop : Bell Telephone Laboratories. (*Rad. Engineering*, Dec., 1932, Vol. 12, pp. 12–13 and 17.)

A NOTE ON GRID-BIAS MODULATION [Necessity for Capacity of Class B Amplifier equal to Ten Times the Carrier Power].—L. B. Hallman. (*Rad. Engineering*, Dec., 1932, Vol. 12, p. 14.)

Investigation of the fact that the capacity of a class B amplifier modulated by varying the grid bias must be approximately ten times the carrier power to allow for peaks at, or near, 100% modulation.

MODULATING THE SCREEN-GRID R.F. AMPLIFIER : HOW IT BEHAVES WITH GRID, SCREEN-GRID AND PLATE MODULATION.—H. A. Robinson. (*QST*, Dec., 1932 and Jan., 1933, Vols. 16 and 17, pp. 20–22 and 90, 43–45 and 48.)

BREAK-IN OPERATION WITH CRYSTAL CONTROL : BLOCKED-GRID KEYING APPLIED TO A HIGH-POWER TRANSMITTER.—R. T. Foreman. (*QST*, Dec., 1932, Vol. 16, pp. 31–32 and 90.)

RECEPTION

EXPERIMENTS ON THE RECEPTION OF ULTRA-SHORT WAVES.—Marconi. (*See* abstract under "Transmission.")

FRENCH RECEIVER TRENDS.—Picard. (Summary in *Electronics*, Dec., 1932, p. 377.)

Progress of tone-control, "now fitted to nearly all receivers" ; criticisms of American fading compensators as being too incomplete in their action and contrasting unfavourably with French methods, especially that of Chrétien (*see* Adam, below ; also February Abstracts, p. 100, and 1929, p. 510) ; unpopularity of radio-gramophones with French makers and public : French valves better than American (higher μ, higher mutual conductance) : practical disappearance of the double-grid frequency-changer in favour of two separate triodes (*cf.* and contrast February Abstracts, p. 115, "Olympia, 1932"), although the "Strobodyne" principle with one triode only is still used, and one maker uses a triple-grid valve as frequency-changer.

TRENDS OF DESIGN AT THE NINTH RADIO EXHIBITION, PARIS, 1932.—M. Adam. (*Rev. Gén. de l'Élec.*, 24th Dec., 1932, Vol. 32, No. 25, pp. 845–851.)

Pre-selector band-pass filters, giving "superinductance" receivers of high selectivity, the coils wound on glass and giving loss angles not greater than 0°24′ (sensitivity and fidelity curves of such receivers are given): band-pass filters in superheterodyne receivers: Chrétien anti-fading circuits: new valves: loud speakers, moving coil and moving iron: new progress in the latter, through the study of the armature hysteresis cycle. "For displacements less than 0.2 mm the magnetic loud speaker is of equal value to the electrodynamic, and has the advantage of five times the sensitivity of the latter."

THE DESIGN OF BROADCAST RECEIVERS.—P. K. Turner. (*World Radio*, 27th Jan., 1933, Vol. 16, pp. 125–126.)

An instalment of a long series beginning in the issue for 21st October, 1932, Vol. 15, pp. 924 and 925.

FUTURE TRENDS IN BROADCAST RECEIVERS: POSSIBLE NEW GADGETS.—K. Jarvis. (*Electronics*, Dec., 1932, p. 368.)

Extracts from a paper read at a recent I.R.E. meeting. "There are certain requirements of every radio and the most expensive in the near future will not be much better than the cheaper sets in respect to these fundamentals [selectivity, fidelity, etc.]. . . The higher priced receivers will be differentiated from the cheap ones by the employment of additional services, for example, automatic volume control, automatic tone control, muting systems, etc. In time these services will become fundamental. . . By that time other gadgets will have been developed."

The author suggests possible examples of these new "gadgets": utilisation of the 0–30 c/s band for an additional volume-control emission from the broadcasting station, which would increase the l.f. amplification of the receiver when the input at the transmitter increased, thus permitting greater volume-level changes than are now possible [*cf.* D'Orsay Bell, *Wireless World*, 7th Aug., 1929, pp. 515–516, where a similar idea was put forward for the particular purpose of diminishing interference from an overlapping side-band]: utilisation of the 0–30 c/s band for station call-letters, for a time service, or for facsimile service for news or visual advertising.

Another new departure suggested was that detectors should be developed which would "tolerate, or even enjoy, modulation percentages in excess of 100%," thus avoiding the bad distortion now produced by selective fading of the carrier and the consequent increase in effective modulation. "Receivers might be developed which would handle cases where modulation of several hundred per cent. was experienced. If such high modulation became the practice, the interference range would be decreased." Another suggestion was the use of very low impedance output valves. At present, to get high output into a loud speaker a class B amplifier is used, and during periods of low signal strength the valve presents a high impedance to the loud speaker: the result is that "transients in the loud speaker are high, with corresponding distortion. Low impedance tubes would damp the speaker, confining transients to a few cycles or fractions of a cycle."

IRON POWDER COMPOUND CORES FOR COILS [Ferrocart, etc.].—G.W.O.H. (*See* under "Subsidiary Apparatus and Materials.")

A NOTE ON THE THEORY AND PRACTICE OF TONE-CORRECTION.—F. M. Colebrook. (*Wireless Engineer*, Jan., 1933, Vol. 10, No. 112, pp. 4–12.)

Author's abstract:—The side-band attenuation and consequent audio-frequency output amplitude distortion, due to the reception of radio-telephony in circuits of low decrement, can be corrected by means of suitably designed audio-frequency amplifying stages. The present paper describes briefly the nature of the side-band attenuation which will occur in practice, the corresponding correcting audio-frequency amplification required, and shows by theory and experiment how such amplification can conveniently be realised.

The possible sources of harmonic distortion in this type of reception are discussed, and it is shown that only one of these is likely to be of importance in practice, namely the curvature of the characteristic of the valve in the tone-correcting stage. The means of reducing the harmonic distortion from this cause to less than 5% are described. A summary of the main results obtained is given in the final section of the paper.

HIGH-SELECTIVITY TONE-CORRECTED CIRCUITS.—J. Robinson: G.W.O.H. (*Wireless Engineer*, Dec., 1932, Vol. 9, No. 111, pp. 685–686.)

A letter prompted by the editorial referred to in Feb. Abstracts, p. 99. G.W.O.H. replies.

THE RADIO RECEIVER CHARACTERISTICS RELATED TO THE SIDE-BAND COEFFICIENT OF THE RESONANCE CIRCUIT.—S. Takamura. (*Proc. Inst. Rad. Eng.*, Nov., 1932, Vol. 20, pp. 1774–1801.) *See* January Abstracts, p. 38.

OUTSTANDING BATTERY SET DEVELOPMENT ["Quiescent Push-Pull"].—E. Yeoman Robinson. (*Wireless World*, 6th January, 1933, Vol. 32, pp. 6–8.)

Push-pull is uneconomical for battery users, and although attempts have been made to secure economy by biasing the two valves so that one valve is virtually inoperative during the half-cycle when its counterpart is performing its function, the scheme has not been very successful. Using high efficiency pentodes, however, it is only necessary to balance the anode circuit of the valves at the bias point, and this can be done easily by adjusting the screening grid voltage of one valve. By thus using high efficiency pentodes in "quiescent push-pull," it is possible to obtain an a.c. power output of 1.3 watts with a total h.t. consumption of only 6 mA at 120 V. *See* also next abstract.

THE QUIESCENT PUSH-PULL TWO.—W. I. G. Page. (*Wireless World*, 20th January, 1933, Vol. 32, pp. 40–42.)

A two-stage battery operated receiver for the amateur constructor. The principal feature is the attainment of a power output of 1½ W with a plate current consumption of only 8 mA. This is achieved by the employment of two pentodes connected in " quiescent push-pull " (*see* preceding abstract).

THE MODERN D.C. THREE [with Screen-Grid Detector].—W. I. G. Page. (*Wireless World*, 30th December, 1932, Vol. 31, pp. 568–571, and 6th January, 1933, Vol. 32, pp. 12–13.)

A SCREEN-GRID-VALVE DYNATRON OSCILLATOR CIRCUIT FOR SUPERHETERODYNES, FREE FROM HARMONICS.—(*Radio, B., F. f. Alle*, Dec., 1932, p. 535.)

In this circuit the screen grid, not the anode, is at the highest potential (about 80 v), while the anode is only at half this potential; the oscillatory circuit is in the anode lead. The generator oscillates without a break from the longest waves down to 15 m. For still shorter waves, r.f. chokes must be introduced into the screen-grid and anode leads.

THE SCREEN-GRID VALVE AS FREQUENCY CHANGER IN THE SUPER-HET.—C. R. Burch: White. (*Wireless Engineer*, Dec., 1932, Vol. 9, No. 111, p. 686.)

A letter prompted by White's article (Feb. Abstracts, p. 99) on the method of feeding the local oscillation into the anode circuit of the first detector (*cf.* Cocking, 1931 Abstracts, p. 383).

VERBESSERUNGEN AN DER DREIGITTERENDSTUFE (Improvements to the Pentode Output Stage [Reduction of Capacity in Choke Filter Output Circuit]).—H. Piesch: Sims. (*Radio, B., F.f. Alle*, Dec., 1932, pp. 528–530.)

An article on Sim's *Wireless World* paper (1932 Abstracts, p. 524: *see* also p. 456.)

DIE AUFGABE DES SCHWINGAUDIONS AUF ZWEI RÖHREN VERTEILT (The Functions of the Leaky-Grid Detector, with Reaction, divided between Two Valves).—(*Radio, B., F. f. Alle*, Jan., 1933, pp. 36–37.)

To preserve the amplifying power of the audion (usually sacrificed to obtain smooth reaction) an American amateur suggests a circuit in which a screen-grid valve is added, with its control grid connected to the grid of the ordinary audion and its anode circuit coupled through an a.f. transformer to the succeeding stage.

SIDEBAND SPLASH.—R. W. Hallows. (*Wireless World*, 20th January, 1933, Vol. 32, pp. 43–44.)

The article deals briefly with the annoying type of interference caused by the beating of an unwanted side-wave with the wanted carrier.

INTERFERENCE: NOTES ON METHODS FOR ELIMINATION OF INTERFERENCE CAUSED BY NON-RADIO DEVICES.—E. T. Glas. (*Wireless Engineer*, Dec., 1932, Vol. 9, No. 111, pp. 680–684.)

Among various points mentioned are the following:—cars as a rule cause little interference: thus tramway interference is strongest when the car is coasting and only the lighting system is being fed, and interference decreases on wet days owing to the easy formation of true arcs. Most commutator machines below 10 kw cause the worst interference on the 200–300 m range; simple breaking devices are often most troublesome on the 1 300–1 900 m range. A commutator machine worked either on d.c. or a.c. nearly always gives worse interference when working on a.c., when the inferior commutating action results, among other things, in an unfavourable time curve. The slightly increased r.f. inductance of a coil with iron, compared with one without iron, is more than counteracted by the unfavourable increase in capacity, when only r.f. has to be considered.

The use of r.f. filters is discussed, particularly the choice between type *a* (Fig. 4), where the condenser is across the inductances on the apparatus side, and type *b* where it is across them on the mains side: for " small " machines (and circuit breaking points) the first type is the most effective, for " big " machines (above about 2 kw) the second type.

LES BLOCS ANTIPARASITES ET LEUR EMPLOI (Devices to prevent Man-Made Interference with Radio Reception, and Their Use).—P. Hémardinquer. (Summary in *Rev. Gén. de l'Elec.*, 17th Dec., 1932, Vol. 32, No. 24, p. 190 D.)

The summary ends: " the best results appear to be obtained by the use of a capacity-free mains transformer, proposed by M. Toulon, delivering the energy from the mains but opposing a very high impedance to the high-frequency currents."

INTERFERENCE FILTERING [Special Wave-Trap Circuit].—(Summary of French Patent in *Electronics*, Dec., 1932, p. 376.)

" By introducing ohmic resistance into the circuit of a wave-trap, etc., its effectiveness at the carrier frequency of the unwanted station is decreased, but its effect as regards the side-bands is increased. To compensate for the first loss, the interfering signals are fed in opposed phases to the receiving circuit, as in the system shown."

REDUCING MAN-MADE STATIC [The Use of a Shielded Lead-In and the Calculation of the Appropriate Impedance-Matching Network].—G. H. Browning. (*Electronics*, Dec., 1932, pp. 366–368.)

ZUR FRAGE DER ABGESCHIRMTEN ANTENNEN-ZULEITUNG (The Question of the Screened Aerial Lead [and the Recommendations of the Association of German Electricity Works]).—K. Nentwig. (*Radio, B., F. f. Alle*, Dec., 1932, pp. 530–533.)

See Nesper, 1932 Abstracts, p. 409. The writer concludes that the demand for suppression of interference at the source must be persisted in, although naturally receivers must be designed to be as little susceptible as possible.

THE LAW OF THE BROADCAST LISTENER AND THE ELIMINATION OF WIRELESS INTERFERENCE.—M. Adam. (Summary in *Rev. Gén. de l'Elec.*, 17th Dec., 1932, Vol. 32, No. 24, pp. 190–191 D.)

THE LEGAL POSITION OF PRODUCERS OF WIRELESS INTERFERENCE WITH RESPECT TO THE LISTENERS.—J. Ottoz. (*Ibid.*, p. 191 D.)

DIE AUTOMATISCHE FADINGREGELUNG (Automatic Fading Compensation).—K. Nentwig. (*Radio, B., F. f. Alle*, Jan., 1933, pp. 18–23.)

Dealing in turn with the simplest circuit, depending on an auxiliary battery (for anode-bend detection only); the circuit in which the control impulse is delivered by an auxiliary valve; and the Lentze circuit, in which it is delivered by a two-grid valve and amplified by a triode.

AUTOMATIC VOLUME CONTROL BY REGULATION OF FILAMENT CURRENT, WHICH FORMS ANODE CURRENT OF CONTROL VALVE.—Telefunken Company. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Nov., 1932, Vol. 40, No. 5, p. 185.)

ANTI-FADING CIRCUITS.—Chrétien. (*See* Adam, "Trends of Design . . .", and Picard, both above.)

AUTOMATIC VOLUME CONTROL.—C. H. Smith. (*World Radio*, 30th Dec., 1932 and 13th Jan., 1933, pp. 1378 and 53, 55.)

Describing six types of device, the last two being based on a semi-mechanical control (de Bellescize—relay, and Barton—aerial series capacity varied by microammeter deflection).

PRACTICAL AUTOMATIC VOLUME CONTROL.—W. T. Cocking. (*Wireless World*, 6th and 13th January, 1933, Vol. 32, pp. 2–4 and 29–30.)

The broad principles of a.v.c. have previously been discussed by the writer (1932 Abstracts, p. 639). In this article the two rival systems—the diode and the square law control—are discussed and the particular advantages of each are shown.

RECEIVER TESTING EQUIPMENT FOR SHOP OR FIELD.—J. A. Myers. (*Rad. Engineering*, Dec., 1932, Vol. 12, pp. 10–11.)

PERMEABILITY TUNING.—M. G. Scroggie. (*Wireless World*, 30th December, 1932, Vol. 31, p. 575.) *See* also Hallows, Feb. Abstracts, p. 100.

DIE BESTE SIEBKETTE FÜR NETZANSCHLUSSGERÄTE (The Best Filter Chain for Mains-Driven Apparatus).—H. Piesch. (*Radio, B., F. f. Alle*, Jan., 1933, pp. 6–11.)

TRANSFORMING RECEIVER CONSTRUCTIONAL DIAGRAMS TO WORK FROM DIFFERENT SUPPLY SOURCES [A.C., D.C. and Battery].—E. Schwandt. (*Radio, B., F. f. Alle*, Nov, 1932, pp. 478–490.)

AERIALS AND AERIAL SYSTEMS

DIRECTIVE ANTENNAE FOR BROADCAST STATIONS [particularly at WFLA, Florida].—R. M. Wilmotte. (*Electronics*, Dec., 1932, pp. 362–364.)

"The first application of a directive antenna system for broadcasting to be recognised by the Federal Radio Commission was carried out by the author on station WFLA at Clearwater, Florida [*see* February Abstracts, p. 101]. . . . Station WFLA with the permission of the Federal Radio Commission is now operating regularly with the new antenna on the old power allocation" [whereas with the ordinary aerial it had been required to cut down its aerial power at night from 1 kw to 250 w]. The paper includes polar diagrams of the radiation from the new aerial system as used for night and for day service, and a one-millivolt contour of the service areas on one kilowatt given by the old and the new aerials.

THE IMPROVEMENT OF BROADCASTING AERIAL SYSTEMS [Survey].—(*Ann. des P.T.T.*, Dec., 1932, Vol. 21, pp. 1102–1110.)

Based on U.I.R. records and papers by Eckersley, Kiebitz, Böhm, Harbich and Hahnemann, and others, dealt with in past Abstracts and below.

THE POLYGON BROADCASTING AERIAL FOR SUPPRESSION OF FADING.—Böhm: Böhm, Bechmann and Roosenstein: Telefunken Company. (Summaries of German Patents in *Hochf:tech. u. Elek:akus.*, Nov., 1932, Vol. 40, No. 5, p. 182 and 182–183.)

See 1932 Abstracts, p. 526—Böhm: also p. 346—Lorenz Company and German P.O. The first patent is illustrated in Figs. 3, 4 and 5. The second patent deals with the use of a central vertical aerial, fed with a current equal to the sum of the polygon currents and displaced by 180° with respect to these (Fig. 9: vertical polar diagram Fig. 10) if a uniform all-round radiation in the horizontal plane is desired.

SHORT-WAVE AERIAL SYSTEM WITH HORIZONTAL DIPOLE, CONSISTING OF TWO NETWORKS OF WIRES, AND VERTICAL FEEDERS: FOR PRODUCTION OF PURELY HORIZONTAL POLARISATION.—Telefunken Company. (*Ibid.*, p. 183.)

Particularly suitable for wavelengths of 100–200 m.

WIRKSAME BEKÄMPFUNG DES NAHSCHWUNDES IM RUNDFUNK DURCH SENDEANTENNENGEBILDE BESTIMMTER FORM (The Effective Combating of Near Fading in Broadcasting by Transmitting Aerials of Particular Design [Elektrotechnischer Verein Discussion].—Hahnemann, Harbich, Runge, Gothe, Plendl, Krüger. (*E.T.Z.*, 22nd Dec., 1932, Vol. 53, No. 51, pp. 1233–1236.)

ARGUMENT AS TO RELIABILITY OF FIELD STRENGTH MEASUREMENTS TAKEN IN AIRCRAFT.—Gothe: Krüger. (*See* preceding reference.)

SHORT-WAVE AERIAL SYSTEM WITH ALL-ROUND HORIZONTAL RADIATION [Horizontal Radiators forming Sides of Polygon, Connected in Series by Vertical Lecher Pairs with Adjustable Bridges].—Elektroswias, Leningrad. (Summary of German Patent in *Hoch:tech. u. Elek:akus.*, Nov., 1932, Vol. 40, No. 5, p. 182.)

See Figs. 6 and 7. All the horizontal radiators oscillate in the same phase: their length may be less than $\lambda/2$. Radiation in the vertical plane can be influenced by a reflector consisting of a concentric system of similar design. The vertical diagram of a single 8-wire system is shown in Fig. 8.

EXTENSION OF THE MESNY "MEANDERING" [Zig-Zag] AERIAL SYSTEM.—M. Latour. (Summary of German Patent in *Hoch:tech. u. Elek:akus.*, Nov., 1932, Vol. 40, No. 5, pp. 181–182.)

The ordinary Mesny continuous wire bent into zig-zag form in one plane radiates only perpendicularly to the axis, but it has been found that it will radiate also in its own plane, or in a plane at an angle α, if the geometrical condition

$$h + x \pm x \cos \alpha = (2n + \lambda)\lambda/2$$

is fulfilled, where h is is the height of the vertical parts and x their spacing. The present patent is based on this fact and covers aerial systems made up of several such wires.

DIRECTIVE AERIAL CONSISTING OF A CONDUCTOR BENT INTO A ZIG-ZAG IN ONE PLANE.—International Standard Electric Corporation. (Summary of German Patent in *Hoch:tech. u. Elek:akus.*, Nov., 1932, Vol. 40, No. 5, p. 182.)

Cf. Latour, above. Here the propagation is perpendicular to the aerial plane, and the sum of the lengths of a vertical and a horizontal link is equal to an odd multiple of $\lambda/2$. A similar wire, as reflector, may be placed at a distance of an odd number of quarter wavelengths.

DIRECTING ACTIONS OF WAVE RESONATORS AND THEIR EFFECTS ON THE PLANE OF POLARISATION OF ELECTROMAGNETIC WAVES.—S. Uda and S. Nakamura. (*Journ. I.E.E. Japan*, Aug., 1932, Vol. 52 [No. 8], No. 529: English summary, pp. 95–97.)

For earlier papers on "wave directors" and reflectors *see* 1930 Abstracts, p. 215. The present paper deals first with a straight vertical dipole and a series of straight directors inclined (in the plane perpendicular to the direction of propagation) at an angle to the vertical, this inclination causing a rotation of the plane of polarisation through the same angle. The behaviour of directors of zig-zag form, when used with a similarly zig-zag dipole bent (case i) in the same direction as the directors, and also (case ii) in the opposite sense to the directors, is then examined. *See* also Nakamura, *ibid.*, December, 1932, pp. 137 and 968–971.

SPECIAL AERIALS FOR THE TRANSMISSION AND RECEPTION OF ULTRA-SHORT (80 cm) Waves.—Morita. (*See* abstract under "Transmission.")

EFFECT OF THE EARTH'S NON-HOMOGENEITY IN STRATA ON THE ELECTROMAGNETIC FIELD OF A HORIZONTAL TRANSMITTING AERIAL [Theoretical Investigation and Experimental Confirmation on a 5.4 m Wave].—G. Hara. (*Journ. I.E.E. Japan*, Oct., 1932, Vol. 52, [No. 10], No. 531: English summary pp. 113–114.)

In the equation for the electric field at a point P, one wavelength or more above a non-homogeneous earth, due to a horizontal transmitting aerial near the surface, the first term gives the radiation field at P of the direct wave, the second that of the wave reflected from the surface, and the third that of the wave reflected from the semi-infinitely-extended plane of a different medium which is assumed to lie at a depth d from the surface of the upper medium. The writer obtains expressions for the "coefficient of surface reflection" for the above simple case, and then extends his treatment to the case of more than one stratified non-homogeneity.

In the experimental test, a horizontal dipole was made to emit a 5.4 m wave directly above the surface of a water tank; the water represented the absorbing medium and was rendered non-homogeneous by the introduction of a plate of copper, of fire-brick, or of graphite. The current in a receiving aerial, nearly 6 metres above the transmitting dipole, was measured for different depths of the plate, for the three plates in turn. The theoretical and experimental curves agree well as regards their course, though differing somewhat in magnitude. This discrepancy is shown to be due largely to the effect of the walls of the wooden tank. In a previous paper the writer has proposed a method of detecting the earth's non-homogeneity in strata. For another earlier paper *see* 1932 Abstracts, p. 285.

ENERGIELEITUNGEN FÜR SEHR HOCHFREQUENTE STRÖME (Feeders for Ultra-Short Waves).—F. Bahnemann. (*Hochf:tech. u. Elek:akus.*, Dec., 1932, Vol. 40, No. 6, pp. 189–198.)

Author's summary:—"The various theoretical and experimental researches connected with the propagation of high-frequency currents along lines are discussed. Certain relationships are derived [Section II] from the telegraph equations, for use in checking the experimental measurements. The method of potential measurement employed allows the *direct* determination of the potentials on two-wire systems, in contrast to all previous methods. [The method in question is an adaptation of Rohde's principle—compensation by d.c. potential of the r.f. potential applied to a diode; 1931 Abstracts, p. 616. A special valve was constructed for the Lecher pair measurements, having two diode systems with their filaments in series. The bicorn design shown in Fig. 2 was adopted to avoid errors due to the dielectric introduced between the wires by the original type shown in Fig. 1].

"With ultra-high-frequency currents the radiation caused by asymmetry made itself evident. If losses are to be avoided, the feeder must be made symmetrical. Apart from asymmetry due to incorrect arrangement [not only the wires themselves but also the coupling links at the ends must be arranged to give the greatest symmetry possible], the potential distribution determined experimentally was that predicted by theory. That is to say, the telegraph equations hold good for symmetrical feeders [even at the ultra-high frequencies used—of the order of 10^8 c/s].

"Various possible matching methods are discussed [including Roosenstein's 'transformation lines,' 1931 Abstracts, p. 441], and the results of some tests on a feeder length with a progressively varying characteristic, which seems particularly suitable for the transmission of currents of ultra-high frequency, are given. [Such an insertion is only practicable when its length is of the same order as the wavelength, hence its special suitability for ultra-short waves. The form employed was that of a concentric tubular conductor, whose characteristic impedance changed from 20 to 300 ohms in a length of 125 cm, thanks to the ratio of the radii changing along its length. Symmetry was arranged for by a condenser connected between the inside tube and one wire of the Lecher system. Without this, the potential distribution was quite asymmetrical. Fig. 14 shows the successful use of the insertion to match a Lecher system of characteristic impedance 440 ohms with an ohmic resistance of 20 ohms]."

CALCUL DE LA RÉSISTANCE DE RAYONNEMENT D'UN FEEDER BIFILAIRE (Calculation of the Radiation Resistance of a Two-Wire Feeder).—J. Loeb: Brillouin. (*Ann. des P.T.T.*, Dec., 1932, Vol. 21, pp. 1060–1070.)

Brillouin's method is applied to the problem, on the assumptions that $\lambda \gg D$ (the spacing of the wires), that $D \gg a$ (radius of each wire: usually D/λ and a/D are both of the order of 1–2%), that the attenuation coefficient β is negligible at a first approximation (" but even if β is large, the integrals giving the potential values are not greatly changed"), that the ground is insulating and the dielectric constant equal to that of a vacuum (" the hypothesis is very nearly justified by the fact that the frequency is high"), and that the feeder is fed by travelling waves, to the exclusion of all stationary phenomena. The distributed radiation resistance per unit length is found to be $R = 16\pi^4 \mu c D^2/\lambda^3$ in the c.g.s. system, or in the practical system of units $R = 48\,000\ D^2/\lambda^3$. In the first formula μ is the magnetic permeability of a vacuum. An example shows that while with a 30-m wave the radiation resistance of a feeder may be negligible, with a 15-m wave it may become comparable with the ohmic resistance.

TRANSMISSION LINES FOR SHORT-WAVE RADIO SYSTEMS.—C. B. Feldman. (*Bell Lab. Record*, Dec., 1932, Vol. 11, No. 4, pp. 117–122.)

Among the various points discussed, it is mentioned that except in the ultra-short-wave region the power radiated by balanced two-wire lines is small compared with that transmitted, and the attenuation due to copper losses in such lines is not very different from that in concentric-tube lines of practical size: nevertheless, Figs. 1 and 2 show almost exact agreement between calculated and measured attenuation for the latter type of line and a discrepancy of 70% for the balanced two-wire line. This is due mainly to losses in the earth below the line, brought about probably by small and practically unavoidable unbalance.

MESSUNGEN ÜBER DIE STRAHLUNGSINDUZIERUNG SYMMETRISCHEN ANTENNEN (Measurements on the Radiation Induction in Symmetrical [Short-Wave] Aerials [and the Influence of Height above Ground]).—O. Schmidt. (*Hochf:tech. u. Elek:akus.*, Nov., 1932, Vol. 40, No. 5, pp. 158–167.)

Author's summary:—Through the measurement of the potential distribution along a Lecher pair, the impedance of aerial systems connected to this is measured. In this way the effect of radiation induction, especially at the point of transition from the non-radiating conductor to the strongly radiating aerial, is made evident. The radiation resistance caused by the energy component of the induction produces an increased damping in the connected radiation-free Lecher pair. The wattless component, which in its effect is equivalent to an apparent change in propagation velocity (or in other words a change in the natural wavelength of the aerial), causes a displacement of the potential node.

The variation of the radiation resistance and of the propagation velocity with the height above the ground, in the case of a half-wave aerial (dipole) and of a double dipole, is investigated. Good agreement is found with the values obtained by theory on the assumption of an infinitely conducting earth. It is shown that as an approximation an aerial can be represented as a homogeneous conductor with a "fictitious" impedance Z_A which, from a certain height downwards, depends practically only on the conductor cross section and is not appreciably influenced by the radiation induction [Z_A is defined as the geometrical mean of the radiation resistances at the current and potential loops of a simple dipole]. The radiation induction is illustrated by several examples.

A METHOD OF MEASURING THE SAG OF TELEPHONE LINES [Depending on the Velocity of Propagation of a Transverse Wave].—P. Thomas. (*T.F.T.*, Nov., 1932, Vol. 21, pp. 287–289.)

VERSUCHE AN DRAHTSEILEN (Tests on Stranded Wires).—F. List. (*Zeitschr. V.D.I.*, 31st Dec., 1932, Vol. 76, No. 53, pp. 1297–1298.)

CHANGE OF SAG DUE TO CLEARING OF THE SLEET ON ONE OF THE SPAN WIRES OF A SUSPENDED OVERHEAD TRANSMISSION LINE.—S. Nishiyama. (*Journ. I.E.E. Japan*, July, 1932, Vol. 52 [No. 7], No. 528: English summary pp. 83–84.)

WOODEN TOWERS AT THE LEIPZIG BROADCASTING STATION.—Fr. Herbst. (*Zeitschr. V.D.I.*, 10th Dec., 1932, Vol. 76, No. 50, pp. 1209–1212.)

THE EFFECT OF METAL TOWERS ON THE RADIATION FROM AN AERIAL [Eiffel Tower Diagram].—David. (*See* abstract under "Stations, Design and Operation.")

VALVES AND THERMIONICS

NEW VACUUM VALVES AND THEIR APPLICATIONS [Special Pliotrons, Cathode-Ray Tube for X-Ray Chemical Analysis, Thyratrons, and Phanotrons].—A. W. Hull. (*Gen. Elec. Review*, Dec., 1932, Vol. 35, pp. 622–629.)

Special pliotron for electrometer purposes, capable of measuring 10^{-18}A, with extra "space-charge" grid holding back the small positive ion current from the filament: special low-noise pliotron, "with a l.f. input noise level of less than ½ microvolt (practically all shot-effect) as compared to about 10 times this value for the best tube previously available," suggesting the possibility of new discoveries, "perhaps in the field of physiology, by measuring heart-beats, nerve impulses, thought waves"; power pliotrons, needed in industry and with possible applications in high-frequency heating of metals, producing artificial fever, sterilisation of milk, grain, etc., and generation of ozone.

Special cathode-ray tube for X-ray analysis, with aluminium window stamped very thin in parts and with the cathode focusing the electrons on to this window so that they travel several inches in the air. Thyratrons, with as many positive ions as electrons; particularly the thyratron with "cellular cathode," more than ten times as efficient as filaments and requiring about one watt of heat per ampere of emission: mercury-arc thyratrons: industrial applications of thyratrons: power applications. The phanotron, and its advantages over the tungar rectifier: "the combination of heat-shielded cathode and low-pressure gas appears to give the four desired characteristics of a rectifier . . ."

THE DESIGN OF TRIODES FOR ULTRA-SHORT [Electron Oscillation] WAVES.—Morita. (*See* abstract under "Transmission.")

MAGNETOSTATIC OSCILLATORS FOR GENERATION OF ULTRA-SHORT WAVES.—Kilgore. (*See* under "Transmission.")

A NON-THERMIONIC [Glow Discharge] AMPLIFIER TUBE.—H. J. Reich. (*Phys. Review*, 15th Dec., 1932, Series 2, Vol. 42, No. 6, p. 913.)

Abstract only. "Grid control of a glow discharge is obtained in this tube by so designing and placing the grid that it is out of the direct path of the discharge between anode and cathode."

TRIPLE GRID POWER AMPLIFIER TUBES [as Suppressor Grid Output Pentode, Class B Zero Bias Output Valve, or Class A Low Impedance Triode].—E. W. Herold. (*Rad. Engineering*, Dec., 1932, Vol. 12, pp. 7–9.)

ON THE USE OF THE PENTODE VALVE FOR PRESSURE RECORDING [in Fluids, using Capacity-Change Method: Pentode acting both as Oscillator and Valve Voltmeter by Suitable Use of the Three Grids].—W. D. Oliphant. (*Journ. Scient. Instr.*, Dec., 1932, Vol. 9, pp. 386–388.)

A NEW TYPE OF VALVE DIAGRAM.—G. W. O. Howe: Gundlach. (*E.N.T.*, Dec., 1932, Vol. 9, p. 504.)

Editorial note on the reception of a letter from Howe pointing out that a method of representing valves, very similar to that proposed by Gundlach (January Abstracts, p. 41), was previously described by Beatty in the *Wireless World* (1929 Abstracts, p. 513). *See* also *Wireless Engineer*, Dec., 1932, Vol. 9, No. 111, pp. 665–666, for an editorial on these diagrams, where their great utility for plotting the data of a large number of valves in a manner lending itself to easy classification is emphasised, Beatty's paper being quoted as an example.

SULL'EMISSIONE SECONDARIA DI GRIGLIA NEI TRIODI (On the Secondary Emission from the Grid in Triodes [Experiments indicating an Emission due to Photoelectric Effect of Soft X-Rays from Cathode]).—M. Pinna. (*Nuovo Cim.*, Nov., 1932, Vol. 9, No. 9, pp. 302–311.)

MEASURING MICROPHONIC NOISE IN VACUUM TUBES [Equipment in which Microphonic Response is indicated by Steady Deflection of Output Meter].—H. A. Pidgeon. (*Bell Lab. Record*, Jan., 1933, Vol. 11, No. 5, pp. 145–150.)

THERMAL AGITATION OF ELECTRONS IN A METALLIC CONDUCTOR [Verification of Nyquist's Theory, and Precision Measurement of Boltzmann's Constant].—N. H. Williams and D. A. Wilbur. (Summary in *Science*, 2nd Dec., 1932, Vol. 76, No. 1979, pp. 519–520).

The experiments reported here accurately verify the theoretical relation between the fluctuating p.d. and the resistance and absolute temperature of the conductor. "The most striking thing about this phenomenon is that it furnishes a new and independent means of determining Boltzmann's constant. . . ." [*c.f.* Ellis and Moullin, 1932 Abstracts, p. 588].

THE INSPECTION OF INDIRECTLY HEATED CATHODES BY X-RAYS.—G. Déjardin and J. F. Thovert. (Summary in *Rev. Gén. de l'Elec.*, 17th Dec., 1932, Vol. 32, No. 24, p. 814.)

THE WORK FUNCTIONS OF THE COMPONENTS OF ACTIVATED OXIDE-COATED CATHODES.—Rentschler, Henry and Smith. (*See* abstract under "Phototelegraphy and Television.")

THE VALVE FILAMENT.—R. T. Beatty. (*Wireless World*, 13th and 20th January, 1933, Vol. 32, pp. 31–32 and 56–57.)

SCHIEFE INITIALEMISSION VON GLÜHELEKTRONEN AUS KRISTALLINISCH RAUHEN METALLOBERFLÄCHEN (Oblique Initial Emission of Thermelectrons from Rough Crystalline Metal Surfaces).—H. Seemann. (*Zeitschr. f. Physik*, 1932, Vol. 79, No. 11/12, pp. 742–752.)

DIE POTENTIALDIFFERENZ ZWISCHEN GLÜHENDEN WOLFRAMELEKTRODEN VERSCHIEDENER TEMPERATUR (The Potential Difference between Incandescent Tungsten Electrodes at Different Temperatures).—F. Kuhn. (*Ann. der Physik*, 1932, Series 5, Vol. 15, No. 7, pp. 825–841.)

THE EMISSION OF POSITIVE IONS FROM HEATED METALS: THE TEMPERATURE VARIATION OF THE POSITIVE IONS FROM MOLYBDENUM.—L. L. Barnes. (*Phys. Review*, 15th Nov., 1932, Series 2, Vol. 42, No. 4, pp. 487–491 : 492–497.)

DIRECTIONAL WIRELESS

DIE ULTRAKURZWELLEN-FUNKBAKE (Ultra-Short-Wave Beacons).—E. Kramar: Lorenz Company. (*E.N.T.*, Dec., 1932, Vol. 9, pp. 469–473.)

Dealing in particular with the experimental beacon at Zossen, working on a 7.05 metre wave, note modulated, with a telephonic output of about 2 watts. The keying was accomplished in the manner described in another paper (1932 Abstracts, pp. 642–643). Over flat, wooded country the range for a medium strength of signal, giving good course-reading, was 4–5 km. "Over sea and with an elevated transmitting dipole [the base of the actual experimental aerial was only about 10 ft above flat ground] a range many times this should be attained."

The equi-signal zone for satisfactorily strong signals was 2–3 degrees wide. No errors were caused either by a railway line or by telephone lines: "this is explained by the fact that both sets of signals arrive at the common receiver from the common transmitter by the same path and are thus equally weakened. The method has the advantage over previous methods of working on a comparison of field strengths." The effect of re-radiation from casual conductors was investigated: only a tuned dipole in the immediate neighbourhood of the beacon could disturb the beam. To avoid errors due to various inclinations of the receiving aerial, the transmitting aerial must be vertical.

THE CAUSE AND ELIMINATION OF NIGHT EFFECTS IN RADIO RANGE-BEACON RECEPTION ["Transmission-Line" Aerial System: Application of Adcock Aerials to Equi-Signal Beacon].—H. Diamond. (*Bur. of Stds. Journ. of Res.*, Jan., 1933, Vol. 10, No. 1, pp. 7–34.)

The four vertical aerials of the Adcock principle, as here applied in experimental form, are about 75 ft high; for the sake of large effective capacitance each consists of a six-wire sausage aerial 4 ft in diameter. The aerials of each pair are 400 ft apart. A separate earth system (concentric circles) is provided at the base of each aerial. Each of the two goniometer rotor windings is connected to a tuned series circuit including the primary of a r.f. transformer, whose secondary is connected to two 2-wire parallel-conductor transmission lines leading to one pair of vertical aerials (*cf.* Barfield, Abstracts, 1930, p. 572; Marconi Co., 1931, p. 619). The "special coupling unit" (as each of these tuned series circuits is called) has two functions: to transfer power from the rotor winding to the two transmission lines, and to match the impedance of that winding to the impedance of the two lines in parallel. The lines themselves consist of ordinary 2-conductor 600-volt cable, lead sheathed, buried about 18 inches below the surface; the lead sheath must avoid all connection to the earth systems, except by way of its continuous connection with the earth. The four tuning boxes, each of which houses an aerial loading coil and a transmission line coupling transformer, are located near the bases of the four aerials and are provided with complete screening. The secondary winding of each coupling transformer is tapped to allow accurate matching of its input impedance to the surge impedance of the transmission line. The system involves the accurate control of the time phase angle between the currents in the two vertical aerials of each pair. When this angle is 180°, a true figure-of-eight space pattern is obtained; when it is 180° minus the space phase angle between the two vertical aerials, a cardioid is given; for intermediate values of the angle, intermediate space patterns are obtained. The need of a central open-type "course bending" aerial, such as is required for the loop aerial system, is thus obviated.

Installations of this system on the airways will employ as their vertical aerials insulated steel towers 125 ft high and spaced 500 ft. This should not only increase the field intensity but also decrease the unbalanced detuning found with the experimental model (using wooden supporting masts) as a result of wet weather: the maximum effect of such detuning, over several months, was about 5°. The first part of the paper deals with the night effects obtained with the old loop-aerial equi-signal system, and includes a short theoretical analysis of the phenomenon.

RADIO GUIDANCE [for Aircraft, using Two Rotating Beacons transmitting Simultaneously on Same Frequency: Position of Craft shown by Intersecting Light Beams thrown on Under Surface of Map].—J. E. Miller. (*Proc. Inst. Rad. Eng.*, Nov., 1932, Vol. 20, pp. 1752–1762.)

BLIND LANDING [A Survey].—M. H. Gloeckner. (*Zeitschr. f. Flugtechnik u. Motorluftschiffahrt*, 24th June, 1932, Vol. 23, No. 12, pp. 347–356.)

DIRECT-READING DIRECTION FINDER WITH CONTINUOUSLY ROTATING GONIOMETER COUPLING COIL.—M. Dieckmann and F. Berndorfer. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Dec., 1932, Vol. 40, No. 6, p. 221). *See* also 1930 Abstracts, p. 397.

DIRECTION SIGNALLING IN FOG.—A. Della Riccia. (Summary in *Rev. Gén. de l'Elec.*, 24th Dec., 1932, Vol. 32, No. 25, p. 198 D.)

Using transmitting and receiving frames each subdivided into differently oriented sections: each transmitting section emits the same wavelength but with a different note modulation.

ACOUSTICS AND AUDIO-FREQUENCIES

EXPERIMENTAL STUDY ON THE NON-LOADED CABLE USED AS A LONG-DISTANCE TELEPHONE LINE.—S. Matsumae, T. Yoshida, and N. Shinohara. (*Journ. I.E.E. Japan*, Nov., 1932, Vol. 52 [No. 11], No. 532: English summary pp. 120–121.)

The writers emphasise the necessity for adopting the non-loaded cable for important long-distance circuits, using conductors of diameter greater than 1.3 mm, reducing cross-talk due to the large level difference by segregating and shielding both conductor groups with metallised paper, inserting 3-stage repeaters of new type at 60–80 km intervals, and employing new types of equaliser. " Only the non-loaded cable will have the distinctive features [shorter travelling and transient times, etc.] for future developments from the technical point of view. The non-loaded cable can also be applied to picture transmission, trunk line for broadcasting, etc., and we will obtain a more excellent line than the present systems."

ÜBER DIE SCHALLFELDVERZERRUNGEN IN DER NÄHE VON ABSORBIERENDEN FLÄCHEN, UND IHRE BEDEUTUNG FÜR DIE RAUMAKUSTIK (The Sound Field Distortions in the Neighbourhood of Absorbing Surfaces, and Their Importance in the Acoustics of Rooms).—G. v. Békésy. (*Zeitschr. f. tech. Phys.*, No. 1, Vol. 14, 1933, pp. 6–10.)

Author's summary :—" Sound waves proceeding past an absorbing surface are strongly damped in the neighbourhood of that surface, so that a sound field is formed whose strength increases with the height above the surface. In this way, also, the sound in a theatre, proceeding from the stage and from the orchestra (as a rule) below it, is strongly damped in its passage over the audience seated in the parterre, so that the quick building-up processes in speech and music, which are present only in the direct sound field, are blotted out [for the audience in the back rows] by reverberation effects. [This explains the inferiority in quality, without lack of intensity, in these positions compared with the equally distant upper circle and gallery]. To avoid this, care should be taken that a large part of the sound waves should reach the audience as much as possible from above." Experimental tests on water waves and sound waves are described. Fig. 8 shows the weakening of the direct sound field reaching a member of the audience, caused by the presence of his neighbour in front : the weakening is at a maximum around 800 c/s.

A THEORETICAL STUDY ON THE ARTICULATION AND OPTIMUM REVERBERATION IN AUDITORIUMS : AGAIN ON THE OPTIMUM REVERBERATION OF AUDITORIUMS.—A. Hirayama. (*Journ. I.E.E. Japan*, Aug., 1932, Vol. 52 [No. 8], No. 529 : English summaries pp. 90 and 91–92.)

The first paper leads to the theoretical result that, assuming the optimum audition to be obtained when the reverberation is as great as possible provided that the degree of intelligibility of speech (or music) is kept at 100%, the following formulae are valid :— $T_{opt.} = 0.24\,H$ (in metric system) and $P_{opt.} = \text{const.} \times F$, where $T_{opt.}$ is the optimum reverberation time (no audience) for both speech and music (the numerical factor is 0.212 for speech only and 0.268 for music only), H is the mean room height above the audience seats, $P_{opt.}$ is the optimum mean power of the source, and F is the seating area occupied by the audience.

In the second paper the writer applies these theoretical results to 18 famous auditoriums in England, Germany and America. In a few cases (including the Æolian Hall, London, and the Leipzig Conservatorium) the reverberation time varies with the number of the audience according to the equation for the " ideal " auditorium,

$$T_{opt.} = \{0.432 - 0.152(n/N)\}\,.\,V/N,$$

where N is the number of seats and n the number of the audience.

STUDIES ON THE ROOM ACOUSTICS, PART I. ERRATA. —Hirayama. (*Journ. I.E.E. Japan*, Oct., 1932, Vol. 52 [No. 10], No. 531, p. 114.)

Correction to the paper referred to in 1932 Abstracts, p. 647.

ACOUSTIC FEATURES OF WCAU'S NEW STUDIOS [Philadelphia].—(*Electronics*, Dec., 1932, pp. 358–360.)

" ' Live and dead end ' construction : soundproofing of floating walls, floors and ceilings : Dr. Stokowski's private sound laboratory : air-conditioning, and structural novelties." From one-half to two-thirds of each studio, according to its size, is lined with sound-absorbing material to form a " dead end " where the microphones will be placed to receive the programme from the " live end," whose walls are finished with a hard, reflecting material. The two largest studios have zig-zagging walls to give smoother distribution and freedom from interference. " Velocity " microphones are another feature (ribbon microphones—*see* February Abstracts, p. 103, two).

SUR UNE NOUVELLE METHODE DE CONSTRUCTION D'UN RÉFLECTEUR DE SON, DONNANT DES ONDES CYLINDRIQUES (A New Method of Construction of a Sound Reflector giving Cylindrical Waves [for Public Address Purposes]).—A. Mulder. (*Physica*, No. 9/10, Vol. 12, 1932, pp. 311–315 : in French.)

DAS RICHTUNGSEMPFINDEN BEI TÖNEN UND KLÄNGEN (Perception of the Direction of Notes and Musical Sounds).—M. Reich and H. Behrens. (*Zeitschr. f. tech. Phys.*, No. 1, Vol. 14, 1933, pp. 1–6.)

The accuracy with which we can detect the direction of the source of a sound depends very largely on its nature : thus it is extremely difficult to judge the position of a chirping cricket or the direction of a whistle or foghorn, or of pure notes in general ; whereas a " bang " is easily located. A sudden start to the sound wave renders the perception of its direction sharper and more reliable, while a sound increasing gradually from near inaudibility is very difficult to locate. For compound notes and various musical sounds the perception of direction varies in accuracy. The present paper investigates experimentally the dependence of this accuracy on the wave form of the sound ; pure notes of frequency 50 to 1 600 c/s, a mixture of two pure notes with random phasing, and a mixture of two pure notes with adjustable phasing, being examined in turn. The arrangement was such that the sound wave reached the two ears of the observer with a known adjustable time difference.

The following results were obtained :—(1) The perception of direction is governed by those points on the wave-form curve where the pressure changes occur most rapidly. The greater the rate of change of pressure, the sharper and more accurate is the sense of direction. Deep notes, with their more gradual rise in pressure, are more difficult to locate than high notes: superposition of one frequency on another yields wave forms with more sudden rises than those given by the single notes, and the higher the superimposed note the better is the judgment of direction (but *see* below). This judgment also improves with increasing intensity, within certain limits.

(2) The shorter the time difference between the stimuli to the two ears, the more reliable is the direction given by their combination. (3) With time differences greater than 6×10^{-4} sec., a direction indication is only obtained if first suggested by a smaller time difference which then increases to the large value. (4) The indication is more unreliable and less sharp if, as a result of the repeating wave form, several combination possibilities exist inside the 6×10^{-4} sec. With notes below 800 c/s only one combination is possible within that time, and the sense of direction is comparatively good. With 800 c/s and a path difference of 21 cm a second combination is possible; with 1 600 c/s and zero path difference three combinations may occur, and the direction judgment is very unreliable; with increasing frequency the combination possibilities increase and the judgment becomes more and more unreliable, until for high "chirps" no true sense of direction exists. In the presence of many combinations the observer as a rule picks out either the one with shortest time difference or one indicated by "experience" (chiefly deduced from the instant of arrival of the sound). (5) A pressure increase at one ear may combine with a pressure decrease at the other to give a false sense of direction (for very small time differences) or spoil the sharpness of indication (for larger time differences; these "parasitic combinations" do not occur if the wave form has a sharp rise and gentle fall (Figs. 1a and b), so that such wave forms give a sharper indication than the symmetrical curves (Figs. 1c and d).

BINAURAL SOUND-LOCATORS.—E. T. Paris. (*Science Progress*, Jan., 1933, Vol. 27, No. 107, pp. 457–469.)

RADIO ACOUSTIC SOUND RANGING.—G. T. Rude. (*Hydrographic Rev.*, Nov., 1932, Vol. 9, No. 2, pp. 71–72.)

ECHO SOUNDING. XI.—RECENT FORMS OF THE BRITISH ADMIRALTY ECHO SOUNDER.—(*Ibid.*, pp. 135–144.)

NOTE CONCERNING A DIRECT READING ELECTRICAL CHRONOGRAPH FOR ACCURATE READING OF VERY SHORT INTERVALS OF TIME [for Echo Sounding].—Dubois and Laboureur. (*Ibid.*, pp. 234–235.) *See* also 1932 Abstracts, p. 416.

DETERMINATION OF VELOCITY OF SOUND IN SEA WATER IN CAPE COD BAY.—G. D. Cowie: T. B. Reed. (*Ibid.*, pp. 251–253.)

CORRECTIONS APPLIED TO ECHO SOUNDINGS.—(*Ibid.*, pp. 254–255.)

EXPERIMENTELLE UNTERSUCHUNGEN ÜBER DIE PIEZOELEKTRISCHEN UND DIELEKTRISCHEN EIGENSCHAFTEN DES SEIGNETTESALZES (Experimental Investigations on the Piezoelectric and Dielectric Properties of Rochelle Salt [and the Design of a Piezoelectric Microphone]).—E. Schwartz. (*E.N.T.*, Dec., 1932, Vol. 9, pp. 481–495.)

Author's summary:—(1) Methods of forming and preparing Rochelle salt crystals are given. (2) The piezoelectric properties of the salt are influenced by its dielectric anomalies: consistent measurements by two different methods can be obtained if care is taken to render them independent of the dielectric properties. (3) Pressure and piezoelectric charge are not proportional. The variation with temperature of the piezoelectric modulus is determined.

(4) The dielectric constant depends on the field strength and on the charging time. It first increases with the field strength to a maximum and then descends, the dielectric constants represented by the descending part of the curve being independent of charging time. The variation with temperature of the dielectric constant is determined, including its behaviour for weak fields and short charging times [Fig. 15 shows the very different temperature characteristics for strong fields with long charging times (curve *a*) and weak fields with short charging times (curve *b*, 10 v and 500 c/s)]. The dielectric constant measured piezoelectrically shows a temperature characteristic similar to that for short charging times.

(5) The dielectric constant perpendicular to the *a* axis is influenced by mechanical pressure, becoming smaller with increase of pressure [but there is evidence suggesting a rise at very high pressures]. (6) The dielectric constant perpendicular to the *c* axis has a normal value [smaller than that perpendicular to the *a* axis]. (7) A formula is given for the dependence of the dielectric charge density on the charging time [$(E - E_q)/\dot{q}$ = const., where E is the field strength given by the charging battery and forming the horizontal axis for the curve in Fig. 14, $\dot{q}$ is the slope of this curve at the point q, and E_q is the field strength which the charge density at q can produce in the limiting case]. (8) Experiments in constructing a piezoelectric microphone are reported on [the ideal design, from the acoustical point of view, has the crystal hung from a spring suspension and carrying two electrodes connected by thin wires to the input of a resistance amplifier: this arrangement, however, is comparatively insensitive, requires an amplification of about 10^4, and leads to howling owing to the grid of the first valve being connected to an uncovered electrode. A much more sensitive and satisfactory design (Fig. 19) is an enclosed type in which a brass plate 0.8 mm thick covers the sound box (from which it is insulated by a soft washer) and conducts the sound to the crystal. Whispers at 4 metres can be well heard with a 4-stage resistance amplifier, and reproduction quality is faultless].

ELECTRICAL PICK-UP REQUIRING NO AMPLIFICATION [embodying Plate-and-Grain Microphone].—E. Belin. (Summary of French Patent in *Rev. Gén. de l'Élec.*, 31st Dec., 1932, Vol. 52, No. 26, pp. 207–208 D.)

AMPLIFICATORE MICROFONICO CON REGOLAZIONE AUTOMATICA DI VOLUME (A Microphone Amplifier with Automatic Volume Control [using a Screen-Grid Variable-Mu Valve and giving an Output Voltage Ratio of 15 : 1 for an Input Voltage Ratio of 1 200 : 1]).—S. Bertolotti. (*Alta Frequenza*, Sept., 1932, Vol. 1, No. 3, pp. 412–419.)

A NOTE ON THE THEORY AND PRACTICE OF TONE-CORRECTION.—Colebrook. (*See* under "Reception.")

TRENDS OF LOUD SPEAKER DESIGN AT THE PARIS RADIO EXHIBITION : COMPARISON BETWEEN MAGNETIC AND ELECTRODYNAMIC TYPES.—Adam. (*See* abstract under "Reception.")

REVERBERATION AND THE LOUD SPEAKER.—W. H. P. Sweeny. (*Wireless World*, 20th January, 1933, Vol. 32, pp. 46–48.)

Although meticulous care is given to the design of modern amplifying equipment to reduce distortion to the very minimum, the question of the mutilation of sound waves after they leave the loud speaker is often hardly considered at all. It is pointed out in this article that there are a number of causes of distortion in large rooms of poor acoustic properties, the most serious of which is insistent reflection or reverberation.

THE FIELD COIL OF M.C. LOUD SPEAKER USED AS L.F. CHOKE : REVIVAL SINCE INTRODUCTION OF HIGH TENSION (up to 500 v) RECTIFIER VALVES.—H. Olvensted. (*Die Sendung*, 23rd Dec., 1932, Vol. 9, No. 52, pp. 1130–1131.)

MATERIAL FOR EXPERIMENTAL DIAPHRAGMS [Doped Tussore Silk].—E. Simeon. (*Journ. Scient. Instr.*, Dec., 1932, pp. 392–393.)

THE SCHACKTOGRAPH [a Portable, Mains-driven Gramophone with Electrical Reproduction, giving also Broadcast Reception and Home Recording].—(*E.T.Z.*, 29th Dec., 1932, Vol. 53, No. 52, p. 1255.)

ROOM ERRORS IN LOUD SPEAKER TESTS [Need of at least Two Curves—Total and Direct Radiation : Calculation of Ratio of Reflected to Direct Sound].—E. W. Kellogg. (Summary in *Electronics*, Dec., 1932, p. 376.)

ÜBER DIE DÄMPFUNG VON SAITENGALVANOMETERN FÜR TONFILM- UND REGISTRIERZWECKE (The Damping of String Galvanometers for Sound Film and Recording Purposes).—F. Söchting : Selenophon Company. (*E.N.T.*, Dec., 1932, Vol. 9, pp. 476–480.)

In Part I the writer deals with the subject mathematically and arrives at the accurate formula (10), involving the damping, for the current sensitivity at varying frequencies. By assuming that the motion of the mid-point of the string is that of a system with concentrated mass and springing of the same natural frequency as the string, he derives the much simpler approximate formula (12). In Part II he briefly describes experiments made to check the theoretical results : the measurements showed that the sensitivity curves were in fact resonance curves of great sharpness, as given by formula (12), so that the approximations were justified. The shape of the curves also showed that it was sufficient to measure the sensitivity at one low frequency (about 50 c/s) and at the resonance point. The preference shown to notes near the resonance frequency is not without its advantages, since microphone, amplifier and the photographic processes all tend to weaken the high frequencies. But on the other hand the questions of over-control and building-up time make an increased damping necessary.

Part III deals with various methods of obtaining this necessary damping. The friction method used in the American "light valve" is said to have the disadvantage of a hysteresis effect : oil damping has other objections : various other methods were tried without complete success. Finally a satisfactory solution was found by surrounding the string, close to its fixed ends, by a cushion of soft rubber under compression. A contact surface 3 mm long was sufficient, so that the device had no bad effects. The method has been used successfully for more than a year, in connection with the Selenophon Company's work (Jan. Abstracts, p. 44, top l.h. column).

NEW LAMP FOR SOUND-RECORDING AND TELEVISION [containing Mercury Vapour, and with Grid—"Supplementary Anode"—between Filament and Anode]. (Summary of French Patent in *Electronics*, Dec., 1932, p. 378.)

The anode proper is "an opaque cone with an insulating cone between it and the filament to limit the area of luminosity."

NEW ELECTRONIC INSTRUMENT [Photoelectric Control of Neon Lamp Circuit, Hand governing Amount of Light passing through V-shaped Slit].—Saraga. (Summary in *Electronics*, Dec., 1932, p. 376.)

PITCH CONTROL FOR AN ELECTRONIC MUSICAL INSTRUMENT.—T. R. Bunting. (*Electronics*, Sept., 1932, pp. 287–289.) For corrections to typographical errors see *ibid.*, October, p. 322.

THE COUPLEUX-GIVELET ELECTRONIC ORGAN.—A. Givelet. (Summary in *Génie Civil*, 10th Dec., 1932, Vol. 101, p. 592.) *See* also 1932 Abstract, p. 413.

MAXIMALLEISTUNGEN VON VERSTÄRKERRÖHREN BEI KOMPLEXER BELASTUNG (The Maximum Power Outputs of Amplifier Valves, for Complex Loads [and the Optimum Matching Conditions]).—F. Söchting. (*Elektrot. u. Masch:bau*, 8th Jan., 1933, Vol. 51, No. 2, pp. 17–23.)

"It is a striking fact that hitherto in all calculations the load on the valve has been taken as an ohmic resistance, although the effective resistance of all loud speaker types met with to-day possesses a large reactive component which, moreover, varies greatly with frequency." This the writer attributes partly to the desire to simplify where possible a complicated problem, and partly to the fact that a valve with purely ohmic internal resistance naturally gives its best output to an ohmic load. But as such a condition is not a practical one, the following questions arise :—(1) how should an amplifier be arranged as regards impedance matching, grid and anode voltages, anode current and anode loading, in order to give optimum values for a given complex load ? and (2) how does the obtainable a.c. output vary with frequency, for a given amplifier and load, and what relation does it bear to the output obtainable with an ohmic load ? The present paper deals with these questions, on the simplifying assumption that the valve characteristics can be approximately replaced by straight lines ; the effects of the curvature of the characteristics are considered in a later section. A second assumption is that an output transformer is used, with a negligible voltage drop due to the d.c. resistance of the primary winding. The limits of modulation are taken as reached when grid potential or anode current becomes zero.

The two important cases are dealt with separately, namely where the anode battery voltage remains constant (*e.g.*, amplifiers worked off d.c. mains) and where the anode loss remains constant. For the former case the optimum relation for an ohmic resistance is $R_a = 2R_i$, as shown by Radt in 1926. The writer obtains as the matching condition for a complex load the equation

$$\cos\phi = \tfrac{1}{2}\sqrt{R_a/R_i \,.\, [\sqrt{9 + 8R_a/R_i} - 3]}$$

For the special case where $\phi = 0$ (ohmic resistance) this reduces to Radt's relation $R_a = 2R_i$, and even for $\phi = 90°$ the numerical factor 2 decreases only to $\sqrt{3}$, so that for the angles met with in practice a value of about 2 is correct. This is also shown to be true for the second case. *The maximum obtainable output in both cases is, at a first approximation, equal to or rather greater than that for an ohmic resistance.*

In amplifiers connected to loud speakers the position of this maximum output should be arranged, by correct choice of transformer ratio, to lie at a suitable (in general a rather low) point on the frequency band, so that the drop at high and low frequencies may be reasonably limited. The constancy of apparent power found above corresponds to the power limits in a.c. machines and transformers in Power Engineering, which, similarly, are set by the apparent power (kVA) and not the real power (kW) : in their case it is the heating, in the present case it is the modulation range, which is the determining factor.

The writer points out that the frequency curves of maximum output are not interchangeable with the amplification frequency curves : the determination of these latter curves, of importance for the production (and compensation) of linear distortions, was dealt with in a previous paper (1932 Abstracts, p. 351).

COSTRUZIONE E PROVE DI GENERATORI A FREQUENZA ACUSTICA (The Construction and Testing of Audio-frequency Generators [Two Beat-Note Generators covering together the Range 16–5 000 c/s and giving Constant Voltage and Almost Perfect Sine Form]).—S. Rosani. (*Alta Frequenza*, Sept., 1932, Vol. 1, No. 3, pp. 420–428.)

BEAT-FREQUENCY OSCILLATOR CONTROL : DETERMINING THE PROPER PLATE SHAPE.—G. F. Lampkin. (*Electronics*, Dec., 1932, p. 369.)

A HETERODYNE OSCILLATOR OF WIDE FREQUENCY RANGE [200 to 35 000 c/s, maintaining Same Calibrations for All Frequencies within this Range].—J. G. Kreer. (*Bell Lab. Record*, Jan., 1933, Vol. 11, No. 5, pp. 137–139.)

Specially intended for use in measuring the reflections coefficients of filters, equalisers and other networks.

A MAGNETOSTRICTION OSCILLATOR PRODUCING INTENSE AUDIBLE SOUND, AND SOME EFFECTS OBTAINED.—N. Gaines. (*Physics*, Nov., 1932, Vol. 3, No. 5, pp. 209–229.)

In the apparatus described the magnetostrictive oscillation of nickel can be pushed to the limit set by its mechanical strength. The fundamental frequency is about 8 900 c/s. Among the effects obtained under water are : interior of corks charred to a cinder : erosion of metals and glass : production of colloids of oil and of carbons : " bacteria are killed so quickly that partial sterilisation of milk in continuous process is effected."

ON THE ABSOLUTE MEASUREMENT OF SOUND INTENSITY BY THE RAYLEIGH DISC METHOD, AND THE CALIBRATION OF MICROPHONES [Advantages of the Very Small " Piezophone "].—Y. Niwa and Y. Nishimura. (*Journ. I.E.E. Japan*, Nov., 1932, Vol. 52 [No. 11], No. 532 : English summary pp. 115–116.)

After a description of the design of Rayleigh disc used by the writers, experimental results on the absolute field calibration of a m.c. microphone are discussed : the disturbance of field due to the nearness of the microphone to the disc is much more severe than generally expected. If the " piezophone " microphone (measuring only 4 × 2.5 × 0.15 cm) is used, no field correction is necessary.

ESPERIENZE SULL' ASSORBIMENTO E SULLA DIFFUSIONE DELL' ENERGIA ULTRASONORA (Experiments on the Absorption and Diffusion of Ultrasonic Energy [with aid of Radiometer]).—E. Paolini. (*Alta Frequenza*, Sept., 1932, Vol. 1, No. 3, pp. 357–375.)

The radiometer used in these researches consists essentially of a very light disc (15.4 mm in diameter) at the end of a very light rigid arm (33 mm long) suspended at a point close to the other end by a vertical silver thread, a counter-balancing weight making the arm lie horizontally. A superiority over the Rayleigh disc, as regards supersonic waves, lies in the fact that the latter device requires the disc area to be small compared with the wavelength.

A PISTONPHONE FOR THE DETERMINATION OF THE LOW-FREQUENCY RESPONSE OF THE CONDENSER MICROPHONE.—J. Obata and Y. Yosida. (*Journ. I.E.E. Japan*, Oct., 1932, Vol. 52 [No. 10], No. 531, pp. 774–775 : in Japanese, illustrated.)

ÜBER SCHALLEMPFINDLICHE FLAMMEN (Sound-Sensitive Flames).—H. Zickendraht. (*Helvet. Phys. Acta*, Fasc. 5, Vol. 5, 1932, pp. 317–335.)

A convenient design of sensitive flame is described. Such devices are shown to be acoustic "velocity" receivers, since they react to the maximum velocity of the air particles of the sound wave. They respond also to alternating electric fields. Applications to acoustic measurements are discussed, including some in the supersonic field.

IMPROVED BURNER FOR SINGING FLAMES. OVERTONES IN VIBRATING STRINGS.—J. J. Hopfield. (*Phys. Review*, 15th Dec., 1932, Series 2, Vol. 42, No. 6, p. 913.)

VIBRATIONS PRODUCED IN BODIES BY CONTACT WITH SOLID CARBON DIOXIDE [and Possible Applications.]—Mary D. Waller. (*Proc. Physical Soc.*, 1st Jan., 1933, Vol. 45, Part 1, No. 246, pp. 101–116.)

Among the applications suggested in the final section of the paper are :—the excitation of stout tuning forks (2 000 to 6 000 c/s or more) which are difficult to excite electrically : the recognition and accentuation of overtones, *e.g.* of irregularly shaped bodies—hence a possible use in discovering undesirable resonances in small pieces of machinery, plate condensers, etc. : the setting in vibration of piezoelectric crystals of audible frequency—a natural quartz crystal gave a loud maintained note just above 4 000 c/s. The method is useless for crystals of low thermal conductivity, such as Rochelle salt.

RESEARCHES AND MEASUREMENTS ON NOISE IN THE U.S.A. [including the Analyser and Its "Mechanical Filter"].—C. R. Hanna, H. B. Marvin and S. K. Wolf. (*Rev. Gén. de l'Élec.*, 24th Dec., 1932, Vol. 32, No. 25, pp. 829–830.)

DETERMINAZIONE DEI PARAMETRI ELETTROACUSTICI DI UN TELEFONO E MISURA DI IMPEDENZE ACUSTICHE (The Determination of the Electroacoustic Parameters of a Telephone Receiver, and the Measurement of Acoustic Impedance [and of the Absorption Coefficients of Materials].—G. Sacerdote and E. Gotta. (*Alta Frequenza*, Sept., 1932, Vol. 1, No. 3, pp. 331–356.)

The study of a telephone–resonator tube combination admits of the precise determination of the electroacoustic parameters of the telephone : when these are known, acoustic impedance measurements can be made by a purely electrical method which can be used for determining the absorption coefficients of sound-insulating materials. Tests are described which agree with the theory given and justify the approximations introduced.

AN IMPROVED VIBROGRAPH [for Analysis of Vibrations of Stretched Strings, Tuning Forks, etc.].—T. Tirunarayanachar. (*Review Scient. Instr.*, Dec., 1932, Vol. 3, pp. 766–776.)

The writer mentions that her application of the instrument to the vibrations of a tuning fork failed to confirm the statement of Parameswaran and Subbaraya that, contrary to the usually accepted view that a tuning fork has no overtones which are harmonics, the octave certainly, and the third also possibly, are to be found accompanying the fundamental.

ÜBER DIE AUSBREITUNG DER SCHALLWELLEN IN ANISOTROPEN DÜNNEN PLATTEN (On the Propagation of Sound Waves in Thin Anisotropic Plates).—G. v. Békésy. (*Zeitschr. f. Physik*, 1932, Vol. 79, No. 9/10, pp. 668–671.)

THE VELOCITY OF SOUND IN AN ABSORPTIVE GAS [Theoretical Investigation].—D. G. Bourgin. (*Phys. Review*, 1st Dec., 1932, Series 2, Vol. 42, No. 5, pp. 721–730.)

DISPERSION OF SOUND IN SEVERAL GASES, AND ITS RELATION TO THE FREQUENCY OF MOLECULAR COLLISIONS.—W. T. Richards and J. A. Reid. (*Nature*, 12th Nov., 1932, Vol. 130, p. 739.)

ZERSTREUUNG VON LICHT DURCH SCHALLWELLEN (Dispersion of Light caused by Sound Waves [in a Fluid]).—P. Debye. (*Physik. Zeitschr.*, 15th Nov., 1932, Vol. 33, No. 22, pp. 849–856.) *See* also 1932 Abstracts, p. 576 (Biquard and Lucas : Debye and Sears), and Lucas, under "Prop. of Waves."

EVALUATING HEARING AIDS [Determination of the "Figure of Merit" of any Device for Individual Cases of Deafness]. — Harvey Fletcher. (*Bell Lab. Record*, Jan., 1933, Vol. 11, No. 5, pp. 126–133.)

PHOTOTELEGRAPHY AND TELEVISION

SHIPS AT SEA GET WEATHER MAPS OF WHOLE OCEAN [RCA Latest Facsimile Service, using Diversity Reception and "Carbon Recorder"].—Radio Corporation of America. (*Electronics*, Dec., 1932, p. 371.)

Tested on the s.s. President Harding. Aerials fore and aft act as signal collectors for two separate superheterodyne receivers, whose outputs are combined in a common amplifier. The "carbon recorder" has a stylus which acts on a sheet of carbon paper.

SWITCHING ARRANGEMENT AT FACSIMILE RECEIVER TO ENSURE A STRONG START-STOP SIGNAL WITHOUT TOO STRONG A PICTURE SIGNAL.—Siemens & Halske. (Summary of Austrian Patent in *Elektrot. u. Masch:bau*, 18th Dec., 1932, Vol. 50, No. 51, p. 718.)

TELEVISION IMAGE RECEPTION IN AN AIRPLANE [on a 6–7 Metre Wave].—H. R. Lubcke. (*Proc. Inst. Rad. Eng.*, Nov., 1932, Vol. 20, pp. 1732–1740.)

Covering the same ground as the paper referred to in February Abstracts, p. 108. "Continuous variation of signal strength was observed [when travelling at 120 m.p.h.] occasioned by changing shadows cast by the plane on its antenna, changing pick-up of the polarised wave because of variation of the receiver antenna angle with respect to the oncoming wave, and change of absolute field strength because of the speed of travel through the transmitter field strength pattern," but after a few minutes' experience it was possible to keep a tolerably good image on the screen by adjusting the volume control.

DER PHONOVISOGRAPH (The Phonovisograph [for Simultaneous Disc Recording of Sound and Television]).—R. Wollmann. (*Radio, B., F. f. Alle*, Jan., 1933, pp. 11–14.)

TELEVISION BY CINEMATOGRAPHY FOLLOWED BY SCANNING AND RECORDING ON GRAMOPHONE DISC.—Telehor Company. (Summary of Austrian Patent in *Elektrot. u. Masch:bau*, 18th Dec., 1932, Vol. 50, No. 51, p. 718.)

IMAGES IN COLOUR: SUGGESTED METHOD USING THREE-SECTOR COLOURED DISC ROTATING AT ONE-THIRD SPEED OF MIRROR DRUM.—G. R. Williams. (*Television*, Jan., 1933, Vol. 6, No. 59, p. 25.)

HAND SYNCHRONISATION: A DRIVING DEVICE TO ABOLISH THE HUNTING BETWEEN PERCEPTION AND CORRECTION OF FAULTY SYNCHRONISATION.—P. F. Carmichael. (*Television*, Nov., 1932, Vol. 5, No. 57, p. 345.)

CATHODE-RAY TUBE CONTAINING TWO INDEPENDENT SYSTEMS.—Schlesinger: Loewe Company. (*Television*, Jan., 1933, Vol. 6, No. 59, p. 12.)

A cathode-ray tube has been developed with two independent systems, each ray being focussed "with practically optical exactitude" by turning a single knob: at present it is used in a cathode-ray oscillograph (*cf.* Knoll, February Abstracts, p. 111), "but its use for coloured television would be simple."

REMARKS ON W. HEIMANN'S PAPER "THE SENSITIVITY OF THE BRAUN [Cathode-Ray] TUBE WITH GAS CONCENTRATION, AT VARIOUS FREQUENCIES."—von Ardenne: Heimann. (*See* under "Subsidiary Apparatus and Materials.")

CATHODE-RAY TELEVISION IN WHICH THE RAY RE-SETS ITSELF AT END OF LINE AND END OF PICTURE BY ACTION ON AUXILIARY ELECTRODES ON FLUORESCENT SCREEN.—Telefunken Company. (Summary of Austrian Patent in *Elektrot. u. Masch:bau*, 18th. Dec., 1932, Vol. 50, No. 51, pp. 718–719.)

NON-LOADED CABLE FOR PICTURE TRANSMISSION, ETC.—Matsumae, Yoshida, and Shinohara. (*See* abstract under "Acoustics and Audio-frequencies.")

WHITE LIGHT FOR TELEVISION [a New Mercury Lamp excited by Electrodeless Discharge].—A. P. Peck: E. B. Myers. (*Television*, Jan., 1933, Vol. 6, No. 59, pp. 15–16.)

It is said that the Myers Lamp has been tested for frequency response up to nearly 400 kc/s without showing the slightest sign of inertia. It is intended especially for large television reproducers. In the demonstration, the ground glass screen about 26″ square had in front of it, on the side of the "audience," a large plano-convex water lens which made the pictures appear to have "depth." Two sizes of lamp are illustrated, one giving 3 000 c.p. and the other (10″ long) a quarter of a million c.p. Apparently the glass tube enclosing the mercury must be of a definite shape so that the electrons freed by the breaking-up of the mercury atoms may follow chosen paths aud certain "waves of ionisation" may take place unrestricted. "The inventor . . . believes that about 20 electrons are dissociated from the mercury atom at certain levels of mercury ionisation."

PLANO-CONVEX WATER LENS IN FRONT OF TELEVISION SCREEN TO GIVE "DEPTH" TO THE IMAGE.—Myers. (*See* above abstract.)

NEW LAMP FOR SOUND-RECORDING AND TELEVISION [containing Mercury Vapour, and with Grid—"Supplementary Anode"—between Filament and Anode].—(Summary of French Patent in *Electronics*, Dec., 1932, p. 378.)

The anode proper is "an opaque cone with an insulating cone between it and the filament to limit the area of luminosity."

DESIGN FOR PROJECTION APPARATUS [using the Crater Type Neon Lamp].—Mervyn Sound and Vision Company. (*Television*, Jan., 1932, Vol. 6, No. 59, pp. 22–24). *See* also February Abstracts, p. 106.

DIE LICHTEMISSION BEI GASENTLADUNGEN INSBESONDERE VON RESONANZLINIEN (Light Emission from Gas Discharges, especially from Resonance Lines [Theoretical and Experimental Treatment of Neon Sodium Vapour Lamp, etc.]).—W. de Groot. (*Physica*, No. 9/10, Vol. 12, 1932, pp. 289–310: in German.)

ACTION D'UN CHAMP MAGNÉTIQUE SUR UNE CELLULE PHOTOÉLECTRIQUE À REMPLISSAGE GAZEUX (The Effect of a Magnetic Field on a Gas-Filled Photoelectric Cell [and the Influence of the Positive Ions on the Slow Response Effect]).—P. Fourmarier. (*Comptes Rendus*, 27th Dec., 1932, Vol. 195, No. 26, pp. 1387–1389.)

The effect of a magnetic field perpendicular to the electron flow in a photoelectric cell is to reduce the photoelectric current. The Note describes some experiments on this effect in the case of various gas-filled cells, both for constant and sudden illumination. The results seem to corroborate the writer's hypothesis (1932 Abstracts, p. 648) as to the influence of positive ions on the slow response effect in photoelectric cells.

These ions, being of small velocity, are eminently sensitive to the magnetic field, while the effect of the field on the electrons diminishes as the voltage (and hence their velocity) increases. The curve shows that the ratio of the ionisation current due to the electrons, when the magnetic field is present, to the current when it is not present, increases steadily with the voltage up to a maximum and then decreases: the decrease after a certain voltage has been reached indicates the intervention, in the ionisation, of elements particularly sensitive to the magnetic field—*i.e.*, the positive ions. This is confirmed by the less marked effect of the field on cells filled with helium, whose positive ions have much greater velocities than those of neon and argon.

On the other hand, the current component which decreases on the application of the magnetic field is the component which produces the slow response effect. Thus it would seem to be established that this effect is due to the positive ions.

CONTRIBUTION À L'ÉTUDE DES CELLULES PHOTOÉLECTRIQUES À ATMOSPHÈRE GAZEUSE (Contribution to the Study of Gas-Filled Photoelectric Cells).—G. A. Boutry. (*Journ. de Phys. et le Rad.*, Nov., 1932, Vol. 3, pp. 520–536.)

For *Comptes Rendus* Notes on this work *see* 1931 Abstracts, p. 275 (two) and 446.

PHOTOELECTRIC CELL REPLACED BY DISCHARGE TUBE CONTAINING ATOMS IN METASTABLE STATE [Neon with Argon Admixture, using Neon Light Scanning].—Philips Company. (Summary of Austrian Patent in *Elektrot. u. Masch:bau*, 18th Dec., 1932, Vol. 50, No. 51, p. 719.)

PROCÉDÉS MODERNES DE FABRICATION DES CELLULES PHOTOÉLECTRIQUES (Modern Methods of Manufacturing Photoelectric Cells. Part I).—G. Déjardin. (*Rev. Gén. de l'Elec.*, 7th Jan., 1932, Vol. 33, No. 1, pp. 3–13.)

Including cells with a very thin window for passing ultra-violet rays, high-current cells (Dunoyer), annular and "collapsed sphere" cells (Kunz and Shelford, Abstracts, 1930, p. 284), Dewar cylinder cell with 1 200 cm² cathode surface (Fleischer, 1932, p. 292), 30 cm pyrex cylinder cell with coaxial cavity, cells with anodes in form of grid, and cells with anxiliary electrodes (especially the Toulon cell with secondary emission—1931, p. 161).

RECENT IMPROVEMENTS IN PHOTOELECTRIC CELLS.—N. R. Campbell. (*Journ. Scient. Instr.*, Dec., 1932, Vol. 9, pp. 369–373.)

Dealing first with nomenclature, the writer classifies as "emission" cells those which use the Hallwachs effect; as "conductive" cells those based on the photo-conductive effect of selenium or tellurium, or both; and as "rectifier" cells those which depend on a "sperrschicht" (barrier layer) action, including cells making use of selenium as a barrier layer. He then deals with these three types in turn, and discusses their particular suitability for various purposes.

CHROM-SELENIUM PHOTOCELLS.—C. G. Fink and D. K. Alpern. (Summary in *Electronics*, Dec., 1932, p. 378.)

"Chrom-selenium films obtained by electrodeposition are more uniform and stable than selenium plates." The sensitivity is from 150 (commercial) to 500 (laboratory type) μA/lumen, as against 500 for the cuprous oxide reverse (posterior wall) cell, 5 000 for the Schottky cuprous oxide obverse (anterior wall) cell, and 300 for the selenium obverse cell.

NOTE ON RATING OF PHOTOELECTRIC TUBES [and the Effect of the Temperature of the Light Source].—L. R. Koller. (*Review Scient. Instr.*, Dec., 1932, Vol. 3, pp. 760–761.)

SENSIBILITÉ DANS LE SPECTRE DES PILES À ÉLECTRODES DE CUIVRE RECOUVERTES DE SOUS-OXYDE DE CUIVRE (Sensitivity, along the Spectrum, of Photovoltaic Cells with Copper Electrodes covered with Sub-Oxide of Copper).—G. Athanasiu. (*Comptes Rendus*, 7th Nov., 1932, Vol. 195, pp. 767–769.)

PHOTOCELLS FROM RECTIFIER DISCS [Development of Grondahl-Geiger, Lange, and Schottky Cells: Description of Cell made from Standard Rectifier Disc].—E. D. Wilson. (*Electronics*, Oct., 1932, pp. 312–313 and 324.)

RADIO TUBES USED AS PHOTOCELLS [Ordinary Receiving Valves used as Photocells by leaving Grid "floating" and adjusting Cathode and Anode Potentials].—W. P. Koechel. (*Electronics*, Dec., 1932, pp. 372–373.)

A NEW USE FOR OLD VALVES [as Photoelectric Cells, through Action of Magnesium Deposit].—D. B. McCarthy. (*Television*, Nov., 1932, Vol. 5, No. 57, pp. 337 and 336.)

PHOTOELECTRIC EMISSION FROM DIFFERENT METALS.—H. C. Rentschler, D. E. Henry and K. O. Smith. (*Review Scient. Instr.*, Dec., 1932, Vol. 3, pp. 794–802.)

An abstract of this paper was referred to in 1932 Abstracts, p. 649. The method described by Rentschler for the making of his ultra-violet-sensitive uranium cell (1931 Abstracts, p. 161), when applied to any metal which can be made in wire form, yields cells with characteristic curves which are exceedingly uniform for the same metal: the method seems to give metal surfaces capable of giving the true photoelectric effect of the metal under test.

Among the results of such tests, described in the present paper, are the following: the values of the photoelectric work function for tungsten and tantalum agree with the value of the thermionic work function for those metals; for solid thorium, uranium, zirconium and calcium the photoelectric work functions are higher than the thermionic work functions reported for monomolecular layers of these metals on tungsten, apparently supporting the theory that the thermionic emission of such a thin layer is higher than for the solid metal. The photoelectric data for barium and for materials present in oxide-coated cathodes indicate that the activated oxide-coated cathodes contain something which has a lower work function than that of pure barium.

Bemerkung zu F. Waibel, Über die Natur der Spontanströme bei Belichtung verschiedener Detektorsubstanzen (Remark on the Paper by F. Waibel, On the Nature of the Spontaneous Current given by Illumination of Various Detector Materials).—E. Rupp. (*Zeitschr. f. Physik*, 1932, Vol. 79, No. 7/8, p. 562.)

For reference to the paper in question see January Abstracts, p. 47. Rupp here denies that he has observed a barrier-layer photoelectric effect in lead sulphide.

Optische und lichtelektrische Untersuchungen an dünnen Metallschichten (Optical and Photoelectrical Investigations of Thin Metallic Films). — R. Schulze. (*Physik. Zeitschr.*, 1st Jan., 1933, Vol. 34, No. 1, pp. 24–38.)

This paper first considers the theory of optical phenomena of thin metallic films and the emission of photoelectrons therefrom. A full description is given of the preparation of unsupported films of thickness as small as 10 mμ; the final attenuation was attained by cathode spraying. Refractive index and index of attenuation were found to be constant for any one wavelength down to film thicknesses of 2 mμ, and the values obtained agreed closely with those of previous experimenters. Photoelectric measurements are described which gave for the absorption coefficient β and the mean free path λ of the photoelectrons from gold the values $\beta = 0.32\ \text{m}\mu^{-1}$, $\lambda = 3.12 \times 10^{-7}$ cm.

Supported films were also produced under different conditions, and it was found that the further the supporting film was from the source of metallic vapour producing the film on it, the greater was the tendency to a granular structure and production of the Tyndall effect. A comprehensive list of literature references is given.

The Theory of the Crystal-Photoeffect.—H. Teichmann. (*Proc. Roy. Soc.*, Jan., 1933, Vol. 139, No. A 837, pp. 105–112.)

This theoretical paper shows that " the existence of a difference in the electron-concentration between different parts of the crystal, in connection with the quantum-mechanical model of a semi-conductor developed by A. H. Wilson (1932 Abstracts, p. 108), postulates the existence of the crystal-photoeffect and gives a satisfactory explanation of the experimental facts."

Photoelectric Quantum Counters for Visible and Ultra-Violet Light: Part I.—G. L. Locher. (*Phys. Review*, 15th Nov., 1932, Series 2, Vol. 42, No. 4, pp. 525–546.)

On the Confirmation of the Existence of a New Photoelectric Phenomenon [Effect of Intermittent Illumination on Thin Platinum Films on Glass].—Q. Majorana. (*Comptes Rendus*, 19th Dec., 1932, Vol. 195, No. 25, pp. 1258–1260.)

Further development of the researches referred to in 1932 Abstracts, p. 592. The belief that the increase of electrical resistance produced by the illumination is due, at any rate partly, to a direct action and not merely to a heating effect, is confirmed. For a paper on these experiments, in which several different metals were used, see *Physikalische Zeitschrift*, 1st December, 1932, Vol. 33, No. 23, pp. 947–952.

Theory of the Energy Distribution of Photoelectrons.—L. A. Du Bridge. (*Phys. Review*, 15th Dec., 1932, Series 2, Vol. 42, No. 6, p. 905.)

MEASUREMENTS AND STANDARDS

Recording Field Strength: Equipment used by the B.B.C. for Automatic Measurement [for U.I.R. Night Fading Observations].—C. H. Smith. (*Wireless Engineer*, Jan., 1933, Vol. 10, No. 112, pp. 14–18.)

Generating High Frequencies with Precision: A Precise Radio-Frequency Generator [of Great Stability, Variable in Very Small Frequency Increments].—R. A. Heising: H. J. Scott. (*Bell Lab. Record*, Dec., 1932, Vol. 11, No. 4, pp. 100–101: 102–108.)

The first paper discusses the need for, and the principle of, the generator described in detail in the second. " If a million cycles, from the fixed quartz oscillator, were modulated with 3 456 cycles from the variable oscillator, the desired frequency [1 003 456 c/s] would be present in the output of the modulation. Both the carrier and the difference frequency would also be present, however, and would be separated from the desired frequency by much less than 1%. Filters cannot be built with sufficiently sharp cut-offs to make the desired selection.

" The desired frequency is therefore built up by two summing steps instead of one. In the first step, 50 000 cycles is modulated with 3 456 cycles. The 53 456-cycle component of the output is distant from the carrier by more than 6%, and can readily be isolated by a filter. It is then made to modulate 950 000 cycles, and the sum-frequency, being more than 5% distant from the carrier, is again readily isolated. The availability of any frequency between 800 and 1 200 kc is brought about by providing many fixed frequencies through harmonic generators all ultimately controlled by a single million-cycle source. . . . " The apparatus has been particularly useful in the study of the characteristics of quartz-plate filters, and similar work.

Valve Oscillator with Retroaction through a Rod-Shaped Conductor set in Longitudinal Vibration by Electrostatic Attraction.—W. Runge. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Dec., 1932, Vol. 40, No. 6, p. 221.)

A Precision Tuning Fork Frequency Standard [including the use of Maginvar].—E. Norrman. (*Proc. Inst. Rad. Eng.*, Nov., 1932, Vol. 20, pp. 1715–1731.)

Two audio-frequency standards employing forks of maginvar (an alloy developed by the G.E.C.), and one employing a steel fork, were checked against each other by apparatus allowing a continuous and simultaneous test of all three forks. The temperature coefficient of the two alloy forks is about + 15 parts in a million, while for steel forks the coefficient is about 100 parts in a million. "Suitable circuits and requirements for high precision and constancy of output are outlined. One of the frequency standards, and a method of obtaining a high power output, are described."

MODES OF VIBRATION OF PIEZOELECTRIC CRYSTALS.—N. H. Williams. (*Phys. Review*, 15th Dec., 1932, Series 2, Vol. 42, No. 6, p. 913.)

ISOTHERMAL AND ADIABATIC MODULI OF ELASTICITY OF QUARTZ CRYSTALS.—R. de Mandrot. (*Helvet. Phys. Acta*, Fasc. 5, Vol. 5, 1932, pp. 362–368.)

THE MEASUREMENT OF THE PIEZOELECTRIC DEFORMATIONS OF QUARTZ AND TOURMALIN PLATES BY MEANS OF A MODIFIED OPTICAL LEVER.—G. A. Fink. (*Phys. Review*, 15th Dec., 1932, Series 2, Vol. 42, No. 6, pp. 912–913.)

EXPERIMENTAL INVESTIGATIONS ON THE PIEZOELECTRIC AND DIELECTRIC PROPERTIES OF ROCHELLE SALT.—Schwartz. (*See* under "Acoustics and Audio-frequencies.")

TEMPERATURE VARIATION OF VISCOSITY AND OF THE PIEZOELECTRIC CONSTANT OF QUARTZ.—R. S. Van Dyke. (*Phys. Review*, 15th Nov., 1932, Series 2, Vol. 42, No. 4, p. 587.)

METHOD OF ALTERING THE FREQUENCY OF A PIEZOELECTRIC CRYSTAL BETWEEN FIXED ELECTRODES WITH AIR GAP, BY VARYING THE PRESSURE OF THE SURROUNDING MEDIUM.—Radio Corporation of America. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Nov., 1932, Vol. 40, No. 5, p. 183.) *See* Fig. 13.

SINGLE FREQUENCY PIEZOELECTRIC PLATE HAVING THE VARIOUS DIAMETERS PROPORTIONAL TO THE SQUARE ROOT OF THE MODULUS OF ELASTICITY IN THE CORRESPONDING DIRECTION.—Straubel. (Summary of German Patent in *Hochf:tech. u. Elek:akus.*, Nov., 1932, Vol. 40, No. 5, p. 183.) *See* 1931 Abstracts, p. 568.

PIEZOELECTRIC CONTROL OF OSCILLATOR FREQUENCY [Circuit giving Correctly Phased Grid Potential, with Exciting Potential displaced 90° with respect to Anode Potential].—Schäffer, Lubszynski and Hoffmann. (Summary of German Patent in *Hochf:tech u. Elek:akus.*, Nov., 1932, Vol. 40, No. 5, p. 183.) *See* Fig. 14.

LOW-FREQUENCY MECHANICAL STIMULATION OF PIEZOELECTRIC CRYSTAL TO GIVE HIGH-FREQUENCY OSCILLATIONS OF NATURAL FREQUENCY OF CRYSTAL.—Loewe. (*Ibid.*, p. 183.) *See* Fig. 15.

CRYSTAL CONTROL APPLIED TO THE DYNATRON OSCILLATOR.—MacKinnon. (*See* under "Transmission.")

GRID/FILAMENT CONNECTION OF QUARTZ, IN PIERCE OSCILLATOR CIRCUIT, SUPERIOR TO GRID/PLATE OR PLATE/FILAMENT CONNECTION.—MacKinnon. (*Ibid.*)

THEORETICAL INVESTIGATION ON CURRENTS THROUGH THE BRIDGE AND THROUGH THE ENDS OF A LECHER WIRE SYSTEM [and the Occurrence of Single and Double Humps].—H. Ataka. (*Journ. I.E.E. Japan*, Oct., 1932, Vol. 52 [No. 10], No. 531: English summary, pp. 111–112.)

See also Mohammed and Kantebet, 1932 Abstracts, p. 175, and back reference (Takagishi).

COMBINING THE FREQUENCY METER AND MONITOR: ADDING AN OUTPUT DETECTOR TO THE ELECTRON-COUPLED FREQUENCY METER.—C. J. Houldson: Schnell. (*QST*, Jan., 1933, Vol. 17, pp. 27–30.) *See* also Schnell, *ibid.*, pp. 30–31.

A FREQUENCY MONITORING UNIT FOR BROADCAST STATIONS [Western Electric No. 1-A Unit].—Coram. (*See* under "Stations, Design and Operation.")

DIE ALLSEITIGE FELDVERTEILUNG IN ZWEI KREISZYLINDRISCHEN, KONAXIAL GESCHICHTETEN STOFFEN BEI AXIALER RICHTUNG DES WECHSELSTROMES (The Complete Field Distribution in a Cylindrical Conductor of Circular Cross Section composed of an Inner Conductor of One Material and an Outer Sheath of Another, for an Alternating Current in an Axial Direction).—J. Fischer. (*Hochf:tech. u. Elek:akus.*, Dec., 1932, Vol. 40, No. 6, pp. 207–214.)

Among the applications of the results of this theoretical investigation of the electric and magnetic fields are the cases of (*a*) a conducting tube with a non-conducting core, (*b*) a solid conducting cylinder with a non-conducting sheath, (*c*) a conducting tube with a differently conducting core (silvered copper wire, coppered aerial wire), (*d*) Krarup cable, and (*e*) a circular-plate condenser, with and without losses.

METHODS FOR MEASUREMENT OF HIGH RESISTANCE AT HIGH FREQUENCY.—P. B. Taylor. (*Proc. Inst. Rad. Eng.*, Nov., 1932, Vol. 20, pp. 1802–1805: Discussion, pp. 1805–1806.)

"Particularly adapted to high resistances, say from a thousand ohms to a megohm, a range for which other methods fail," and suitable for frequencies at least up to 10 mc/s. Three voltmeter readings are taken, namely V, with the circuit containing only C and L, the latter being an inductance in which an e.m.f. of constant amplitude is induced by a loose coupling: the voltmeter is always across the condenser C; V_R, same as before except that a known resistance R, of the order of one ohm, is switched in series with L; and V_G, with the unknown resistance G paralleling the condenser and the voltmeter, and R short circuited. Slight retuning of C may be necessary if R and G are not entirely free from reactance. G is given by

$$G = \omega^2 C^2 R \,.\, V_R/V_G \,.\, (V - V_G)/(V - V_R).$$

In Swedlund's modification R is made variable and is adjusted till $V_R = V_G$ exactly: or two separate values of R are used, each making V_R very nearly equal to V_G. By this method the voltmeter need not be calibrated and no reading V is necessary.

THE EFFECT OF DISPLACEMENT CURRENTS ON THE HIGH-FREQUENCY RESISTANCE OF CIRCULAR SINGLE-LAYER COILS.—A. J. Palermo. (*Proc. Inst. Rad. Eng.*, Nov., 1932, Vol. 20, pp. 1807–1810.)

Author's summary:—In existing theoretical formulae for obtaining the high-frequency resistance of circular single-layer coils, the effect of displacement currents has been neglected. It was thought that the displacement currents, in going from one turn of the coil to another through the dielectric, would affect the distribution of current over the cross section of the conductor and, consequently, the effective resistance at high frequencies. The present paper shows that this effect is of minor importance by applying, for the first time, the similitude principle to circular single-layer coils. The paper also experimentally substantiates the results predicted by the similitude principle.

A NEW ABAC FOR SINGLE-LAYER COILS.—H. Seki. (*Wireless Engineer*, Jan., 1933, Vol. 10, No. 112, pp. 12–13.)

THE USE OF VACUUM TUBE ELECTROMETERS FOR MEASURING THE POTENTIALS OF HIGH-RESISTANCE CELLS.—R. E. Burroughs and J. E. Ferguson. (*Phys. Review*, 15th Dec., 1932, Series 2, Vol. 42, No. 6, p. 913.)

NEW TYPE OF ELECTROSTATIC VOLTMETER [suitable for measuring Potential Gradients and High Electrostatic and R. F. Voltages].—G. S. Field. (*National Research Council, Canada, 14th Annual Report*, 1930–1931, pp. 44–45.)

"When a piece of material having a comparatively high dielectric constant is placed in a medium having a lower dielectric constant and in which there exists a potential gradient, the piece of immersed material will tend to set itself so that its longest axis is parallel to the lines of electric force. By suspending an elongated piece of metal in air, for example, it is possible to measure the potential gradient existing in the air, by measuring the amount of rotation of the metal." Experimental results are given.

CORRECTION OF FREQUENCY ERROR IN MOVING IRON VOLTMETERS [Graphical Demonstration of Solution].—D. C. Gall: R. O. Carter. (*Journ. Scient. Instr.*, Nov., 1932, Vol. 9, pp. 361–362.) *See* Jan. Abstracts, p. 50.

A ROTARY VOLTMETER [Electrostatic Generator Voltmeter drawing No Current and giving High Accuracy from 1 Volt to 110 Kilovolts].—P. Kirkpatrick. (*Elec. Engineering*, Dec., 1932, Vol. 51, pp. 863–865.) *See* also January Abstracts, p. 50.

SUBSIDIARY APPARATUS AND MATERIALS

A METHOD OF EXTENDING THE FREQUENCY RANGE OF THE CATHODE RAY TUBE.—H. Hartridge. (*Nature*, 21st Jan., 1933, Vol. 131, pp. 95–96.)

The method described in this letter accomplishes the concentration of the light from the fluorescent screen by means of a long-focus collimation lens in conjunction with a short-focus cinema lens of large aperture. This arrangement gives increased precision of observation in the direction of travel of the spot of light. For the camera, a motor-driven drum with the film wound round its circumference is suggested.

REMARKS OF W. HEIMANN'S PAPER "THE SENSITIVITY OF THE BRAUN [Cathode-Ray] TUBE WITH GAS CONCENTRATION, AT VARIOUS FREQUENCIES."—M. von Ardenne: Heimann. (*Hochf:tech. u. Elek:akus.*, Dec., 1932, Vol. 40, No. 6, p. 217.)

"Heimann's investigations [Jan. Abstracts, p. 51] are confined to cathode-ray tubes working with the relatively low electron speed of about 300 v. The writer has carried out, at the beginning of 1932, similar measurements on his own tubes, which work on an average range of accelerating voltage 1 500–3 000 v. These unpublished results show in general a similar character, though the anomalies are not so marked"; thus with the higher-voltage tubes the null-point anomaly can be neglected in practice, so that the inconvenience of counteracting it can be avoided.

Heimann's verdict as to the unsuitability of hydrogen as a filling is in direct contradiction with von Ardenne's, who found that the lack of sharpness at the upper end of the frequency range began at considerably higher frequencies with hydrogen than with other gases (1932 Abstracts, p. 237). This discrepancy is due to the higher voltages used by von Ardenne.

Heimann replies that the null-point anomaly in the low-voltage tubes can easily be counteracted, as shown in his paper, and that later researches not yet published have indicated the possibility of a far-reaching diminution of the high-frequency effect also.

CATHODE-RAY OSCILLOGRAPHY.—R. A. Watson Watt. (Summary of lecture in *World Radio*, 13th Jan., 1932, Vol. 16, p. 57.)

DÄMPFUNGSMESSUNGEN AN SPULEN MIT EISENKERN (Damping Measurements on Iron-Cored [Ferrocart] Coils).—H. Frühauf. (*Hochf:tech. u. Elek:akus.*, Dec., 1932, Vol. 40, No. 6, pp. 214–217.)

For these tests, ordinary cylindrical air-cored coils (shielded and unshielded) and Ferrocart toroidal coils were wound with similar wire to give about the same inductances (ranging from 128 to 192 μH) and were combined with the same condensers to form oscillatory circuits with wavelengths ranging from 140 to 880 metres. The resonance resistances of these circuits were then measured over this wave range, and the loss resistances determined from the known values of inductance and wavelength.

At first the measurements were carried out both by the dynatron method (Frühauf, 1931 Abstracts, p. 509) and by Pauli's resonance method, but the results were so consistent that finally only the dynatron method was used. It was found that the circuits with the ferrocart coils showed resonance resistances *constant over a wider frequency zone than the circuits with the air-cored coils*. Moreover, the ferrocart circuits gave higher resonance resistances (and therefore *lower damping resistances*) than the air-core circuits, except when the circuit condenser was very small, when the ferrocart circuit was less efficient than the air-core circuit. This was due to the losses in the winding/core capacity of the ferrocart coil, and if this capacity was increased deliberately by winding the wire direct on to the core, the resonance resistance was greatly decreased (Fig. 1, curve VIIa compared with Ia). Ferrocart coils must therefore be given suitable winding separation in order to keep the self-capacity small. The tuning curves shown in Figs. 7 and 8 illustrate the superior selectivity given by these coils.

IRON POWDER COMPOUND CORES FOR COILS [Ferrocart, etc.].—G.W.O.H. (*Wireless Engineer*, Jan., 1933, Vol. 10, No. 112, pp. 1–3.)

Editorial partly prompted by the papers by Vogt (1932 Abstracts, p. 640) and Deutschmann (February Abstracts, p. 113.)

ELECTROLYTIC CONDENSERS.—P. R. Coursey. (*Wireless World*, 13th January, 1933, Vol. 32, pp. 24–26.)

PRIMARY BATTERY SUBSTITUTES FOR AUTOMOBILE RADIO RECEIVERS.—J. Dunsheath. (*Rad. Engineering*, Oct., 1932, Vol. 12, pp. 9–10.)

POWER TRANSFORMER TESTING.—R. F. Shea. (*Rad. Engineering*, Oct., 1932, Vol. 12, pp. 14–15 and 24.)

NEW PLIOTRONS, CATHODE-RAY TUBES FOR X-RAY ANALYSIS, THYRATRONS AND PHANOTRONS.—Hull. (*See* abstract under "Valves and Thermionics.")

HARMONIC COMMUTATION FOR THYRATRON INVERTERS AND RECTIFIERS.—C. H. Willis. (*Gen. Elec. Review*, Dec., 1932, Vol. 35, pp. 632–638.)

THE NEW "K" TUBE [Neon Tube particularly designed for Operation of Relays].—C. B. Brown. (*Radio-Craft*, Oct., 1932, Vol. 4, p. 206.)

ON NEW INTEGRAPHS OF THE ASKANIA WORKS [Differentio-Integraph, Prism Derivator, etc.].—J. Picht. (Long summary in *Review Scient. Instr.*, Nov., 1932, Vol. 3, pp. 713–714.)

STATIONS, DESIGN AND OPERATION

EXPERIMENTS ON ULTRA-HIGH-FREQUENCY COMMUNICATIONS [on 8.2-Metre Wave from Summit of Mt. Fuji].—T. Nakai, R. Kimura and S. Ueno. (*Journ. I.E.E. Japan*, Dec., 1932, Vol. 52 [No. 12], No. 533: English summary pp. 137–138.)

The visible range from the height of 3 780 metres covered an area of radius about 220 km. Reception in the heart of Tokyo (100 km) was appreciably disturbed by noises, but in the suburbs it was very clear. Tests on a ship showed that the signals fell suddenly at the border of the visible range (see dotted line in diagram). Reception in a passenger train was only good when the train was running through open fields. Difficulty was experienced in damp weather in starting the tourmalin plate: this was remedied by means of a special desiccating apparatus. For diagrams of transmitter and receivers *see* p. 975.

COMMUNICATION TESTS ON ULTRA-SHORT WAVES [7.7 and 8.8 Metres] BETWEEN SMALL ISLANDS AND MAIN LAND [Distances of the order of 40 Kilometres].—S. Uda, T. Obata, I. Arisaka and T. Seki. (*Journ. I.E.E. Japan*, Nov., 1932, Vol. 52 [No. 11], No. 532, pp. 868–872: in Japanese.)

TESTS FOR BROADCASTING AND FOR SOME OTHER SPECIAL COMMUNICATION BY ULTRA-SHORT WAVES.—S. Uda and I. Arisaka. (*Journ. I.E.E. Japan*, Sept., 1932, Vol. 52 [No. 9], No. 530, pp. 655–659: in Japanese.)

ULTRA-SHORT-WAVE [15 cm] SERVICE BETWEEN LYMPNE AIRPORT, NEAR HYTHE, AND STINGLEVERT, NEAR CALAIS.—Standard Telephones and Cables, Ltd. (Paragraph in *Zeitschr. V.D.I.*, 10th Dec., 1932, Vol. 76, No. 50, p. 1231.)

ONE MORE STEP IN UNIVERSAL COMMUNICATION [the "Transceiver," a Two-Way Transmitter and Receiver weighing 22 Pounds with Battery Unit, for Ultra-Short Waves around 5 Metres].—RCA Victor Company. (*Rad. Engineering*, Dec., 1932, Vol. 12, p. 18.)

SUR LE RAYONNEMENT DU POSTE RADIOÉMETTEUR DE LA TOUR EIFFEL (The Radiation Diagram of the Eiffel Tower Wireless Station).—P. David. (*Comptes Rendus*, 19th Dec., 1932, Vol. 195, No. 25, pp. 1247–1249.)

The Note gives the polar diagram for the 1 445-metre wave, and concludes:—"The radiation diagram thus resembles that of a loop aerial placed in the plane aerial–tower. This result seems to prove that the metallic parts of the tower are the seat of important currents, due to inductive and capacitive coupling with the aerial. The whole therefore radiates as a triangular loop, closed at the top by capacity and at the bottom by the ground acting as a conductor. The effective height calculated for such a loop, of the actual dimensions and for the 1 445-metre wave, amounts to about

100 metres. This result confirms, in the special case of the Eiffel Tower whose dimensions are large, the rôle which metal pylons may play in the radiation of aerials."

A Frequency Monitoring Unit for Broadcast Stations [Western Electric No. 1-A Unit]. —R. E. Coram. (*Bell Lab. Record*, Dec., 1932, Vol. 11, No. 4, pp. 113–116.)

The heterodyne note, through the medium of a relay, controls the indication of a meter reading directly in c/s. "The use of a relay in the plate circuit of the detector contributes to this monitoring unit a feature unique among equipment of its type. This feature is the ability to measure the carrier frequency whether or not the carrier is modulated. The relay has no 'sense of amplitude' but only a 'sense of frequency.' Thus the unit can be connected wherever its installation is most convenient: at any stage in the transmitter, or even to a small antenna nearby."

New Milestones in Commercial Wireless.—Chetwode Crawley. (*Wireless World*, 30th Dec., 1932, Vol. 31, pp. 572–574.)

Particulars of the Principal Short-Wave Stations of the World.—Namba. (*See* second Namba abstract under "Propagation of Waves.")

Empire Broadcasting.—R. L. Smith-Rose. (*Nature*, 7th Jan., 1932, Vol. 131, pp. 16–17.)

The Empire Broadcasting Station.—(*Engineer*, 16th Dec., 1932, Vol. 154, No. 4014, p. 622; *Engineering*, 23rd Dec., 1932, Vol. 134, No. 3493, pp. 749–750.)

Christmas Greetings Over the Empire: How the Broadcast was Done.—(*World Radio*, 6th Jan., 1933, Vol. 16, pp. 18–19 and 26.)

GENERAL PHYSICAL ARTICLES

Experimental Establishment of the Relativity of Time.—R. J. Kennedy and E. M. Thorndike. (*Phys. Review*, 1st Nov., 1932, Series 2, Vol. 42, No. 3, pp. 400–418.)

Michelson Interferometer Experiment: Miller's Result on Mount Wilson explained as the Esclangon Effect.—E. Carvallo. (*Comptes Rendus*, 7th Nov., 1932, Vol. 195, pp. 769–771.)

Contemporary Advances in Physics, XXIV. High-Frequency Phenomena in Gases, First Part.—K. K. Darrow. (*Bell S. Tech. Journ.*, Oct., 1932, Vol. 11, No. 4, pp. 576–607.)

An account of the present state of our knowledge of the behaviour of conducting gases subjected to high-frequency electrostatic fields.

The Twenty-Third Kelvin Lecture: "The Work of Oliver Heaviside."—W. E. Sumpner. (*Journ. I.E.E.*, Dec., 1932, Vol. 71, No. 432, pp. 837–851.)

MISCELLANEOUS

Polar Chart Makes Vector Addition Easy.—G. H. Arapakis. (*Elec. World*, 15th Oct., 1932, p. 537.)

The saving in time can be 75 to 80% compared with the method of using trigonometric tables.

Optico-Electrostatics [Optical Method of Determining the Electric Field in a Dielectric].—H. Tutumi. (*Journ. I.E.E. Japan*, Oct., 1932, Vol. 52 [No. 10], No. 531: short English summary p. 108, full paper in Japanese, with explanatory chart in English, pp. 754–766.)

Part I gives an analytical discussion of a new orthogonal trajectory which consists of the loci of points where the absolute value of the field intensity is constant, and of points where the direction is the same. Part II describes the experimental optical methods of making this trajectory visible.

Photoelectric Relays.—W. R. King. (*Rad. Engineering*, Nov., 1932, Vol. 12, pp. 10–12.)

Reading Print by Photocell [Photoelectrograph and Visagraph for the Blind].—R. C. Walker. (*Wireless World*, 23rd December, 1932, Vol. 31, pp. 548–550.)

See also next abstract and Abstracts, 1931, pp. 504 (Fournier) and 566; 1932, pp. 242 and 659 (Thomas).

Photoelectrograph for the Blind.—Perls: Thomas. (*E.T.Z.*, 3rd Nov., 1932, Vol. 53, No. 44, pp. 1061–1062.) *See* also preceding abstract.

Plants as Detectors [Rectifying Effect of Sap Movement].—M. Marinesco. (Summary in *E.T.Z.*, 24th Nov., 1932, Vol. 53, No. 47, p. 1135.) *See* also 1932, Abstracts, pp. 113 and 660.

A Universal Precision Stimulator [Thyratron Circuit for Nerve Physiology Researches]. —O. H. A. and F. O. Schmitt. (*Science*, 7th Oct., 1932, Vol. 76, No. 1971, pp. 328–330.)

Researches on the Influence of Electrical Conditions on the Growth of Infants [increased Rate of Growth when Insulated from Earth].—F. Vlès. (*Comptes Rendus*, 3rd and 16th Jan., 1933, Vol. 196, pp. 62–65 and 216-218.)

Partial Sterilisation of Milk in Continuous Process, by Use of Magnetostriction Generator.—Gaines. (*See* abstract under "Acoustics and Audio-frequencies.")

New Valves and Their Industrial Applications [Special Pliotrons, Cathode-Ray Tubes for X-Ray Analysis, Thyratrons, and Phanotrons].—Hull. (*See* abstract under "Valves and Thermionics.")

On the Use of the Pentode Valve for Pressure Recording in Fluids.—Oliphant. (*See* under "Valves and Thermionics.")

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.

SIGNALLING SYSTEMS

Convention date (*U.S.A.*), 30*th July*, 1930.
No. 380876

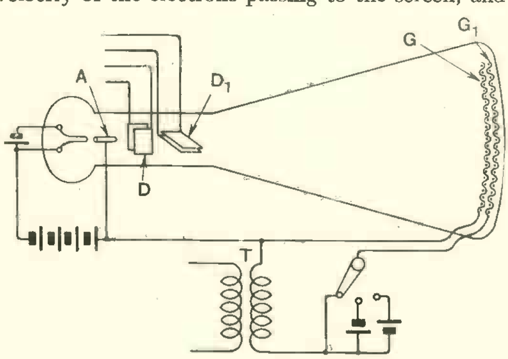
Describes a Morse radio system in which the marking and spacing signals are transmitted on two different carrier frequencies, which, in reception, are converted into corresponding amplitude variations. Subsidiary currents are also derived from the incoming energy and are utilised for automatically heterodyning the signals, so that the efficiency of rectification is improved, and the ratio of desired signal strength to static or other extraneous disturbance is increased.

Patent issued to E. H. Armstrong.

TELEVISION

Convention date (*U.S.A.*), 7*th July*, 1930.
No. 380859

In a Braun-tube receiver the electron stream from the cathode, after passing through a tubular anode A and a pair of deflecting plates D, D_1, is subjected to the action of a pair of grids G, G_1 located close to the fluorescent viewing-screen formed by the end wall of the tube. Incoming picture signals are applied to control grids G, G_1 through a transformer T, the signal voltages serving to vary the velocity of the electrons passing to the screen, and



No. 380859.

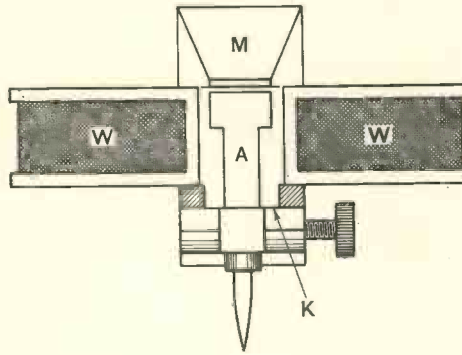
therefore the intensity of the illumination caused by their final impact. One of the control grids may be located outside the tube.

Patent issued to Electrical Research Products Inc.

GRAMOPHONE PICK-UPS

Application date, 1*st August*, 1931. No. 381275

The pick-up is characterised by the absence of any damping means liable to deterioration, the armature being pivoted and damped by magnetic action alone. As shown in side-view, with one of the main magnets M removed, the armature A is provided with cross-arms formed with knife-edges K which rest upon V-shaped grooves, one in the pole-face and the other in the coacting pole-face. The armature oscillates with its upper end in close proximity to the lower pole-face, so that it is



No. 381275.

heavily damped by the magnetic feed. Pick-up voltages are induced in the windings W.

Patent issued to Ferranti, Ltd., and H. V. Carlisle.

SHORT-WAVE RECEIVERS

Convention date (*Germany*), 31*st January*, 1931.
No. 381048

When receiving short-wave signals on a superhet circuit it is necessary to maintain the frequency of the local oscillator at a constant value, which may be ensured by means of piezo-electric control. According to the invention, the necessity for such control is avoided by designing the intermediate-frequency amplifier to have a band-pass characteristic sufficiently wide in its response to cover any variation in the beat frequency caused by slight fluctuations in the local oscillator.

Patent issued to W. Lorenz A-G.

VARIABLE-MU VALVES

Convention date (*U.S.A.*), 26*th June*, 1930.
No. 377692

Relates to variable-mu valves of the type in which the control grid is wound in spiral form with fine and coarse pitched sections. In order to cut down the plate current, which tends to become excessive when the grid bias is such as to give high amplification, an extra screen or shield is mounted near the lower or open-pitched part of the control grid and is connected inside the bulb to the cathode, so as to reduce the positive field from the screening grid. This increases the internal resistance across that section of the valve and so cuts down the total space current. The extra screen also imparts a more gradual slope to the lower end of the characteristic curve of the valve.

Patent issued to Boonton Research Corporation.

LOUD SPEAKERS

Application date, 30th November, 1931. No. 379167.

In an electro-dynamic speaker the field winding consists of a number of coils of strip copper, spaced apart to permit the passage of sound-waves. The speech currents traverse the diaphragm, which is mounted inside the field winding and is in the form of a corrugated disc held along its sides by a pair of grooved bars. The arrangement gives a drive which is distributed uniformly over the whole surface of the diaphragm, and is free from the disturbing effects due, in ordinary constructions, to the space between the pole-pieces and diaphragm.

Patent issued to A. Carpmael.

ELIMINATING INTERFERENCE

Convention date (Germany), 16th January, 1931. No. 378770

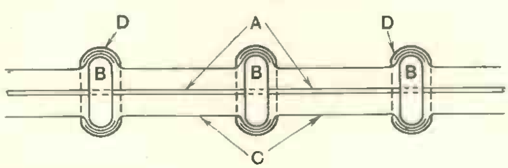
A rejector circuit, tuned to an undesired signal, is inserted both in the aerial down-lead and in the earth connection. In addition an acceptor circuit also tuned to the undesired signal is shunted across the input to the set, so as further to reduce the pick-up voltage fed to the rejector circuits. The various circuits are carefully screened from each other, and the tuning-condensers are ganged together, provision being made for separate vernier adjustments.

Patent issued to Telefunken Ges. für Drahtlose Telegraphie m.b.H.

H.F. FEEDER-LINES

Convention date (Germany), 7th February, 1931. No. 379976

A cable for carrying high-frequency currents, say for energising an aerial system, consists of a central wire A, on which insulating rings or beads B are



No. 379976.

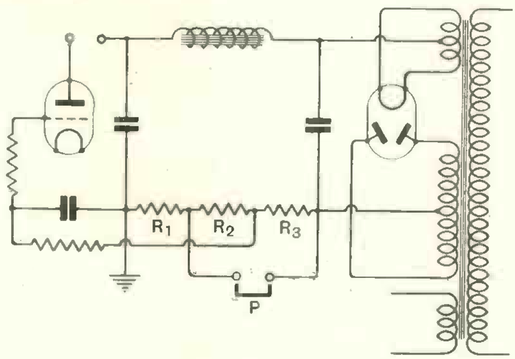
threaded; and an outer conductor C consisting of cylindrical segments of sheet copper ball-jointed together, at D. The cable may be covered by a lead sheath for protection against the weather.

Patent issued to Telefunken Ges. für Drahtlose Telegraphie m.b.H.

MAINS-SUPPLY UNITS

Convention date (Germany), 24th February, 1931. No. 380341

A high-tension eliminator is designed to supply either a small or large output without setting-up undesirable surge voltages, or throwing an undue strain on the rectifier valve. As shown in the Figure, a part of the potentiometer-resistance R_1, R_2, R_3 is adapted to be cut out of action by a plug P. When the plug is inserted only the resistance R_1 is operative, and the anode and grid voltages are then suitable for a heavy-consumption power valve. For a power valve of smaller rating the plug is withdrawn, so that the grid bias is



No. 380341.

determined by the fall across both R_1 and R_2, whilst a third resistance R_3 reduces the anode voltage to a safe value.

Patent issued to Ideal Werke A-G für Drahtlose Telephonie m.b.H.

CIRCULARLY-POLARIZED RADIATION

Convention date (Germany), 12th December, 1930. No. 377078

Pairs of dipole radiators are offset at intervals of half a wavelength from common feed-lines, extending either vertically or horizontally. One pair is slightly detuned above, and the other below the working wavelength, the required differences in tuning being obtained constructionally, *i.e.*, by making slight differences in the length or thickness of the constituent wires. When the two mutally perpendicular dipoles are arranged in the horizontal plane and detuned so as to carry currents with a phase-difference of 90°, the resulting radiation is circularly polarized and gives little vertical radiation, so that it is particularly suitable for broadcast transmission.

Patent issued to Telefunken Ges. für Drahtlose Telegraphie m.b.H.

PIEZO-ELECTRIC COUPLINGS

Convention date (U.S.A.), 25th April, 1931. No. 379248

The inherent capacity between the electrodes of a piezo-crystal coupling two circuits introduces an undesirable reactance capable of transferring energy of a frequency other than that of the fundamental frequency of the crystal. Balanced-bridge arrangements have been used to neutralise this effect, but, according to the invention, the same object is secured by mounting a vertical screen of sheet metal between the two upper electrodes, the lower end of the screen being connected to the other or common electrode and earthed.

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

THERMIONIC AMPLIFIERS

Convention date (Germany), 9th January, 1931.
No. 377563

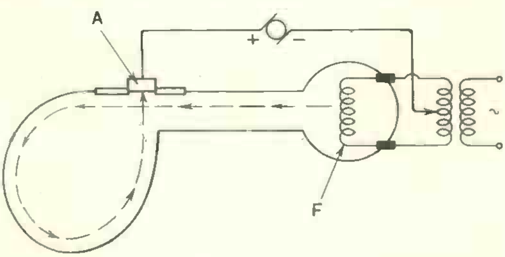
Relates to a method of ensuring a strictly-linear proportion between the input and output of amplifiers capable of handling comparatively heavy loads. Known systems of utilising compensating valves, having characteristics of opposite curvature to that of the amplifier to be corrected, are restricted by the difficulty of accurately "matching" the valve characteristics. According to the invention an auxiliary correcting valve, which need only yield a comparatively small output, is arranged with its output terminals in parallel with the main amplifier, and means are provided for applying to the grid of this valve (*a*) an input proportional to that of the main amplifier, (*b*) an input proportional to the internal voltage drop of the correcting valve, and (*c*) an input proportional to the total current passing through the load. A mathematical analysis is given to show that this compensates for any non-linearity in the main amplifier and its associated circuits. The conditions to be fulfilled when the correcting valve is connected in series with the main output are also specified.

Patent issued to Telefunken Ges. für Drahtlose Telegraphie m.b.H.

HIGH-FREQUENCY GENERATORS

Convention date (U.S.A.), 28th July, 1930.
No. 380201

Ultra-short waves, of the order of one metre, are produced by causing an electron stream to take a curved path which crosses itself, so that certain of the electrons intercept the stream and so set up oscillations. The generating tube is shown in cross-section, the anode *A* being inserted at a point tangential to the path of the electron stream from the filament *F*. The flared end of the tube is either of metal, insulated from the anode, or is metal-lined, and carries a slightly negative charge, so as to force the electrons to take the curved path shown in dotted lines. At the point of intersection, the mutual repulsion between the electrons causes a temporary interruption of the main stream which is repeated at a frequency determined by the anode voltage. The operation of the device is stated to be analogous to that of the ordinary steam whistle.



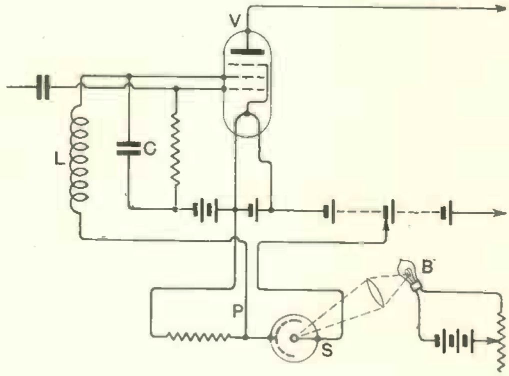
No. 380201.

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

VOLUME CONTROL

Application date, 17th June, 1931. No. 380499

An amplifier, particularly for use in connection with sound films, is provided with a light-operated volume-control which is free from "clicks" or other objectionable noises. The amplifier *V* is of the pentode type, the first grid being connected to the cathode, and the second through an inductance *L* and shunt capacity *C* (forming a "noise" filter) to a point on a potentiometer *P*, part of the resistance of which includes a selenium cell *S*. Volume is adjusted by varying the intensity of light falling on this cell from a lamp *B*.



No. 380499.

Patent issued to Marconi's Wireless Telegraph Co., Ltd., and H. J. Round.

DRY-CONTACT RECTIFIERS

Convention date (Holland), 15th May, 1930.
No. 378444

The two main electrodes of a dry-contact rectifier of the copper-copper oxide type are separated by a thin layer of resin, lacquer, collodion, or similar dielectric which does not comprise either alone, or in combination, any of the elements in the main electrodes. A compact multiple rectifier can be assembled by applying a layer of copper on any suitable base, squirting or smearing the copper with a very thin coating of resin, adding a layer of cupreous sulphide, and then repeating the sequence.

Patent issued to N. V. Philips Gloeilampenfabrieken.

Convention date (Holland), 8th October, 1930.
No. 379538

One electrode is made of magnesium or aluminium, or an amalgam of these metals, whilst the other is made of zirconium or titanium, coated with one or more sulphide compounds together with potassium chlorate, potassium permanganate, or other substance yielding oxygen. An insulating layer is formed immediately both electrodes are pressed together, and is stated to be permanent in action, and not liable to perforation and consequent loss in rectifying properties.

Patent issued to N. V. Philips Gloeilampenfabrieken.

REPRODUCING SOUNDS

Convention date (Germany), 13th February, 1931.
No. 379626

In a system for transmitting or reproducing speech or music, distortion due to the introduction of harmonics or to the production of so-called "combination" notes, by some element having a non-linear response, such as a microphone, amplifier, or loud speaker, is reduced by dividing the frequencies to be amplified into two separate bands by interposing filters before the element which gives rise to the distortion. The division is made on either side of a separating frequency which may lie at any selected point between 100 and 700 cycles. The result of dividing, say, a simple complex of four frequencies into two separated bands in this way, is stated to reduce the number of possible "combination" notes of the first order from twelve to four.

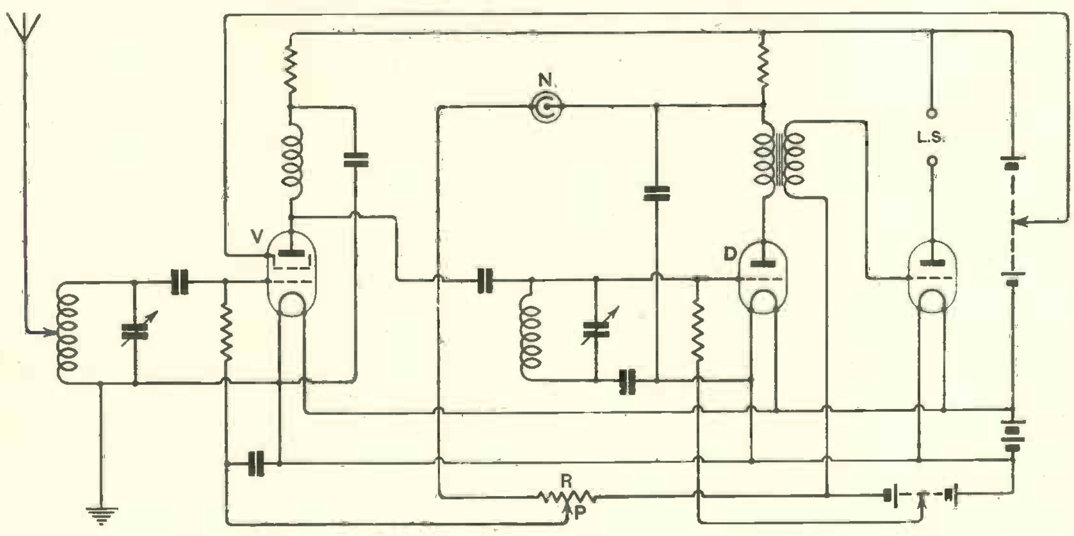
Patent issued to Telefunken Ges. fur drahtlose Telegraphie m.b.h.

AUTOMATIC VOLUME CONTROL

Application date, 13th June, 1931. No. 380445

A gas-filled discharge tube, such as a Neon lamp *N*, is inserted in series with a resistance *R* in shunt with the plate circuit of the detector valve *D*, the applied potential being greater than the striking voltage of the Neon lamp. The tapping point *P* is adjusted so that the bias on the control grid of the S.G. amplifier *V* gives sufficient amplification to overcome bad fading. As signal strength increases, the change in the voltage drop across the resistance *R* cuts down the sensitivity of the amplifier *V*. The arrangement prevents overloading by strong signals or extraneous interference, and also tends to shorten the duration of static impulses.

Patent issued to W. B. Mackenzie and L. S. B. Alder.



No. 380445.

VOLUME CONTROL

Convention date (Germany), 20th January, 1931.
No. 379609

In order to give a silent "change over" from one selected programme to another, free from background noise due to "static" or intermediate carrier-waves, the grid of the detector valve is normally biased to a point at which the valve is inoperative, and a grid-glow device, such as a thyratron, is automatically brought into action, when the carrier wave of the desired station reaches a certain pre-determined value, so as to remove the prohibitive bias and allow the signals to come through. Simultaneously the thyratron illuminates a part of the tuning dial to give a visible indication that the desired signal is being tuned in.

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

H.F. FEED-LINES

Convention date (U.S.A.), 25th June, 1930.
No. 379796

Difficulty arises in insulating the H.F. cables used, say, for energising a beam aerial because though on the one hand it is desirable to keep the lines closely spaced in order to prevent undesirable radiation, on the other hand, owing to the high voltages carried, the insulators must of necessity be of large size. To overcome this difficulty advantage is taken of the fact that a U-shaped conductor half a wavelength long offers very high impedance—so much so that it constitutes an effective insulator—to currents of corresponding frequency. Ordinary insulators are therefore dispensed with, and the feeder line is suspended where necessary by half-wave loops of conducting wire, on which standing waves are automatically set up. The "insulators" may be any multiple of half a wavelength long.

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

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