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Editorial

Television Cables

THE requirements of broadcasting have set a new standard of quality in telephone transmission. The range and uniformity of frequency response, the linearity of amplitude response, the freedom from interference, in fact, practically every property of the cable and its associated apparatus which was considered satisfactory for general telephonic purposes, falls short of the requirements of modern broadcasting. The development of a system of high quality broadcast transmitters necessitates the parallel development of an interconnecting cable system. In some cases circuits were available which were not originally intended for the purpose. For example, it had long been common practice to place at the centre of a multi-core telephone cable a special 4-wire core in its own lead sheath ; this could be used for special purposes and stood a good chance of being left intact when the cable suffered any injury. This special core has been largely used for transmitting broadcast programmes, but new telephone cables are now being made with such sheathed cores specially provided for the purpose.

This question has recently been under consideration in France by a committee comprising representatives of the Government Postal Department, the National Laboratory and others, in connection with the scheme for erecting nine broadcast transmitters in the neighbourhood of large cities. As it is inadvisable to erect the stations nearer to the cities than about 20 miles, on account of the difficulties which would then be experienced in receiving any other station, the immediate problem was the design of the cable connecting the studios in the cities with the transmitting stations. As the length of cable concerned is thus only about 20 miles the problem would not have presented any great difficulties but for the uncertain factor of the possible development of television. It was felt that if there was any likelihood of television making such great progress during the next thirty years that television broadcast transmitters would be installed side by side with the present transmitters, now was the time to consider the possibility of designing the cable so as to be capable of transmitting the necessary currents. For ordinary telephony it is considered sufficient to transmit currents up to a frequency of about 3,000, for broadcasting speech and music the figures given as desirable for the upper limit vary from 8,000 to 13,000, although one often has to be satisfied with less. To transmit a picture subdivided into 8,000 points 25 times per second requires a frequency of 100,000. We thus see that the frequencies involved in the case of television are no longer in the audio range but are really radio frequencies, and instead of thinking of telephone cables we must turn our attention rather to those cables which are used to carry the high-frequency currents from the radio transmitter to the aerial. These are, however, at the most only a few hundred feet long, and we are now considering lengths of 20 miles.

Experiments* were made on two types of cables, viz.: twin core and concentric. Initial tests were made on a reserve length of 190 metres of the cable used to connect the studio in Paris with the transmitter at Pontoise. The core contained two wires 1.3 mm. diameter. The capacity was found to be invariable but the inductance decreased slightly as the frequency was increased, due undoubtedly to skin effect. The most important variable was the resistance, which increased from its D.C. value of 26 ohms per km. to 71 ohms at 100,000 cycles per second. This leads to a large increase in the attenuation constant, which is approximately proportional to the resistance, but even 71 ohms is small compared with the reactance at this high frequency, which was 377 ohms per km. Although an increase in the size of the wires from 1.3 to 2.0 mm. reduces the D.C. resistance from 26 to 10.4 ohms it was found that the high-frequency resistance was only reduced from 71 to 68 ohms, thus holding out very little hope of improvement in this direction.

An analysis of the components of this resistance, making due allowance both for skin effect and the proximity effect due to the tendency of the currents to concentrate towards the adjacent parts of the twin wires, failed to account for more than 43 of the 71 ohms, or, even more striking, 27 of the 68 ohms in the case of the 2 mm. wires thus leaving 41 ohms unacccounted for. This indicated that very considerable losses were caused by eddy currents set up in the sheath, and this was confirmed by testing cores made up in sheaths of different sizes. The sheaths normally employed consisted of a wrapping of aluminium coated paper, but a core made up with a lead sheath 2 mm. thick gave exactly the same measured losses. The sheath losses were found to be very sensitive to a small increase in the distance between the wires and the sheath; increasing the overall diameter from 10 to 18 mm. reduced the supplementary resistance from 41 to 9 ohms. Experiments were made with cores made up of a number of insulated fine wires, presumably multiply stranded to ensure a more uniform current distribution, but any gain was counterbalanced by the increased diameter and capacity.

For a given overall diameter of sheath one can adopt various sizes and spacing of wires within the sheath, and it is a matter of design to choose the compromise which will give the minimum attenuation.

Experiments were also made with concentric cables. A core of seven wires each 1.7 mm. diameter, having a diameter of about 5 mm. being wrapped with successive layers of cotton and paper to a diameter of about 10 mm. and then with 62 wires 0.5 mm. diameter to form the outer conductor.

In comparison with a twin-core of about the same overall diameter and 2 mm. wires, the capacity is about three times as great and the inductance about a third, both of which are changes for the worse. The resistance, however, is reduced to about a fifth of that of the twin-core and is in agreement with calculation, there being no screen-losses to give a supplemental resistance. The result is that although for frequencies below about 70,000 the twin-core has the lower attentuation, above this frequency the concentric cable has the lower attenuation.

As in the twin-core cable the optimum size of conductor to employ for a given overall diameter is a matter of compromise between a small central conductor with a high resistance but a small capacity, and a large central conductor with a low resistance but a high capacity. One important result which was established by the investigation was that for a given overall diameter, a concentric core can be made with about a half of the attenuation of the twin-core at a frequency of 100,000 cycles per second, and with a smaller variation of attenuation over the frequency range.

Apart from the application to television—concerning which one may regard the anxiety of the French authorities as somewhat premature—the results of the investigation are of interest in the ever-increasing demand for improved quality of music and speech transmission. G. W. O. H.

* *Bulletin de la Société Française des Électriciens*, February, 1934, p. 193.

Some Applications of an A.C. Valve Bridge *

By M. Reed, M.Sc., A.C.G.I., A.M.I.E.E.

Introduction

VALVE bridges of the form shown in Fig. 1 are frequently used in valve-voltmeter and photo-electric cell work, and in other cases where a sensitive recording device is required.

This article shows that when an a.c. supply is also connected such valve bridges can be adapted to problems of quite a different type, namely :

(1) Modulation.

(2) Detection of continuous wave signals.

(3) Amplification and measurement of impulse signals.

These applications are treated in detail below.

Modulation

Fig. 2 shows the variation in plate-filament resistance with grid bias for a Mullard P.M.2 valve. This curve was obtained by noting the plate current for different values of grid bias, a constant plate potential of 150 volts being used. It is seen that up to about 13 volts the resistance increases fairly slowly as the grid is made increasingly negative; from 13 to 20 volts the curve becomes much steeper and large changes in resistance are obtained. It was therefore decided to investigate the properties of the bridge as a modulator in the neighbourhood of 13 volts.† With this aim in view, the circuit arrangement shown in Fig. 3 was utilised. The bridge was made up of the valves V_1 and V_2 and the 100 millihenry high-frequency chokes; the a.c. supply to the bridge was obtained from a 500 kilocycles/sec. oscillator, and the bridge output was connected through a transformer to a two-stage high-frequency amplifier tuned to the supply frequency. This amplifier was screened and neutralised in the standard way, but, for simplicity, only the essential details are shown in the diagram. The bias on V_1 was fixed at 13 volts and the bias on V_2 was varied until the bridge (as indicated by the milliammeter in the final tuned circuit) was balanced. It was found that balance was impossible unless a capacity of 40$\mu\mu$F. was connected between the plate and filament of V_1. This condenser compensated for the various stray capacities which were present, and would probably have been of smaller value if a screened and balanced transformer had been used at T. The bias on V_1 was then varied and the corresponding output values noted, the bias

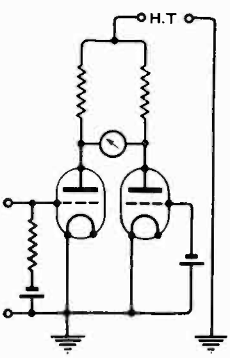


Fig. 1.

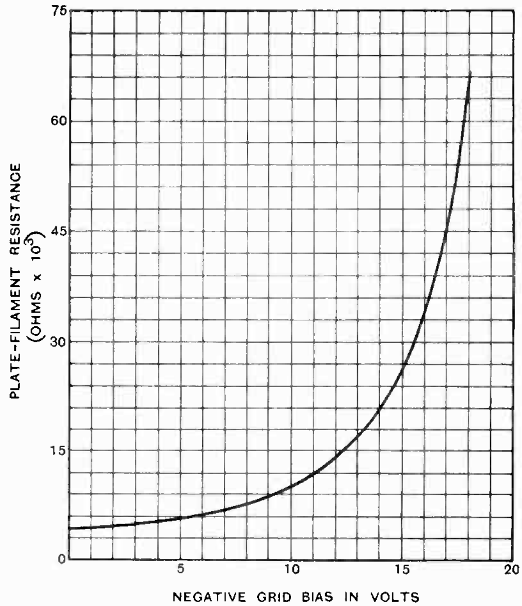


Fig. 2.

* MS. accepted by the Editor, February, 1934.

† This bias also gives a suitable value of plate current.

on V_2 being kept constant at the value obtained above for balance. A curve between grid bias and output is shown in Fig. 4, and it is seen that from 13 to 20 volts the relationship between them is linear. From 13 to 2 volts the graph is curved at the upper end and less steep than the one from 13 to 20 volts. The test was repeated for a number of different initial bias settings on V_1, the bias on V_2 being adjusted to give the corresponding balance value in each case. It was found that in all cases the curves obtained were similar to the one of Fig. 4, although the linear portion of the branch corresponding to *PR* in no case occupied as large a grid swing as in Fig. 4.

Fig. 4 shows that for a fixed bias on V_1 of 16.5 volts, a sinusoidal input of amplitude 3.5 volts applied between terminals *a b* (see Fig. 3) will vary the output between zero and twice the value obtained at 16.5 volts; 100 per cent. modulation without distortion should therefore result. A test with speech showed that, with these settings, deeply modulated undistorted telephony could be easily obtained.

For a fixed bias on V_1 of 13 volts no output is obtained until the bridge is unbalanced by the application of a voltage at *a b*. In this case the positive and negative half-cycles of the input wave operate, respectively, on the *PR* and *PQ* portions of the curve given in Fig. 4 and considerable distortion is introduced. Operating the bridge in this way provides, however, a method of modulation in which the carrier appears only when the modulating signal is introduced, and it may therefore have some application in cases where the reduction of interference with other transmissions is important. It was found that the telephony obtained by this method, although rather distorted, was nevertheless quite intelligible.

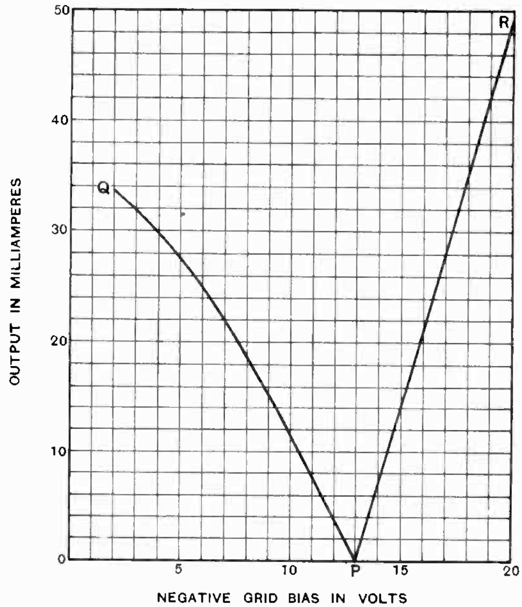


Fig. 4.

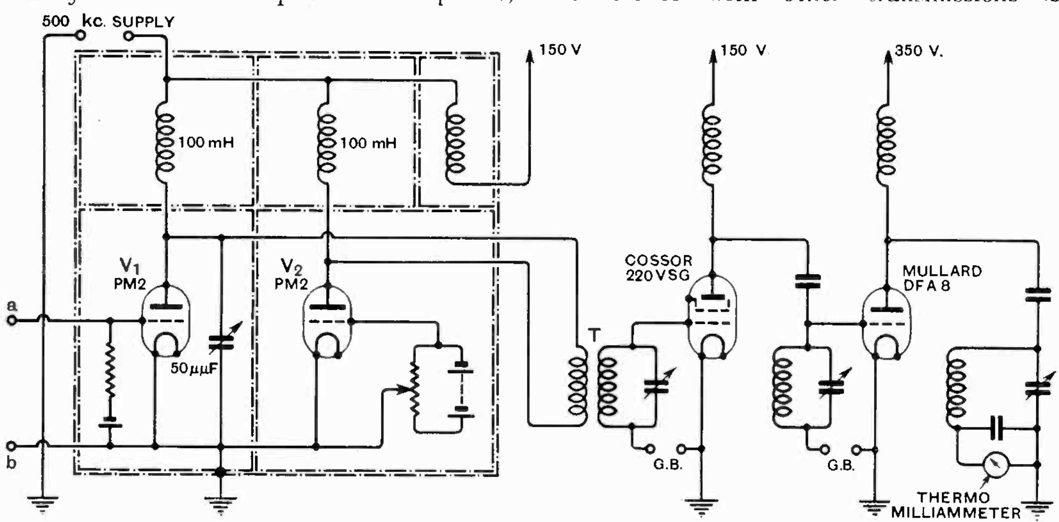


Fig. 3.

Detection of Continuous Wave Signals

Fig. 2 shows that from 6 to 20 volts the curve obtained is non-linear. It therefore follows that the application of a sinusoidal voltage to the terminals *ab*, when the bias on V_1 is more negative than 6 volts, will change the plate-filament resistance from its initial value. This fact can be used to detect the presence of an alternating voltage, irrespective of its frequency, in the following way. The valve bridge is arranged as shown in Fig. 5, a 1,000 cycle per sec. supply being used in place of the high-frequency supply of Fig. 3. The bias on V_1 is then fixed at some value between 6 and 20 volts, the best value being given by the point at which the rate of charge of resistance with the bias voltage is a maximum, and the bridge is balanced by altering the bias on V_2. The introduction of a signal at *ab* then unbalances the bridge and produces a 1,000 cycles/sec. note in the output.

In this way aural reception can be carried out on continuous wave signals without the necessity for a local oscillator. This would enable a coast station, for example, to listen for C.W. signals at the same time as for I.C.W. and spark signals, and it should therefore be of use when "standing-by" for transmissions from mobile stations. On the short wavelengths the bridge method offers additional advantages in that it facilitates the reception of such C.W. transmissions which are so unstable as to make reception by the normal heterodyne method difficult. It was found that when using Mullard P.M.1H.L. valves for the bridge with 100 volts supplied to the plates it was possible, by placing a two-stage high-frequency choke-capacity coupled amplifier in front of the input terminals *ab*, to make this arrangement as sensitive as a P.M.1H.L. when operated as an ordinary detector coupled to a local oscillator.

The arrangement of Fig. 5 will also operate with signals of very low frequency, therefore it could be used as a detector to enable ordinary bridge measurements to be made at frequencies of the order of 15 cycles per sec. or even lower.

Amplification and Measurement of Impulse Signals

In most cases it is necessary to amplify impulse signals before their amplitude and time of duration can be measured. Since these signals are not periodic, it is usual to carry out the amplification by means of resistance-capacity coupled valve amplifiers. The magnification value per stage of such amplifiers cannot, as a rule, be made greater than 20; therefore, in cases where large amplification is required, it may be necessary to employ four or more stages. By using the arrangement of Fig. 3 (or of Fig. 5 for lower frequencies), however, it is possible, assuming that the bridge is initially balanced, to convert the impulse signals introduced at terminals *ab* into a.c. signals the frequency of which is given by that of the bridge supply

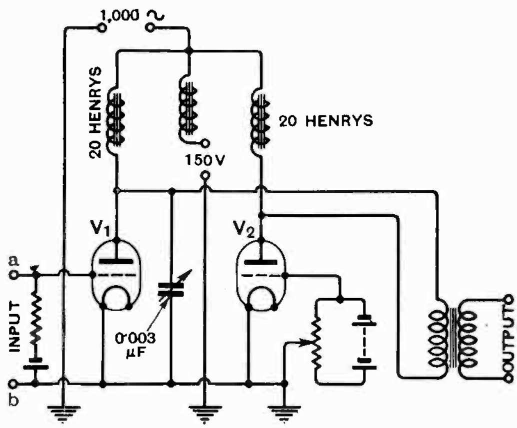


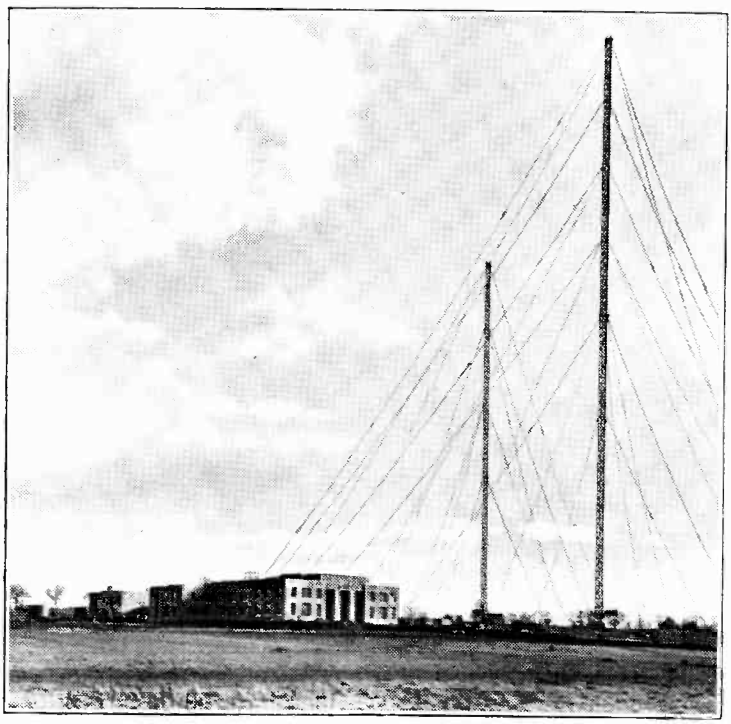
Fig. 5.

voltage. The a.c. output obtained from the bridge can then be amplified by means of tuned-anode amplifiers in the usual way, with the result that a stage magnification value of 20 can be easily exceeded. In this arrangement the frequency of the supply voltage to the bridge must be sufficiently high to ensure that a number of cycles of high frequency output are obtained during the time occupied by each impulse.

A method of measuring the duration and the amplitude of impulse signals follows from the above. The output of the bridge can be applied to an oscillograph and the number of cycles released by the impulse noted, then if f is the frequency of the supply and n the number of cycles recorded, the duration of the impulse is given by $\frac{n}{f}$ seconds. This method of time measurement has an advantage in that the provision of an auxiliary timing wave is avoided. The amplitude of the output from the bridge also provides a measure of the magnitude of the impulse.

Note on the Bridge Supply Voltage

Theoretically, the operation of the valve bridge should be independent of the magnitude of the supply voltage so long as its amplitude does not exceed the value of the H.T. voltage applied to the bridge valves. In practice, however, it is difficult to obtain two valves which are sufficiently closely matched to remain so when the plate voltage is varied between fairly wide limits. In the case of the arrangement of Fig. 5, if the supply voltage is too high the bridge does not remain balanced at every instant of the supply voltage cycle. Since the supply is of audio frequency, the points at which the bridge becomes unbalanced produce an audible note, with the result that it is impossible to obtain a good balance. The arrangement of Fig. 3 is also affected by the value of the supply voltage because, although the bridge is initially unbalanced, the depth of modulation obtained depends on the extent to which the bridge can be balanced at the negative peak of the modulating signal. In both cases it is therefore necessary that the supply voltage should be kept as low as possible to ensure a good balance. On the other hand, the output obtained from the bridge when it is unbalanced increases with the supply voltage; therefore, to obtain reasonable sensitivity, it is not advisable to make this voltage too low. It was found that a satisfactory compromise could be obtained when the R.M.S. value of the supply voltage did not exceed 15 per cent. of the H.T. voltage applied to the bridge valves. This value could probably be exceeded if the bridge valves were carefully selected.



"Wireless World" photo.

THE NATIONAL TRANSMITTER

A GENERAL view of the high-power station of the B.B.C. now nearing completion at Droitwich. The station, which will supersede the Daventry long-wave transmitter, will operate with a power of 120 kW. and supply the "National" programme to the greater part of southern England. Test transmissions are expected to begin in May and the full service will be taken over in the early autumn.

Stability of Resistance-coupled Amplifiers *

By W. Baggally

SUMMARY.—In a multi-stage resistance-capacity coupled amplifier with common anode supply, it is well known that the impedance of this source gives rise to retroaction which may lead to instability and continuous oscillation of the amplifier.

This form of retroaction may be reduced by employing the well-known "decoupling" circuit consisting of a condenser and resistance in the anode circuit of each valve, and in the following paper a theory is worked out enabling the conditions for stability to be determined.

Graphs are given which render the calculation of the decoupling circuits a very simple process.

WE will first consider the arrangement of Fig. 1; it will be shown later that by making some simplifying assumptions which are usually justified in practice, a multi-stage resistance amplifier with decoupling circuits and common anode current supply of finite impedance may be represented for the purpose of the present discussion by this circuit, in which A is an amplifier giving a voltage gain of A which is independent of frequency, and t and T are the time constants of the two kinds of resistance-condenser circuits.

These circuits, of which there are n of the t type and N of the T type, are supposed not to react on each other or on the amplifier A in any way; this condition could, for example, be approximately fulfilled by making each circuit have say ten times the impedance of the one preceding it or by interposing valves between the circuits.

It does not matter what the actual values of the condensers and resistances are, so long as the time constants of all the t type and T type circuits are t and T respectively.

The condition for stability in Fig. 1 is that the product of the various gains and losses (expressed as voltage ratios) round the circuit shall be numerically less than unity.

To prove this we note that if a voltage e is injected anywhere into the system and if a is a complex quantity representing the total product of the vector gains and losses, the voltage will travel round the circuit continuously, being multiplied by a for each complete turn, therefore the total voltage appearing at the point of injection will be

$$e(1 + a + a^2 + a^3 + \ldots \textit{ad. inf.})$$

which is only finite when $|a|$ is less than unity.

If r and k are the resistance and capacity respectively in the T type circuit, the voltage loss ratio is

$$\frac{r}{r + 1/jpk} = \frac{jpkr}{1 + jpkr} = \frac{jpT}{1 + jpT}$$

and similarly the ratio in the t type circuit is

$$\frac{1}{1 + jpt}$$

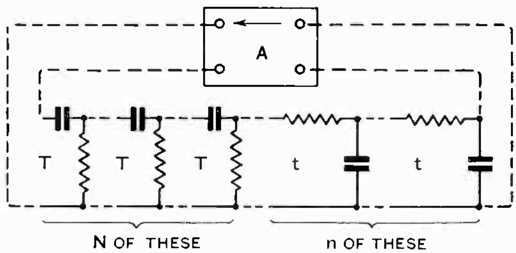


Fig. 1.

Therefore the condition for stability may be written

$$A \cdot \left(\frac{pT}{\sqrt{1 + p^2T^2}}\right) \cdot \left(\frac{1}{\sqrt{1 + p^2t^2}}\right)^n < 1 \quad .. \quad (1)$$

In these expressions, $j = \sqrt{-1}$, $p = 2\pi f$, f = frequency.

The expression on the left of (1) has a maximum with respect to frequency; if (1) is satisfied at the frequency corresponding to this maximum it will be satisfied at all other frequencies.

* MS. accepted by the Editor, November, 1933.

To find the frequency for which the left of (1) is a maximum it will suffice to differentiate $p^{2N}/(1 + p^2T^2)^N(1 + p^2t^2)^n$ with respect to p^2 and equate to zero, which gives, after simplification, the quadratic in p^2,

$$p^4nT^2t^2 - p^2t^2(N - n) - N = 0 \quad \ldots \quad (2)$$

and rejecting the negative root we have, if $x = T/t$

$$p^2T^2 = \frac{N - n + \sqrt{(N - n)^2 + 4Nnx^2}}{2n} \quad (3)$$

which when substituted back into (1) gives on squaring,

$$A^2 \cdot \left(\frac{N - n + \sqrt{(N - n)^2 + 4Nnx^2}}{N + n + \sqrt{(N - n)^2 + 4Nnx^2}}\right)^N \left(\frac{2nx^2}{2nx^2 + N - n + \sqrt{(N - n)^2 + 4Nnx^2}}\right)^n < 1 \quad \ldots \quad \ldots \quad (4)$$

To see what this means, let us suppose the amplification A to be slowly increased from zero, then as soon as the left hand side of (4) reaches the value unity, the system will commence to oscillate at the frequency given by (3), since under these conditions this is the only frequency for which (1) is not satisfied, *i.e.*, the only frequency at which the system is unstable.

In considering the actual resistance amplifier, we shall assume that :—

(*a*) There are N + 1 valve stages in all.

(*b*) The shunting effect of the grid leak circuit on the valve preceding it can be ignored.

(*c*) All the grid-leak-and-condenser circuits have the same time constant T.

(*d*) The decoupling resistances are small in comparison with the corresponding anode resistance.

(*e*) The impedance of the anode supply is a pure resistance, small in comparison with the decoupling resistances.

(*f*) The retroaction from the last stage to the first predominates over all other back couplings so that the effects associated with the intermediate stages may be ignored in comparison.

(*g*) The decoupling circuits associated with the first and last stages have both the same time constant t.

The assumption in (*f*) also demands that the decoupling circuits in the intermediate stages have a time constant of the same order of magnitude as t or greater than t.

Bearing these things in mind, we may draw

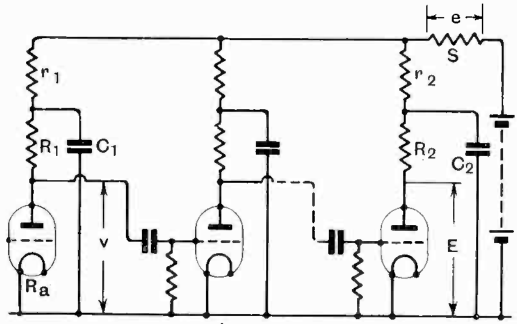


Fig. 2.

the amplifier as in Fig. 2, which also gives the symbols used in the following analysis.

At high frequencies the effect on the amplification produced by the grid condensers and leaks can be ignored ; because at these frequencies the reactance of the condensers is much smaller than the resistance of the leaks. Let m be the amplification at high frequencies between the grid of the second stage and anode of the last stage ; *i.e.*, the total amplification less that of the first valve, then at low frequencies we have N grid-leak-and-condensers, each reducing the amplification in the ratio, $\dfrac{pT}{\sqrt{1 + p^2T^2}}$.

So that at low frequencies,

$$\left|\frac{E}{v}\right| = m \cdot (pT/\sqrt{1 + p^2T^2})^N \quad \ldots \quad (5)$$

Also

$$\frac{e}{E} = \frac{s}{r_2 + s} \cdot \frac{\dfrac{(r_2 + s)/jpC_2}{r_2 + s + 1/jpC_2}}{R_2 + \dfrac{(r_2 + s)/jpC_2}{r_2 + s + 1/jpC_2}} \quad \ldots \quad (6)$$

Approximating by means of assumptions (*d*) and (*e*) above, we have

$$\left|\frac{e}{E}\right| \doteq \frac{s}{R_2} \cdot 1/\sqrt{1 + p^2t^2} \quad \ldots \quad \ldots \quad (7)$$

in scalar form.

We also have

$$\frac{v}{e} = \frac{R_a}{R_1 + R_a} \cdot \left(\frac{(R_a + R_1)/jpC_1}{R_a + R_1 + 1/jpC_1}\right) \Big/ \left(r_1 + \frac{(R_a + R_1)/jpC_1}{R_a + R_1 + 1/jpC_1}\right) \quad \ldots \quad \ldots \quad (8)$$

which when approximated as above and reduced to scalar form gives

$$\left|\frac{v}{e}\right| = \frac{R_a}{R_1 + R_a} \cdot 1 \sqrt{1 + p^2t^2} \quad \ldots \quad (9)$$

The condition for stability is that the scalar magnitude of the product of the vector losses and gains round the circuit shall be less than unity; *i.e.*, the product of the right hand expressions in (5), (7) and (9) less than unity; the product may be written

$$A \cdot \left(\frac{pT}{\sqrt{1 + p^2T^2}}\right)^N \cdot \left(\frac{1}{\sqrt{1 + p^2T^2}}\right)^2 < 1 \quad \ldots \quad (10)$$

where

$$A = \frac{msR_a}{R_2(R_1 + R_a)} \quad \ldots \quad \ldots \quad (11)$$

which is of exactly the same form as (1) if $n = 2$.

All the conclusions about Fig. 1 consequently apply to the resistance amplifier of Fig. 2 if the approximations assumed above are valid.

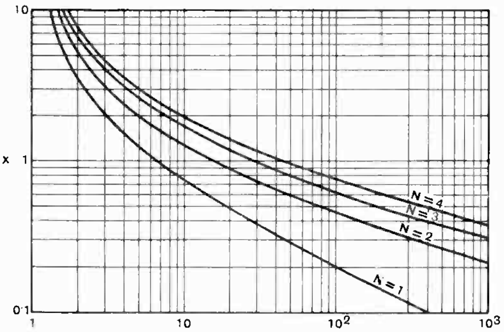


Fig. 3*a*.

Putting $n = 2$ in (3) we have

$$p^2T^2 = (N - 2 + \sqrt{(N - 2)^2 + 8Nx^2})/4 \quad \ldots \quad (12)$$

which determines the frequency of the "motor-boating" at the threshold of instability.

Putting $n = 2$ in (4) gives

$$A^2 \cdot \left(\frac{N - 2 + \sqrt{(N - 2)^2 + 8Nx^2}}{N + 2 + \sqrt{(N - 2)^2 + 8Nx^2}}\right)^N \cdot \left(\frac{4x^2}{4x^2 + N - 2 + \sqrt{(N - 2)^2 + 8Nx^2}}\right)^2 < 1 \quad \ldots \quad \ldots \quad (13)$$

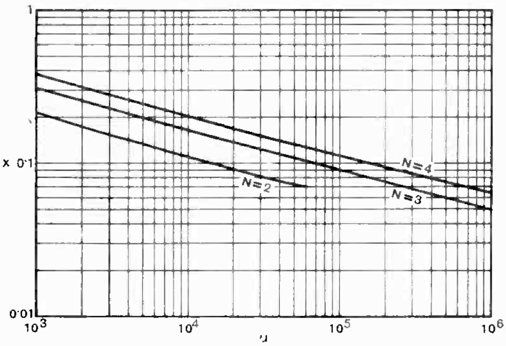


Fig. 3*b*.

For purposes of computation, this is most conveniently arranged in the form

$$A^2 < (1 + y)^N(1 + 1/x^2y)^2 \quad \ldots \quad (14)$$

wherein

$$y = 4/(N - 2 + \sqrt{(N - 2)^2 + 8Nx^2}) \quad (15)$$

and A is given by (11).

Putting

$$u = (1 + y)^N(1 + 1/x^2y)^2 \quad \ldots \quad (16)$$

we can plot graphs of u against x for $N = 1$, 2, 3, etc., corresponding to 2, 3, 4, etc., stages in the amplifier, which has been done in Fig. 3.

For the threshold condition of stability, $u = A^2$, and since all the quantities in the expression (11), for A are assumed known, u, and hence x, are also known for the threshold condition.

Calling these latter quantities U and X, the condition for stability is that u shall be greater than U; and since u is an inverse function of x, we have finally that the condition for stability demands that

$$x < X \quad \ldots \quad \ldots \quad \ldots \quad (17)$$

The equation (12) giving the frequency of threshold oscillation may be written in the more convenient form,

$$f = 1/2\pi T\sqrt{Y} \quad \ldots \quad \ldots \quad \ldots (18)$$

where Y is the value of y corresponding to a value X of x.

It will be noted from (16) that u cannot be less than unity, so that if $A < 1$, condition (14) is always fulfilled, the amplifier remaining stable whatever the value of x; which is otherwise obvious.

In order to substantiate experimentally the foregoing theory, it will suffice to show that there is agreement between the measured and calculated values of that resistance which, when inserted in the common H.T. supply lead to a given resistance amplifier, just causes instability.

Accordingly, a three-stage amplifier was set up with the following characteristics: $Ra = 35{,}000$ ohms. $R_1 = R_2 = 80{,}000$ ohms. $r_1 = r_2 = 5{,}000$ ohms. $C_1 = C_2 = 4$ mfd. giving $t = 0.02$. Grid condensers $= 0.1$ mfd. Grid leaks $= 0.5$ megohm. giving $T = 0.05$. $N = 2$. $m = 160$.

Now $x = T/t = 2.5$, and we find from the graph for $N = 2$ that $u = 3.9$; but $u = A^2$ at the threshold so that $A = \sqrt{3.9} = 1.975$.

Transposing (11) and inserting these values we find $s = 3{,}160$.

A resistance box was connected in series with the anode supply to the amplifier

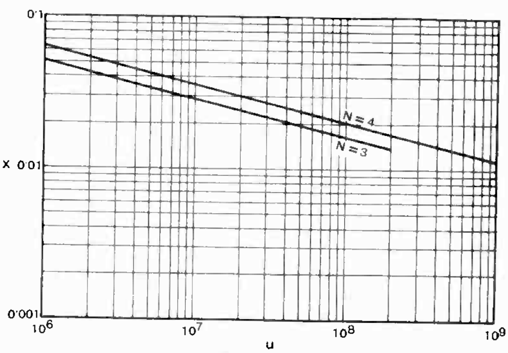


Fig. 3*c*.

(accumulators) and was set so as just to maintain oscillations, the resistance inserted being 2,990 ohms. the observed and calculated values of s thus agreeing within 6 per cent. which may be considered satisfactory for this kind of measurement.

The frequency of oscillation calculated from (18) was 5.04 c.p.s. and the observed frequency, 4 c.p.s., the discrepancy of about 20 per cent. being possibly due to variations in the grid leaks and condensers.

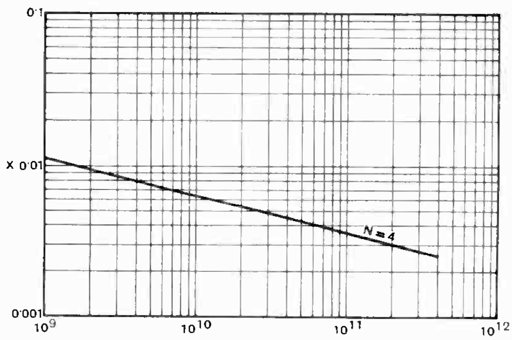


Fig. 3*d*.

Bearing in mind that the theory is approximate only, the above figures would indicate that it is sufficiently closely in agreement with reality for practical design purposes, especially since a large factor of safety will usually be allowed so as to take care of changes due to valve replacement and increases in battery resistance, etc.

If we are designing an amplifier and wish to determine the size of the decoupling condensers and resistances, the procedure will be as follows.

From the amplifier design proper, we shall have arrived at the values for m, N, R_a, R_1, R_2 and T, also s will be known from the details of the H.T. supply system, so that all the data are available for calculating A from (11). (Probably we shall allow a large factor of safety in s, say 100 per cent. increase.)

For the threshold of oscillation we have $u = A^2$, and from the graph for the correct value of N we read off the value of x, and since T is known, this determines t; the decoupling resistance will be determined by considerations of D.C. voltage drop, so we finally find the minimum permissible value for the condenser.

Direct Reading Harmonic Scales *

By D. C. Espley, M.Eng., A.M.I.E.E., and L. I. Farren, Wh.Sch., A.C.G.I., D.I.C.

(Communication from the Staff of the Research Laboratories of the General Electric Company, Limited, Wembley, England)

SUMMARY.—In this paper a number of simple scales are described which enable a rapid estimation to be made of the harmonic content of the current in thermionic valve output circuits with resistive loads. The scales are substantially direct reading and, with the limitation of convenient size, can be applied to valve characteristics plotted to any scale.

1. Introduction

If a line is drawn through the mean working point on the anode voltage—anode current characteristics of a thermionic valve such that its slope $-\frac{\partial E_a}{\partial I_a}$ is equal to the value of the resistive load in the anode circuit, then the harmonic content of the anode current can be obtained from the intercepts of this line and the curves of constant grid voltage. It will be clear that for n intercepts, the highest harmonic which can be calculated is of the order $(n - 1)$. The formula for the ratio of second harmonic to the fundamental current is well known for the case of three intercepts on the usual characteristics measured at equal intervals of grid voltage:

$$\frac{I_{2f}}{I_f} = \frac{1}{2}\left[\frac{I_3 - 2I_2 + I_1}{I_3 - I_1}\right] \quad \ldots \quad (1)$$

where I_2 is the working point anode current, and I_3 and I_1 are the positive and negative peak values of the anode current for a sinusoidal grid voltage input.

The familiar 9 : 11 scale for 5 per cent. second harmonic is derived from this equation, but the scale is neither sufficiently accurate nor flexible enough to warrant its general use. Improved scales are suggested which have the additional advantage that they provide a measure of harmonics of higher order than the second.

2. Second Harmonic Scale—3 Points

A more useful form for equation (1) is given in terms of $(I_3 - I_2)$ and $(I_2 - I_1)$ so that we may write

$$\frac{I_{2f}}{I_f} = \frac{1}{2}\left[\frac{(I_3 - I_2) - (I_2 - I_1)}{(I_3 - I_2) + (I_2 - I_1)}\right]$$

$$= \frac{1}{2}\left[\frac{\alpha/\beta - 1}{\alpha/\beta + 1}\right] \quad \ldots \quad (2)$$

where $\alpha = I_3 - I_2$

$\beta = I_2 - I_1$

To obtain the current differences α and β it is necessary to measure current values on the I_a axis. It will be seen in Fig. 1 that actual distances along the load line L_1L_2, between any particular intercepts, will

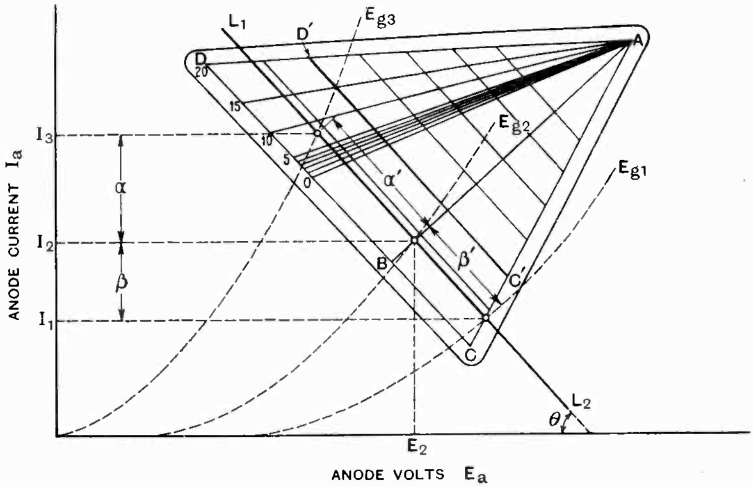


Fig. 1.—*Second harmonic scale—3 points.*

* MS. accepted by the Editor, November, 1933.

always be proportional to the differences between the relevant currents. Hence the ratios of these distances can always be used instead of the ratios of the current differences.

If $(I_3 - I_2) \operatorname{cosec} \theta = \alpha'$

$(I_2 - I_1) \operatorname{cosec} \theta = \beta'$

in which θ is the angle indicated in Fig. 1, then α' and β' will be distances measured along the load line L_1L_2.

Equation (2) can now be written

$$\frac{I_{2f}}{I_f} = \frac{1}{2}\left[\frac{\alpha'/\beta' - 1}{\alpha'/\beta' + 1}\right] \quad \ldots \quad \ldots \quad (2a)$$

The ratio of the intervals α' and β', to any arbitrary scale, is then obtained directly in terms of the percentage x of second harmonic.

Thus $$\frac{\alpha'}{\beta'} = \frac{50 + x}{50 - x} \quad \ldots \quad \ldots \quad (3)$$

Values of $\frac{\alpha'}{\beta'}$ are tabulated in Table I for various values of x.

TABLE I.

x	$\frac{\alpha'}{\beta'}$	x	$\frac{\alpha'}{\beta'}$
1%	1.04	5%	1.22
2%	1.08	10%	1.50
3%	1.13	15%	1.86
4%	1.17	20%	2.33

We see from Table I that for 5 per cent. second harmonic $\frac{\alpha'}{\beta'}$ is 1.22 or $\frac{11}{9}$. A scale of the form generally used for this particular value of harmonic is shown in Fig. 2, together with a modified version which makes use of the well-known radial divider principle commonly employed in the analysis of heat engine indicator diagrams. The extent to which OX and OY may be subdivided is purely arbitrary; four divisions are shown in Fig. 2 by way of example. The scale is arranged so that $\frac{OY_1}{OX_1} = \ldots\ldots = \frac{OY_4}{OX_4} = \frac{11}{9}$

This ratio is adopted for the division of the base CD of the triangle ACD in which $CD = XY$ and AB is perpendicular to CD. AB can be of any length, but is preferably of the same order as CD. It is clear that AB will divide any line parallel to CD, such as $C'D'$, in the ratio $\frac{11}{9}$. The advantage of this simple triangular scale lies in the fact that $B'D'$ can have any value between BD and zero, whereas in the other case OY is divided into four parts and hence, in all but four particular cases, interpolation is necessary. Further, if we require a set of scales similar to the lower one of Fig. 2, which will cover the range of harmonic percentages given in Table I, eight such scales are necessary.

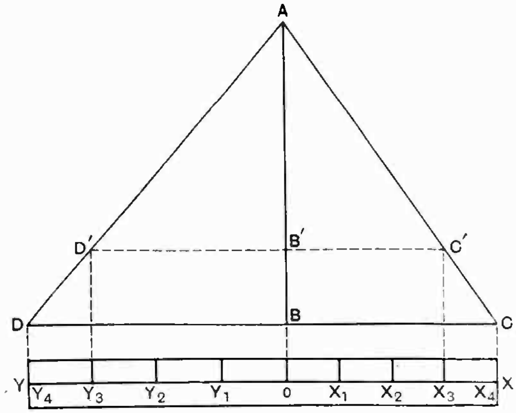


Fig. 2.—*Radial divider principle applied to the 5 % second harmonic scale.*

If in a measurement $\frac{\alpha'}{\beta'}$ has a value within the range of Table I, but is not one of the tabulated values, then none of the eight scales can fit. In such a case the estimation of the exact value of harmonic content is guesswork. This objection vanishes immediately if we embody the eight scales into a combined triangular scale using the radial divider principle. If the length OX is kept constant for the eight scales the length OY will be different for the various harmonic percentages, but its value can be calculated from Table I using the relationship $\frac{\alpha'}{\beta'} = \frac{OY}{OX}$.

The complete scale is shown in Fig. 1. BC represents the constant length OX and lines $A0$, $A1$, . . . $A20$ are engraved so that

$B0 = BC$

$B1 = 1.04\ BC$

$B2 = 1.08\ BC$

- - - - - - - - - - - -

$B20 = 2.33\ BC$

In a particular example chosen by the

authors, the scale was drawn on a triangular sheet of clear celluloid about $\frac{1}{16}$ in. thick, and BC and AB were 5 cms. and 16 cms. long, respectively. A maximum second harmonic content of 20 per cent. ($x = 20$) was considered sufficient for most purposes and thus from Table I, $BD = 2.33 \times BC = 11.65$ cms.

The procedure for measurement can be described with the aid of Fig. 1. The line AB is moved through the working point (E_2I_2), until AC passes through the I_1 intercept. The base CD is always kept parallel to the load line L_1L_2. The position of the I_3 intercept on the scale then indicates the percentage of second harmonic directly. In the example chosen it will be seen that this percentage x is about 8 per cent. To facilitate a rapid measurement a number of lines such as $C'D'$ are drawn on the scale, parallel to CD and spaced, say, 2 cms. apart. By this means it is always possible to adjust the scale by eye so that L_1L_2 and the nearest line $C'D'$, and hence the base CD, are parallel. It should be remembered that, apart from the very small geometrical inaccuracies which exist in the finished scale, an estimation of harmonic content obtained by this method is just as accurate as that derived by calculation from equation (1).

Where the graph paper used for plotting the characteristics has a wide spacing, the scale estimation is definitely more accurate as no direct readings of absolute current values are involved.

In some cases it may be found that $\frac{\alpha'}{\beta'}$ is less than unity, due to the phase of the second harmonic being reversed in sign. The rule is, that when $\frac{\alpha'}{\beta'}$ is greater than unity the second harmonic is considered as $-\frac{x}{100}\cos 2\omega t$ if the fundamental is $\sin \omega t$. For $\frac{\alpha'}{\beta'}$ less than unity, the second harmonic is $+\frac{x}{100}\cos 2\omega t$. The scale can still be used in the latter case and the procedure is to reverse the scale (*i.e.*, the upper surface is turned to the paper) and adjust AB until AC passes through the I_3 intercept, when the position of the I_1 intercept on the scale will give the value of x, to which must be attached the sign indicated above. The same effect may be achieved by rotating the scale through 180 deg. in the plane of the paper, so that A now lies on the opposite side of L_1L_2.

An alternative method would be to mark off reciprocal values of $\frac{\alpha'}{\beta'}$ within the length Bo, but the extra labour involved in constructing the scale does not seem justified since the reversed scale method is so easily applicable.

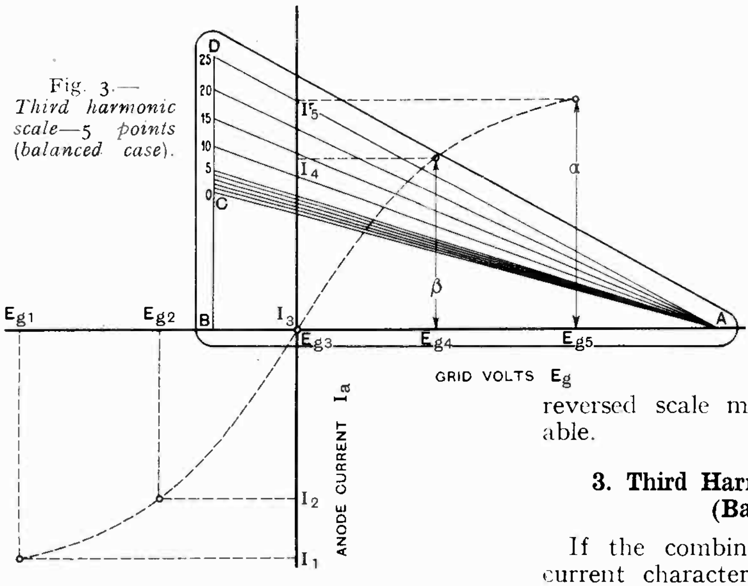


Fig. 3.—*Third harmonic scale—5 points (balanced case).*

3. Third Harmonic Scale—5 Points. (Balanced Case)

If the combined anode voltage—anode current characteristics are drawn for two valves in a balanced or push-pull circuit, then, assuming that the valves are matched, corresponding intercepts will be equally spaced along the load line from the working point. This means that all even harmonic components in the combined output current are absent. Fig. 3 shows the combined load line transferred to $E_g - I_a$ axes where the abscissae are in terms of the variable E_g and the ordinates represent the effective instantaneous values of the A.C. anode current. As the output current from a balanced circuit is equal to the difference between the currents in the side circuits, it will be clear that the load line of Fig. 3 can be plotted from the differences between the instantaneous values of the separate anode currents at corresponding values of the variable E_g.

If five points are available on this new load line we know that the third is the only harmonic which can be obtained by calculation, as the second and fourth must be absent.

It can be shown* that the ratio of the third harmonic to the fundamental current is given by the expression

$$\frac{I_{3f}}{I_f} = -\tfrac{1}{2}\left[\frac{I_5 - 2I_4 + 2I_2 - I_1}{I_5 + I_4 - I_2 - I_1}\right] \quad \ldots \quad (4)$$

This may be re-written for the case of symmetry about I_3 (*i.e.*, $I_5 + I_1 = 2I_3$ and $I_4 + I_2 = 2I_3$)

$$\frac{I_{3f}}{I_f} = -\tfrac{1}{2}\left[\frac{\alpha/\beta - 2}{\alpha/\beta + 1}\right] \quad \ldots \quad \ldots \quad (5)$$

where $\alpha = I_5 - I_3$

$\beta = I_4 - I_3$

If y is the percentage of third harmonic, then

$$\frac{\alpha}{\beta} = \frac{100 - y}{50 + y} \quad \ldots \quad \ldots \quad (6)$$

Values of $\frac{\alpha}{\beta}$ are tabulated in Table II for values of y from zero to 25 per cent.

TABLE II.

y	$\frac{\alpha}{\beta}$	y	$\frac{\alpha}{\beta}$
0%	2.00	5%	1.73
1%	1.94	10%	1.50
2%	1.88	15%	1.31
3%	1.83	20%	1.14
4%	1.78	25%	1.00

The scale is illustrated in Fig. 3. ABD is a right-angled triangle in which $BD = 2BC$. As the values of $\frac{\alpha}{\beta}$ for various values of y are known from Table II, we can subdivide CD so that

$$2.00\ B0 = BD$$
$$1.94\ B1 = BD$$
$$1.88\ B2 = BD$$
$$\text{- - - - - - - - - -}$$
$$1.00\ B25 = BD$$

The operation of the scale is similar to that described for the three intercept scale. The line AB is moved through the middle point I_3 until AD passes through point I_5. AB must always be perpendicular to the I_a axis. The position of I_4 on the scale then determines the ratio $\frac{\alpha}{\beta}$ and hence the percentage of third harmonic directly.

Owing to the symmetry of the curve, consideration of the points I_1, I_2 and I_3 would lead to the same result.

4. Third Harmonic Scale—5 Points. (General Case)

It has been stated previously that with n intercepts available, the highest harmonic which can be calculated is of the order $(n - 1)$. Hence for five intercepts we should be able to calculate the second, third and fourth harmonic amplitudes, or, more usually, their percentage ratios to the fundamental current.

In the case just described the circuit was considered balanced, and hence the even harmonics were not present. In some cases, however, with triode valves working as amplifiers in the usual way, or particularly in the case of pentodes, the third harmonic can be of the same order as, or even greater than, the second.

A scale will now be described which can be employed for estimating the ratio of third harmonic to the fundamental current, independent of the amount of second and fourth harmonics present.

Fig. 4 shows a set of anode voltage—anode current curves for a triode valve, drawn for five values of grid voltage, the intervals between the grid voltages being constant.

The dynamic load, which is considered resistive, is represented by the line L_1L_2 of slope $R = -\frac{\partial E_a}{\partial I_a}$ and passes through the working point H. The load line cuts the characteristics at F, G, H, J and K giving current intercepts I_5, I_4, I_3, I_2 and I_1 respectively.

* D. C. Espley, "The Calculation of Harmonic Production in Thermionic Valves with Resistive Loads," *Proc. I.R.E.*, vol. 21, October, 1933.

The corresponding grid voltages are E_{g5}, E_{g4} . . . E_{g1}, respectively.

If we assume that the voltage input to the grid is sinusoidal, and has a peak amplitude equal to $E_{g5} - E_{g3}$, then the alternating component of the anode current will be of the form

$$I_a = A_1 \sin \omega t + A_2 \cos 2\omega t + A_3 \sin 3\omega t + A_4 \cos 4\omega t \quad .. \quad (7)$$

where A_2, A_3 and A_4 may have either positive or negative signs. This is true since the wave is symmetrical about $\omega t = (2\tau + 1)\frac{\pi}{2}$ where τ is any integer, and thus all the even harmonic components will be cosines and all the odd harmonics will be sines.

For convenience we will assume that I_m is the mean anode current and that

$$(E_{g5} - E_{g3}) \sin \omega t = 0 \text{ when } t = 0.$$

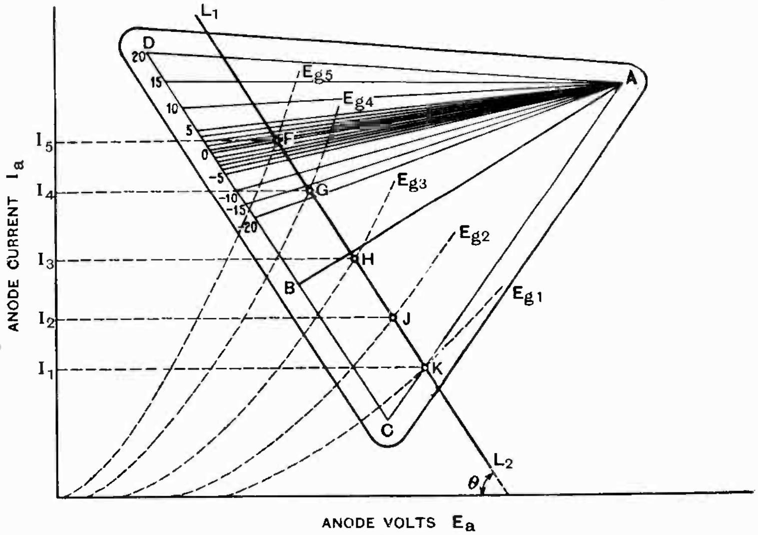


Fig. 4.—*Third harmonic scale—5 points (general case). First operation.*

On these assumptions we have :—

(1) At $\omega t = 0$ and π, $\quad I_m + I_a = I_3$.

(2) At $\omega t = \frac{\pi}{6}$ and $\frac{5\pi}{6}$, $\quad I_m + I_a = I_4$.

(3) At $\omega t = \frac{\pi}{2}$, $\quad I_m + I_a = I_5$.

(4) At $\omega t = \frac{7\pi}{6}$ and $\frac{11\pi}{6}$, $\quad I_m + I_a = I_2$.

(5) At $\omega t = \frac{3\pi}{2}$, $\quad I_m + I_a = I_1$.

Expanding these equations more fully, we get :—

$$I_1 = I_m - A_1 - A_2 + A_3 + A_4 \quad .. \quad (8)$$

$$I_2 = I_m - \frac{A_1}{2} + \frac{A_2}{2} - A_3 - \frac{A_4}{2} \quad .. \quad (9)$$

$$I_3 = I_m + A_2 + A_4 \quad .. \quad .. \quad .. \quad (10)$$

$$I_4 = I_m + \frac{A_1}{2} + \frac{A_2}{2} + A_3 - \frac{A_4}{2} \quad .. \quad (11)$$

$$I_5 = I_m + A_1 - A_2 - A_3 + A_4 \quad .. \quad (12)$$

From equations (8) to (12) we can get the following relationships :—

$$\left.\begin{aligned} \tfrac{1}{2}[I_5 - I_1] &= A_1 - A_3 \\ I_4 - I_2 &= A_1 + 2A_3 \end{aligned}\right\} \quad .. \quad (13)$$

Referring to Fig. 4 we see that

$$\left.\begin{aligned} \tfrac{1}{2}[I_5 - I_1] &= \tfrac{1}{2} FK \sin \theta \\ I_4 - I_2 &= GJ \sin \theta \end{aligned}\right\} \quad .. \quad (14)$$

$$\therefore \quad \frac{A_1 + 2A_3}{A_1 - A_3} = \frac{2GJ}{FK} \quad .. \quad .. \quad (15)$$

If we write

$$\frac{2GJ}{FK} = \frac{\alpha'}{\beta'},$$

then for a percentage y of third harmonic,

$$\frac{100 + 2y}{100 - y} = \frac{\alpha'}{\beta'} \quad .. \quad .. \quad (16)$$

If the coefficient of $\sin 3\omega t$ is positive the ratio $\frac{\alpha'}{\beta'}$ is greater than unity, but if the coefficient is negative then $\frac{\alpha'}{\beta'}$ is less than unity. Values of $\frac{\alpha'}{\beta'}$ are tabulated in Table III for various values of y, ranging from $-$ 20 per cent. to + 20 per cent.

The complete scale is shown in Fig 4. The base CD of the triangle is divided so that $\frac{BD}{BC} = \frac{\alpha'}{\beta'}$ for the maximum value of y (*i.e.*, + 20 per cent.) given in Table III.

TABLE III.

y	$\frac{\alpha'}{\beta'}$	y	$\frac{\alpha'}{\beta'}$
−20%	0.50	0%	1.00
−15%	0.608	1%	1.03
−10%	0.726	2%	1.06
− 5%	0.857	3%	1.09
− 4%	0.885	4%	1.13
− 3%	0.913	5%	1.16
− 2%	0.941	10%	1.33
− 1%	0.97	15%	1.53
		20%	1.75

BD is subdivided so that

$B-20 = 0.5\ BC$

$B-15 = 0.608\ BC$

$B0 \quad = 1.0\ BC$

$B20 \quad = 1.75\ BC$

The simple method of reversing the scale, which is employed with the second harmonic scale for measuring a harmonic with reversed sign, is not applicable in this case as the ratio $\frac{\alpha'}{\beta'}$ is not symmetrical

$$\left(i.e. \left[\frac{\alpha'}{\beta'}\right]_{y_1} \left[\frac{\alpha'}{\beta'}\right]_{-y_1} \neq 1.0\right).$$

This explains why additional lines are engraved on the scale in order to measure a third harmonic with a negative phase angle.

The procedure for measuring the percentage of third harmonic directly from the load line necessitates two operations, which can best be explained by reference to Figs. 4 and 5.

The first operation, illustrated in Fig. 4, is to bisect *FK*.

This is done by keeping *CD* parallel to the load line L_1L_2 and moving the scale until *A*0 and *AC* pass through the points *F* and *K* respectively. Thus *AB* will bisect *FK*, giving the term proportional to β' $\left(i.e., \frac{FK}{2}\right)$ required in equation (16).

The second operation is illustrated in Fig. 5.

AB is now moved towards *K*, keeping *CD* parallel to L_1L_2, so that the distance between the intersections of *AB* and *AC* with L_1L_2 remains constant.

The scale is moved in this manner until *AB* passes through *J*. This second operation determines α', and the position of *G* on the scale indicates the percentage of third harmonic directly.

In the case illustrated the percentage of third harmonic is 5.0 per cent.

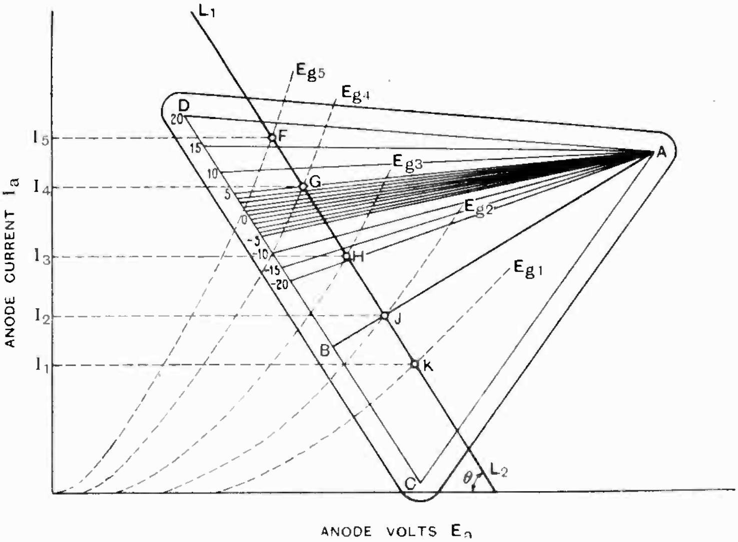


Fig. 5.—*Third harmonic scale—5 points (general case). Second operation.*

If, after the second operation, the point *G* lies between A_0 and *AB*, then the third harmonic has a negative phase angle with respect to the fundamental.

The scale shown will measure percentages up to ± 20 per cent. which is quite sufficient for most practical cases.

For uniformity of description of all the above scales *AB* has been shown perpendicular to *CD*, but it is clear that *AB* will divide any line parallel to *CD* in the ratio $\frac{BD}{BC}$ whatever the shape of the triangle.

Thus *A* could always be chosen so that *ACD* is an equilateral triangle, which facilitates the construction of the scale.

Inductance of Solenoids in Cylindrical Screen Boxes*

By W. G. Hayman, B.E., B.Sc.
(University of Western Australia)

SUMMARY.—A formula is given for the direct determination of the number of turns required for a given solenoid, and simple corrections which enable it to be applied to the case of screened coils. The formulae developed are then used to design the screened coils for a superheterodyne receiver.

IN a previous contribution (1) the derivation of a simple formula for the inductance of a solenoid was discussed. This formula, in perhaps its most convenient form, is:

$$L = \frac{d^2N^2}{17.8d + 40l} \text{ microhenrys} \quad .. \quad \text{(i)}$$

in which: d is the mean diameter of the winding in inches,
l is the length of winding,
and N the total number of turns.

Recently (2) Hideo Seki has adapted a nomogram to this formula which saves much computation, but which does not give the direct solution so much desired in design problems.

It is desirable that the number of turns of a given gauge of wire wound on a former of specified diameter to be placed in a given screen box, be directly calculable.

Starting with formula (i) as a basis and substituting for the winding length its equivalent in terms of the total turns (N) and the winding pitch (or turns per inch) n, a quadratic in N results, the solution of which may be written:

$$N = Lp\left[1 + \left(1 + \frac{18}{dLp^2}\right)^{\frac{1}{2}}\right] \quad .. \quad \text{(ii)}$$

in which $p = 20/nd^2$ .. .. .. (iii)

The limits of inaccuracy in this formula will be of the same order as stated in the original note for formula (i), viz., 2 per cent. over the range of d/l from 0.2 to 4.

Formula (ii) looks more difficult to handle than it really is, as apart from the two additions (of unity in each case) the whole calculation may be made on a slide rule with ease and with no temptation to excessive accuracy.

It is interesting to note that a variation in the diameter of the former of only a few thousandths of an inch will make as much as a whole turn difference in the length of winding of a medium wave broadcast coil (3) so that the accuracy of the formula should be ample for all preliminary design problems.

As an example of the use of the formula, a 380-microhenry coil 2in. in diameter, wound with 33 turns per inch, will be designed.

(a) $p = 20/nd^2 = \dfrac{20}{33 \times 4} = 0.151$

(b) $p^2 = 0.0227$

(c) $18/dLp^2 = \dfrac{18}{2 \times 380 \times .0227} = 1.042$

whence $N = 380 \times .151 \times 2.43 = 139$ turns.

A calculation by Nagaoka's method gives an inductance of 379.9 microhenrys; a fortuitous check which, although gratifying, is far beyond the normal limits of accuracy of the formula.

Having thus established a simple formula giving a direct estimate of the number of turns, the next step should consist of some simple modification to take into account the effect of the "screen can" as the Americans so aptly express it. Its effect, which always results in a reduction of the inductance, may be conveniently divided into two parts:

(a) That due to the mutual inductance between the single short-circuited turn (the "can" proper) and the coil, and (b) the effect due to the "ends" of the can on the coil.

In an admirable analysis of the "Modern Screened Coil" A. L. M. Sowerby (4) gives some excellent data and notes that "it has been usual to assume in the past that the

* MS. accepted by the Editor, November, 1933.

screen might be permitted to approach the side of the coil . . . but that the ends of the coil should be kept at a very respectful distance from the metal. The results show that the inductance is more seriously affected by the sides of the screen."

A consideration of the relative mutual inductance of coil and concentric short-circuited turn as compared with the mutual inductance between coil and the ends of the screen leaves no doubt as to the accuracy of the assumption. It should not be a difficult analysis to arrive at a mathematical expression, but for the present an empirical result may be stated.

A careful study of numerous test figures showed that the reduction in inductance followed roughly a relation based on the difference of the cubes of the diameter of the coil and the "can" and that to a first approximation :

$$L_{screened} = L_{unscreened} \times (D^3 - d^3)/D^3 \quad \ldots \quad \text{(iii)}$$

in which D = diameter of screen and d = diameter of coil.

This relation serves for short coils, but as the coil length approaches half that of the

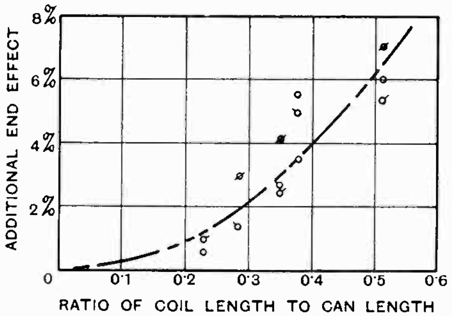


Fig. 1.

can an additional correcting factor seems desirable. By taking a number of coils of the same diameter but of different lengths and assuming that the cube relation holds, it is possible to draw a diagram as drawn in Fig. 1 showing the additional effect due to the proximity of the ends. For the correction to be easily applied it is essential that it be simple in form ; one such curve is shown on the diagram which corresponds to the relation.

$$\text{End effect correction} = \left(1 - \left(\frac{l}{2l_{can}}\right)^2\right)$$

in which l = length of coil and l_{can} = length of screen can. Whilst these factors make no pretence to theoretical form or to the correct division of the effect as between the side and ends of the screen, they do enable a coil to be designed to have a given inductance when screened. Their whole merit lies in the elimination of the cut and try method so often employed in the design of a screened coil.

To show what results may be expected, parts of Tables I and II of Sowerby's article in the September 23rd, 1930, issue of *The Wireless World* have been reproduced here (Table I), together with the computed inductance based on coils of 200 microhenry inductance (unscreened) in cans $3\frac{1}{8}$in. in diameter and 4in. long.

TABLE I.

Coil No.	d''	l''	N	Correction Factors.		Calculated L	Measured L	% Error.
1	$1\frac{1}{4}$	0.92	90	0.94	0.99	186	187	0.6
2	$1\frac{1}{2}$	1.10	80	0.89	0.98	174	176	1.1
3	$1\frac{1}{2}$	1.50	88	0.89	0.97	173	174	0.6
4	$1\frac{1}{2}$	2.0	98	0.89	0.94	167	168	0.6
5	$1\frac{3}{4}$	1.12	72	0.83	0.98	163	164	0.6
6	2	1.0	62	0.74	0.99	146	148	1.3
7	2	1.38	67	0.74	0.97	143	139	2.5
8	2	2.05	80	0.74	0.94	139	134	3.5

It can reasonably be claimed that a definite and simple design method has been established for screened coils of reasonable size compared with the screens, *i.e.*, coils which do not much exceed half the dimensions of the screen.

The whole process is singularly devoid of complicated formulae and awkward "constants" and is admirably suited to slide-rule computations. To illustrate further the use of the formulae derived it is proposed to apply them to the design of the antenna or signal frequency coils and the oscillator coils of a superheterodyne receiver.

The problem may be briefly stated as follows :—The signal frequency circuits are tuned by one section of a ganged condenser,* and another section is so "padded" that, in conjunction with a suitable oscillator coil, its frequency always differs by a constant amount from the signal frequency circuit.

Many analytical solutions to this problem

* Despite the appearance of many condensers having sections with a special "law" the majority of commercial designs still use the method outlined.

have appeared (5) (6) but none have been given in such a direct and useful form as by Landon and Sveen in a paper read before the Radio Engineers' Club of Chicago (5). They tabulate the ratio of the oscillator inductance

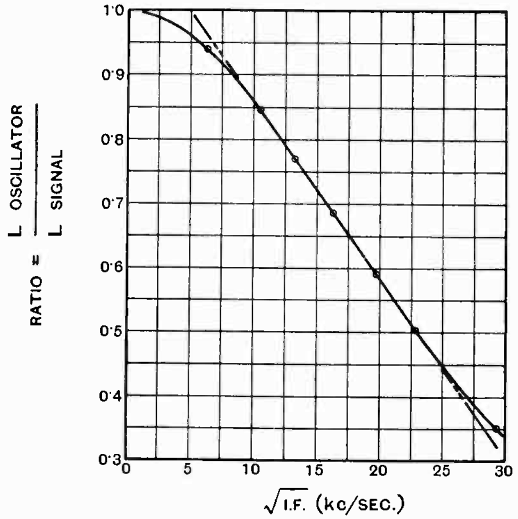


Fig. 2.

to signal frequency inductance and also the ratio between padder condenser capacity and maximum tuning capacity for various intermediate frequencies from 40 to 3,000 kilocycles per second. Their table, together with columns marked (i), (ii) and (iii), which are referred to in the Appendix, is reproduced in slightly modified form as Table II.

TABLE II.

No.	I.F. Kc/sec.	$\frac{C_{padder}}{C_{tune.\ max.}}$	(i)	$\frac{L_{oscillator}}{L_{signal}}$	(ii)	(iii)
1	40	11.59	—	0.939	—	1.2
2	110	4.27	4.22	0.845	0.844	3.2
3	175	2.71	2.73	0.770	0.768	4.9
4	265	1.82	1.85	0.683	0.684	7.1
5	465	1.08	1.08	0.536	0.536	11.6
6	520	0.97	0.97	0.501	0.502	12.2
7	1,000	0.55	—	0.309	—	19.7
8	1,700	0.37	—	0.176	—	28.3
9	3,000	0.25	—	0.0784	—	41.4

These constants and the formulae already deduced in the early part of this note enable the screened coils of the superheterodyne to be designed in a very direct manner which will now be demonstrated. Assume that the coils are required for the medium broadcast band with an intermediate frequency of 175 kilocycles, that the condenser has a maximum variation of 360 micromicrofarads and that the coils are to be wound with 33 S.W.G., d.s.c. wire on $1\frac{1}{2}$in. diameter formers screened in $2\frac{1}{2}$in. $\times 3\frac{1}{2}$in. cans.

For the assumed range the trimmer capacity will be about $45\mu\mu$F., so that the maximum tuning capacity will be $405\mu\mu$F. and the inductance to reach 550 metres will therefore be 211 microhenrys.

On the assumed former any gauge wire between 30 and 34 S.W.G. will give reasonable coils, and wire winding 80 turns per inch has been selected, so that :

$$p = \frac{20}{80 \times 1.25^2} = 0.16$$

and $\quad p^2 = 0.0256$

From equation (iii) we find that the "proximity factor" (or ratio of the inductance of the unscreened coil to that of the screened coil) is 8/7, and, assuming a 4 per cent. allowance for a coil length about

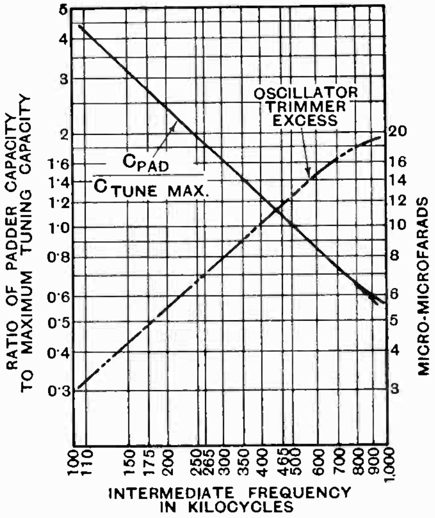


Fig. 3.

four-tenths the can length, the unscreened inductance of the coil will be $\frac{211 \times 8}{7} \times 1.04$ or 251 microhenrys.

Whence, $N = 251 \times 0.16$

$$\left[1 + \left(1 + \frac{18}{251 \times 1.25 \times 0.0256}\right)^{\frac{1}{2}}\right] = 112 \text{ turns.}$$

The oscillator inductance ratio for 175 kc/s intermediate frequency is 0.77, and proximity factor is as before, but, as the coil is shorter, a 2 per cent. " length factor " should suffice.

The factors give an effective inductance of 190 microhenrys so that

$$N = 190 \times 0.16$$

$$\left[1 + \left(1 + \frac{18}{190 \times 1.25 \times 0.0256}\right)^{\frac{1}{2}}\right] = 91 \text{ turns.}$$

APPENDIX

The values in Table II are also shown in graphical form in Fig. 2 and Fig. 3 from which values for other than tabulated frequencies may be interpolated.

From Fig. 2 it is obvious that in the range 100 to 600 kilocycles the ratio of the inductance of the oscillator coil to that of the signal frequency coil is related in a linear manner to the square root of the intermediate frequency.

Actually this ratio may be determined from the equation $1.136 - 0.0278\ (\text{I.F.})^{\frac{1}{2}}$, and values calculated from this equation are tabulated in column (ii), (I.F.) being expressed in kc/sec).

Likewise the ratio of the padder capacity to maximum tuning capacity may be calculated from a simple formula since the ratio is linearly related to the intermediate frequency when both are plotted in logarithmic co-ordinates (Fig. 3).

$$\frac{C_{\text{padder}}}{C_{\text{tune max.}}} = \frac{378}{(\text{I.F.})^{0.954}}$$

(I.F.) being expressed in kc/sec.)

Values calculated from this relation and given in column (i) of the table show a satisfactory coincidence with the original tabulated values.

Column (iii) gives the values of the excess trimmer capacity in the oscillator circuit to give the least deviation from the desired intermediate frequency as calculated by Sveen and Landon. These values are also shown in Fig. 3.

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6. Ganging the Tuning Controls of a Superheterodyne Receiver. A. L. M. Sowerby, *W.E. & E.W.*, Vol. 9, No. 101, Feb., 1932 (p. 70).

Books Received

Valve Oscillators of Stable Frequency.

A critical survey of present knowledge, by F. M. Colebrook, B.Sc., D.I.C., A.C.G.I. (Special Report No. 13 of the Radio Research Board).

The accuracy with which wireless transmitters can be adjusted and kept exactly on their allotted wavelength, has become a vital matter and the subject of much recent research by a special committee of the Radio Research Board whose progress up to the present time is outlined in this booklet.

Broadcasting and other large fixed stations can maintain a high degree of frequency stability by means of quartz crystal or tuning fork control, or by small-power master-oscillators, but these methods while eminently suitable for stations with fixed wavelengths involve somewhat elaborate equipment and are therefore unsuitable for ships and aircraft where several different wavelengths are employed, and where only much simpler apparatus can be used. The problem of providing frequency stability without elaborate equipment is at present being investigated.

The Report now published is divided into two sections. The first deals with the subject as a whole and constitutes a practical textbook of the fundamental principles, illustrated by reference to typical circuit arrangements used in practice. The second part consists of Abstracts from the most important published papers on the subject. Pp. 56 with 7 diagrams. Published by H.M. Stationery Office. Price 1s.

Télévision et Transmission des Images.

By René Mesny.

A short text-book on the theory and practice of Television and Phototelegraphy including the general principles, photoelectric cells, receiving and transmitting apparatus, synchronisation and amplification. Pp. 216 with 97 diagrams. Published by Armand Colin, Paris. Price 10.50 francs.

Short Wave Wireless Communication.

By G. W. Ladner, A.M.I.E.E., and C. R. Stoner, B.Sc., A.M.I.E.E. (2nd Edition, Revised and Enlarged).

A note of the First Edition appeared in our issue of January 13th, 1933. In the new edition additional matter has been included in the chapters on the Development of Short Waves, Electromagnetic waves, Propagation of Short Waves, Modulation, High Frequency Feeders, Aerials, and Ultra-short Waves. Pp. 384 + xii, with Frontispiece, 12 plates and 215 diagrams and illustrations. Published by Chapman and Hall, Ltd., 11, Henrietta Street, London, W.C.2. Price 15s.

Principles of Radio.

By Keith Henney, M.A. (2nd Edition, Revised and brought up to date).

A text book for students comprising the Fundamental Laws of Electricity, Ohm's Law, Generators, Inductance, Capacity, Properties of Alternating Currents, Coils, Condensers, Valves, Amplifiers, Rectifiers, Receivers, Transmitters, Television, etc. Pp. 491 + xii, with 311 diagrams and illustrations. Published by John Wiley and Sons, Inc., New York, and Chapman and Hall, Ltd., 11, Henrietta Street, London, W.C.2. Price 21s. 6d.

Recently published from the National Physical Laboratory, Teddington

The Valve Maintained Tuning Fork as a Primary Standard of Frequency.

By L. Essen, B.Sc., and the late W. D. Dye, D.Sc., F.C.G.I., F.R.S.

Read before the Royal Society in London on 14th December, 1933.

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.

Electron-coupled Transmitter

To the Editor, The Wireless Engineer

SIR,—The letter from Mr. A. D. Hodgson in the February number of *The Wireless Engineer* has just come to my notice. Mr. Hodgson is to be congratulated on the very thorough investigation he has made of the subject, with only the commercial pentode at his disposal. I should like to point out, however, that the authors were completely unaware of Mr. Hodgson's work on the subject.

Our experimental work showed that the screening provided by the suppressor grid was sufficiently good to make neutralising unnecessary, though the mesh of the suppressor grid was the same as that employed for the remaining grids. Any grid is an approximation to a complete screen, and considerable departures from an extremely close mesh can be made before complete instability results. Mr. Hodgson's difficulty in obtaining stability without the use of neutralising probably results from the fact that he was using the commercial type of pentode in which all the electrode leads are brought out through one pinch, in which case a certain capacity is introduced between the anode and the remaining electrodes, the effects of which can only be removed by neutralising.

The valves mentioned by Mr. Hodgson as having been used for his experiments were designed for use as low-frequency pentodes, without regard to high-frequency screening. They were not intended for use as electron-coupled oscillators, the frail structure of the second, or H.T., screening grid making them unsuitable for this purpose, apart from other disadvantages.

The limitations introduced by these disadvantages appear to make a comparison between Mr. Hodgson's work and our own somewhat difficult.

H.M. Signal School, R. A. YEO.
Portsmouth.

What is Reaction?

To the Editor, The Wireless Engineer

SIR,—In the January issue of *The Wireless Engineer* the two meanings of the word "demodulation" put forward by Mr. C. B. Fisher are discussed.

May I draw your attention to the word "reaction," from which derives the adjective "reactive," having also two meanings? A reactive network may signify a circuit with reactance or a network including a special form of feed-back. In English literature the term regeneration is more general and it seems to be more adequate for this purpose. The word retro-action is also extensively used. However, as it is used in France, the same meaning is very often denoted by the vocable reaction. It seems that it would be advantageous to get rid of this word, which may be definitively replaced by regeneration or retro-action. It is to be noted that the last word is more adequate for the construction of the equivalent of the verb "to react." To regenerate has already a different meaning. F. PINTO BASTO.

Lisbon.

Applications of the Dynatron

To the Editor, The Wireless Engineer

SIR,—It was with the greatest interest that I read the articles and correspondence in the *Wireless Engineer* on the frequency of dynatron oscillators.

Although this problem was discussed many a time, and has recently been thoroughly investigated by F. M. Colebrook in his excellent and valuable survey on the "Valve Oscillators of Stable Frequency" (Radio Research—Special Report No. 131), it seems to me that it will be very useful to emphasise some of the principal statements on this subject in connection with the recent correspondence of Mr. G. Farren Clarke in the February issue of the *Wireless Engineer*.

1. The theoretical considerations as well as the simple equations, which—in the majority of cases are used in the matter in question—relate to *the ideal conditions of the linear characteristic* and in this case only can we expect the full agreement between the theory and the experiment.

2. In this ideal case there is *only one critical value* of the dynatron *negative resistance*

$$(r) = -\frac{L}{RC} \quad \ldots \quad (1)$$

(R — series resistance of the coil L; C — capacity) where the formula for the angular frequency

$$\omega_1 = \frac{1}{\sqrt{LC}}\sqrt{1+\frac{R}{(r)}} \quad \ldots \quad (2)$$

has its physical meaning. Therefore, it is not possible to draw conclusions from the formula (2) beyond this critical condition. Consequently, it is not allowable to discuss the formula (2) in regard to (r) and R independently. This circumstance, however, has been reasonably observed by Mr. C. Farren Clarke in his correspondence, as well as in my correspondence to the *Wireless Engineer* (August 1932) and in my paper on frequency variation of oscillators (*The Proc. of the Instit. of Radio Eng.*, v. 21, No. 7, p. 961, July 1933).

3. The formula (2) shows that, as a rule, the angular frequency ω differs from the value *

$$\omega_0 = \frac{1}{\sqrt{LC}} \quad \ldots \quad (3)$$

In my opinion, this difference between ω_1 and ω_0 is not a matter worth troubling about, on condition

* ω_0 which is called by Colebrook: "maximum stationary value of the angular frequency."

that the value of (r) is constant. In an ideal dynatron and for a given circuit L, C, R, the resistance (r) must be constant and accurately determined, otherwise the formula (2) as well as all the considerations relating to the stationary state of work will not be applicable. If we suppose that (r) changes with change of the supply voltages we will be obliged to change at the same time R (or L and C) in order that the condition (1) be always accomplished.

The circumstance that the generated frequency (2) differs from the frequency (3) does not mean that the frequency stability of such a system is not good. If it is indispensable, it is always possible—by means of one of the many ways (*e.g.*, by additional resistance in the arm of capacity)—to obtain the circuit for which the frequency will be expressed by the formula (3); then the frequency will be *apparently* independent of the resistance (r). The same is seen also in the case of the formula (2), if we substitute (r) from (1).

$$\omega_1 = \frac{1}{\sqrt{LC}} \sqrt{1 - \frac{R^2C}{L}} \quad \ldots \quad (4)$$

4. In the real conditions of operation on the curved and limited characteristics the above formulae can be used only as approximate ones. The nearer the system is to the threshold of oscillation generation the better will be the approximation. Now, if the operative conditions (*e.g.*, the supply voltages) are varying and the system leaves the critical state, the frequency varies also. This frequency drift (in respect to ω_1), which can be explained by the appearance of harmonics, is given —in our case—by the formula.†

$$\frac{\triangle\omega}{\omega_1} = -\tfrac{1}{2}(3m_2^2 + 8m_3^2 + 15m_4^2 + \ldots) \quad (5)$$

(where

$$m_2 = \frac{V_2}{V_1}, m_3 = \frac{V_3}{V_1} \ldots \text{etc.}$$

V_1, V_2, V_3—etc., are amplitudes of the fundamental, the second harmonics, the third harmonics, etc. of the voltage across the circuit). Let us suppose that for given initial supply voltages the operation of the system is beyond the critical state, *i.e.*, we have a content of harmonics expressed by m_1', m_2', m_3', etc.

Thus, the frequency drift from (4) is given by the formula

$$\frac{\triangle\omega'}{\omega_1} = -\tfrac{1}{2}(3m_2'^2 + 8m_3'^2 + \ldots) \quad \ldots \quad (6)$$

Now, if we change the supply voltages, another content of harmonics expressed by m_1'', m_2'', etc., will correspond to these new voltages. The frequency drift from (4) will be

$$\frac{\triangle\omega''}{\omega_1} = -\tfrac{1}{2}(3m_2''^2 + 8m_3''^2 + \ldots) \quad \ldots \quad (7)$$

Therefore the proper frequency drift from the initial frequency is

$$\triangle\omega = \triangle\omega' - \triangle\omega'' = -\tfrac{1}{2}[3(m'_2 - m_2'')^2 + 8(m_3' - m_3'')^2 + \ldots] \quad \ldots \quad (8)$$

Generally, it is not possible to foresee what will be the sense of the frequency drift (the sign of $\triangle\omega$). It depends on the way in which the content of different harmonics varies with the variation of the supply voltages. As concerns the formula (4), ω_1 remains constant as long as the data of the circuit are constant, and the frequency variations can be estimated by means of the formula (8).

5. We can now explain the discrepancy between theory and experimental results in the oscillating system when we change, for instance, the resistance R and then calculate and measure the frequency. The change of R causes, on the one hand, the variation of ω_1 according to (4), and, on the other hand, the variation of the content of harmonics according to (8). Of course, calculation made on the basis of the formula (4) only cannot give good results.

6. Different impedances enclosed in the system (as, for instance, Prof. Mallet's series inductance outside the oscillatory circuit) can increase the frequency stability within a certain range of the variation of supply voltages. The increase of stability in this region is due to the equalisation of the energy distribution of harmonics, and not to the adjustment of the frequency to the phase value determined by (3). Thus, in order to explain Prof. Mallet's experimental results (the increase of frequency stability for varying supply voltages) the recourse to the postulation of a non-linear negative resistance is necessary. This recourse is still more necessary, as instability (due to the supply voltage variations) does not exist for a system with linear characteristics.

National Laboratory of Telecommunications, Warsaw, Poland. JANUSZ GROSZKOWSKI.

† J. Groszkowski, "The Interdependence of Frequency Variation and Harmonic Content and the Problem of Constant-frequency Oscillators," *Proc. of the Inst. of Radio Eng.*, v. 21, No. 7, July, 1933, p. 269.

Beat Frequency Oscillator

To the Editor, The Wireless Engineer

SIR,—I have read with interest the article on beat-frequency audio oscillators in your September 1933 issue and also the letter from Mr. Morgan in the February 1934 issue.

May I pass along some information that may be of interest to Mr. Morgan and other readers?

During the past ten years I have built nine different beat-frequency audio oscillators of different types. They all had various degrees of stability, which in the later three models I traced to the difference in temperature co-efficients of the fixed mica capacities used in their construction. In my experience any good form of inductance will be considerably more stable than the fixed condenser associated with it. This may account for the surprising stability noticed by Mr. Morgan in his later model.

I have checked this point by means of two large variable air condensers of the laboratory type and found that remarkable stability and freedom from drift could be obtained in this manner. With mica condensers we have the change in capacity due to operating current as well as the ambient temperature effects.

In all the articles I have read, greatest stress has been placed on using temperature compensated inductances, but very little, if any, mention is made of the mica condensers, their temperature coefficients or the proper design to follow to reduce the temperature effects to a minimum. I would be greatly interested in hearing from some of your other readers regarding their experiences in this respect. W. W. LINDSAY, JR.

Los Angeles,
California.

To the Editor, The Wireless Engineer

SIR,—In your February issue, Mr. F. G. Morgan contests my statement concerning the H.F. component in the oscillogram. The ripple shown in Fig. 14 appears, as the authors themselves point out, to consist solely of a 3.2 kc. note, and not of random impulses. In other words, it is a fairly pure tone of this frequency, and it is not readily believable that this could be described as sounding like valve hiss.

Your correspondent's mystification concerning tuned scratch filters and gramophone pick-ups is easily removed. Considering the better class of pick-up with a small and rigid armature, a resonance will be introduced into the frequency response due to the mass of the armature being driven through the compliance of the needle, the equivalent being formed of a series resonant circuit. The natural frequency will be between 4 and 6 kc., according to the relative mechanical reactances of armature and needle. Since, as I have previously stated, the disturbances communicated to the needle point are aperiodic (a moment's consideration of the nature of record material will render this apparent), they will cause the resonant circuit to emit its characteristic frequency in addition to scratch, and the relief given by a tuned filter is due to the fact that it attenuates the aggravated resonance.

Should Mr. Morgan be still unconvinced, let him meditate upon the fact that the tuned filter requires a different setting for different types of instrument: also that the oil-damped and at least one form of the needle armature class of pick-up have a sensibly aperiodic response, and the surface noise produced when using these is a high-pitched and colour-free hiss, the level of which is very low relative to the sound output.

A more probable explanation of the 3.2 kc. noise would appear to be that it is caused by some mains disturbance, in the form of a harmonic, due either to the mains themselves or to the harmonic-producing activities of the rectifying valve, and being either induced into the chokes by proximity to the power transformer, or by-passed from the rectifier by virtue of their self-capacity. In either case, it is significant that the output valve of the oscillator receives its plate current directly from the chokes, no resistance decoupling being incorporated, thus making either of these suggestions possible. The authors themselves are most fitted to settle the question, since they have all the necessary apparatus. The repetition of their experiment with a battery feed to the oscillator instead of that from the supply-unit would be very helpful. ARCHIBALD W. STEWART.

Manchester.

Decoupling Efficiency

To the Editor, The Wireless Engineer

SIR,—I am afraid I chose a rather unfortunate example to illustrate my point on decoupling efficiency, which you published in your November issue, but, since it has produced a most interesting letter from Mr. Stephens, perhaps we need have no regrets.

Referring to Fig. 1, Mr. Stephens arrives at the expression

$$\frac{\omega^2C^2R^2}{1 + \omega^2C^2R^2} \times 100\,\%$$

as representing the decoupling efficiency. This is perfectly correct, but only on two conditions: that the object of decoupling is to reduce degeneration, and that the anode load of the valve is purely resistive.

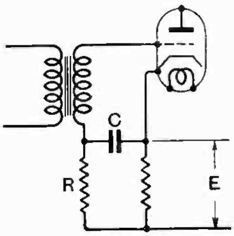


Fig. 1.

On commercial mains receivers the chief object in decoupling the grid circuit of a valve is to avoid any low frequency component of the imperfectly smoothed D.C. anode current from getting on to the grid of the valve and so producing hum. With this object in mind, the expression I gave for decoupling efficiency

$$100\left[1 - \frac{1}{\omega C\sqrt{R^2 + \dfrac{1}{\omega^2C^2}}}\right]\%$$

is correct since the phase of the voltage developed across the condenser C is immaterial except in so far as it affects its magnitude, and this is taken care of in the expression. This expression is also correct for any form of resistance capacity decoupling.

Incidentally, Mr. Stephens's results are not really so startling as they appear, since an error has crept into his arithmetic. The decoupling efficiency of 1 MF and 10,000 ohms at 50 cycles is, according to his own formula, 90 per cent. and not 9 per cent. Further on, his figures of 31,850 ohms and 138,000 ohms should be divided by ten.

London, W.1. R. I. KINROSS.

Patent Specifications

To the Editor, The Wireless Engineer

SIR,—I presume that there is some good reason why the official titles to Patent Specifications should give such vague information concerning the actual subject of their contents, but believe that the ordinary man who may have to consult these Specifications must often long for a less formal title which will tell him, in plain language, what is the chief matter of the invention.

Taking, for example, the first specification that I picked out of a file of Wireless Patents: No. 396822, which relates to Combined Volume and Reaction Control; the official title is "Improvements in Electric Wave Signalling Apparatus," which tells one nothing, and it is not till one has waded through the whole specification that the actual nature of the Patent is discovered.

I can imagine that anyone wishing to turn up Patents relating solely to Volume Control would have a very long and tedious task before him, and it surely should be possible for the authorities to permit of a descriptive sub-title which would indicate in plain language the actual subject-matter of the specification.

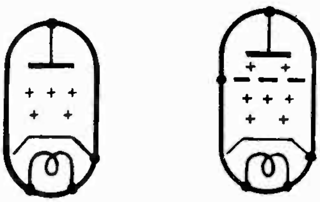
W. H. MERRIMAN.

Triode and Thyratron Symbols

To the Editor, The Wireless Engineer

SIR,—The following might be of interest to other radio engineers :—

Now that gas and vapour-filled rectifiers and thyratrons (relays) with thermionic cathodes are being increasingly used, I would suggest that some method of differentiating between these and vacuum valves, in the conventional circuit diagrams, would be advantageous ; at present a triode and thyratron have the same symbol.



RECTIFIER THYRATRON

The addition of several + signs scattered within the interior of the envelope, as indicated in the diagram, might serve to indicate the nature of these devices, viz., that, whilst possessing a thermionic cathode emitting electrons (shown in the usual manner) positive ions are also present within the tube to neutralise the space charge. If the + signs were arranged somewhat as shown one would not mistake their significance and assume that the grid, say, was at a positive potential.

Whilst a multiplicity of symbols for circuit diagrams is not desirable, I feel that some distinction between gas and vacuum tubes should be made as their electrical properties are so markedly different.

A. J. MADDOCK.

Monkseaton,
Northumberland.

A New Property of the Ear ?

To the Editor, The Wireless Engineer

SIR,—In taking acoustic measurements with loud speakers, it seemed, sometimes, as if the pitch of the tone, which has almost the sine form, changed when the ear was brought near the loud speaker.

In order to investigate whether it here concerned a personal deviation or a mistake in the apparatus, the same test was taken with a score of people with an *A* tuning-fork of 435 c/s.

If the tuning-fork was struck with force, it appeared that all the people with the tuning-fork near the ear heard a lower tone than when the tuning-fork was held at some distance.

Some persons with a trained ear for music took the difference to be about half a tone, so they heard the *A* as a *G* sharp.

If one lets the forcibly struck tuning-fork vibrate till the end right near the ear, one hears first of all a strong *G* sharp and a weak *A*. When the sound decreases, the strength of the *G* sharp becomes gradually less in proportion to that of the *A*, after which one hears the *A* only.

This makes one surmise that the ear hears the pitch of a tone, which has the sine form, in a different way when the intensity rises above a definite value. The following rough measurement was therefore taken :

With the aid of a tone-generator, different tones were produced by a loud speaker, the tonal purity was checked by a microphone with an amplifier to which a cathode-ray-oscillograph was connected.

The curves projected by the latter were not to be distinguished visibly from a sine-curve. The intensity, too, of the sound was always kept below " the highest limit of audibility."

It appeared that with the increase of intensity of the sound with constant frequency and sine form, according to the oscillograph, this lowering of the tone was clearly to be observed, even in the middle of the room.

In the case of very low tones one observes a rise of the tone.

With two persons with a trained ear for pitch, this symptom was further traced by making them advance the ear closer and closer to the loud speaker with every tone. They heard quite near the loud speaker the tones of 150–300 c/s about half a tone higher, and those of 350–3,000 c/s, from half a tone to one and a half lower than at a greater distance.

The result of their observations has been indicated in the list below (half a tone means a change in frequency of about 6 per cent.).

Frequency in Cycles per Second.	Impression of Change of Pitch with rather great Intensity on		
	Person A.	Person B.	
150 ..	$\frac{3}{4}$ tone +	$\frac{3}{4}$ tone +	
200 ..	$\frac{1}{2}$,, +	$\frac{1}{2}$,, +	
250 ..	$\frac{1}{2}$,, +	$\frac{1}{2}$,, +	
300 ..	$\frac{1}{2}$,, +	$\frac{1}{2}$,, +	
350 ..	$\frac{1}{2}$,, —	$\frac{1}{2}$,, —	
400 ..	$\frac{1}{2}$,, —	$\frac{1}{2}$,, —	
450 ..	$\frac{1}{2}$,, —	$\frac{1}{2}$,, —	
500 ..	$\frac{1}{2}$,, —	$\frac{1}{2}$,, —	
550 ..	$\frac{1}{2}$ to $1\frac{1}{2}$,, —	$\frac{1}{2}$ to 1 ,, —	(*a*)
600 ..	$\frac{1}{2}$,, $1\frac{1}{2}$,, —	$\frac{1}{2}$,, $1\frac{1}{2}$,, —	(*a*)
900 ..	$\frac{1}{2}$,, $1\frac{1}{2}$,, —	$\frac{1}{2}$,, 1 ,, —	(*a*)
1,000 ..	$\frac{1}{2}$,, —	$\frac{1}{2}$,, 1 ,, —	(*a*)
1,500 ..	$\frac{1}{2}$,, +	$\frac{1}{2}$,, —	
2,000 ..	$\frac{1}{2}$,, —	$\frac{1}{2}$,, —	
3,000 ..	$\frac{1}{2}$,, —	$\frac{1}{2}$,, —	
4,000 ..	? —	? —	(*b*)

(*a*) With the increase of intensity the pitch changed " within the ear " 6 to about 18 per cent.

(b) With 4,000 c/s it could not be estimated to how much the apparent decrease amounted.

I have not been able to find any announcement of this symptom in the literature on acoustics. Though one finds there symptoms which point to the appearance of "multiples" of the key-tone, whilst the resonance-theory of the ear indicates that one can expect as many higher as lower (Fletcher, Trendelenburg, Richardson). As the above-mentioned symptom is somewhat "strange," it is perhaps desirable that closer measurements should be taken in a physiological-technical laboratory.

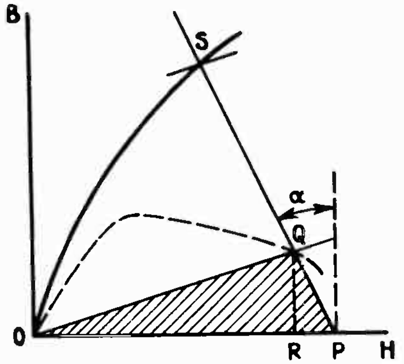
J. J. H. VRIJDAGHS,
Directeur Groningen Middelbare
Technische School.

The Alternating-current Inductance of an Iron-cored Coil Carrying Direct Current

To the Editor, The Wireless Engineer

SIR,—I want to add something to the interesting article, by R. T. Beatty, published in the February issue of your paper with the above heading.

Besides the graphical construction given there, in order to find the a.c. inductance, when the gap



ratio and the direct current are given, I want to mention the following simple method.

The curve *B-H* is drawn first (*OS* in the figure). Next, the straight line *PS* is placed on the diagram, taking $OP = m = \frac{4\pi TI}{x}$ (the magneto-motive force per cm) and $tg\alpha = \frac{a}{x}$ (gap ratio): *a* length of air gap and *x* length of path in iron. The point *S* thus found gives the magnetic working conditions. It is supposed that the incremental permeability, or the slope of a small loop, is known in each point *S* of the reversal curve of the iron. A straight line *OQ*, parallel to the axis of the small loop in *S*, is drawn through *O*. It can be proved that the resulting segment *QR* is equal to $\frac{LI}{AT}$ (*A* area of core section) and the shaded area to $4\pi\frac{LI^2}{V}$ (*V* volume of core). Thus, when $\frac{a}{x}$ varies, *L* can be represented by *QR*. The dotted line represents the locus described by *Q*. It is easy to see that *L* passes through a maximum when $\frac{a}{x}$ varies.

Bucarest VI. T. TANASESCU.

Effective Resistances of Inductance Coils at Radio Frequency

To the Editor, The Wireless Engineer

SIR,—Regarding my paper on "Effective Resistances of Inductance Coils at Radio Frequency," published in your January issue, an error occurs in the last two lines of paragraph 3.4. It should read "when $\frac{f}{p^2} > 10^8$ '*Pd*' settles down to the constant value of 0.165" instead of "*d*" settles down, etc.

Another point has also been mentioned by a correspondent, and that is that Figures 6, 7, 8 are not well defined. In Fig. 6, *M* is the number of layers on a solenoid, in Fig. 7, *M* is the number of layers on a disc coil, and Fig. 8 is for Multi-Layer Coils.

I regret that these errors have occurred; the first one I think must have been in the proof I corrected, although it is not in the original MS.

Kensington, W.10. B. B. AUSTIN.

The Cathode-ray Tube in Wireless Engineering *

IN this outstandingly good book the wireless engineer will find a labour-saving compendium, to which he will turn with complete confidence whenever he wants to know how to use the cathode-ray tube for any particular purpose, how to build the amplifier and time-base circuit most suited to that purpose, what photographic technique he should use, why he may have to take certain precautions and make certain corrections. His confidence will be enhanced by clear internal evidence that the book is no mere academic exercise, but that it is a systematic re-statement of the wide experience which Baron von Ardenne has accumulated in producing and applying some of the best general-service oscillographs ever made.

It is true that the best oscillographs he has yet made are still younger than this book of July, 1933, but that is surely the best of all evidence that he is the right man to take as a guide, so long as he can be persuaded not only to go on doing the work of oscillograph development, but to go on telling us how and why it is done in the particular way which has led to such striking successes in the last few years.

The book covers the whole field of the physical properties, the manufacture, and the uses of the sealed-off medium-voltage oscillograph. While it is true that tubes of this type were of some practical value from the time of Braun, the contribution of van der Bijl and J. B. Johnson in introducing controlled gas-focussing was of revolutionary importance, and opened the way to von Ardenne's own major contribution. The association by von Ardenne of the previously known Wehnelt cylinder with the previously known gas-focussing technique, coupled with a number of minor improvements, constituted a second revolution which put an end to a period of almost complete stagnation. Since that second revolution there has been no symptom of slackening pace. The Braun tube was apt to take longer in the setting up than in the using, the Johnson tube was almost exclusively a visual device, the modern sealed-off tube working on voltages of one to three thousand, and permitting photography of single traverses in which the recording spot moves at speeds of ten or twenty miles per second, is the product of the author of this book, and of those whom his early work has since stimulated into a healthy and still highly fruitful rivalry.

The author has the unusual merit of combining in a single book an adequate discussion of principles with an equally satisfactory group of practical instructions. The user cannot fail to gain from understanding the factors which prevent the oscillograph from behaving at the highest frequencies as a purely electrostatic device with an infinitely finely focussed indicating spot; if however he merely wants to know how to build a television amplifier he will find detailed circuit diagrams, specifying the values to be given to resistances, capacities and the like, awaiting him.

It is probably in relation to television that von Ardenne's book will be most eagerly read in this country. His belief that the future of television was almost certainly tied up with the future of the cathode-ray oscillograph was probably the main reason for his taking up the problems of the tube itself. In the last forty pages of this book he supplements the very detailed material of the earlier chapters, which deal fully with individual components and accessories, by a general discussion of their application in sound-film work and in television at the sending and receiving ends respectively. The discussion is eminently fair, and does not gloss over the acute difficulties of the general problem of television. It does however indicate that the more limited problem of "telefilm," the radio diffusion for home reception of images derived at the sending station from cinematographic film, is very near, if indeed it has not already reached, practical solution in relation to specially favoured localities, and that in this respect the cathode-ray tube is well on its way to the drawing-room.

The book is very cordially to be commended to the wireless engineer; it seems very desirable indeed that it should appear in an English edition.

R. A. W. W.

* *Die Kathodenstrahlröhre und ihre Anwendung in der Schwachstromtechnik* von Manfred von Ardenne, Berlin, 1933. Julius Springer; cloth 36 R.M.

The Industry

AMONG other new apparatus shown by British Radiophone, Ltd., of Aldwych House, Aldwych, London, W.C.2 at the recent British Industries Fair was a Portable Service Station. This compact and comprehensive test set embodies a modulated signal generator with accurately calibrated attenuator, energy for its operation being obtained from supply mains of any type and of voltages between 100 and 250. Wavelength range is 200–3,000 metres.

A meter with a 5in. scale provides A.C. and D.C. voltage and milliamp. readings from 0 to 1,000, both in three ranges. Two ranges are also provided for resistance measurements, and, in addition, the instrument is usable (with a conversion chart) as an output meter designed for input impedances of 4,000, 8,000 and 16,000 ohms. The price is £25.

A well-prepared catalogue, entitled "Technical Summary of Precision Apparatus for Radio- and Audio-frequency Laboratories" has just been issued by H. W. Sullivan, of Leo Street, Peckham, London, S.E.15. The apparatus described includes wavemeters, H.F. and L.F. oscillators, standard inductances, etc.

The introduction of an Osram A.C. heptode frequency changer is announced.

A new low-capacity metal rectifier, designed for efficient operation at frequencies as high as 1,000 kilocycles, has just been produced by the Westinghouse Brake and Saxby Signal Company, Ltd., of 82 York Road, King's Cross, London, N.W.1. This is known as the Westector, Type WX, and its uses are described in a technical leaflet just issued by the makers.

Abstracts and References

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PROPAGATION OF WAVES

INTERACTION OF RADIO WAVES.—V. A. Bailey and D. F. Martyn. (*Nature*, 10th February, 1934, Vol. 133, p. 218.)

This preliminary letter outlines a possible explanation of the interaction of waves from the Luxembourg broadcasting station with carrier waves from other stations, recently reported by Tellegen (and others: *see* March Abstracts, p. 144, l-h col.). The powerful waves affect the mean velocity of agitation of the electrons in the ionosphere and this produces a change in the frequency of collisions of electrons with molecules and hence in the absorbing power of that part of the ionosphere near the station; the latter will therefore vary in accordance with the modulation frequency of the powerful station and this will be impressed in part on any other carrier wave which may traverse this region. The effect may also be just appreciable in the case of the Warsaw station. For a new letter on Luxembourg interference *see* p. 206, r-h col.

ATMOSPHERIC PRESSURE AND THE IONISATION OF THE KENNELLY-HEAVISIDE LAYER [and the Presence of Winds in the High Levels of the Stratosphere].—D. F. Martyn. (*Nature*, 24th Feb., 1934, Vol. 133, pp. 294–295.)

Experiments carried out in Melbourne and Sydney during 1931 and 1932 have shown a very close correlation between the average night-time ionisation density in E layer and the barometric pressure at ground-level measured at a time ranging *from 12 to 36 hours after the ionisation observation*. The phenomena strongly suggest the presence of winds at high levels of the stratosphere.

IONOSPHERIC MEASUREMENTS IN THE POLAR REGIONS.—M. A. Bontch-Bruewitch. (*Nature*, 3rd Feb., 1934, Vol. 133, pp. 175–176.)

A brief note on the results of Polar Year wireless observations at Murmansk (68° 56′ N. 33° 05′ E) during June, July and August, 1933. The results agree in general with those obtained by Appleton at Tromsö (1933 Abstracts, p. 613: *see* also January, p. 28, r-h column). The writer finds that rapid motion exists in the ionised layer. "No increase of the shielding effect of the E layer and no changes in absorption have been observed at times when this layer dropped to a height of 65 km" which seems to indicate that such a low level of E layer corresponds to a deep barometric minimum of the upper atmosphere. A separate "absorbing layer" seems to be produced at times below the E layer, at a height probably less than 65 km. Undoubted correlation between the cessation of echoes and magnetic activity is found.

STUDIES OF THE IONOSPHERE [to April, 1933] AND THEIR APPLICATION TO RADIO TRANSMISSION.—S. S. Kirby, L. V. Berkner, and D. M. Stuart. (*Bur. of Stds. Journ. of Res.*, January, 1934, Vol. 12, No. 1, pp. 15–51.) The full paper referred to in the solar eclipse report (March Abstracts, p. 143, r-h column).

NOTE ON A MULTIFREQUENCY AUTOMATIC RECORDER OF IONOSPHERE HEIGHTS.—T. R. Gilliland. (*Proc. Inst. Rad. Eng.*, February, 1934, Vol. 22, No. 2, pp. 236–246.) *See* February Abstracts, p. 86, l-h column.

RADIO OBSERVATIONS OF THE BUREAU OF STANDARDS DURING THE SOLAR ECLIPSE OF AUGUST 31ST, 1932.—Kirby, Berkner, Gilliland and Norton. (*Proc. Inst. Rad. Eng.*, February, 1934, Vol. 22, No. 2, pp. 247–264.) *See* March Abstracts, p. 143.

THE EFFECT OF SOLAR ACTIVITY ON RADIO COMMUNICATIONS [Observations in 1933 on Sunspots and Medium, Short, and Ultra-Short Waves].—E. J. Alway and C. G. Phillips. (*World-Radio*, 23rd Feb. and 9th March, 1934, Vol. 18, pp. 282–283 and 360–361: to be concluded.)

AURORAS, ELECTRIC ECHOES, MAGNETIC STORMS.—J. Larmor. (*Nature*, 10th Feb., 1934, Vol. 133, pp. 221–223.)

Remarks on the principles underlying investigations of the structure of the ionosphere by wireless methods and on the connection of magnetic storms and auroras with anomalies in wireless radiation.

SCIENTIFIC WORK IN THE "CENTURY OF PROGRESS" STRATOSPHERE BALLOON [Ascent to 18 665 Metres' Height: Preliminary Report].—A. H. Compton. (*Proc. Nat. Acad. Sci.*, January, 1934, Vol. 20, No. 1, pp. 79–81.)

"The radio signals were transmitted with surprising clarity on a wavelength of 19.7 m.

Immediately upon leaving the earth the oscillation frequency of the transmitter changed by about 30%, due doubtless to change in capacity. Whereas close to the ground almost 100% modulation was necessary to transmit satisfactory signals, at high altitudes 30% modulation was sufficient. The signals were received directly at Chicago, New York and intermediate stations" [from New Jersey: power expenditure not mentioned].

STEADY STATES PRODUCED BY RADIATION, WITH APPLICATION TO THE DISTRIBUTION OF ATMOSPHERIC OZONE [Distribution of Ozone over Considerable Range of Altitudes].—O. R. Wulf. (*Phil. Mag.*, February, 1934, Series 7, Vol. 17, No. 111, pp. 251–263.)

ÄNDERUNG DER DIELEKTRIZITÄTSKONSTANTEN IM HOCHVAKUUM UNTER DEM EINFLUSS FREIER ELEKTRONEN (The Change of Dielectric Constant in a High Vacuum under the Influence of Free Electrons).—E. Muhrer. (*Hochf:tech. u. Elek:akus.*, January, 1934, Vol. 43, No. 1, pp. 1–12.)

The writer first discusses the work of other investigators; "only Bergmann and Düring and Mitra and Sil worked with an electron source in high vacuum," and "hitherto the experimental results have departed greatly from the theoretical predictions," for reasons which are outlined. For a criticism and bibliography of past work the writer recommends a *Dissertation* by Sven Benner (Stockholm, 1931). "In the work dealt with in the present paper a maximum capacity-change in a high-vacuum tube was obtained and accurately confirmed by calculation": contrary to the usual technique in which the electrons are shot through the condenser space, the tube was so designed (at Barkhausen's suggestion) that the condenser plates acted also as the anode. With this arrangement a 50% decrease of dielectric constant was attained, the wavelengths used ranging from 8.25 to 3.30 m.

Preliminary theoretical work indicates that an examination of the expression

$$\{1 - \sin 2\pi T/T_0 / 2\pi T/T_0\} \div (T/T_0)^2$$

shows that for $T/T_0 = 0$ a finite limiting value is approached, namely $2\pi^2/3$. Now the maximum possible percentage decrease of dielectric constant is given by this expression multiplied by $0.55 \times (a/b)^2$, so that by introducing this limiting value we have

$$\Delta\epsilon_{\max.} = 0.55 \times 2\pi^2/3 \times (a/b)^2 = 3.6 \times (a/b)^2\%.$$

This supposes that the current strictly follows the space-charge law and that all of it reaches the anode, which does not actually occur with a positive grid: the formula therefore gives somewhat too high results, but is useful in designing the tube. A ratio of 5 was chosen for a/b: *i.e.*, the distance from grid to anode was 5 mm, from cathode to grid 1 mm. The cathode was so constructed as to approximate to a flat surface. The whole tube was about the size of a receiving valve.

The measurements confirm the theoretical formula for the influence of wavelength and path time, and on the other hand furnish information regarding the high electron densities appearing in the grid/anode space in the region of positive grid potentials: these densities are 2–4 times as large as those calculated from potential and current. As the anode potential increases in comparison with the grid potential this difference grows smaller and smaller, and disappears when the grid potential is zero.

STOCKHOLM DISSERTATION ON THE DIELECTRIC CONSTANTS OF AN IONISED GAS.—Sven Brunner. (*See* preceding abstract.)

REFLECTION OF WAVES AT EARTH'S SURFACE [Calculation for Normal Incidence].—G. W. O. H. (*Wireless Engineer*, February, 1934, Vol. 11, No. 125, pp. 59–60.) Further development of the Editorial referred to in Feb. Abstracts, p. 86, l-h col.

DER BRECHUNGSINDEX DES WASSERS FÜR WELLEN VON 3–3.6 M LÄNGE (The Refractive Index of Water for Waves of Length 3–3.6 m).—M. M. Alimowa and N. S. Nowosilzew. (*Ann. der Physik*, 1934, Series 5, Vol. 19, No. 1, pp. 118–120.)

THE PROPAGATION OF ELECTROMAGNETIC WAVES ALONG INSULATING TUBES [Mathematical Investigation].—L. Zachoval. (*Acad. Tchèque des Sci., Prague*, Bull. International, 1932, pp. 136–146: in German.)

All the media are assumed to be absolutely non-conducting, and the innermost and outermost to be the same. If the free wavelength is near to the limiting value, the waves are propagated with the speed of light and the lines of force are perpendicular to the outer and inner surfaces of the tube: if the wavelength is very short, the field outside the tube falls exponentially in the radial direction, and at the axis the displacement current is opposite in direction to that at the surface.

DIE AUSBREITUNG ELEKTROMAGNETISCHER WELLEN IN EINEM SUPRALEITER (The Propagation of Electromagnetic Waves in a Superconductor [Theoretical Considerations]).—W. Braunbek. (*Zeitschr. f. Physik*, 1934, Vol. 87, No. 7/8, pp. 470–483.)

The complex index of refraction of a superconductor is found by making the specific resistance equal to zero in the expression given by the classical electron theory of metallic optics. The passage of a progressive wave through a thin superconducting layer and the penetration of a stationary wave [corresponding to the case of total reflection] are discussed on known theoretical lines and it is shown how the occurrence of a critical penetration frequency might lead to an experimental determination of a lower limit of the number of electrons taking part in the superconductivity [in analogy with determinations of electron density in the ionosphere].

THE PROPAGATION OF DISTURBANCES IN NON-HOMOGENEOUS ISOTROPIC MEDIA, AND WAVE PROPAGATION AND DIFFRACTION IN NON-HOMOGENEOUS ISOTROPIC MEDIA.—W. von Ignatowsky. (*Physik. Ber.*, 1st Jan., 1934, Vol. 15, No. 1, pp. 53–54 and 54.)

THE OPTICS OF NON-HOMOGENEOUS MEDIA.—M. Herzberger. (*Ibid.*, p. 54.)

REMARKABLE OPTICAL PROPERTIES OF THE ALKALI METALS.—R. de L. Kronig. (*Nature*, 10th Feb., 1934, Vol. 133, pp. 211–212.)

This letter considers more closely the interpretation of Wood's experiments proposed by Zener (March Abstracts, p. 144, l-h col.). The increase in transparency of thin films of alkali metals must be ascribed to a change in the coefficient of extinction [attenuation, absorption] rather than to a change in the reflecting power, as Zener suggests. Calculations in support of this view-point are given.

OPTICAL ROTATION OF UNPOLARISED LIGHT [Experiment proving Beam to be composed of Large Number of Plane Polarised Components of Random Distribution].—A. Langsdorf, Jr., and L. A. Du Bridge. (*Journ. Opt. Soc. Am.*, January, 1934, Vol. 24, No. 1, pp. 1–4.)

CHANGES OF PHASE AT NORMAL REFLECTION AT VERY THIN LAYERS OF GOLD.—P. Rouard. (*Comptes Rendus*, 8th Jan., 1934, Vol. 198, No. 2, pp. 164–166.) Continuation of the work referred to in 1933 Abstracts, p. 440.

THE INTERACTION OF LIGHT WAVES AND ELECTRONS: A CORRECTION.—E. L. Hill. (*Review Scient. Instr.*, January, 1934, Vol. 5, No. 1, p. 4.) Correction to a Note in the same journal, Vol. 4, 1933, p. 426.

A METHOD OF OBSERVING RIPPLES ON THE SURFACE OF LIQUIDS.—V. N. Thatte and P. S. Nilkanthan. (*Journ. Scient. Instr.*, January, 1934, Vol. 11, No. 1, pp. 29–30.)

SOME SEISMOLOGICAL ASPECTS OF THE BULLER EARTHQUAKE, 1929 [New Zealand].—L. Bastings. (*New Zealand Journ. of Sci. and Tech.*, September, 1933, Vol. 15, No. 2, pp. 128–142.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

THE NATURAL COURSE OF ATMOSPHERIC PROCESSES AND THE POSSIBILITY OF INFLUENCING THEM ARTIFICIALLY.—E. Wertheimer. (*Physik. Ber.*, 1st Jan., 1934, Vol. 15, No. 1, p. 87.)

THE OCCURRENCE OF LOCAL HEAT THUNDERSTORMS. 3RD COMMUNICATION:—THE DOWNPOURS IN BERLIN AND N. GERMANY ON 14TH AND 15TH JULY, 1932.—H. von Ficker. (*Physik. Ber.*, 1st Jan., 1934, Vol. 15, No. 1, p. 89.)

THE STORM OF 1ST JUNE, 1933, AT HANOÏ, TONKIN [particularly the Observation of "Undulating" Lightning Flashes, without Branching: Horizontal, Vertical, and with Left-Handed Spiral Movement towards North].—E. Mathias. (*Comptes Rendus*, 5th Feb., 1934, Vol. 198, No. 6, pp. 525–528.)

EINE BEMERKENSWERTE BLITZAUFNAHME (A Remarkable Photograph of a Lightning Flash).—B. Walter. (*Physik. Zeitschr.*, 15th Jan., 1934, Vol. 35, No. 2, pp. 88–91.)

The recording camera was slightly moved during a multiple flash and this enables a time analysis of the various branches to be made. The electrical constitution of the region where the flash strikes the ground has considerable influence on the nature of the flash.

THREE DISCHARGES OF BALL LIGHTNING.—M. Holmes. (*Nature*, 3rd Feb., 1934, Vol. 133, p. 179.)

This letter gives a short description of three discharges of ball lightning in Antrim on Jan. 11th, 1934.

LIGHTNING AND SUPPLY: ESTIMATION OF THE PROBABILITY OF DAMAGE AND INTERRUPTIONS.—E. T. Norris. (*Electrician*, 9th February, 1934, Vol. 112, No. 2906, pp. 187–190.)

CONTRIBUTION TO THE EXPERIMENTAL STUDY OF THE ELECTRIC DISCHARGE [by Recording on Film moving at 200 Metres/Second].—I. C. Purcaru. (*Comptes Rendus*, 8th Jan., 1934, Vol. 198, No. 2, pp. 158–160.)

FUNKENENTLADUNGEN IN LUFT-STAUBGEMISCHEN (Spark Discharges in Mixtures of Air and Dust [Influence of Quiet and Moving Dust on Discharge in Atmospheric Air—Marked Effect of Dust on Electrodes]).—S. Franck. (*Zeitschr. f. Physik*, 1934, Vol. 87, No. 5/6, pp. 323–339.)

ÜBER MESSUNGEN DER LEBENSDAUER VON IONEN IN FREIER LUFT (On Measurements of the Life of Ions in Free Air).—J. Scholz. (*Physik. Ber.*, 1st Jan., 1934, Vol. 15, No. 1, p. 75.)

STUDIES OF THE ATMOSPHERIC ELECTRICAL POTENTIAL DROP AND ITS FLUCTUATIONS, WITH SPECIAL ATTENTION TO THE EFFECT OF A CITY [and a Mathematical Relation to Terrestrial Magnetic Processes].—H. Kuhn. (*Physik. Ber.*, 1st Jan., 1934, Vol. 15, No. 1, pp. 76–77.)

LE CHAMP MAGNÉTIQUE DU TOURBILLON PRINCIPAL DES COURANTS ÉLECTRIQUES DE LA COUCHE CONDUCTRICE ATMOSPHÉRIQUE ET CELUI DU TOURBILLON PRINCIPAL DES COURANTS TELLURIQUES (The Magnetic Field of the Main Circulation of the Electric Currents of the Conducting Layer of the Atmosphere and that of the Main Circulation of the Earth Currents).—D. Stenquist. (*Physik. Ber.*, 1st Jan., 1934, Vol. 15, No. 1, p. 74.)

RATE OF IONISATION OF THE [Lower] ATMOSPHERE [Diurnal Variation].—A. R. Hogg. (*Nature*, 3rd Feb., 1934, Vol. 133, p. 175.)

POLARISATION OF THE SOLAR PROTUBERANCES.—B. Lyot. (*Comptes Rendus.*, 15th Jan., 1934, Vol. 198, No. 3, pp. 249–251.)

AUDIBILITY OF AURORAS AND LOW AURORAS [Low "Swishing" Aurora observed in 1908–1909 at Hartford, Conn.].—F. C. Kelley. (*Nature*, 10th Feb., 1934, Vol. 133, p. 218.) *See* also Jan. Abstracts, p. 31, r-h col., and Feb., p. 87, l-h col.; *also* 1933, p. 323.

COSMIC ULTRA-RADIATION AND AURORAE BOREALES.—A. Corlin. (*Nature*, 6th Jan., 1934, Vol. 133, pp. 24–25.)

Numerous observations during 1929–1930 indicate that cosmic-ray ionisation increased during the occurrence of aurorae, while during 1932–33 it decreased during aurorae; increased influence from the sun at sunspot maxima may account for the 1929–1930 increase.

ADDITION TO THE PAPER "FURTHER MEASUREMENTS OF COSMIC RADIATION IN THE STRATOSPHERE" [Influence of Sunspots on Intensity of Cosmic Radiation at Heights above 15 km].—E. Regener. (*Physik. Zeitschr.*, 1st Dec., 1933, Vol. 34, No. 23, p. 880.) For the previous paper *see* February Abstracts, p. 88, l-h column (two).

AN ATTEMPT TO DETECT RADIATION IN THUNDER CLOUDS.—W. A. Mackay. (*Proc. Camb. Phil. Soc.*, 31st Jan., 1934, Vol. 30, Part 1, pp. 70–73.)

The writer has attempted to detect radiation in thunderclouds by sending up photographic plates attached to balloons. Ten plates were recovered and examined; the result was negative in every case. A description is also given of a small ionisation chamber with quartz condenser, intended for the detection of radiation in thunder clouds.

COSMIC RAYS AND THE NEW FIELD THEORY.—M. Born. (*Nature*, 13th Jan., 1934, Vol. 133, pp. 63–64.)

"The new field theory proposed recently (*cf.* March Abstracts, p. 167, l-h col.) seems to be able to give the explanation of the high penetrating power of very fast particles, either protons or electrons, which is a serious difficulty in the adopted theory of electronic motion, that is, Dirac's equation." *See* also under "General Physical Articles."

THE MAXIMUM RANGE OF COSMIC RAYS [Theoretical Paper; Problem of Travel Time of Cosmic Rays the same as that of Time Scale of Universe].—P. S. Epstein. (*Phys. Review*, 15th Jan., 1934, Series 2, Vol. 45, No. 2, p. 136: abstract only.)

THE EXPANSION OF THE UNIVERSE AND THE INTENSITY OF COSMIC RAYS.—P. S. Epstein. (*Proc. Nat. Acad. Sci.*, January, 1934, Vol. 20, No. 1, pp. 67–78.)

THEORY OF THE ORIGIN OF COSMIC RADIATION [based on Assumption that Nuclear Charges can Disappear Slowly.].—R. M. Langer. (*Phys. Review.*, 15th Jan., 1934, Series 2, Vol. 45, No. 2, p. 138: abstract only.)

SUPERNOVAE AND COSMIC RAYS [Cosmic Rays Produced by Supernovae].—W. Baade and F. Zwicky. (*Phys. Review*, 15th Jan., 1934, Series 2, Vol. 45, No. 2, p. 138: abstract only.)

EXPERIMENTS ON THE DISTRIBUTION OF LOW-ENERGY COSMIC RAYS IN THE ATMOSPHERE.—W. E. Danforth and M. R. Lipman. (*Journ. Franklin Inst.*, January, 1934, Vol. 217, No. 1, pp. 73–78.)

The energy spectrum of cosmic ray secondaries is found to extend down to at least 5×10^6 electron volts: the intensity in rays per unit solid angle per square cm per sec., between 5×10^6 and 10^7 volts, is roughly 1/8 of the total intensity above 10^7 volts.

A NEW HARD COMPONENT OF THE COSMIC ULTRA-RADIATION.—A. Corlin. (*Nature*, 13th January, 1934, Vol. 133, p. 63.)

A hitherto unknown hard component of cosmic radiation has been found from measurements in a deep iron-ore mine near Kiruna, in Sweden.

MEASUREMENT OF THE IONISATION PER CENTIMETRE OF PATH BY INDIVIDUAL SECONDARY COSMIC RAYS.—W. F. G. Swann. (*Phys. Review*, 15th December, 1933, Series 2, Vol. 44, No. 12, pp. 961–968: *Journ. Franklin Inst.*, January, 1934, Vol. 217, No. 1, pp. 79–86.)

An abstract of preliminary work was referred to in 1933 Abstracts, p. 500. The accuracy of the present measurements establishes the ionisation per cm of path as about 90 ions per cm at atmospheric pressure in argon (corresponding to about 60 for air rather than about 150) and demonstrates the importance of double and triple rays, which contribute to the higher figure found by certain earlier observers.

HOFFMANN STÖSSE AND THE ORIGIN OF COSMIC-RAY IONISATION.—W. F. G. Swann. (*Phys. Review*, 15th December, 1933, Series 2, Vol. 44, No. 12, pp. 1025–1027.)

HOFFMANN STÖSSE AND THE ORIGIN OF COSMIC RAY IONISATION.—W. F. G. Swann. (*Journ. Franklin Inst.*, January, 1934, Vol. 217, No. 1, pp. 113–117.)

This letter points out "that an appreciable part, and possibly nearly the whole, of the observed cosmic-ray intensity may be attributed to bursts of the 'Hoffmann stösse' type in the atmosphere."

A POSSIBLE EXPLANATION OF THE FREQUENCY DISTRIBUTION OF SIZES OF HOFFMANN STÖSSE [in Cosmic Radiation].—C. G. Montgomery. (*Phys. Review*, 1st Jan., 1934, Series 2, Vol. 45, No. 1, pp. 62–63.)

CLOUD PHOTOGRAPHS OF COSMIC-RAY "STÖSSE" [Probable Generation of Neutrons: Discussion of Nature of Ionising Agents].—G. L. Locher. (*Journ. Franklin Inst.*, December, 1933, Vol. 216, No. 6, pp. 673–682.)

DISINTEGRATION OF ATOMS BY COSMIC RADIATION [Barometer Effect shows Presence of Very Soft Component: Secondary Radiation from Brick Walls].—E. G. Steinke, A. Gastell, H. Nie. (*Naturwiss.*, 22nd Dec., 1933, Vol. 21, No. 51, pp. 898–899.)

ATOMIC DISINTEGRATION [of Pb, Fe, Al, and C] BY COSMIC RAYS.—W. Messerschmidt. (*Physik. Zeitschr.*, 15th December, 1933, Vol. 34, No. 24, p. 896.)

PRELIMINARY REPORT OF THE RESULTS OF ANGULAR DISTRIBUTION MEASUREMENTS OF THE COSMIC RADIATION IN EQUATORIAL LATITUDES [pointing to the Radiation, within the Range of the Measurements, being Entirely Positive].—T. H. Johnson. (*Journ. Franklin Inst.*, Dec., 1933, Vol. 216, No. 6, pp. 781–785.)

THE LATITUDE VARIATION OF COSMIC RAY INTENSITY AND THE LENTICULAR FORM OF THE ATMOSPHERE [Absorption Hypothesis conforming with Observations assuming a 0.667 Axis Ratio for Elliptical Cross Section].—W. M. H. Schulze. (*Gerlands Beitr.*, No. 3/4, Vol. 38, 1933, pp. 353–356.)

VARIATION OF COSMIC RADIATION WITH LATITUDE.—P. Auger and Leprince-Ringuet. (*Nature*, 27th Jan., 1934, Vol. 133, pp. 138–139.)

The writers' measurements, with Geiger-Müller counters, of the variation with latitude of cosmic radiation coming in one particular direction agree with the results of other investigators of latitude variation. Measurements of angular distribution of the radiation gave asymmetry in the neighbourhood of the equator in favour of radiation coming from the west.

THE EAST-WEST EFFECT OF COSMIC RADIATION ON THE "ZUGSPITZE."—A. Ehmert. (*Phys. Review*, 1st Jan., 1934, Vol. 35, No. 1, pp. 20–25.)

THE IONISATION BY COSMIC-RAY PARTICLES AND SWIFT BETA-PARTICLES.—G. L. Locher. (*Journ. Franklin Inst.*, January, 1934, Vol. 217, No. 1, pp. 39–58.)

"The counting of droplets in cloud tracks may lead to erroneous values of the specific ionisation, because of a newly-discovered process of dissipation of energy along individual tracks passing through matter."

SCIENTIFIC WORK IN THE "CENTURY OF PROGRESS" STRATOSPHERE BALLOON.—Compton. (*See* under "Propagation of Waves.")

INVESTIGATION OF ELECTRON COUNTERS [for Cosmic Ray Ionisation].—C. Bosch. (*Ann. der Physik*, 1934, Series 5, Vol. 19, No. 1, pp. 65–98.)

COSMIC-RAY COUNTERS AND COSMIC-RAY COUNTS.—G. F. Hull. (*Phys. Review*, 1st Dec., 1933, Series, 2, Vol. 44, No. 11, p. 952: abstract only.)

A MORE SENSITIVE DESIGN OF THE GEIGER-MÜLLER COUNTER ["Vane-Type" Counter].—T. R. Cuykendall. (*Review Scient. Instr.*, December, 1933, Vol. 4, No. 12, pp. 676–678.)

PROPERTIES OF CIRCUITS

DEFORMAZIONE DELLA MODULAZIONE DI AMPIEZZA IN CATENE DI CIRCUITI RISONANTI (Distortion of Amplitude Modulation in a Series of Resonant Circuits).—G. Cocci. (*Alta Frequenza*, December, 1933, Vol. 2, No. 5, pp. 651–700.)

The following results are reached :—(1) The combination of two side-bands and carrier cannot represent a signal with pure amplitude modulation unless two supplementary conditions are satisfied, namely equal amplitudes of the two side-bands and equal and opposite phase differences with respect to the carrier. The transmission through a chain of resonating circuits destroys these relations and transforms the pure amplitude modulation into a mixed amplitude and phase modulation. (2) In the general case, besides the three parameters of the fundamental (amplitude, phase and frequency) and the frequency and phase of the modulation, three parameters are needed (instead of the simple depth of modulation m) to define the type of modulation. These are the depth of modulation m, the dissymmetry d/m, and the dephasing ϕ_d [$\phi_d = \frac{1}{2}(\phi'_a + \phi'_b)$: *see* p. 654]; they are thus the characteristic elements (semi-axes and inclination of the axes) of the modulation ellipse. (3) With these parameters it is possible to obtain, in a comparatively simple form, the expressions for the instantaneous values of the modulation of amplitude and phase.

(4) The expression for the amplitude modulation is especially important in that it expresses the output current of a linear detector to which the complex signal is applied. (5) The expression for the amplitude modulation is developed into a Fourier series, stopping at the terms involving the fourth powers of m and d : this series is satisfactory for modulation depths up to 70%. (6) By means of this series the harmonic distortion and the complex intensity of the output are calculated : the output intensity, for small values of dissymmetry d/m and dephasing ϕ_d, is roughly proportional to the modulation depth m ; it diminishes slowly with increasing d/m and rapidly with increasing ϕ_d. The harmonic distortion behaves similarly ; it is zero for pure amplitude modulation, takes on comparatively small values as d/m increases, and much larger values as ϕ_d increases ; both the harmonic distortion and the diminution of audio-frequency output become rapidly more marked, other things being equal, with increased modulation depth m.

(7) The formulae and tables given are applied to the rapid solution of simple cases, and some particulars of the working of a linear detector are studied. (8) Six parameters are defined for the characterisation of the transmission of a modulated signal through a linear network (p. 668 onwards). (9) The transmission through an oscillatory circuit is examined in detail. To characterise the losses a quantity depending on the circuit constants is chosen and named the "attenuation frequency." It is shown that if the modulation frequency is small compared with the attenuation frequency, there is no appreciable distortion ; if it is comparable, with lack of syntony there occurs a fairly marked dissymmetry d/m but a small dephasing ϕ_d ; finally, if it is large, detuning gives a ϕ_d which at first is quite large, but then decreases while the effect of d/m predominates.

(10) The above analysis is applied to broadcast receivers which, as regards their r.f. portions, can be treated as chains of resonant circuits in series ; the causes of distortion are examined, namely the intrinsic dissymmetry of the receiver (unequal transmission of the two side-bands of the signal to which it is tuned) and the detuning. The relative importance of these two factors is considered : the conclusion is reached that, with receivers in general use to-day, in view of the comparatively high values of the attenuation frequency the distortion in such circuits is normally small : but that it has great importance in special receivers of the "Stenode" type, or when it is

desired to extend the frequency range of the transmitted modulation (receivers for specially high quality of reproduction, or for television).

(11) The effectiveness of the ordinary [I.R.E.] tests for selectivity is examined and it is shown that under ordinary conditions they furnish with sufficient approximation the resonance curve of the r.f. portion of the receiver.

ITERATIVE IMPEDANCES [Corrections].—J. B. Pomey. (*Rev. Gén. de l'Élec.*, 27th Jan., 1934, Vol. 35, No. 4, pp. 105–106.)

Corrections to the paper referred to in 1933 Abstracts, p. 324.

THE PERFORMANCE OF A THERMIONIC TUBE AS RECTIFIER [Determination by Graphical Method without Any Assumption which may not be realised in Practice: Experimental Confirmation with Philips 505 Valve]. —T. Tanasescu. (*Wireless Engineer*, February, 1934, Vol. 11, No. 125, pp. 68–72.)

ON THE OSCILLATIONS OF A CIRCUIT HAVING A PERIODICALLY VARYING CAPACITANCE.—Barrow. (*See* under "Transmission.")

SUBHARMONIC FREQUENCIES PRODUCED IN NON-LINEAR SYSTEMS.—W. M. Goodhue. (*Journ. Franklin Inst.*, January, 1934, Vol. 217, No. 1, pp. 87–101.)

MECHANICAL MODEL FOR THE DEMONSTRATION OF "KIPP" PHENOMENA IN NON-LINEAR CIRCUITS WITH SATURATED CHOKES.—W. Volkers. (*Elektrot. u. Masch: bau*, 4th Feb., 1934, Vol. 52, No. 5, pp. 56–57.)

A NEW ANALOGY BETWEEN MECHANICAL AND ELECTRICAL SYSTEMS.—F. A. Firestone. (*Journ. Acous. Soc. Am.*, No. 3, Vol. 4, 1933, pp. 249–267.)

NEGATIVE LENGTHS OF TELEPHONE LINE [Construction of Equivalent Networks, using Negative Resistance Devices].—A. C. Bartlett. (*Phil. Mag.*, February, 1934, Series 7, Vol. 17, No. 111, pp. 230–232.)

DISCHARGE PHENOMENA IN OSCILLATORY CIRCUITS WITH SPHERE SPARK GAP AT ATMOSPHERIC PRESSURE.—W. Krug. (*Physik. Zeitschr.*, 15th Jan., 1934, Vol. 35, No. 2., pp. 76–82.)

TRANSMISSION

DER STETIG VERÄNDERLICHE ULTRAKURZWELLENSENDER OHNE DROSSELN (The Continuously Adjustable Ultra-Short-Wave Transmitter without Chokes [or Rejector Circuits, in the Supply Leads: and the Use of Completely Symmetrical Transmitters in a Multiple System for High Outputs]).—G. Renatus (*Hochf:tech. u. Elek:akus.*, January, 1934, Vol. 43, No. 1, pp. 12–15.)

Chokes and rejector circuits perform their function well in keeping the ultra-high frequencies away from the supply leads, and can be tolerated when the transmitter works on a fixed frequency and on a fixed site. They present serious disadvantages, however, whenever a frequent wave-change is necessary, or where (as in apparatus for diathermy, mobile equipments, etc.) conditions are unavoidably changed. The writer therefore has investigated the possibility of dispensing with them. He finds that this can be done provided the transmitter is constructed so as to be symmetrical *not merely as to its geometrical dimensions* but also as to its radiative properties and as to the relations of the potentials at anode and grid to each other and to earth. Under such conditions there occurs no difference in alternating potential, either in amplitude or in phase, between the two feeding points—the cathode and the mid-point of the grid/anode inductance; and also no differences between the feeding points and earth. Figs. 6 and 7 show the "completely symmetrical" transmitter. The latter figure shows an indirectly heated valve, and is arranged as a bridge circuit, all the various loss resistances being indicated. The symmetry is independent of frequency, and the excitation frequency can be varied by the grid/anode condenser C'_{ag} (*see* Fig. 5).

Such a circuit functions properly anywhere in its wave-range without the use of chokes or rejector circuits, and lends itself to perfect screening. It is extremely useful for measuring purposes, etc., since its calibration curve has no gaps, and no re-calibration is needed when the locality is altered or the batteries changed. A further important advantage is that a number of such circuits can be combined to form a multiple synchronous transmitter. Since the anode and grid inductances are equal, the usual $\lambda/2$-long line between every two systems can be omitted and the various systems placed at $\lambda/4$ intervals, the grid and anode sides being alternated so that the whole transmitter works correct as to phase. Unlike a push-pull combination, such a synchronous multiple transmitter continues to work, without an appreciable variation of frequency, if one of its units fails; moreover, valves of different types and size can be employed.

MODULATION OF VERY SHORT RADIO WAVES BY MEANS OF IONISED GAS.—E. G. Linder. (*Nature*, 17th Feb., 1934, Vol. 133, p. 259.)

The intensity of a beam of radiation of wavelength 9.5 cm can be easily modulated by causing it to traverse an ionised gas in a glow discharge (with ion densities of the order of 10^{11} ions/cm^3) in which the ion density is caused to vary. The modulation appears to be principally due to absorption.

ON THE OSCILLATIONS OF A CIRCUIT HAVING A PERIODICALLY VARYING CAPACITANCE.—W. L. Barrow. (*Proc. Inst. Rad. Eng.*, February, 1934, Vol. 22, No. 1, pp. 201–212.)

An experimental confirmation of the existence of interesting types of oscillation, predicted in a previous theoretical study (Abstracts, 1933, p. 565). The oscillations were generally of a complicated non-sinusoidal character, but for certain adjustments became sinusoidal. Thus for certain unstable conditions predicted by the theory, where the amplitude should increase without limit, the experimental circuit gave a large-amplitude sinusoidal oscillation. Some of the observed effects are met with in the acoustical application of frequency modulation (warble tone—1933, p. 45): "they are not thought to occur in any r.f. case of present occurrence (this would mean a modulating frequency comparable with or larger than the carrier frequency) but could be produced by suitable apparatus if desired."

OSCILLATORS WITH AUTOMATIC CONTROL OF THE THRESHOLD OF REGENERATION [for establishing Continuous Working at this Point, giving Constancy of Frequency].—J. Groszkowski. (*Proc. Inst. Rad. Eng.*, February, 1934, Vol. 22, No. 2, pp. 145–151.)

Résumé of the Polish paper dealt with in February Abstracts, p. 90. The method is applied first to the dynatron; then to the dynatron with back coupling; and finally to the binode, which is made to combine the functions of the two valves otherwise required, the tetrode portion acting as a dynatron, the diode as a rectifier for the automatic threshold control. With this last arrangement, using an indirectly heated binode, the stability for supply fluctuations not exceeding 10% was of the order of 10^{-5}.

APPLICATIONS OF THE DYNATRON [and the Discrepancy between Theory and Experimental Results as regards Frequency].—G. F. Clarke: Scroggie. (*Wireless Engineer*, February, 1934, Vol. 11, No. 125, p. 75.) Further correspondence on Scroggie's paper (*see* Abstracts, February, p. 90, r-h column): *cf.* also Usui, March, p. 150.

ELECTRON-COUPLED TRANSMITTER [and the Use of the High-Power Pentode: Earlier Work and British Patents: Doubtful Success of Suppressor Grid in providing Screening].—A. D. Hodgson: Drabble and Yeo: Dow. (*Wireless Engineer*, February, 1934, Vol. 11, No. 125, pp. 73–74.) *See* February Abstracts, p. 90, r-h column, for the paper prompting this letter.

A UNIVERSAL ANTENNA COUPLING SYSTEM FOR MODERN TRANSMITTERS: ALL-BAND OPERATION WITH ANY ANTENNA: IMPROVED EFFICIENCY: REDUCED HARMONIC OUTPUT.—A. A. Collins. (*QST*, February, 1934, Vol. 18, No. 2, pp. 15–17 and 86–87.) *See* also Everitt, 1931 Abstracts, p. 380.

OPTIMUM OPERATING CONDITIONS FOR CLASS C AMPLIFIERS [Analysis of Plate Efficiency and Output: Linear Amplifier with Any Desired Operating Angle: Rapid Method of determining Optimum Conditions: etc.].—W. L. Everitt. (*Proc. Inst. Rad. Eng.*, February, 1934, Vol. 22, No. 2, pp. 152–176.)

RADIOTELEGRAPH KEYING TRANSIENTS [Investigation of Their Nature and of Methods of Reducing Them].—R. Lee. (*Proc. Inst. Rad. Eng.*, February, 1934, Vol. 22, No. 2, pp. 213–235.)

LINEAR MODULATION BY A 55-TUBE [Duplex-Diode Triode: Economical Signal Generator with Linear and Variable Modulation: High Efficiency].—S. Bagno and S. S. Egert. (*Electronics*, January, 1934, pp. 16–17.)

NEUTRALISATION OF SCREEN-GRID VALVES BY BRIDGE CONNECTION BRINGING SCREEN GRIDS AND CATHODES TO EQUAL POTENTIALS.—W. Buschbek: Telefunken. (German Pat. 583 865, pub. 11.9.1933.)

DISCUSSION ON "DETERMINATION OF GRID DRIVING POWER IN RADIO-FREQUENCY POWER AMPLIFIERS" [Additional Confirmation under Different Conditions].—W. H. Doherty: Thomas. (*Proc. Inst. Rad. Eng.*, February, 1934, Vol. 22, No. 2, pp. 267–268.) *See* 1933 Abstracts, p. 621.

RECEPTION

DAS LEISTUNGSLOS GESTEUERTE BREMSAUDION (The Brake-Field Audion controlled without Power Expenditure).—H. E. Hollmann. (*E.N.T.*, January, 1934, Vol. 11, No. 1, p. 3–15.)

A preliminary account of some of this work was dealt with in 1933 Abstracts, pp. 621–622, and a further account, regarding the reception of decimetre waves, in January Abstracts, pp. 34–35. The present paper covers the following ground:—(1) the simple brake-audion: (*a*) the brake-field circuit as a resistance transformer; (*b*) the output load of the brake-field valve; (*c*) the automatic adjustment of the working point; and (*d*) matching by transformer. (2) Control of the brake-audion without power expenditure for broadcast band: (*a*) capacitive short-circuiting of "current interchange" (arising from the saturation condition $i_g + i_h = i_{em}$); and (*b*) back-coupling (vectorially reversed compared to a normal triode circuit).

(3) Application to ultra-short waves:—(*a*) short-circuiting the "current interchange" for waves of a few metres (capacitive short-circuiting hardly effective with present valves; no oscillations; moreover, the matching conditions of the simple directly modulated brake-audion are, in any case, much better here than for the longer waves); and (*b*) "inversion oscillations" (1933, pp. 563–564)—short-circuiting the current interchange for decimeter waves, generation of frequency spectrum with maxima for $n^2\lambda^2E_g$ = const. (4) The brake-field characteristic: consideration of the potential and space-charge relations in the brake-field space shows the formation of a virtual cathode in front of the brake electrode; the space between this and the brake electrode can be treated as a self-contained diode. Owing to the very low current density and relatively high field strength, the space charge is practically unnoticeable, so that the form of the characteristic depends exclusively on the Maxwellian temperature velocities of the electrons and on the voltage drop along the filament.

AUDION CIRCUIT FOR MEDIUM-WAVE RECEPTION WITH INTERPOSED OSCILLATING ULTRA-SHORT-WAVE CIRCUITS GIVING INTERNAL RE-TRANSMISSION AND INCREASED SIGNAL STRENGTH.—Krafft and Datzmann. (German Pat. 576 860: *Funktech. Monatshefte*, January, 1934, No. 1, p. 41.)

The incoming signals on (say) 500 m are rectified by the audion and modulate the locally produced 3 m oscillations due to the coupling between the circuits III and IV. The depth of modulation can be made as large as desired, and practically determines the amplitude of the l.f. oscillations in the anode circuit.

SUPER-REGENERATIVE RECEIVERS FOR ULTRA-SHORT WAVES.—(*World-Radio*, 2nd Feb., 1934, Vol. 18, No. 445, pp. 170–171.)

LINEAR RECTIFICATION [on Weak Signals: by use of Valve giving Reversed Plate Current with Straight Curve beyond Reversed Portion of Characteristic, combined with Diode to prevent Reversal: Sharp Cut-Off obtained]—R. Lambert. (*Electronics*, January, 1934, p. 21.)

DETECTOR CHARACTERISTICS [" Bottom Bend " in Leaky-Grid Detector Characteristic due to Harmonics between Grid and Filament: Not found when Voltmeter is protected by Filter].—P. P. Eckersley. (*Wireless Engineer*, February, 1934, Vol. 11, No. 125, pp. 72–73.)

AMPLIFICATION AND DETECTION WITH HIGH-RESISTANCE RECEIVING VALVES: CHARACTERISTICS REPRESENTED BY A SUMMATION OF POWERS OF EXPONENTIAL *e*.—Strutt. (*See* long abstract under " Valves and Thermionics.")

DIE ANWENDUNG VON DOPPELANODENRÖHREN ZUR RÜCKKOPPLUNG BEI RICHTVERSTÄRKERN UNTER BESONDERER BERÜCKSICHTIGUNG DER THEORIE DER RÜCKKOPPLUNG IN EMPFANGSSCHALTUNGEN (The Use of Double-Anode Valves for Retroaction in Amplifiers with Anode-Band Detection, with Special Attention to the Theory of Retroaction in Receiving Circuits).—W. Kautter. (*Physik. Ber.*, 15th Jan., 1934, Vol. 15, No. 2, p. 162.)

A Danzig Dissertation. The amplifier with anode rectification, compared with the audion with leaky-grid rectification, has the important advantage (particularly for strong signals) of smaller distortion; it has, however, the disadvantage of a harsher oscillation-threshold. The use has therefore been suggested of a valve with two anodes and a common grid and filament, one anode (with a large repose current) serving for retroaction purposes while the other (with a small repose current) carries out the rectification. The writer deals, by theory and experiment, with the action of such a valve. Its practical usefulness is limited by the fact that the two anodes act on each other by a mutual interaction of the two space charges: the rectification deteriorates as a result of the retroaction anode, and the oscillation characteristic is affected by the rectifying anode. These static interactions can only be eliminated by a complete screening of the space charges from one another, although the connection of a condenser between the two anodes improves the action to a certain extent. *See* also next reference.

ÜBER DIE STATISCHEN UND DYNAMISCHEN RÜCKWIRKUNGEN ZWISCHEN RÖHRENSYSTEMEN MIT GEMEINSAMEM GITTER BEI HOCHFREQUENZ (The Static and Dynamic Retroactions between Valve Systems with a Common Grid, for High Frequencies [Double-Anode Valves for Anode-Bend Detection and Retroaction]).—W. Kautter. (*Telefunken-Zeit.*, November, 1933, Vol. 14, No. 65, pp. 46–51.) *See* preceding abstract.

HOW DOES RETROACTION WORK IN A RECEIVER? [Straightforward Treatment of the Reaction Audion by the Use of Negative Conductances].—W. Kautter. (*Funktech. Monatshefte*, January, 1934, No. 1, pp. 11–14.) For previous papers on this method of treatment *see* 1933 Abstracts, pp. 622–623.

SUB-HARMONICS [Reception of Distant Stations: an Alternative Explanation based on Harmonics generated at Receiver: Interference by Luxembourg].—(*World-Radio*, 23rd Feb., 1934, Vol. 18, No. 448, p. 278.) Continuation of correspondence referred to in March Abstracts, p. 152, r-h column.

DISTORTION OF AMPLITUDE MODULATION IN A SERIES OF RESONANT CIRCUITS.—Cocci. (*See* under " Properties of Circuits.")

SUPERHETERODYNE RECEIVERS: VARIATION WITH FREQUENCY OF THE AMPLITUDE AT MIXING-VALVE GRID COMPENSATED BY A COUPLING, BETWEEN SIGNAL AND HETERODYNE CIRCUITS, WITH COEFFICIENT VARYING WITH FREQUENCY IN OPPOSITE SENSE.—Philips Company. (German Pat. 577 348: *Funktech. Monatshefte*, January, 1934, No. 1, p. 42.)

CONVERSION CONDUCTANCE.—(*Wireless World*, 23rd February, 1934, Vol. 34, pp. 131–132.)

Hitherto there has been little quantitative data published concerning the frequency-changer of the superheterodyne receiver. In this article the meanings of " conversion conductance " and " optimum heterodyne " are explained, and a table is given which should assist in the accurate design of the frequency-changer stage.

THE SCHALECO 7-VALVE BAND-FILTER SUPERHETERODYNE RECEIVERS [15–2 000 Metres: A.C. or D.C. Mains].—(*Funktech. Monatshefte*, January, 1934, No. 1, pp. 45–48.)

WORLD-RADIO A.C. SUPER-3 S.W. RECEIVER.—(*World-Radio*, 23rd Feb., 1934, Vol. 18, No. 448, pp. 269–272.)

SOME OF THE PROBLEMS OF MOTOR-CAR RADIO DESIGN.—F. Cutting and H. A. Gates. (*Rad. Engineering*, January, 1934, Vol. 14, No. 1, pp. 16–17 and 22.)

IMPROVED CIRCUIT FOR MULTI-VALVE RECEIVER HEATING FROM MAINS, REDUCING CHOKE MAGNETISATION BY D.C. COMPONENT.—Telefunken. (German Pat. 559 397: *Funktech. Monatshefte*, January, 1934, No. 1, p. 44.)

H.T. BATTERY CURRENT ECONOMY: THE " BOOSTER ECONOMY UNIT," TO GIVE SAME EFFECT AS Q.P.P. AND CLASS B METHODS.—Graham Farish Company. (*World-Radio*, 16th Feb., 1934, Vol. 18, No. 447, p. 232.)

TRACING FAULTS IN WIRELESS RECEIVERS. PART VII.—J. H. A. Whitehouse. (*World-Radio*, 2nd Feb., 1934, Vol. 18, No. 445, pp. 164–165.)

NEW DEVICE TAKES ADVERTISING OUT OF RADIO PROGRAMMES: TALK ELIMINATOR, SIMILAR TO AVC, DEPENDS FOR OPERATION ON PAUSES IN HUMAN SPEECH.—G. W. Kenrick. (*Sci. News Letter*, 6th Jan., 1934, Vol. 25, No. 665, p. 13.)

CATENARY VOLUME CONTROL [to "Bring Out the Low Notes at Low Volume Levels"].—Howard Radio Company. (*Electronics*, January, 1934, p. 20.)

QUIET AUTOMATIC VOLUME CONTROL [Partial but Useful Form of Quiescence without Extra Valve or other Component].—M. G. Scroggie. (*World-Radio*, 23rd Feb., 1934, Vol. 18, No. 448, pp. 278 and 279.)

LOGARITHMIC RECTIFICATION FOR FADING COMPENSATION, by COMBINING RECTIFIER WITH SUITABLY DISTORTING AMPLIFIER.—H. O. Roosenstein: Telefunken. (German Pat. 583 864, pub. 11.9.1933: additional to Patent referred to in March Abstracts, p. 153, l-h column.)

VOLUME CONTROL BY RETROACTION ADJUSTMENT [Range of Control increased by Introduction of Metal Damping Plate].—Barthélémy. (French Pat. 733 702: *Funktech. Monatshefte*, January, 1934, No. 1, p. 41.)

TWO-BAND TUNING BY USING LARGE CONDENSER FOR TUNING AND SMALL FOR RETROACTION, FOR LONG WAVES, and *vice versa* FOR SHORT WAVES.—E. Paul. (German Pat. 584 000, pub. 13.9.1933.)

TUNING SCALE WITH VERTICAL SLOTS AND MOVING DIAGONAL EDGE: RESONANCE INDICATED BY GLOW-DISCHARGE TUBE.—L. Rottenburg. (German Pat. 583 131, pub. 29.8.1933.)

TUNING MADE EASY [Various Types of Scale and Tuning Indicators, including Variable-Area Tuning Lamps].—(*Wireless World*, 9th February, 1934, Vol. 34, pp. 94–96.)

SIGNAL INDICATOR LAMP: A VISUAL AID TO ACCURATE TUNING.—J. J. E. Aspin. (*Wireless World*, 9th February, 1934, Vol. 34, p. 93.)

A special circuit is described for this device, which has "found some favour in American receiver design." An ordinary flash-lamp bulb is used.

SCALE ILLUMINATION BY MAINS-FED GLOW-DISCHARGE LAMP CONNECTED AS RECTIFIER AND SIMULTANEOUSLY PROVIDING THE GRID BIAS.—Philips Company. (Austrian Pat. 130 399: *Funktech. Monatshefte*, January, 1934, No. 1, p. 42.)

THE BEST AERIAL COUPLING.—M. G. Scroggie. (*Wireless World*, 2nd February, 1934, Vol. 34, pp. 70–72.)

Clearing up popular misconceptions on the subject of aerial coupling, and giving data on the choice of the most satisfactory operating conditions.

A SPARKLESS ELECTRIC BELL [without Make-and-Break] GIVING NO RADIO INTERFERENCE.—Établissements Deri. (French Pat. 754 314, pub. 6.11.1933: *Rev. Gén. de l'Élec.*, 27th Jan., 1934, Vol. 35, No. 4, p. 30 D.)

AERIALS AND AERIAL SYSTEMS

GERICHTETE RUNDFUNKANTENNEN (Directional Broadcasting Aerials [Transmitting Aerial with Suitably Spaced Reflector Aerial: Mathematical Investigation of Radiation-Fed and Directly-Fed Reflectors, and of the Optimum Spacing]).—R. Rücklin. (*Hochf:tech. u. Elek:akus.*, January, 1934, Vol. 43, No. 1, pp. 22–27.)

The increasing importance of such aerials is first pointed out. Section I deals with the calculation of the reflector current, as regards magnitude and phase, in a radiation-fed reflector at various distances from the transmitting aerial: for simplicity's sake the two aerials are taken to be vertical dipoles (vertical aerials and their images in the ground). The general expression for the reflector current is given in equation 4: in the case of resonance between the two aerials the last factor becomes unity, and Figs. 3 and 4 show the current ratios and the phase differences γ in the two aerials, for various spacings, calculated from the equation thus simplified. Section II deals first with the distant field strengths due to such a combination (whether the reflector is fed directly or by radiation) in various directions, leading to equation 6a for the characteristic of the system: the most favourable aerial action is obtained with $\gamma = 2\pi \cdot d/\lambda$, the most favourable reflector action with $\gamma = \pi - 2\pi \cdot d/\lambda$, shown by the dotted straight lines in Fig. 4. These lines intersect at $d/\lambda = 1/4$, where γ is 90°. With a directly fed reflector this value would be arranged, and if then the two currents were made equal the radiation in the direction opposite to that of maximum radiation would be entirely suppressed. The section then deals with the distant field strengths as functions of the radiated *power* at the transmitter, applying the results already obtained to the general formula for the radiation output from a system of linear radiators, and arriving at the formula 10a for the distant field (in mv/m) given by a radiated power N_s (in kw) in the system under consideration.

This formula is then applied, in section III, to the calculation of the night field strengths, for various vertical projection angles, in the direction of maximum radiation and at 45° to this direction; on the assumption of complete reflection at the Heaviside layer and complete absorption by the earth. Such calculations lead to the vertical characteristics of Figs. 8–10, for different reflector conditions. Fig. 11 gives the night field strengths of a 100 kw transmitter at various distances (forwards and backwards) along the direction of maximum radiation, for a directly fed reflector spaced $\lambda/4$, $\gamma = \pi/4$; one radiation-fed reflector spaced $\lambda/4$ and tuned for greatest aerial current; and another spaced $\lambda/5$ and tuned for the greatest screening action. Figs. 12 and 13 give the calculated polar diagrams for the field strengths, at four fixed distances, for a directly fed reflector spaced $\lambda/4$, $\gamma = \pi/2$ and a radiation-fed reflector spaced $\lambda/5$ and tuned for best reflecting action.

Section IV sums up the practical results deduced from these curves, as regards the merits of the three reflector arrangements. The forward radiation is the same, within about 20%, for all three; in output of energy, also, they are of equal value. But as regards screening action they differ considerably, the directly fed reflector being much the best, giving a backward field strength at 1 000 km which is only 1/60 of that in the forward direction. The radiation-fed reflector spaced $\lambda/4$ and tuned to resonance is the worst, giving a ratio of 1/2. The other radiation-fed reflector, spaced $\lambda/5$ and tuned (by local tests) to give greatest reflection, gives a ratio of 1/20. With all three types the ratio is reduced to 1/4 in directions at 45° to the maximum. Applying Figs. 12 and 13 to practical use, it is seen that for a backwards sector of 50° angle the field strengths at distances over 1 000 km can be reduced to 1/10 of those given by a non-directional aerial, by using either a directly fed reflector or a radiation-fed reflector tuned for maximum reflection. But the direct feed gives more margin, and moreover enables the screened sector to be considerably enlarged, since by suitable phase adjustment the maximum screening action can be arranged at an angle to the main backward direction instead of along it.

BEAM ARRAYS: INVESTIGATION OF THE ECONOMIC FACTORS OF DESIGN [Optimum Projection Angles: Supporting Structures: Transmission Lines: Relations between Capital Outlay and Field-Strength Gains].—T. Walmsley. (*Wireless Engineer*, February, 1934, Vol 11, No. 125, pp. 82–84.) Abstract of I.E.E. paper.

AERIALS AND AERIAL-SWITCHING ARRANGEMENTS FOR PRESENT-DAY RAPID WAVELENGTH CHANGES ON SHORT-WAVE SERVICES.—Mögel. (*See* abstract under "Stations, Design and Operation.")

DECREASING SAG OF CENTRALLY-FED AERIAL BY TAKING WEIGHT OF DOWNLEAD ON A TRIATIC STAY.—AEG. (German Pat. 577 645: *Funktech. Monatshefte*, January, 1934, No. 1, p. 43.)

BUDAPEST'S 1 030 FT RADIATOR [Steel Lattice Mast with Insulated Base].—(*World-Radio*, 16th Feb., 1934, Vol. 18, No. 447, pp. 231 and 235.)

FADING REDUCTION ON MEDIUM WAVES BY SIMULTANEOUS TRANSMISSION FROM A VERTICALLY POLARISED AERIAL AND FROM A HORIZONTALLY POLARISED SYSTEM OF TWO OR MORE AERIALS INCLINED TO EACH OTHER.—C. Lorenz Company. (German Pat. 583 862, pub. 11.9.1933: *Hochf:tech. u. Elek:akus.*, January, 1934, Vol. 43, No. 1, p. 35.)

SOPRA UNA DIMOSTRAZIONE PER LE FORMULE DEL CAMPO GENERATO DA UN'ANTENNA (Derivation [from Maxwell's Theory, without the Use of the Dipole Conception] of the Formulae for the Field generated by an Aerial [and the Convenience of Giorgi's "m-kg-s-Ω" System of Units]).—D. Graffi: Giorgi. (*Alta Frequenza*, December, 1933, Vol. 2, No. 5, pp. 645–650.) *See* 1933 Abstracts, p. 456, r-h column.

ULTRA-SHORT-WAVE BEAM AERIAL FOR TRANSMISSION OR RECEPTION, WITH ELLIPTICAL MIRROR AT FOCUS OF LARGER PARABOLIC MIRROR.—E. Gerhard. (German Pat. 584 272, pub. 16.9.1933: *Hochf:tech. u. Elek:akus.*, January, 1934, Vol. 43, No. 1, p. 35.)

"INVERTED-V" SHORT-WAVE AERIALS [Application to Empire Broadcasting Reception].—C. H. Smith. (*World-Radio*, 23rd Feb., 1934, Vol. 18, No. 448, pp. 280 and 283.)

RECEIVING AERIAL FOR ELIMINATING INTERFERENCE: AUXILIARY CONDUCTOR PARALLEL TO DOWN-LEAD AND CONNECTED TO EARTHED END OF AERIAL COUPLING COIL.—C. Lorenz Company. (German Pat. 583 644, pub. 7.9.1933: *Hochf:tech. u. Elek:akus.*, January, 1934, Vol. 43, No. 1, p. 35: Fig. 2, not Fig. 3 as shown.)

REDUCTION OF LOSS DUE TO EARTHED SCREENING OF SHIELDED DOWN-LEAD, BY EARTHING THROUGH ADJUSTABLE RESISTANCE OR CONDENSER.—Telefunken. (German Pat. 577 958: *Funktech. Monatshefte*, January, 1934, No. 1, p. 43.)

THE GAIN OF A RECEIVING LOOP CIRCUIT: NEGLECT OF $G_0/\omega C$ UNJUSTIFIABLE.—Taylor. (*See* abstract under "Measurements and Standards.")

VALVES AND THERMIONICS

FORTSCHRITTE IN DER ENTWICKLUNG VON GROSS-SENDERÖHREN (Progress in the Development of Large Transmitting Valves [Development and Construction of 300 kw Valve with Seamless Tubular Niobium Cathode and "Semi-Indirect" Heating]).—S. Ganswindt and K. Matthies. (*Zeitschr. f. tech. Phys.*, No. 1, Vol. 15, 1934, pp. 25–30.)

The reasons for the choice of niobium are discussed: having succeeded in making seamless tubes of this metal, exact in dimensions, the next step was to decide on the best method of heating, in order that with cylindrical coaxial electrodes (for the sake of uniform field distribution and consequent straightness of characteristic) there should be no appreciable magnetic field outside the cathode. Three methods were tried: "semi-indirect," electronic, and radiative: the first was found to be the best, although presenting a difficult practical problem. In this method the cathode and an internal concentric conductor form a go-and-return path for the current, but the internal conductor also acts as a heater, being constructed of tungsten wires arranged in tubular form. The cathode tube is supported at its far end by fixing it (with quartz insulation) to the closed end of the anode cylinder itself.

The magnetic field is so small that alternating current can be employed. The cathode takes about 1 700 A at 15 v. The r.f. output is 300–350 kw (efficiency 75%), the anode potential being 10 000–12 000 v. These valves are used at the Vienna station and at German high-power stations.

OPTIMUM OPERATING CONDITIONS FOR CLASS C AMPLIFIERS.—Everitt. (*See* under "Transmission.")

THE USE OF A BINODE IN A FREQUENCY STABILISATION CONNECTION, AS DYNATRON WITH AUTOMATIC THRESHOLD CONTROL.—Groszkowski. (*See* abstract under "Transmission.")

LINEAR MODULATION BY A 55-TUBE [Duplex-Diode Triode].—Bagno and Egert. (*See* under "Transmission.")

RADIOEMPFANGSRÖHREN MIT GROSSEM INNEREN WIDERSTAND (Radio Receiving Valves with High Internal Resistance: A. Radio-Frequency Amplifier Valves with a Single Control Grid: B. Modulator [Detector] Valves with a Single Control Grid).—M. J. O. Strutt. (*Hochf:tech. u. Elek:akus.*, January, 1934, Vol. 43, No. 1, pp. 15–18: 18–22.)

Following on the work dealt with in March Abstracts, p. 148. "In modern reception technique wide use is made of valves (*e.g.* tetrodes and pentodes) whose anode-current/control-grid-potential characteristic possesses a 'regulating' character: this involves, in general terms, that the anode current does not fall suddenly to zero as the control-grid potential becomes more and more negative, but sinks only gradually: *see* Ballantine and Snow's paper on the reduction of distortion and crosstalk by means of variable-mu valves, and Jobst's paper on similar valves [Abstracts, 1931, p. 156: 1932, pp. 226–227.]. The purpose of the present article is to give a simple method, supported by experimental checking, by which all the important properties of such valves can be calculated from the valve characteristic above mentioned. Since measurements of some of these properties (*e.g.* cross-modulation or distortion of modulator valves) are somewhat complicated, such a method is a great help to the practical worker, and moreover the calculation gives an insight into the influence of the course of the characteristic on other properties."

The fundamental idea of the method lies in representing the characteristic approximately by the sum of a number of terms in powers of (exponential) e. At least two such terms are in general required; theoretically there is no limit to their number, and the more there are the better the agreement with measured values but the more complicated the calculation. In Figs. 1 to 4 of Part A the grid voltage V is measured horizontally and the anode current vertically, and Fig. 1 is an example of the fact that in many cases a single power of e gives a good enough approximation, the formula here employed in calculating the curve (whose measured values are shown by the circular points) being simply $i = 28.7e^{0.995V}$, while on the other hand three terms involving different powers of e are needed to obtain the curve shown in Fig. 3.

For the consideration of the various distorting effects liable to occur in r.f. and i.f. amplifier valves (exaggeration of modulation, modulation distortion, production of harmonics of the carrier wave, cross-modulation, and rectifying action) the writer uses the approximate expressions 2, 3 and 4 given by Carter (1932, p. 587, l-h col.), and shows how the use of his own approximation, dealt with above and expressed generally by $i = \Sigma A_n e^{a_n V}$ .... (5), can be applied to these so as to dispense with the measurement of the coefficients a and γ involved in them, the necessary data being obtained by the measurement of the valve characteristic. Figs. 5 and 6 (for two different types of valve) show this method applied to the anode-current/grid-potential characteristics given in Figs. 4 and 1 respectively. The final section of Part A points out that for a given limit of modulation magnification, distortion, or cross-modulation the permissible peak voltage of the modulated carrier is proportional to $\sqrt{a/\gamma}$: this expression can be put in terms of the approximation 5 and in the case of a characteristic such as Fig. 1, where only a single power of e is needed, reduces to $\sqrt{6/a_n^2}$. In such a case, therefore, the permissible input voltage for a limited amount of distortion is inversely proportional to the slope of the "local equivalent straight line" of the characteristic, if the latter has its ordinates (anode current) plotted logarithmically.

All the above work in Part A applies only to valves whose internal resistance is much greater than the impedance in the anode circuit, so that the anode current is governed entirely by the control-grid voltage V, other voltages being assumed constant. This same limitation applies to Part B, which deals with detector valves. Here again it is assumed that the i/V characteristic can be represented approximately by $i = \Sigma A_n e^{a_n V}$, and this expression is used in considering the case where two voltages are applied to the control grid, one ($E_h \sin \omega_h t$) being from the local oscillator and the other ($E_i \sin \omega_i t$) the signal; the anode circuit of the detector is tuned to $|\omega_h - \omega_i| = \omega_0$. If the current flowing in this circuit in $i_0 \cos \omega_0 t$, the quantity i_0/E_i is entitled the "heterodyne slope" S_1 of the modulator (or detector) valve: with the help of the approximate summation for i the writer calculates S_1 for small and large values of E_h, E_i being assumed small in both cases. For small E_h, equation $5a$ shows that S_1 is proportional to E_h; for large E_h equation $5b$ gives the slope and, for the frequently occurring case of

$$E_h = -V_0 + \text{const.},$$

shows that as E_h increases i_0 and consequently S_1 again decrease: there must therefore be an intermediate value of E_h at which the heterodyne slope is a maximum (Herd, 1930 Abstracts, p. 629).

The writer then compares this quantity S_1 with the ordinary mutual conductance S, for the signal frequency ω_i in the presence of a second modulating voltage, of an amplifier valve. For small values of E_h, S is independent of E_h: for large values S is given by equation $6a$ and is thus exactly the same as S_1 (equation $5b$). The two equations 4 and $5b$ are made to form the basis of a simple method of measuring the heterodyne slope S_1, on condition that (as often occurs in practice) $a_n E_i \ll 1$ and $a_n E_h \gg 1$. A *single* voltage $E_h \sin \omega_h t$ of any suitable frequency is applied to the control grid, and the anode-circuit *direct current* is measured as a function of the grid d.c. potential V_0; E_h can either remain fixed or vary, provided always that $a_n E_h \gg 1$. Then, as shown by equation $4a$, the heterodyne slope is given by the first differential of the anode d.c. with respect to the control-grid d.c. voltage.

The next section deals with various types of distortion, and the resulting formulae show a close relation to the corresponding equations derived in Part A for h.f. amplifier valves.

Part B ends with some experimental curves, taken with the measuring circuit shown in Fig. 1, confirming the various theoretical results. Thus Figs. 2 and 3 show the measured values of heterodyne slope for two different valves, compared with the curves calculated from the anode-direct-current/control-grid-d.c.-voltage characteristic. The same equipment is used for measuring the coefficients in the series representing an anode-alternating-current/grid-alternating-potential characteristic: these coefficients play an important part in the investigation of h.f. amplifier valves. Finally the writer points out that modulator valves with two grids and two modulating voltages V_a and V_b can be treated in an exactly analogous way, the approximate formula being in this case

$$i = \Sigma C_n e^{a_n V_a + b_n V_b}.$$

INVERSE METHOD OF SOLVING TUBE PROBLEMS [and the Use of "Isoclines"].—I. G. Maloff. (*Electronics*, January, 1934, pp. 20–21.)

Paragraph on a *Broadcast News* paper amplifying the writer's I.R.E. Convention statement that in many cases it is easier to work the problem backwards.

THE PERFORMANCE OF A THERMIONIC TUBE AS RECTIFIER [Determination by Graphical Method without Any Assumption which may not be realised in Practice: Experimental Confirmation with Philips 505 Valve].—T. Tanasescu. (*Wireless Engineer*, February, 1934, Vol. 11, No. 125, pp. 68–72.)

THE USE OF A DOUBLE-ANODE VALVE FOR RETROACTION AND DETECTION.—Kautter. (*See* abstract under "Reception.")

THE STATIC AND DYNAMIC RETROACTIONS BETWEEN VALVE SYSTEMS WITH A COMMON GRID, FOR HIGH FREQUENCIES [Double-Anode Valves for Anode-Bend Detection and Retroaction].—Kautter. (*Ibid.*)

AMPLIFIER NOISE—A BIBLIOGRAPHY [of Four Recent Papers].—(*Electronics*, January, 1934, p. 20.) *See* below.

INFLUENCE OF CIRCUIT CONSTANTS ON RECEIVER OUTPUT NOISE.—J. M. Stinchfield. (*Radiotron-Cunningham Application Note* No. 25, 19th Oct., 1933.)

Mentioned in the above bibliography: "practical data are included enabling a receiver designer to keep output noise to the lowest value."

BEITRAG ZUR ENDRÖHREN-FRAGE (Contribution to the Output Valve Question [Comparison of Directly and Indirectly Heated Triodes and Pentodes: Linear and Non-Linear Distortion: the Optimum Load-Resistance: Future Development: etc.].—F. Berg. (*Funktech. Monatshefte*, January, 1934, No. 1, pp. 27–32.)

Of the twenty points derived from the investigation, the writer calls particular attention to Nos. 11 and 14. The former states that on the assumption of a lowest frequency of 160 c/s the optimum load resistance is about 1/5th of the valve resistance, while the latter points out that the maximum anode d.c. voltages do not agree with the maximum anode carrying capacities, and that these values should in future be made to agree. Other points are (No. 8) that linear distortion is least when the load resistance for middle frequencies (round 800 c/s) is equal to the valve resistance; (No. 9) that the modulation range is greater for a smaller load resistance, since larger a.c. grid potentials occur at the low frequencies; and (No. 12) that consequently the pentode has more advantage over the triode, as regards power delivery, than would appear from a consideration only of the optimum working characteristics.

VERVORMING EN AFGEGEVEN VERMOGEN BIJ EINDLAMPEN (Distortion of Output in Output Valves [Graphical Methods of Calculation]). A. J. H. van der Ven. (*Physik. Ber.*, 1st Jan., 1934, Vol. 15, No. 1, p. 48.)

SUR LE FONCTIONNEMENT DE LA BIGRILLE CHANGEUSE DE FRÉQUENCE (On the Action of a Two-Grid Valve as a Frequency Changer).—M. Lambrey and S. Krauthamer. (*Comptes Rendus*, 8th Jan., 1934, Vol. 198, No. 2, pp. 156–158.)

Contrary to those workers who consider the generation of the beat-note current to be due to a modification of the oscillatory régime of the inner grid under the influence of the instantaneous potential of the outer grid, the writer maintains that the r.f. variation of this latter potential has no effect in changing the oscillatory régime of the inner grid. "The two voltages $u_1 = U_1 \cos \omega t$ (outer grid) and $w_1 = W_1 \cos \omega' t$ (inner grid) are thus practically independent and the beat-note current results from the appearance, in the expression for the plate current, of a term in $u_1 w_1$ . . . A good approximation, in the general case, is obtained in the evaluation of the beat-note current by considering that the valve amplifies a very small sinusoidal voltage $u_1 = U_1 \cos\omega t$, its constants being considerably modified by the frequency ω' by the displacement of the working point under the influence of the instantaneous potential of the inner grid." Under the experimental conditions of a small load impedance, the amplitude of the beat-note current is given by $\frac{1}{2}(\partial^2 i/\partial u \partial w) U_1 W_1$. A table is given showing the beat-note currents measured and calculated on this basis: the ratios vary from unity to about 1.35. *See* also next abstract.

ON THE ACTION OF TWO-GRID VALVES AS FREQUENCY CHANGERS.—Y. Rocard. (*Comptes Rendus*, 5th Feb., 1934, Vol. 198, No. 6, pp. 554–556.)

"MM. Lambrey and Krauthamer [*see* preceding abstract] have called attention to the inadequacy of the point of view which attributes the beats in the plate current of a frequency-changing 'bigrille' to a kind of modulation of the heterodyne oscillation generated between the first grid and the plate. It is perhaps useful to obtain a clear idea of the mechanism of the phenomenon." The writer's analysis leads to equations 7 and 8. Of these he points out that for a given mean frequency $\omega' - \omega$, and for the reception of ω, the existence of the denominator in 8 leads to an important amplitude dissymmetry in the beats created by the term of frequency ω'. As regards the term of frequency $\omega(v_p)$, taking this into consideration means modifying the constants ϵ, α and β (in equation 2 for the plate potential v_p, derived from the static characteristic). "The expressions 7 and 8 suggest all kinds of technical consequences, some relating to the design of the 'bigrilles' and others relating to their use": *e.g.* the possibility of a retroactive effect, for $\omega > \omega'$, by regulating the control-grid/inner-grid and control-grid/plate capacities in such a way as to diminish the denominator of expression 8; and the possibility of neutrodyning.

THE OSRAM MX 40, A HEPTODE FREQUENCY CHANGER.—(*Electrician*, 9th February, 1934, Vol. 112, No. 2906, p. 199.)

DIE GRUNDPRINZIPIEN DER "HEXODEN" (The Basic Principles of the ["Mixing" and "Fading"] Hexodes).—K. Steimel. (*Telefunken-Zeit.*, November, 1933, Vol. 14, No. 65, pp. 33–46.)

The writer begins by pointing out that the basic principle of the hexodes (a name which should refer only to the four-grid valves here dealt with, not to any valve with six electrodes) really only demands three grids. He therefore first discusses the carrying-out of this principle (the two-fold control, without power consumption, of one and the same stream of electrons) by a three-grid valve, and then shows how a fourth grid became desirable in order that the "mixing" hexode should be able to generate the necessary heterodyning oscillations; this fourth grid now becomes the control grid for the heterodyne frequency, the third grid (now at a high positive potential) becoming an oscillating anode for this frequency (Fig. 31, for inductive retroaction coupling; Fig. 34, for the simple resistance-capacity coupling made possible by the fact that no phase rotation is necessary). After dealing with various points, including the decoupling of the signal and heterodyning oscillations (the coupling capacity between the electrodes in the mixing hexode is only of the order of $10^{-2}\,\mu\mu F$ compared with $5\,\mu\mu F$ for a s.g. valve) and the question of harmonic production, the writer turns to the "fading" hexode and its circuits and characteristics. He concludes by mentioning that a valve similar to the *mixing* hexode was developed independently in America, the pentagrid converter (*cf.* Lyons, 1933 Abstracts, p. 504): "a valve corresponding to the *fading* hexode has not appeared."

THE HEXODE.—W. Hasenberg. (*Funktech. Monatshefte*, May, 1933, No. 5, pp. 165–173.)

INDIRECTLY HEATED VALVES SUITABLE FOR ULTRA-SHORT-WAVE GENERATION: TYPES RS 282, 270 AND 272.—Elsner: Telefunken. (*See* March Abstracts, pp. 149–150.)

GRAPHITE-ANODE 205 D TUBE [and Its Advantages]. —Hygrade Sylvania Corporation. (*Electronics*, January, 1934, p. 29.)

ELECTRODES—CARBON AND GRAPHITE [History, Manufacturing Methods and Industrial Applications (No Reference to Valves)].—F. J. Vosburgh. (*Elec. Engineering*, December, 1933, Vol. 52, No. 12, pp. 844–848.)

ON THE HISTORY AND DEVELOPMENT OF THE THERMIONIC VALVE [Physical Society's Exhibition Discourse].—Ambrose Fleming. (*Journ. Scient. Instr.*, February, 1934, Vol. 11, No. 2, pp. 44–49.)

AN ELECTRICAL INSTRUMENT FOR DETECTING INVISIBLE FLAWS IN NON-MAGNETIC CONDUCTORS SUCH AS TUNGSTEN WIRE.—Dana. (*See* under "Miscellaneous.")

THE STRUCTURE OF OXIDE FILMS ON NICKEL [Electron Diffraction Method Shows Massive NiO with Rock-Salt Type Lattice].—G. D. Preston. (*Phil. Mag.*, February, 1934, Supp. No., Series 7, Vol. 17, No. 112, pp. 466–470.)

THE ADSORPTION OF HYDROGEN ON TUNGSTEN.—J. K. Roberts. (*Proc. Camb. Phil. Soc.*, 31st Jan., 1934, Vol. 30, Part 1, pp. 74–79.)

The method developed by the writer for studying the adsorption of hydrogen on a clean tungsten surface depends on the difference in the accommodation coefficient of neon for a bare surface and for a surface with an adsorbed film on it. The adsorption is found to be of the nature of chemi-sorption.

THE EMISSION OF ELECTRICITY FROM COLUMBIUM [Determination of Electron and Positive Ion Work Function].—H. B. Wahlin and L. O. Sordahl. (*Phys. Review*, 15th Dec., 1933, Series 2, Vol. 44, No. 12, p. 1030.)

ZUR ELEKTRONENTHEORIE DER METALLE (Electron Theory of Metals [Thermoelectric Effect and Thermionics]).—A. Sommerfeld. (*Naturwiss.*, 26th Jan., 1934, Vol. 22, No. 4, pp. 49–52.)

A note on the theory of the thermoelectric effect and of thermionics, showing the limits of application of the elementary theory as opposed to wave mechanics.

DIRECTIONAL WIRELESS

SMALL VERTICAL AERIAL FOR IMPROVING SHARPNESS OF GONIOMETER MINIMUM USED ALSO FOR SENSE DETERMINATION *not* BY AMPLIFYING ITS SIGNALS BUT BY REDUCING THOSE FROM FRAME AERIAL, BY ADDED RESISTANCES.—Telefunken. (German Pat. 574 373: *Funktech. Monatshefte*, January, 1934, No. 1, p. 43.)

CLOSED ADJUSTABLE RING ABOVE OR BELOW DIRECTION-FINDING FRAME, TO INCREASE RECEPTION FROM DIRECTIONS ADVERSELY AFFECTED BY NEIGHBOURING CONDUCTORS. —E. Bellini. (German Pat. 583 488, pub. 4.9.1933.)

POSITION FINDING FOR AIRCRAFT, ETC., BY A CRISS-CROSS OF SHARPLY CONCENTRATED RADIO BEAMS.—M. Wallace. (German Pat. 583 329, pub. 1.9.1933: *Hochf:tech. u. Elek:akus.*, January, 1934, Vol. 43, No. 1, p. 36.)

OBSERVATIONAL ERRORS IN EQUI-SIGNAL SYSTEMS DIMINISHED BY ALTERNATE SWITCHING TO RIGHT AND LEFT EARS SYNCHRONOUSLY WITH AERIAL SWITCHING. — Telefunken. (German Pat. 583 218, pub. 30.8.1933.)

CATHODE-RAY FINDER WOULD LOCATE SHIPS [giving Bearing, Course and Approximate Distance]. — Bainbridge-Bell. (*Sci. News Letter*, 3rd February, 1934, Vol. 25, No. 669, p. 72.)

ACOUSTICS AND AUDIO-FREQUENCIES

ÜBER DEN EINFLUSS DES MEMBRANMATERIALS AUF DIE EMPFINDLICHKEIT VON KONDENSATORMIKROPHONEN (The Influence of the Diaphragm Material on the Sensitivity of the Condenser Microphone).—H. Lueder and E. Spenke. (*E.N.T.*, January, 1934, Vol. 11, No. 1, pp. 20–32.)

By energy principles the efficiency of loudspeakers, of whatever type, cannot exceed unity. From this fact Schottky derived an upper limit for the receiving sensitivity of reversible electro-acoustic systems. An important part in deriving the final expression for the optimum value was played by the reaction of the electrical load on the mechanical vibrating system. But in this respect there is a fundamental difference between the electrodynamic principle and the electrostatic: in the former, the reaction decreases the sensitivity, in the latter it increases it. Schottky's optimum, therefore, loses its validity for condenser microphones, and the question arises "what does limit the sensitivity of such a microphone, since the reaction of the electrical load does not?" The answer to this question, which forms the most important result of the present work, necessitates an extension in two directions of the existing theory of the condenser microphone. This answer is that the "pressure-chamber" sensitivity (*i.e.* the sensitivity given by the voltage across the load resistance in relation to the pressure at the displaced diaphragm) is limited by the properties of the diaphragm material. A measure of the suitability of a material for use as a diaphragm in a condenser microphone is the figure of merit $G = 1/\rho \, . \, \sqrt{\sigma/H}$; here H is the diaphragm thickness, ρ its density, and σ the strain on the material, so that σH is the biasing tension on the diaphragm.

The writers remark that the results of section 4, which essays to treat the diaphragm condenser—a system with an infinite number of mechanical and one electrical degree of freedom—as an electro-acoustic quadripole, should within the limits of their validity be useful for other similar problems; and that their work makes possible a complete design of the best possible condenser microphone as regards "pressure-chamber" sensitivity.

KRITISCHES VOM KONDENSATORMIKROPHON (Critical Remarks on the Condenser Microphone [for Measuring Purposes: Comparison of H.F. and L.F. Connection Methods and the Corresponding Calibration Methods]).—K. Krüger. (*Funktech. Monatshefte*, January, 1934, No. 1, pp. 37–39.)

MISURATORE PORTATILE DI RUMORI (Portable Noise Meter [using Electrostatic Microphone with Counter-Electrode: Calibration by use of Hydraulic Pressure System]).—E. Paolini. (*Alta Frequenza*, December, 1933, Vol. 2, No. 5, pp. 741–748.)

CALIBRATION OF CONDENSER MICROPHONES FOR SOUNDMETERS.—E. J. Abbott. (*Journ. Acous. Soc. Am.*, No. 3, Vol. 4, 1933, pp. 235–244.)

A TUNING-FORK AUDIOMETER AND NOISE OBSERVATIONS IN NEWPORT NEWS, VIRGINIA.—E. Z. Stowell. (*Ibid.*, No. 4, Vol. 4, 1933, pp. 344–352.)

A NEW PORTABLE METER FOR NOISE MEASUREMENT AND ANALYSIS.—W. O. Osbon and K. A. Oplinger. (*Ibid.*, No. 1, Vol. 5, 1933, pp. 39–45.)

A LOGARITHMIC RECORDER FOR FREQUENCY RESPONSE MEASUREMENTS AT AUDIO-FREQUENCIES.—S. Ballantine. (*Journ. Acous. Soc. Am.*, No. 1, Vol. 5, 1933, pp. 10–24.)

THE CATHODE-RAY OSCILLOGRAPH AND ITS USE FOR DETERMINING THE PERFORMANCE OF LOUDSPEAKERS.—A. H. Davis. (*World-Radio*, 16th Feb., 1934, Vol. 18, No. 447, pp. 236–237.)

THE NEW "RESONATOR" LOUDSPEAKER [with Resonant Tubes for Reinforcing Output of Dynamic Loudspeaker].—P. Hémardinquer. (*Radio Craft*, November, 1933, Vol. 5, p. 269.)

A WIRED-RADIO PUBLIC ADDRESS SYSTEM [using Electric Light Wiring to convey Address to Radio Receivers throughout the Building].—D. R. Freeling. (*Radio Craft*, November, 1933. Vol. 5, pp. 272–273.)

THE PHOTOELECTRIC GRAMOPHONE [Records made by Cutting Stylus].—A. L. J. Bernaert. (*Wireless World*, 2nd February, 1934, Vol. 34, pp. 81–82.)

The article describes a new non-photographic method of recording sound on film. A cutting stylus is used which cuts a film into two strips the edges of which, under conditions of no modulation, are straight. Modulation gives the cutting stylus a lateral movement, thus giving an undulatory cut to the two inner edges of the severed film. Two records are thus obtained at one operation.

DE ELECTRISCHE GRAMOFOONOPNEMER (The Electrical Gramophone Pick-Up [Theoretical and Experimental Investigation of Quality, Scratch and Wear: Matching Needle Point and Groove: etc.]).—A. Cramwinckel and P. R. Dijksterhuis. (*Radio-Niews*, No. 3, Vol. 16, 1933, pp. 61–72: special number.)

COEFFICIENT OF NON-LINEAR DISTORTION OF PHOTOCELLS IN SOUND-FILM EQUIPMENTS.—Kotowski and Lichte. (*See* under "Phototelegraphy and Television.")

THE DETERMINATION OF THE ACOUSTICAL OUTPUT OF A TELEPHONE RECEIVER FROM INPUT MEASUREMENTS.—R. D. Fay and W. M. Hall. (*Journ. Acous. Soc. Am.*, No. 1, Vol. 5, 1933, pp. 46–56.)

ELECTRIC PIANO WITH PLUCKED STEEL BARS [with Special Amplifier of 30 Watts' Capacity].—Lloyd Loar. (*Sci. News Letter*, 13th Jan., 1934, Vol. 25, No. 666, p. 28.)

ELEKTRISCHE MUSIK [Book Review].—P. Lertes. (*Zeitschr. V.D.I.*, 20th Jan., 1934, Vol. 78, No. 3, p. 96.)

THE "ELECTRONDE" [Electronic Musical Instrument worked off 4.5-Volt Dry Battery: for use with Radio Receiver].—(*Electrician*, 5th Jan., 1934, Vol. 112, No. 2901, p. 18.)

COMPONENT TONES FROM A BELL.—A. T. Jones and G. W. Alderman. (*Journ. Acous. Soc. Am.*, No. 4, Vol. 4, 1933, pp. 331–343.)

THE PHYSICS OF DEAFNESS [Investigations leading to the Design of "Deaf-Aids"].—H. Sell. (*Zeitschr. f. tech. Phys.*, No. 1, Vol. 15, 1934, pp. 30–39.)

APPARATUS FOR RECEIVING SPEECH THROUGH THE SENSE OF TOUCH [Gault "Teletactor" for the Deaf].—L. D. Goodfellow and A. Krause. (*Review Scient. Instr.*, January, 1934, Vol. 5, No. 1, pp. 44–46.) *See* also Abstracts, 1930, p. 471, and 1933, p. 510.

BEAT FREQUENCY OSCILLATOR [Success of Design: the Wave Form of Gramophone Scratch and Valve Hiss].—F. G. Morgan: Cooper and Page. (*Wireless Engineer*, February, 1934, Vol. 11, No. 125, p. 72.) *See* also March Abstracts, p. 156, r-h column (two).

CONSTANT FREQUENCY BEAT-NOTE GENERATORS [Discussion of Causes and Prevention of Frequency Variation and Description of a Generator built on the Phase-Compensating Principle of Kusunose and Ishikawa].—H. Meyer: Kusunose and Ishikawa. (*Bull. Assoc. suisse des Élec.*, 19th Jan., 1934, No. 2, Vol. 25, pp. 49–51.) *See* 1932 Abstracts, p. 342, r-h column.

A POWER AMPLIFIER FOR LABORATORY USE [Mains-Driven: Uniform Amplification (within 3–4%) in Range 20–12 000 c/s: Distortionless Output up to 7.5 Watts].—R. S. Dadson. (*Journ. Scient. Instr.*, January, 1934, Vol. 11, No. 1, pp. 18–23.)

CONTRIBUTION TO THE OUTPUT VALVE QUESTION.—Berg. (*See* under "Valves and Thermionics.")

NATIONAL BROADCASTING COMPANY'S NEW STUDIOS IN RADIO CITY, NEW YORK.—O. B. Hanson. (*Rad. Engineering*, December, 1933, Vol. 13, No. 12, pp. 8–10 and 18.)

SOUND REFLECTORS: THE ACOUSTICS OF REFLECTORS FOR PULPITS, BANDSTANDS, ETC.—J. Parr. (*Proc. Roy. Inst. Brit. Architects*, Vol. 40, 1933, pp. 588–595.)

A NEW REVERBERATION TIME FORMULA.—W. J. Sette. (*Journ. Acous. Soc. Am.*, No. 3, Vol. 4, 1933, pp. 193–210.) *See* 1933 Abstracts, p. 276, l-h column.

THE RELATIONSHIP BETWEEN LOUDNESS AND THE MINIMUM PERCEPTIBLE INCREMENT OF INTENSITY.—R. R. Riesz. (*Ibid.*, pp. 211–216.)

THE USE OF PRESSURE-GRADIENT MICROPHONES FOR ACOUSTICAL MEASUREMENTS.—I. Wolff and F. Massa. (*Ibid.*, pp. 217–234.)

THE ESTIMATION OF FRACTIONAL LOUDNESS.—P. H. Geiger and F. A. Firestone. (*Journ. Acous. Soc. Am.*, No. 1, Vol. 5, 1933, pp. 25–30.)

THE INTEGRAL LAWS OF SOUND PERCEPTION RELATING LOUDNESS AND APPARENT DURATION OF SOUND IMPULSES.—S. Lifshitz. (*Ibid.*, pp. 31–33.) *See* also 1933 Abstracts, p. 510.

SOUND ABSORPTION IN NON-REACTIVE GAS MIXTURES.—Reed Lawlor: D. G. Bourgin. (*Journ. Acous. Soc. Am.*, No. 4, Vol. 4, 1933, pp. 284–287: No. 1, Vol. 5, 1933, pp. 57–59.)

A STUDY OF THE VELOCITY OF SOUND IN AIR.—M. Grabau. (*Ibid.*, No. 1, Vol. 5, 1933, pp. 1–9.)

THE MEASUREMENT OF TRANSMISSION LOSS THROUGH PARTITION WALLS.—E. H. Bedell and K. D. Swartzel, Jr. (*Journ. Acous. Soc. Am.*, No. 1, Vol. 5, 1933, pp. 34–38.)

THE SUPERSONIC INTERFEROMETER AND ABSORPTION MEASUREMENTS.—W. D. Hershberger. (*Journ. Acous. Soc. Am.*, No. 4, Vol. 4, 1933, pp. 273–283.)

THE ABSORPTION BY POROUS MATERIALS AT NORMAL INCIDENCE—A COMPARISON OF THEORY AND EXPERIMENT.—H. L. Penman and E. G. Richardson. (*Ibid.*, pp. 322–330.)

METHOD OF CALCULATING THE AVERAGE COEFFICIENT OF SOUND ABSORPTION.—C. F. Eyring. (*Ibid.*, No. 3, Vol. 4, 1933, pp. 178–192.)

L'ASSORBIMENTO ACUSTICO DEI MATERIALI POROSI (The Acoustic Absorption of Porous Materials [Theory of Resonance Conditions in Air Channels: Experimental Verification]).—D. Faggiani. (*Physik. Ber.*, 15th Jan., 1934, Vol. 15, No. 2, p. 109—two.) *See* also March Abstracts, p. 157, l-h col.

THE ACOUSTICAL FOUNDATIONS OF RADIO ENGINEERING [including Data of Sound Strengths, Absorbing Powers, etc.].—(*Radio, B., F. für Alle*, January, 1934, No. 1, Supp. pp. 1–21.)

The first chapter of a "Handbook of Radio Engineering and Related Subjects" to appear in this journal. Chapter II, which begins in the same issue, deals with the electrical foundations.

SOME CALCULATED RESULTS OF THE DIFFRACTION OF SOUND WAVES BY A CYLINDRICAL OBSTACLE [of Great Length parallel to Wave Front and with Diameter of Same Order as Wavelength].—T. Kuyama. (*Proc. Phys.-Math. Soc. Japan*, No. 9, Vol. 15, 1933, pp. 365–370.)

VELOCITY OF HIGH FREQUENCY SOUND IN TUBES [Verification of Kirchhoff-Helmholtz Formula].—G. A. Norton. (*Phys. Review*, 1st Dec., 1933, Series 2, Vol. 44, No. 11, pp. 951–952 : abstract only.)

CONTRIBUTION TO THE DETERMINATION OF THE VELOCITY OF SOUND WITH AN ACOUSTIC INTERFEROMETER.—E. Grossmann. (*Physik. Zeitschr.*, 15th Jan., 1934, Vol. 35, No. 2, pp. 83–88.)

ON THE BEHAVIOUR OF LIQUID FILMS IN A VIBRATING AIR COLUMN [Soap Films Showing Positions of Nodes and Antinodes in a Kundt's Tube].—N. W. Robinson and R. W. B. Stephens. (*Phil. Mag.*, January, 1934, Series 7, Vol. 17, No. 110, pp. 27–33.)

EINIGE OPTISCHE VERSUCHE ÜBER DIE REFLEXION VON ULTRASCHALLWELLEN (Some Optical Experiments on the Reflection of Supersonic Waves [at Curved Mirrors in Liquids].—E. Hiedemann and H. R. Asbach. (*Zeitschr. f. Physik*, 1934, Vol. 87, No. 7/8, pp. 442–446.)

OPTICAL INVESTIGATION OF THE OSCILLATION FORM OF PIEZOELECTRIC OSCILLATORS IN LIQUIDS.—E. Hiedemann and H. R. Asbach. (*Physik. Zeitschr.*, 1st Jan., 1934, Vol. 35, No. 1, pp. 26–28.)

ANISOTROPY OF SPHERICAL SOUND WAVES [Maximum Intensity in Meridian Plane of Spark, Minimum along Direction of Spark].—S. Y. Skomtao and L. K. Su. (*Nature*, 10th Feb., 1934, Vol. 133, pp. 214–215.)

CHLADNI PLATES AT HIGH FREQUENCIES [unable to take up Vibrations of Frequency as high as 15 000 c/s but oscillate at Submultiple thereof].—R. C. Colwell. (*Nature*, 17th February, 1934, Vol. 133, p. 258.)

NEW METHODS FOR DIRECT VISUALISATION OF ULTRASONIC WAVES AND FOR THE MEASUREMENT OF ULTRASONIC VELOCITY [Use of Periodically Oscillating Density as Optical Grating].—C. Bachem, E. Heidemann and H. R. Asbach. (*Nature*, 3rd Feb., 1934, Vol. 133, p. 176.) For the application of such an optical grating to the measurement of electromagnetic wavelengths *see* Bergmann, March Abstracts, p. 161.

INTENSE SOUNDS CURDLE PROTEINS [Egg coagulated : Vegetable Oils "cracked" : etc. : Frequencies 1 000–15 000 c/s].—E. W. Flosdorf and L. A. Chambers. (*Sci. News Letter*, 13th Jan., 1934, Vol. 25, No. 666, p. 24.)

PHOTOTELEGRAPHY AND TELEVISION

A VELOCITY-MODULATION TELEVISION SYSTEM.—L. H. Bedford and O. S. Puckle. (*Nature*, 17th Feb., 1934, Vol. 133, p. 263.)

Short note of a lecture on a system of television using scanning of the velocity modulation type, by cathode-ray tubes. On the transmitting side, light is projected from the fluorescent screen of the tube through a film picture on to a photoelectric cell. The output of the photocell amplifier operates, through a screen-grid valve and a thyratron, an electrical time-base circuit supplying the potential difference to one pair of the deflecting plates of the oscillograph. A second valve-and-thyratron circuit supplies a traversing time-base potential difference to the second pair of deflecting plates. Transmission to a second tube of the voltages applied to the two pairs of deflecting plates of the first tube suffices for reproduction of the image on the screen of an oscillograph at the receiving station. Special amplifiers have been developed to give uniform amplification over a frequency band of 240 kc/s, which is required for a picture frequency of 25 per sec. with detail corresponding to 120 or 160 scanning lines. Means of superposition of intensity modulation upon velocity modulation are being investigated. *See* also *Electrician*, 9th Feb., 1934, Vol. 112, No. 2906, p. 186, and below.

NEW TELEVISION SYSTEM : VELOCITY AND INTENSITY MODULATION COMBINED [Cossor System].—Bedford and Puckle. (*Wireless World*, 9th Feb., 1934, Vol. 34, pp. 88–91.)

Long illustrated summary of the I.E.E. paper referred to above. "In addition to using the system of modulation by variable velocity [*see* Thun, 1933 Abstracts, p. 454, l-h col.] as its chief means of picture reproduction, the Cossor system employs ordinary cathode-ray intensity modulation as an auxiliary to 'intensify' the received image. . . . The results [of a laboratory demonstration] were found to be very pleasing, particularly in view of the fact that it has been developed in a space of only eighteen months." For another long summary of the paper, and subsequent Discussion, see *Wireless Engineer*, March, 1934, Vol. 11, No. 126, pp. 137–141.

CATHODE-RAY TELEVISION : AFTER-GLOW IN RELATION TO TRAVERSING SPEED—DOUBLE TIME-BASE CIRCUIT — MAINS UNIT FOR ANODE SUPPLY.—G. Parr and T. W. Price. (*Electrician*, 2nd Feb., 1934, Vol. 112, No. 2905, pp. 168–169.)

Summary of a Television Society paper on the Edison Swan Company's experimental work.

TEN YEARS' PROGRESS IN PHOTOTELEGRAPHY AND TELEVISION, TELEFUNKEN-KAROLUS SYSTEMS.—W. Ilberg. (*Telefunken-Zeit*, November, 1933, Vol. 14, No. 65, pp. 5–26.)

ELECTROSTATIC ELECTRON LENSES FOR CATHODE-RAY TUBES.—Knoll. (*See* under "Subsidiary Apparatus and Materials.")

A SENSITIVE COLD-CATHODE CATHODE-RAY OSCILLOGRAPH WITH CONCENTRATION (and Increased Sensitivity) BY AN OPPOSING FIELD.—Malsch and Westermann. (*See* under "Subsidiary Apparatus and Materials.")

A NEW CATHODE-RAY OSCILLOGRAPH [with Ray accelerated in Two Stages].—Harris. (*See* under "Subsidiary Apparatus and Materials.")

INVESTIGATIONS OF METALLIC DISCHARGE TUBES FOR COLD-CATHODE CATHODE-RAY OSCILLOGRAPHS [and the Use of an Auxiliary Perforated Screen between Cathode and Anode-Screen, especially for Multiple-Ray Tubes].—Dicks. (*See* abstract under "Subsidiary Apparatus and Materials.")

PROBLEMS OF CATHODE-RAY TELEVISION [Horizontal and Vertical Resolution compared : the Optics of Thick Electronic Lens Systems : etc.].—I. G. Maloff. (*Electronics*, January, 1934, pp. 10–12, and 19.)

"A NEW TELEVISION RECEIVER" [using Mirror Drum : Statement of Previous Work and Patent].—V. Babits. (*Wireless Engineer*, February, 1934, Vol. 11, No. 125, p. 74.) Letter prompted by photograph and description in issue for October, 1933.

I RECENTI PROGRESSI DELLA RADIOTELEVISIONE (Recent Advances in Television by Radio [Short Survey including the Ultra-Short-Wave E.I.A.R. Transmitter at Turin]).—A. Banfi. (*Alta Frequenza*, December, 1933, Vol 2, No. 5, pp. 629–644.)

The Turin transmitter emits a wave of 6.30 m with a possible modulation (grid modulation) from 20 to 500 000 c/s. The pilot oscillator generates this frequency *directly*, at the comparatively high power of 50 w. The fourth (output) stage consists of two triodes, each of about 1.5 kw, in a symmetrical neutralised circuit. The attenuation of the waves is high, but well below that found in America (Jones, 1933 Abstracts, p. 334) owing to local conditions such as the prevalent types of building. The paper ends with a discussion of the S.A.F.A.R. cathode-ray television receiver.

TELEVISION [Iconoscope and Kinescope].—V. K. Zworykin. (*Journ. Franklin Inst.*, January, 1934, Vol. 217, No. 1, pp. 1–37.)

This paper describes the theory of the writer's television system (March Abstracts, p. 158, three), its characteristics and modes of operation, and gives some photographs of images obtained on the fluorescent screen of the receiver.

A NEW ULTRA-SHORT-WAVE TRANSMITTER FOR TELEVISION EXPERIMENTS [15 kw Telegraphy Output].—Telefunken. (*Funktech. Monatshefte*, January, 1934, No. 1, p. 40.)

The new transmitter has an additional stage and can provide undistorted transmission of a band of 500 000 c/s. (on a 7–8 m wave) for the image alone, corresponding to 180 lines and a framing frequency of 25 p.s. The modulation method is such that the carrier wave has its smallest value when the television scanner is delivering no current (" upwards " modulation). Picture and synchronising signals are on the same carrier wave. The sound programme is taken over by the old transmitter on a somewhat longer wave in the same band. Picture and sound transmissions will be from sound-films.

NEW LIGHT MODULATOR FOR TELEVISION : A RECENT DEMONSTRATION [Piezoelectric Quartz Cell : Double-Image Polariscope giving Use of Ordinary and Extraordinary Rays].—H. A. Hankey : L. M. Myers. (*Wireless Engineer*, February, 1934, Vol. 11, No. 125, p. 67 : summary only.) For Kerr cell equipment making use of both rays *see* Levin, 1933 Abstracts, p. 573, l-h column.

OPTICAL ROTATION OF UNPOLARISED LIGHT [Experiment proving Beam to be composed of Large Number of Plane Polarised Components of Random Distribution].—A. Langsdorf, Jr., and L. A. Du Bridge. (*Journ. Opt. Soc. Am.*, January, 1934, Vol. 24, No. 1, pp. 1–4.)

SEEING IN SODIUM-VAPOUR LIGHT.—M. Luckiesh and F. K. Moss. (*Journ. Opt. Soc. Am.*, January, 1934, Vol. 24, No. 1, pp. 5–13.)

PHOTOZELLEN-KLIRRFAKTOR IN TONFILMANLAGEN (Coefficient of Non-Linear Distortion of Photocells in Sound-Film Equipments).—P. Kotowski and H. Lichte. (*E.N.T.*, January, 1934, Vol. 11, No. 1, pp. 15–19.)

The analysis of the action of a photocell leads to equation 4, from which it is seen that the change Δi of photocell current is strictly proportional to the change $\Delta \phi$ of illumination *only in two special cases :* either when the cell is worked in a practically short-circuited condition, or when a cell is used which presents marked saturation phenomena, in which case the fluctuations in bias due to the changes in load have no effect on the sensitivity. In all other cases these fluctuations produce non-linear distortion. A simplified practical formula for the coefficient of this distortion is found (equation 9) from which it is seen that the factors governing its value are the depth of light modulation ($\Delta \phi / \phi$), the matching ratio (shunt resistance, across cell and valve input, to d.c. resistance of cell) and the relative slope of the characteristic at the working point. All these factors are proportional to the coefficient, so that the latter disappears if one of them is zero.

Under sound-film conditions, gas-filled alkali cells give a non-linear distortion coefficient increasing with the sensitivity, of about 1% for every 100×10^{-6} A/lumen sensitivity ; selenium cells, at very low frequencies, have coefficients about half as large for similar conditions and sensitivities ; while high-vacuum cells are free from this distortion. Since only selenium cells (and these only at very low frequencies) display sensitivities much above 100×10^{-6} A/lumen, at present they are the only ones to give inadmissibly high values of distortion coefficient. The use of a third electrode by Geffcken and Richter, to obtain a cell whose sensitivity did not depend on the biasing potential, is mentioned. For good gas-filled cells the coefficient can be diminished by allowing a constant current, not small compared to the modulated current, to flow through the cell ; this occurs naturally in " patina " cells (1932 Abstracts, p. 470), and can be produced artificially by a shunt : in spite of the lowered internal resistance the coefficient falls on account of the decreased relative slope of the characteristic. Alternatively, amplifier valves or current sources may be chosen with characteristics curved so as to neutralise the distortion.

GAS-FILLED PHOTOELECTRIC CELL WITH POSITIVELY BIASED SPACE-CHARGE GRID WHOSE DISTANCE FROM PHOTO-CATHODE IS EQUAL TO OR LESS THAN A FREE PATH LENGTH.—Philips Company. (German Pat. 582 252, pub. 11.8.1933.)

UNTERSUCHUNGEN AN SELENSPERRSCHICHTPHOTOZELLEN INSBESONDERE IM HINBLICK AUF DIE VERWENDBARKEIT DIESER ZELLEN ZU METEOROLOGISCHEN STRAHLUNGSMESSUNGEN (Investigations of Selenium Barrier-Layer Photocells with Particular Reference to the Applicability of these Cells to Meteorological Radiation Measurements).—W. Grundmann and L. Kassner. (*Physik. Zeitschr.*, 1st Jan., 1934, Vol. 35, No. 1, pp. 16–20.)

The behaviour of the cells as regards ageing, illumination time and intensity, and temperature was investigated. No temporal ageing of the cells in the absence of illumination was found. During one long continued illumination period, each cell has an ageing process lasting several days in which the current falls discontinuously. The final value of the current depends on the intensity of the illumination used and on the particular cell itself. Complete regeneration occurs if the cell is shaded for a period of 30 min. After this the cell still has an ageing period on re-illumination but the process is much quicker—generally less than 30 min. If the intensity of a long illumination is decreased, partial regeneration of the cell occurs. The photoelectric current, for constant illumination, is independent of temperature fluctuations $< \pm 10°C$. The cell is found to be unsuitable for meteorological measurements, both momentary and continued.

NEUE FORTSCHRITTE AUF DEM GEBIET DER SPERRSCHICHTPHOTOZELLEN (Recent Progress in the Field of Barrier-Layer Photoelectric Cells).—F. Rother and H. Bomke. (*Physik. Zeitschr.*, 1st Dec., 1933, Vol. 34, No. 23, pp. 865–870.)

This paper describes experiments on the effect of covering the copper plate before oxidation with a thin layer of another metal (Ag, Sn, Au, Pt, Rh, Pd, Co, Ni). Oxide layers thus treated are very suitable for use as barrier-layer photocells. The temperature coefficient of the cell can be varied by suitable choice of the metal in the intermediate layer. The process of formation of the copper oxide is discussed on the writers' diffusion theory (1933 Abstracts, p. 400, r-h column).

A NOTE ON THE THEORY OF THE PHOTOELECTRIC CURRENT ACROSS A METAL SEMI-CONDUCTOR CONTACT.—R. H. Fowler. (*Proc. Camb. Phil. Soc.*, 31st Jan., 1934, Vol. 30, Part 1, pp. 55–58.)

This paper contains a theoretical discussion of the experimental results of Nasledow and Nemenow on the "front wall effect" (1933 Abstracts, p. 336). The results appear to be "the natural consequence of the current theory of semi-conductors, under a certain assumption which may be checked by more detailed calculations.

ELEKTRONENBEUGUNGSVERSUCHE ÜBER DIE VERÄNDERUNG VON HALBLEITERKRISTALLFLÄCHEN DURCH ELEKTRONENBOMBARDEMENT (Electron Diffraction Experiments on the Change of Semi-Conducting Crystal Surfaces by Electron Bombardment [Preliminary Account]).—R. Suhrmann. (*Physik. Zeitschr.*, 1st Dec., 1933, Vol. 34, No. 23, p. 878.)

The grating structure of the surface disappears on bombardment with electrons but reappears after one or two hours.

PHOTOELECTRIC PROPERTIES AND ELECTRICAL RESISTANCE OF METALLIC FILMS.—D. Roller and D. Wooldridge. (*Phys. Review*, 15th Jan., 1934, Series 2, Vol. 45, No. 2, pp. 119–120.)

Cadmium amd mercury do not show the dependence of threshold wavelength and photoelectric emission on film thickness which is observed in the alkali metals, platinum, silver and gold. It is supposed that it is impossible to form truly thin films of cadmium and mercury under ordinary conditions of deposition, and the writers have tested this supposition experimentally. The critical thickness of cadmium was placed at 1 800 molecular layers or about 400×10^{-7} cm, and of mercury at 200 or 300×10^{-7} cm, and they are the only metals with a large critical thickness.

ON THE SPATIAL DISTRIBUTION OF PHOTOELECTRONS EJECTED FROM THE ATOMIC K-SHELL.—J. A. van der Akker. (*Phys. Review*, 1st Jan., 1934, Series 2, Vol. 45, No. 1, pp. 49–55.)

THE EFFECT OF ALKALI IONS ON THE PHOTOELECTRIC EMISSIVITY OF TUNGSTEN.—A. K. Brewer. (*Phys. Review*, 15th Dec., 1933, Series 2, Vol. 44, No. 12, pp. 1016–1019.)

"Known quantities of Na^+, K^+, Rb^+ and Cs^+ ions were deposited on tungsten and the changes in the photoelectric current measured. . . . The results show that the alkali dissolves so rapidly in the tungsten that the dependence of the work function on f [the fraction of surface covered] cannot be determined at temperatures above 500° C."

ÜBER DEM ÄUSSEREN LICHTELEKTRISCHEN EFFEKT BEI TIEFEN TEMPERATUREN (The External Photoelectric Effect at Low Temperatures [Preliminary Account: Experimental Verification of Fowler's Theory]).—R. Suhrmann. (*Physik. Zeitschr.*, 1st Dec., 1933, Vol. 34, No. 23, p. 877.)

MEASUREMENTS AND STANDARDS

A NEW AMPLIFYING VOLTMETER [using a Philips "Selectode E 445" with Parabolic Characteristic, and giving a Direct Reading of R.M.S. Values with Calibration Independent of Frequency: Mains-Driven].—M. Robert and R. Ozoux. (*Comptes Rendus*, 3rd Jan., 1934, Vol. 198, No. 1, pp. 62–64.)

"Amplifying voltmeters hitherto described, utilising the phenomena of detection by curvature of characteristics, give indications which are nearer to the average value than to the r.m.s. value. After many trials we have succeeded in finding a screen-grid valve (Philips' Selectode, E 445) which for a suitable ratio of plate and screen-grid voltages gives a parabolic curve of plate current as a function of grid potential." If a negative p.d., exactly equal to the negative grid potential necessary to bring the plate current to zero, is connected in series with the a.c. potential to be measured, a moving-coil milliammeter in the plate circuit will give deflections proportional to the squares of the r.m.s. potential differences applied to the grid, whatever their form and frequency may be. In the complete instrument, a screen-grid amplifier valve gives an effective amplification of 600: then comes the "selectode," and a final stage of d.c. amplification allows a robust milliammeter to be used. All the supplies are from the mains.

A NEW VALVE GALVANOMETER [S-G. Valve in Bridge Circuit, with Bias Voltage in Anode Circuit].—G. Barth. (*Zeitschr. f. Physik*, 1934, Vol. 87, No. 5/6, pp. 399–408.)

SUR LA MESURE OU LA DÉTECTION DES FAIBLES COURANTS ALTERNATIFS (The Measurement or Detection of Small Alternating Currents [Sensitivity similar to that of D.C. Meters obtained by use of Superposed Fixed Auxiliary Current, Bridge-Connected Dry Plate Rectifiers, and Galvanometer]).—E. Gambetta. (*Comptes Rendus*, 5th Feb., 1934, Vol. 198, No. 6, pp. 551–553.)

The auxiliary current may be of the same frequency as the current under measurement, or may differ largely (to avoid beats affecting the galvanometer): it may even be direct current. The total rectified current is sent through a galvanometer, in which the part corresponding to the auxiliary current is compensated, so that the deflections are directly proportional to the effective values of the a.c. to be measured: the auxiliary current is chosen so that the rectifier may work on the straight part of its characteristic. In valve output circuits where there is already a d.c. component the method is simplified by using this as the auxiliary current. With an ordinary good galvanometer an a.c. sensitivity of the order of 5×10^{-9} A/mm, constant over the whole scale from zero, can be obtained. If the a.c. under measurement is applied through a suitable transformer this sensitivity may be still higher.

ON THE ELECTROSTATIC PEAK VOLTMETER WITH EXTENDED RANGE: CORRECTION.—L. G. A. Sims. (*Journ. Scient. Instr.*, January, 1934, Vol. 11, No. 1, p. 31.) See Feb. Abstracts, p. 105, l-h column.

MEASURING AVERAGE CURRENT IN A JUMPY DIRECT-CURRENT CIRCUIT [with D.C. Voltmeter filled with Oil and Sealed Off].—F. W. Maxstadt. (*Review Scient. Instr.*, January, 1934, Vol. 5, No. 1, pp. 14–17.)

ÜBER DIE GRUNDLAGEN DES RÖHREN-VOLTMETERS (The Fundamentals of the Valve Voltmeter [and the Various Sources of Error]).—A. Allerding. (*Zeitschr. f. Fernmeldetech.*, No. 9, Vol. 14, 1933, pp. 129–131.)

DETERMINATION OF VOLTAGE WAVE FORMS WITH THE ROTARY VOLTMETER.—P. Kirkpatrick. (*Review Scient. Instr.*, January, 1934, Vol. 5, No. 1, pp. 33–37.) A new application for the instrument dealt with in 1933 Abstracts, p. 172, l-h column.

THE EVOLUTION OF THE GALVANOMETER [Physical Society's Exhibition Discourse].—R. S. Whipple. (*Journ. Scient. Instr.*, February, 1934, Vol. 11, No. 2, pp. 37–43.)

A COMPACT RADIO FIELD STRENGTH METER [Portable, for Broadcast Band: Range 1 v/m—1 mv/m: Overall Accuracy 2–5%].—P. B. Taylor. (*Proc. Inst. Rad. Eng.*, February, 1934, Vol. 22, No. 2, pp. 191–200.)

In the course of his paper the writer investigates the theory of the resonant circuit, and shows that there is insufficient justification for the common practice of neglecting the term $G_0/\omega C$ (where G_0 is the conductance in parallel with the loop, due to condenser dielectrics, voltmeter, etc.) in the expression for the gain $(G_0/\omega C + R_0/\omega L)^{-1}$. He then develops a method of measuring the gain without knowledge of the circuit constants, so that the detector circuit can be readily calibrated. Any loop used may be calibrated by the instrument itself in the field.

A BRIDGE FOR SMALL INDUCTANCES [Correspondence: the Use of a Mutual Inductometer].—A. Campbell: Starr. (*Journ. Scient. Instr.*, January, 1934, Vol. 11, No. 1, pp. 30–31.) See Feb. Abstracts, p. 103, r-h column.

MISURE DI CAPACITÀ (The Measurement of Capacity [Simple but Exact Method using Mains-Driven Transformer and Milliammeter with Dry-Plate Rectifier]).—A. Albin. (*L'Elettrotec.*, 5th Feb., 1934, Vol. 21, No. 4, p. 80.)

THE MEASUREMENT OF SMALL CAPACITIES [1–5 000 $\mu\mu$F and over: by the Differential Transformer Method].—G. Müller and H. J. Zetzmann. (*Funktech. Monatshefte*, January, 1934, No. 1, pp. 6–7.)

MEASUREMENT OF THE ELECTRICAL CONDUCTIVITY OF THE EARTH AT VARIOUS DEPTHS BY THE CURRENTS INDUCED BY A CIRCULAR CURRENT [with Avoidance of Appreciable Skin Effect]. W. Nunier. (*Physik. Ber.*, 1st Jan., 1934, Vol. 15, No. 1, pp. 95–96.)

For Koenigsberger's theoretical work employed in these tests see *ibid.*, p. 96. See also below.

THE MAGNETIC FIELD OF THE CURRENTS INDUCED BY A CIRCULAR CURRENT IN SUPERFICIAL CONDUCTORS [Calculation, agreeing with Measurements].—W. Nunier. (*Physik. Zeitschr.*, 1st Jan., 1934, Vol. 35, No. 1, pp. 8–15.). See also above and below.

MEASUREMENT OF THE ELECTRICAL CONDUCTIVITY OF AN INFINITE HALF-SPACE, BY INDUCTION. —J. Koenigsberger. (*Physik. Zeitschr.*, 1st Jan., 1934, Vol. 35, No. 1, pp. 6–8.)

MEASUREMENT OF THE RESISTANCE OF EARTH ELECTRODES.—P. D. Morgan and H. G. Taylor. (*World Power*, January and February, 1934, Vol. 121, Nos. 121 and 122, pp. 22–26 and 76–81.)

AN INSTRUMENT FOR THE [Direct] MEASUREMENT OF THE RESISTANCE OF EARTH PLATES.—(*Journ. Scient. Instr.*, January, 1934, Vol. 11, No. 1, pp. 23–24.)

A SIMPLE METHOD OF MEASURING THE DECAY OF OSCILLATIONS IN AN OSCILLATORY CIRCUIT [Steel Ball on Inclined Rails charges and discharges Condenser: also used for Measurement of High Resistances by "Leakage" Method].—G. W. Brindley. (*Journ. Scient. Instr.*, December, 1933, Vol. 10, No. 12, pp. 393–394.)

THE EFFECTIVE RESISTANCE OF INDUCTANCE COILS AT RADIO FREQUENCY [Condensed Version of Butterworth's 1926 Treatise].—B. B. Austin: Butterworth. (*Wireless Engineer*, January, 1934, Vol. 11, No. 124, pp. 12–16.)

THE ALTERNATING-CURRENT INDUCTANCE OF AN IRON-CORED COIL CARRYING DIRECT CURRENT [Determination from B/H and $B/(B/\mu_1 - H)$ Curves only].—R. T. Beatty. (*Wireless Engineer*, February, 1934, Vol. 11, No. 125, pp. 61–63.)

DIE WECHSELSTROMGESPEISTE SPULE ENDLICHER WICKLUNGSHÖHE MIT UNENDLICH LANGEM METALLISCHEM KERN (The A.C.-fed Coil of Finite Length with an Infinitely Long [Non-Magnetic] Metallic Core).—H. Buchholz. (*Archiv f. Elektrot.*, 17th Jan., 1934, Vol. 28, No. 1, pp. 27–50.)

The coil is assumed to be of a single layer, closely wound. Formulae are finally given which are applicable with sufficient accuracy for practical purposes to coils with cores as short as the winding.

DEVELOPMENT OF STANDARD-FREQUENCY TRANSMITTING SETS [particularly the 5 000 kc/s Transmissions from the Beltsville 30 kw Transmitter: the Use of the Synchronised Oscillator and Harmonic Amplifier].—L. Mickey and A. D. Martin. (*Bur. of Stds. Journ. of Res.*, January, 1934, Vol. 12, No. 1, pp. 1–4.)

A DIFFERENTIAL FREQUENCY INDICATOR [for Monitoring the Frequency of a Transmitter].—J. Groszkowski. (*Journ. Scient. Instr.*, January, 1934, Vol. 11, No. 1, pp. 6–10.) *See* 1933 Abstracts, p. 401.

THE VALVE-MAINTAINED TUNING FORK AS A PRIMARY STANDARD OF FREQUENCY.—D. W. Dye and L. Essen. (*Proc. Roy. Soc.*, 1st January, 1934, Vol. 143, No. A 849, pp. 285–306.)

"The paper describes the work leading to the installation of a 1 000 c/s valve-maintained tuning fork as a frequency standard in continuous operation at a frequency within 1 part in a million of its nominal value."

MAGNETOSTRICTIVE ALLOYS WITH LOW TEMPERATURE COEFFICIENTS OF FREQUENCY [for Magnetostriction Oscillators: Suitable also for Tuning Forks].—J. McD. Ide. (*Proc. Inst. Rad. Eng.*, February, 1934, Vol. 22, No. 2, pp. 177–190.)

QUARTZ PLATE MOUNTING WITH ADJUSTABLE ELECTRODE SPACING BY CONE AND THREAD.—C. Lorenz Company. (German Pat. 567 552: *Funktech. Monatshefte*, January, 1934, No. 1, p. 44.)

IMPROVED PIEZOELECTRIC ELECTRODES CONCAVE TO THE CRYSTAL [touching It only at the Edge: Decreased Deterioration: Lines of Force at Middle of Electrodes traverse Crystal more Normally, without Production of Bending Vibrations: Particularly Advantageous for Ultra-Short Waves].—Carl Zeiss Company. (French Pat. 754 576: *Rev. Gén. de l'Élec.*, 27th Jan., 1934, Vol. 35, No. 4, p. 32 D.)

OPTICAL INVESTIGATION OF THE OSCILLATION FORM OF PIEZOELECTRIC OSCILLATORS IN LIQUIDS.—E. Hiedemann and H. R. Asbach. (*Physik. Zeitschr.*, 1st Jan., 1934, Vol. 35, No. 1, pp. 26–28.)

NEW METHODS FOR DIRECT VISUALISATION OF SUPERSONIC WAVES [Optical Grating Principle].—Bachem and others. (*See* abstract under "Acoustics and Audio-frequencies.")

ON THE MAGNETIC UNITS.—H. Abraham. (*Bull. Nat. Res. Council*, Washington, December, 1933, No. 93, pp. 8–38.)

MATHEMATICAL CONSIDERATIONS UNDERLYING THE FORMULATION OF THE ELECTROMAGNETIC EQUATIONS AND THE SELECTION OF UNITS.—Leigh Page. (*Ibid.*, pp. 39–47.)

THE ESTABLISHMENT AND MAINTENANCE OF THE ELECTRICAL UNITS.—H. L. Curtis. (*Ibid.*, pp. 80–93.)

POSSIBLE EXTENSIONS OF THE EXISTING INTERNATIONAL SERIES OF ELECTRIC UNITS INTO A COMPLETE ABSOLUTE SYSTEM.—A. E. Kennelly. (*Ibid.*, pp. 94–112.)

A DEFINITIVE SYSTEM OF UNITS [Giorgi's System based on Metre, Kilogramme, Second and Ohm].—G. A. Campbell: Giorgi. (*Ibid.*, pp. 48–79.)

"It is believed that no possible plan will accomplish as much of advantage to all concerned with so little inconvenience as the plan here proposed." *See* also next abstract.

THE CONVENIENCE OF GIORGI'S "M-KG-S-Ω" SYSTEM OF UNITS.—Graffi: Giorgi. (*See* reference under "Aerials and Aerial Systems.")

SUBSIDIARY APPARATUS AND MATERIALS

A NEW CATHODE-RAY OSCILLOGRAPH [with Ray accelerated in Two Stages, Deflection taking place before Second Stage] AND ITS APPLICATION TO THE STUDY OF POWER LOSS IN DIELECTRIC MATERIALS.—F. K. Harris. (*Bur. of Stds. Journ. of Res.*, January, 1934, Vol. 12, No. 1, pp. 87–102.)

"With a cathode/anode voltage of 500 volts and a fluorescent-screen voltage of 5 000 volts [between screen and a grid of copper wires spaced 1 mm, quite close to screen—*cf.* Sommerfeld, 1928 Abstracts, pp. 689–690] the electrostatic sensitivity is 3 mm/v and there is no difficulty in obtaining instantaneous photographs of 60 c/s phenomena." No gain in brightness was given by increasing the second accelerating voltage beyond 5 000 volts, at any rate with the fluorescent material (natural willemite) used for that particular comparison: the material finally adopted (for its photographic activity) was a mixture of calcium tungstate with two kinds of artificial willemite. The oscillograph is stated to be a modification of a Rogowski design (1925), and Sommerfeld's two-stage tube and other suggestions of the same device are mentioned. The photographs are taken through a slanting viewing window in the side of the tube, with the grid interposing between it and the screen.

A SENSITIVE COLD-CATHODE CATHODE-RAY OSCILLOGRAPH WITH CONCENTRATION [and Increased Sensitivity] BY AN OPPOSING FIELD.—F. Malsch and E. Westermann: Rogowski. (*Archiv f. Elektrot.*, 17th Jan., 1934, Vol. 28, No. 1, pp. 63–65.)

"A short time ago Rogowski showed a new way of constructing sensitive c.r. oscillographs [1933 Abstracts, p. 635]. The electron ray is generated in a discharge tube with high electrode potential and then retarded by a counter-electrode. As Rogowski showed, the counter-field may simultaneously be used to concentrate the electrons on the fluorescent screen." The present paper describes an oscillograph tube built on this principle, and gives some results obtained with it: these represent nothing like the limit of the tube's possibilities. The tube displays a high sensitivity (combined with high recording power) hitherto only to be obtained with hot-cathode tubes. No pre-concentration is employed. The writers mention that another way of obtaining low electron speeds was shown by Malsch and Rogowski to be possible: in an ordinary c.r. discharge tube the cathode was bored through so that a fine canal ray fell on an electrode arranged just behind the cathode, and there set free electrons which, by a small potential, were carried away as an electron beam in a direction independent of the canal ray direction. A plan of Rogowski's is also mentioned by which a special design of cathode and anode can effect concentration by means of the cathode/anode potential, without the need of any special potential source: thus if the anode is made in the form of a hollow cylinder coaxial with the tube axis, provided with one or more ring-shaped slits, and the cathode is extended in the form of an outer cylinder, concentration takes place at those points where the slits in the anode allow a "durchgriff" by the cathode on the internal space traversed by the electrons. Such an arrangement may well be used for pre-concentration, while the opposing field method provides the main concentration.

ELECTROSTATIC ELECTRON LENSES FOR CATHODE-RAY TUBES.—M. Knoll. (*Archiv f. Elektrot.*, 17th Jan., 1934, Vol. 28, No. 1, pp. 1–8.)

Author's summary:—For technical cathode-ray tubes electric electron lenses have the advantages, over magnetic lenses, of great simplicity, small current requirements, and flexibility owing to the wide possible choice of electrode potentials. The forms of electrode hitherto employed, however, are badly suited to rays of large cross section. Successful results are found with electrode arrangements of two tubes of different diameters one inside the other, or three tubes of the same diameter arranged one after the other. The resulting electrostatic field diagram shows that these electrode forms, like the well-known perforated disc electrodes, behave as concentrating lenses whether the inner electrode is biased negatively or positively [with respect to the outer: with negative bias the main action on the electron beam is that of the concave potential surface of the inner electrode, with positive bias that of the convex potential surface of the outer; for it is at these points that the slowest electron speeds within the lens occur].

The image quality of the three-electrode combination, for a ten-fold magnification [*e.g.* Fig. 6b], is about the same as that of a magnetic lens. This type of lens produces real images on the screen for three different electrode potentials: strongly positive, weakly negative, and strongly negative bias of inner electrode with respect to outer. In the last case the image [of a square-meshed net] shows a strongly marked "cushion-pattern," corresponding exactly to the optical phenomenon of that name and originating in a crossing-over of individual rays inside the lens [Figs. 6a and 7]. The practical construction of such a tubular (or ring) electrode system may be carried out by clamping in series, with interposing insulating rings, the flanged tubular electrodes, or by forming the electrode rings of metallic deposits on the walls of an insulating tube. In metal cathode-ray tubes the tube itself can be made to form the lens system by interrupting it with insulating washers.

If the circular tube electrodes are replaced by rectangular or plate electrodes, an electron-optical "cylinder lens" is obtained which yields a line focus (useful in X-ray tubes and sound-film tubes). If only a half (measured in the axial direction) of either of the electrode combinations described is employed, the result is an electrostatic accelerating lens without potential reversal, corresponding to a condensing lens combined with a dispersing lens (reversed tele-objective in optics): then, with an entrance velocity small compared with the leaving velocity, a comparatively small electron image can be obtained from a comparatively large emission surface, with only a short distance between surface and lens. By employing a series of a number (in the limit, an infinite number) of ring-shaped lens elements, and by suitable distribution of the lens potential among these elements [Fig. 13], it is possible to vary the focus even with the entrance and leaving velocities kept constant. It would appear possible in this way to develop (without the use of network electrodes) dispersing lenses, fields with approximately parallel equipotential surfaces, and electron lens systems with chromatic and spherical correction.

INVESTIGATIONS OF METALLIC DISCHARGE TUBES FOR COLD-CATHODE CATHODE-RAY OSCILLOGRAPHS [and the Use of an Auxiliary Perforated Screen between Cathode and Anode-Screen, especially for Multiple-Ray Tubes].—H. Dicks. (*Archiv f. Elektrot.*, 17th Jan., 1934, Vol 28, No. 1, pp. 50–55.)

Author's summary:—A metal discharge tube for voltages between 2 and 80 kv and currents between 0 and 20 mA is described. An auxiliary screen between cathode and [anode] screen [and close to the former] has a favourable effect on the ray cone and offers advantages in multiple oscillography [*cf.* Rogowski, 1933 Abstracts, p. 635]. The shape of the electron beam can be regulated by the shape of the aperture in this auxiliary screen.

REFOCUSING OF ELECTRON PATHS BY MEANS OF A MAGNETIC FIELD [Application to Electron Optics].—W. E. Stephens and A. L. Hughes. (*Phys. Review*, 15th Jan., 1934, Series 2, Vol. 45, No. 2, p. 123: abstract only.)

ONE METHOD OF TIME-MARKING IN CATHODE-RAY OSCILLOGRAM [by Modulating the Wehnelt Cylinder Potential].—S. Watanabe: Richardson. (*Physik. Ber.*, 1st Jan., 1934, Vol. 15, No. 1, p. 33.)

Previous use (with specimen oscillogram) of the method dealt with in 1933 Abstracts, p. 283.

A COMBINATION SWEEP CIRCUIT AND PERIODIC CONTACTOR FOR STUDYING CIRCUIT AND LINE TRANSIENTS WITH THE CATHODE-RAY OSCILLOGRAPH [using Thyratron with Constant Bias and High-Resistance Potentiometer shunting Condenser for Sweep Amplitude Control].—H. J. Reich and G. S. Marvin. (*Review Scient. Instr.*, January, 1934, Vol. 5, No. 1, pp. 7–9.) For the periodic contactor forming part of the combination *see* 1931 Abstracts, p. 396.

EFFECT OF ELECTRIC CURRENT ON A DAMP PHOTOGRAPHIC PLATE: INCREASED SENSITIVITY AT CATHODE, DECREASED AT ANODE.—W. Kossel: Hausser. (*Zeitschr. f. tech. Phys.*, No. 1, Vol. 15, 1934, pp. 23–25.)

VACUUM-LEAK HUNTING WITH CARBON DIOXIDE.—D. L. Webster. (*Review Scient. Instr.*, January, 1934, Vol. 5, No. 1, pp. 42–43.)

A SIMPLE SAFETY AND ALARM EQUIPMENT FOR HIGH-VACUUM APPARATUS.—J. Obrist. (*Zeitschr. f. tech. Phys.*, No. 12, Vol. 14, 1933, pp. 543–546.)

A HOT-WIRE POINTER VACUUM METER [for Pressures down to about 10^{-4} mm Hg].—H. Murmann. (*Zeitschr. f. tech. Phys.*, No. 12, Vol. 14, 1933, pp. 538–540.)

AN IMPROVED FORM OF MERCURY DISTILLER.—P. G. N. Nayar and others. (*Indian Journ. of Phys.*, Part I, Vol. 8, 1933, pp. 91–93.)

INVESTIGATIONS ON AN IMPULSE PROLONGING CIRCUIT [Parallel Connection of Relay and Condenser].—A. Boom. (*Zeitschr. f. Fernmeldetech.*, 22nd Dec., 1933, Vol. 14, No. 12, pp. 186–191.)

SPEEDOMAX—AN ELECTRON-TUBE HIGH-SPEED RECORDING POTENTIOMETER [Small D.C. Voltage to be recorded is Modulated for Ease of Amplification: controls Push-Pull Rectifiers driving Split-Field Series Reversing Motor which adjusts Potentiometer: Overshooting prevented by Opposing E.M.F. from Tachometer Magneto].—Leeds and Northrup Company. (*Electronics*, January, 1934, p. 21.)

AN ELECTRONIC MULTIPLIER FOR HIGH-SPEED COUNTING [far above the Ordinary Limit of 600 Operations per Minute: Single-Tube Inverter Circuit giving Higher Ratios than the "Scale of Two" Counter].—H. W. Lord and O. W. Livingston. (*Electronics*, January, 1934, pp. 7–9.) For the single-tube inverter circuit employed *see* 1933 Abstracts, p. 459, l-h column.

LARGE RECTIFIERS WITHOUT VACUUM PUMPS.—W. Dällenbach. (*E.T.Z.*, 25th Jan., 1934, Vol. 55, No. 4, pp. 85–89.)

METAL-CLAD GRID-CONTROLLED MERCURY RECTIFIERS FOR RADIO STATIONS.—S. R. Durand. (*Electronics*, January, 1934, pp. 4–6.)

THE PERFORMANCE OF A THERMIONIC TUBE AS RECTIFIER.—Tanasescu. (*See* under "Properties of Circuits.")

AN EXPERIMENTAL IGNITRON RECTIFIER.—L. R. Ludwig, F. A. Maxfield, and A. H. Toepfer. (*Elec. Engineering*, January, 1934, Vol. 53, No. 1, pp. 75–78.) *See* also Slepian and Ludwig, 1933 Abstracts, p. 636, r-h column.

KOVAR, AN IRON ALLOY WHICH MAY BE SEALED TO GLASS.—H. Scott. (Mentioned in paper referred to above.)

THE GLOW DISCHARGE AND ITS TRANSITION TO THE ARC DISCHARGE IN HIGH-VOLTAGE MERCURY RECTIFIERS.—M. M. Tschetwerikowa. (*Zeitschr. f. Physik*, 1933, Vol. 87, No. 3/4, pp. 258–263.)

THE USE OF THE THYRATRON FOR TEMPERATURE CONTROL [with Mirror Galvanometer and Photocell].—R. M. Zabel and R. R. Hancox. (*Review Scient. Instr.*, January, 1934, Vol. 5, No. 1, pp. 28–29.)

THE MAGNETIC DEFLECTION OF ELECTRIC ARCS.—H. H. Burghoff: Marx. (*Elektrot. u. Masch:bau*, 4th Feb., 1934, Vol. 52, No. 5, pp. 49–53.) Prompted by Marx' development of the arc-in-air rectifier (1933 Abstracts, p. 459, r-h column).

INVESTIGATIONS ON ELECTRIC ARCS [in Various Gases: with Rotating Mirror and Cathode-Ray Oscillograph].—F. Kesselring. (*E.T.Z.*, 25th Jan. and 1st and 15th Feb., 1934, Vol. 55, Nos. 4, 5 and 7, pp. 92–94, 116–118, and 165–168, 176.)

ELECTRODES—CARBON AND GRAPHITE [History, Manufacturing Methods and Industrial Applications (No Reference to Valves)].—F. J. Vosburgh. (*Elec. Engineering*, December, 1933, Vol. 52, No. 12, pp. 844–848.)

DISCHARGE TUBE WITH PROBES [Characteristics of Multiple Probe Tubes: Use for Control of Potentiometer Voltage, Control of Periodically Successive Phenomena, Production of Delta Voltages].—H. Geffcken and H. Richter. (*Physik. Zeitschr.*, 1st Jan., 1934, Vol. 35, No. 1, pp. 33–36.)

THE COPPER-OXIDE RECTIFIER AS A LABORATORY INSTRUMENT.—L. O. Grondahl. (*Review Scient. Instr.*, January, 1934, Vol. 5, No. 1, pp. 24–29.)

Battery charging: operation of d.c. apparatus (including motors and relays) from a.c. circuits: replacing h.t. batteries: measurements (*e.g.*, replacing thermoelectric meters for wavemeters; galvanometers for bridge circuits): radio detection: in oscillograph circuit (*e.g.*, for recording very small current followed by very large current in opposite direction): protection against arcing at switch and relay contacts: to prevent acoustic shocks to telephone operators.

SUPPLEMENT AND CORRECTION TO THE PAPER "CALCULATION OF THE CAPACITY OF A CIRCULAR PLATE CONDENSER WITH ELECTRODES INCLINED AT AN ANGLE TO ONE ANOTHER."—H. Nitka. (*Zeitschr. f. Physik*, 1933, Vol. 86, No. 11/12, pp. 831–832.) *See* January Abstracts, p. 49, l-h column.

CALIT AND CALAN, TWO NEW HIGH QUALITY INSULATING MATERIALS IN HIGH-FREQUENCY ENGINEERING.—(*Hochf:tech. u. Elek:akus.*, January, 1934, Vol. 43, No. 1, pp. 33–34.)

MINERAL INSULATING MATERIALS: "MYCALEX."—M. Mollet. (*Rev. Gén. de l'Élec.*, 30th Dec., 1933, Vol. 34, No. 26, pp. 905–908.)

HIGH-FREQUENCY PROPERTIES OF DIELECTRICS. PART I.—ANOMALOUS VARIATION OF CAPACITY AND RESISTANCE OF QUARTZ WITH TEMPERATURE AND FREQUENCY.—K. Nakamura. (*Physik. Ber.*, 1st Jan., 1934, Vol. 15, No. 1, pp. 34–35.)

IS THERE AN INTERMEDIATE REGION BETWEEN THE THERMAL BREAKDOWN AND THE PURE ELECTRICAL BREAKDOWN?—P. H. Moon and A. S. Norcross: Inge and Walther. (*Archiv f. Elektrot.*, 8th Dec., 1933, Vol. 27, No. 12, pp. 827–831.)

IMPROVED RESONANCE METHOD FOR DIELECTRIC CONSTANT STUDY.—J. G. Malone, A. L. Ferguson and L. O. Case. (*Electronics*, January, 1934, p. 25.)

STATIC BREAKDOWN OF SOLID AND LIQUID BODIES [Oscillograms of Breakdown of Oil and Compound Insulating Materials resembling exactly those of Static Breakdown in Gases].—K. Buss. (*Archiv f. Elektrot.*, 17th Jan., 1934, Vol. 28, No. 1, pp. 55–56.)

REMARK ON THE PAPER BY HERR KOPPELMANN: IS THE BREAKDOWN OF INSULATING LIQUIDS A HEAT PROCESS?—H. Edler: Koppelmann. (*Ibid.*, pp. 61–63.) *See* 1933 Abstracts, p. 578, l-h column.

HEATING [of Dipole Substances] IN A HIGH FREQUENCY CONDENSER FIELD ON THE BASIS OF ANOMALOUS ABSORPTION [Confirmation of Debye's Electrolyte Theory].—H. Haase. (*Physik. Zeitschr.*, 15th Jan., 1934, Vol. 35, No. 2, pp. 68–76.)

CONDUCTIVITY IN THE INTERMEDIATE REGION BETWEEN STRONG AND WEAK ELECTROLYTES [Theoretical Paper].—R. M. Fuoss. (*Physik. Zeitschr.*, 15th Jan., 1934, Vol. 35, No. 2, pp. 59–68.)

CONDUCTION OF CURRENT IN A DIELECTRIC, IN WHICH BOTH TYPES OF IONS ARE MOBILE [Theoretical Investigation].—J. J. Sämmer. (*Phys. Review*, 1st Jan., 1934, Vol. 35, No. 1, pp. 29–33.)

CONDUCTIVITY OF INSULATING OR SLIGHTLY CONDUCTING LIQUIDS IN THIN LAYERS: VARIATIONS WITH TEMPERATURE.—Th. Meyer. (*Comptes Rendus*, 8th Jan., 1934, Vol. 198, No. 2, pp. 160–163.)

LACQUER-COATED RESISTORS [Graphite on Pyrex, sealed in Glyptal Lacquer: 10^8–10^{12} Ohms: Small Size].—L. F. Curtiss. (*Review Scient. Instr.*, December, 1933, Vol. 4, No. 12, pp. 679–680.) For preliminary note *see* Jan. Abstracts, p. 53, Bureau of Standards.

A SIMPLE HIGH RESISTANCE.—V. Dumert. (*Nature*, 30th Dec., 1933, Vol. 132, p. 1005.)

A letter referring to a description by Burbidge of a simple high resistance (February Abstracts, p. 108, r-h col.) and pointing out the great difference between wire wound resistances and carbon film and non-metallic resistors. Another simple high resistance is also described.

A DEVICE FOR TESTING THE CONTINUITY OF THE ENAMEL ON MAGNET WIRE.—H. W. Bousman. (*Gen. Elec. Review*, December, 1933, Vol. 36, No. 12, p. 558.)

CHARACTERISTICS OF INSULATED WIRES USED IN RADIO SET PRODUCTION.—R. G. Zender. (*Electronics*, January, 1934, pp. 18–19.)

A NEW METHOD OF MAKING EXACTLY INTERCHANGEABLE INDUCTANCES [Final Adjustment by twisting a "Displacing Ring" with Slanting Hole or Groove through which the Wire passes].—(German Pat. 550 263: *Funktech. Monatshefte*, January, 1934, No. 1, pp. 39–40.)

FURTHER NOTES ON IRON-CORE COILS FOR USE AT R.F. OR I.F.—W. J. Polydoroff: Crossley. (*Electronics*, January, 1934, p. 13.)

Remarks prompted by Crossley's article referred to in February Abstracts, p. 108, l-h col.

PRECISION CURRENT TRANSFORMERS [with Nickel-Iron Cores].—A. Keller. (*E.T.Z.*, 28th December, 1933, Vol. 54, No. 52, pp. 1258–1259.)

EMPIRICAL INVESTIGATION OF MAGNETISATION LAW.—K. Tōsaka. (*Journ. I.E.E. Japan*, November, 1933, Vol. 53 [No. 11], No. 544, pp. 1009–1019: English summary pp. 96–101.)

ON THE USE OF MUTUAL INDUCTANCES FOR THE CONTROL OF CURRENT TRANSFORMERS.—F. Neri. (*L'Elettrotec.*, 5th Feb., 1934, Vol. 21, No. 4, pp. 69–74.)

VOLTAGE STABLILISATION BY IRON-WIRE BALLAST RESISTANCE IN TRANSFORMER PRIMARY CIRCUIT.—C. Lorenz Company. (German Pat. 582 514, pub. 18.8.1933.) For a different method of employing iron-wire ballasting *see* March Abstracts, p. 165, l-h column, Santuari.

INDUCTOR ALTERNATORS FOR SIGNALLING PURPOSES.—F. W. Merrill. (*Elec. Engineering*, January, 1934, Vol. 53, No. 1, pp. 78–86.)

INDUCTION MOTORS AS SELSYN DRIVES.—L. M. Nowacki. (*Elec. Engineering*, December, 1933, Vol. 52, No. 12, pp. 848–853.)

NEW CELL-SWITCHING SYSTEM FOR ACCUMULATOR BATTERIES [eliminating Leads to Battery Switchboard].—W. Hollatz. (*E.T.Z.*, 28th December, 1933, Vol. 54, No. 52, pp. 1264–1265.)

DRY CELLS WITH SOLID RADIOACTIVE ELECTROLYTE AND IONISED AIR.—L. Bouchet. (*Comptes Rendus*, 18th Dec., 1933, Vol. 197, No. 25, pp. 1598–1599.)

H.T. BATTERY CURRENT ECONOMY: THE "BOOSTER ECONOMY UNIT," TO GIVE SAME EFFECT AS Q.P.P. AND CLASS B METHODS.—Graham Farish Company. (*World-Radio*, 16th Feb., 1934, Vol. 18, No. 447, p. 232.)

D.C. MAINS ADAPTER USING MAINS VOLTAGE FOR LARGE-CURRENT STAGES AND A HIGHER VOLTAGE FROM (*e.g.*) A GLOW DISCHARGE OSCILLATOR, AFTER RECTIFICATION, FOR THE VOLTAGE-AMPLIFYING STAGES.—M. von Ardenne. (German Pat. 582 273, pub. 11.8.1933.)

GARAGE BATTERY CHARGER.—H. B. Dent. (*Wireless World*, 2nd February, 1934, Vol. 34, pp. 73–74.)

FILTER SYSTEMS FOR USE WITH AUTO RADIO POWER SUPPLIES [and a Comparison of Motor-Generator and Vibrator Systems].—J. S. Meck. (*Rad. Engineering*, January, 1934, Vol. 14, No. 1, pp. 19–20.)

NEGATIVE LENGTHS OF TELEPHONE LINE [Construction of Equivalent Networks, using Negative Resistance Devices].—A. C. Bartlett. (*Phil. Mag.*, February, 1934, Series 7, Vol. 17, No. 111, pp. 230–232.)

A THERMIONIC VALVE AMPLIFIER FOR USE WITH A DUDDELL OSCILLOGRAPH.—W. Jackson. (*Wireless Engineer*, February, 1934, Vol. 11, No. 125, pp. 64–67.)

A DIRECT-COUPLED AMPLIFIER FOR [Nerve and Muscle] ACTION CURRENTS [Further Development of Wynn-Williams Bridge].—E. L. Garceau and A. Forbes. (*Review Scient. Instr.*, January, 1934, Vol. 5, No. 1, pp. 10–13.)

DIRECT CURRENT AMPLIFIER FOR RADIOMETERS [Thermopiles, Photocells, etc.: Tests on Reproducibility of Performance].—Bureau of Standards.—(*Bur. of Stds. Tech. News Bull.*, January, 1934, No. 201, p. 3.)

A BOLOMETER WITH MANY USES [as Switching Relay (without Amplifier) for Barrier-Layer Photocell, etc.: using Two Currents of Air from Electrically Driven Membrane].—W. Jaekel. (*Zeitschr. V.D.I.*, 3rd Feb., 1934, Vol. 78, No. 5, pp. 169–170.)

THERMOELECTRIC FORCE OF THIN FILMS.—E. A. Johnson and L. Harris. (*Phys. Review*, 1st Dec., 1933, Series 2, Vol. 44, No. 11, pp. 944–945.)

Sputtering of very thin thermocouples of antimony and bismuth gives a remarkable decrease of thermoelectric e.m.f. with decrease in the thickness of the bismuth film, for thicknesses less than 10^{-4} cm.

NEW SOLUTIONS OF GRAPHO-MECHANICAL CALCULATION: THE DERIVOGRAPH AND POLAR PLANIMETER.—F. E. Myard. (*Génie Civil*, 3rd Feb., 1934, Vol. 104, No. 5, pp. 103–106.)

A DIFFERENTIAL-GEAR SPEED CONTROLLER.—W. D. Lansing. (*Review Scient. Instr.*, December, 1933, Vol. 4, No. 12, pp. 684–686.)

SYNCHRONISED ELECTRIC MOTOR WITH QUARTZ CYLINDER AS ROTOR: SPEED OF 1 000 r.p.m.: FORCE AT PERIPHERY 100 gms.—Optique et Précision de Levallois: de Gramont. (French Pat. 754 305, pub. 6.11.1933: *Rev. Gén. de l'Élec.*, 27th Jan., 1934, Vol. 35, No. 4, p. 29 D.) For de Gramont's work on the rotation of a pivoted quartz crystal *see* 1933 Abstracts, p. 575.

A PORTABLE HIGH-VOLTAGE GENERATOR OF PRACTICAL UTILITY [500 μA at More than a Million Volts: Belt Type].—E. H. Bramhall: van de Graaf. (*Review Scient. Instr.*, January 1934, Vol. 5, No. 1, pp. 18–23.)

STATIONS, DESIGN AND OPERATION

MICRO-RAY [Teleprinter and Telephone] RADIO LINK ACROSS THE ENGLISH CHANNEL.—(*Nature*, 3rd Feb., 1934, Vol. 133, pp. 167–168.)

Note on the recently opened commercial "micro-ray" radio service on a wavelength of 17 cm between the civil airports at Lympne, Kent, and St. Inglevert, France. *See* also 1933 Abstracts, p. 286: *Electrician*, 2nd Feb., 1934, Vol. 112, No. 2905, pp. 156–157: and *Génie Civil*, 10th Feb., 1934, Vol. 104, No. 6, pp. 128–129.

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY'S 56-Mc/s ULTRA-SHORT-WAVE AEROPLANE TESTS [Communication up to 100 Miles under Routine Conditions].—(*QST*, February, 1934, Vol. 18, No. 2, pp. 21 and 45.)

"ULTRA-SHORTS" FOR THE POLICE [Bayonne, New Jersey].—W. W. Macdonald. (*Wireless World*, 9th February, 1934, Vol. 34, pp. 92–93.) *See* also Feb. Abstracts, p. 109.

THE FREQUENCY CONSTANCY OF THE VIENNA HIGH-POWER BROADCASTING STATION [U.I.R. Measurements].—(*Telefunken-Zeit.*, November, 1933, Vol. 14, No. 65, pp. 52–53.)

The Telefunken continuous temperature-compensation method of quartz control (Jan. Abstracts, p. 47) is used at the Bisamberg (Vienna) station, and the maximum deviation from the prescribed frequency of 580 kc/s, during August and September, 1933, appears to be less than the margin of error of the Brussels measuring equipment, which at that frequency is ± 4 c/s.

RADIO-LUXEMBOURG [with Chireix Modulation Method].—(*E.T.Z.*, 25th Jan., 1934, Vol. 55, No. 4, p. 100.)

THE BERLIN HIGH-POWER BROADCASTING STATION.—W. Brecht. (*Zeitschr. V.D.I.*, 10th Feb., 1934, Vol. 78, No. 6, pp. 190–194.)

DISTRIBUTION OF BROADCAST PROGRAMMES OVER TELEPHONE NETWORK IN GERMANY.—(*Electronics*, January, 1934, p. 26: paragraph only.)

PRESENT-DAY REQUIREMENTS OF COMMERCIAL SHORT-WAVE PLANT [New Points arising from the Changes in Propagation according to Sunspot Cycle: Necessity of Rapid and Easy Wave-Change, and Its Difficulties: etc.].—H. Mögel. (*Telefunken-Zeit.*, November, 1933, Vol. 14, No. 65, pp. 27–33: to be continued.)

THE DEVELOPMENT OF RECORDING SYSTEMS OF TELEGRAPHY OVER LINES AND BY RADIO.—P. Storch. (*E.T.Z.*, 1st and 8th Feb., 1934, Vol. 55, Nos. 5 and 6, pp. 109–112 and 141–143.)

A DIFFERENTIAL FREQUENCY INDICATOR [for Monitoring the Frequency of a Transmitter].—J. Groszkowski. (*Journ. Scient. Instr.*, January, 1934, Vol. 11, No. 1, pp. 6–10.) *See* 1933 Abstracts, p. 401.

GENERAL PHYSICAL ARTICLES

ON THE QUANTUM THEORY OF THE ELECTROMAGNETIC FIELD.—M. Born. (*Proc. Roy. Soc.*, 1st January, 1934, Vol. 143, No. A 849, pp. 410–437.)

This paper attempts to create a field theory agreeing with reality by generalising the approved principles of quantum mechanics. Maxwell's equations in the original form are found to be incompatible with the suggested quantum laws; they must be replaced by another set of equations, a special form of Mie's general field theory. It is found that this theory gives the existence of an electron with finite radius and finite energy, whose potential agrees with Coulomb's law for large distances. *See* also under "Atmospherics and Atmospheric Electricity."

A UNIFIED FIELD THEORY.—II. GRAVITATION.—D. Meksyn. (*Phil. Mag.*, February, 1934, Supp. No., Series 7, Vol. 17, No. 112, pp. 476–482.)

For reference to Pt. I see March Abstracts, p. 167, l-h col. In the present part the gravitational field due to two particles is described by an eight-dimensional space-time whose metric satisfies Einstein's law of gravitation $G_{\mu\nu}=0$.

POSSIBLE MODIFICATIONS OF THE LORENTZ-MAXWELL FIELD EQUATIONS (Preliminary Report).—V. Johnson and E. S. Akeley. (*Phys. Review*, 15th Jan., 1934, Series 2, Vol. 45, No. 2, p. 128: abstract only.)

THE REPRESENTATION OF RADIATION REACTION IN WAVE MECHANICS [Modification of Wave Equation to apply to cases when Electron is Greatly Accelerated].—W. F. G. Swann. (*Journ. Franklin. Inst.*, January, 1934, Vol. 217, No. 1, pp. 59–71.)

ON THE THEORY OF THE ELECTRIC CHARGE [Case of Electrified Particles or Electrical Charges in an Electromagnetic Field].—L. Goldstein. (*Comptes Rendus*, 5th Feb., 1934, Vol. 198, No. 6, pp. 549–551.)

THE EFFECT OF HIGH-FREQUENCY CURRENTS [up to 3×10^7 c/s] ON THE TRANSITION POINT OF SUPERCONDUCTORS.—E. F. Burton and others. (*Canadian Journ. of Res.*, December, 1933, Vol. 9, No. 6, pp. 630–636.)

THE PROPAGATION OF ELECTROMAGNETIC WAVES IN A SUPERCONDUCTOR.—Braunbek. (*See* under "Propagation of Waves.")

SOME ASPECTS OF ELECTROMAGNETIC FORCES AND WAVES.—F. W. Warburton. (*Phys. Review*, 15th Jan., 1934, Series 2, Vol. 45, No. 2, p. 123: abstract only.)

THE MASSES OF THE PROTON AND ELECTRON.—A. Eddington. (*Proc. Roy. Soc.*, 1st January, 1934, Vol. 143, No. A 849, pp. 327–350.)

Theoretical reasoning leads to the conclusion that the mass of an elementary particle (proton or electron) is given by a certain quadratic equation involving the number of such particles in the universe and the cosmical constant.

THE VALUE OF e/m FROM THE ZEEMAN EFFECT [$e/m = 1.7570 \pm 0.0010$].—L. E. Kinsler and W. V. Houston. (*Phys. Review*, 15th Jan., 1934, Series 2, Vol. 45, No. 2, pp. 104–108.)

THE ELECTRONIC ATOMIC WEIGHT AND e/m RATIO [$e/m = (1.757 \pm 0.001) \times 10^7$ e.m.u./gram, determined from Interval between corresponding Components of $H^1\alpha$ and $H^2\alpha$ Lines].—R. C. Gibbs and R. C. Williams. (*Phys. Review*, 15th December, 1933, Series 2, Vol. 44, No. 12, p. 1029.)

ELECTRON ORBITS IN CROSSED ELECTRIC AND MAGNETIC FIELDS.—A. E. Shaw. (*Phys. Review*, 15th December, 1933, Series 2, Vol. 44, No. 12, pp. 1006–1011.)

An investigation of the sharp focusing of crossed electric and magnetic fields for circular electron orbits; measurements reveal the presence of polarisation layers on the plates of the electric field, which cause errors in e/m determinations.

NEGATIVE SECTIONS OF THE COLD-CATHODE GLOW DISCHARGE IN HELIUM.—K. G. Emeléus, W. L. Brown and H. McN. Cowan. (*Phil. Mag.*, January, 1934, Series 7, Vol. 17, No. 110, pp. 146–150.)

SHORT-RANGE BREAKDOWN ["Nahdurchschlag"] AND CATHODE DROP.—W. Rogowski. (*Archiv f. Elektrot.*, 8th Dec., 1933, Vol. 27, No. 12, pp. 857–868.)

MEASUREMENT OF THE TOWNSEND COEFFICIENTS FOR IONISATION BY COLLISION.—F. H. Sanders. (*Phys. Review*, 15th December, 1933, Series 2, Vol. 44, No. 12, pp. 1020–1024.)

MISCELLANEOUS

THE APPLICATION OF METHODS OF GEOMETRICAL INVERSION TO THE SOLUTION OF CERTAIN PROBLEMS IN ELECTRICAL RESONANCE [with help of a Single Circle Diagram].—W. G. Cady. (*Physik. Ber.*, 1st Jan., 1934, Vol. 15, No. 1, p. 33.)

THE CALCULATION OF PEAK STRAINS IN A SHAFT OF VARYING CROSS SECTION, BY PLOTTING THE POTENTIAL LINES IN AN ELECTRICAL MODEL.—A. Thum and W. Bautz. (*Zeitschr. V.D.I.*, 6th Jan., 1934, Vol. 78, No. 1, pp. 17–19.)

MODULATION OF VERY SHORT RADIO WAVES BY MEANS OF IONISED GAS.—Linder. (*See* under "Transmission.")

DEPOSITS OF ELEMENTS BY HIGH-FREQUENCY DISCHARGE.—D. Banerji and D. Bhattacharya. (*Phil. Mag.*, February, 1934, Series 7, Vol. 17, No. 111, pp. 313–316.)

VEHICLE-OPERATED TRAFFIC CONTROL.—W. Jaekel. (*Zeitschr. V.D.I.*, 13th Jan., 1934, Vol. 78, No. 2, pp. 59–60.)

THE ELECTRICAL MEASUREMENT OF TEMPERATURE BY MEANS OF BARRIER-LAYER RECTIFIERS VARYING WITH TEMPERATURE.—Hartmann and Braun. (French Pat. 754 338, pub. 6.11.1933: *Rev. Gén. de l'Élec.*, 27th Jan., 1934, Vol. 35, No. 4, p. 30 D.)

RECENT DEVELOPMENTS SET PACE FOR PROGRESS IN 1934 [Broadcast Facsimile Newspapers: Photocells in Industry: Guard Rays: "Space Control Systems" (Electrostatic or Electromagnetic Alarms): New Shield-Grid Construction protects from Extraneous Charges and shields Control Grid from both Anode and Cathode: etc.].—(*Electronics*, January, 1934, pp. 2–3 and 24.)

DEVELOPMENTS IN THE ELECTRICAL INDUSTRY DURING 1933 [including Thyratrons, Pliotron with Graphite Anode, Water-Cooled Oscillators for Wavelengths down to 1 Metre: Photoelectric Relay Equipments: Electro-surgical Knife, Inductotherm (Therapeutic Heating by Eddy Losses): etc.].—J. Liston. (*Gen. Elec. Review*, January, 1934, Vol. 37, No. 1, pp. 11–63.)

AN ELECTRICAL INSTRUMENT FOR DETECTING INVISIBLE FLAWS IN NON-MAGNETIC [or Magnetic] CONDUCTORS SUCH AS TUNGSTEN [*e.g.* for Factory Inspection of Tungsten Wire].—D. W. Dana. (*Review Scient. Instr.*, January, 1934, Vol. 5, No. 1, pp. 38–41.)

The wire passes through a coil forming part of the tuned circuit of an oscillator. By using frequencies around 6 Mc/s the response is limited to flaws near the surface. Heterodyning is so arranged that perfect wire gives no audible indication: the pitch of a note bears a definite relation to the extent of the defect. Instead of both oscillators running at the same nominal frequency, the examining coil oscillator has its 3rd harmonic equal to the 2nd harmonic of the reference oscillator. This improves the stability, eliminates the "pull together" tendency, and increases the sensitivity over that which would be expected for a given frequency in the examining coil: thus a 1 kc change in the latter frequency will produce a 3 kc beat frequency instead of only 1 kc.

THE MAGNETIC EXPLORATION OF MACHINE PARTS IN METAL [and the Design of a Suitable Mains-Driven 2-Valve Amplifier with Zero Repose Current].—J. Peltier. (*Comptes Rendus*, 5th Feb., 1934, Vol. 198, No. 6, pp. 556–557.) Continuation of the work referred to in 1932 Abstracts, p. 54, r-h column.

THE "PHOTRONIC" BARRIER-LAYER PHOTOELECTRIC CELL AND ITS APPLICATIONS.—R. Higonnet. (*Rev. Gén. de l'Élec.*, 27th Jan., 1934, Vol. 35, No. 4, pp. 125–129.)

FINENESS OF GROUND CEMENT MEASURED BY PHOTOELECTRIC "SUSPENSION TURBIDIMETER."—(*Electronics*, January, 1934, p. 15.)

DEEP-SEA FISHING LEVELS STUDIED BY PHOTOCELLS.—(*Ibid.*, p. 15.)

DETECTING IMPURITIES IN SAND WITH THE PHOTOCELL [giving Accurate Forecast of Mortar Strength].—(*Electronics*, January, 1934, p. 27.)

PHOTOCELLS ENTER THE TEXTILE FIELD [Cutting Control].—(*Electronics*, January, 1934, p. 14.)

PHOTOCELLS MEASURE AREA OF LEAVES [for Plant Physiological Data].—R. B. Withrow. (*Sci. News Letter*, 13th Jan., 1934, Vol. 25, No. 666, p. 25.)

ABSORPTION OF MICRO-WAVES BY MOLECULES.—Potapenko. (*Sci. News Letter*, 9th Dec., 1933, Vol. 24, No. 661, p. 372.)

Potapenko is experimenting with steady oscillations down to 3 cm in wavelength. "The molecules are rotated by the waves and relax gradually to their original position. The energy of the rotation is taken from the waves. When the frequency of waves is above a billion a second [30 cm wavelength] much energy is absorbed. This shows that the molecules take less than a billionth of a second for their relaxation time. The bigger molecules are more sluggish than the smaller."

TREATMENT OF DISEASE BY INDUCED HIGH-FREQUENCY WAVES: FURUNCULOSIS AFFECTED BY SINGLE DEFINITE FREQUENCY.—(*Electronics*, January, 1934, p. 15: paragraph only.)

SELECTIVE WARMING OF CELLULAR STRUCTURES BY ULTRA-SHORT ELECTROMAGNETIC WAVES.—N. N. Malov. (*Physik. Zeitschr.*, 1st Dec., 1933, Vol. 34, No. 23, pp. 880–883.)

INVESTIGATION OF THE DIELECTRIC BEHAVIOUR OF SIMPLE BIOLOGICAL SUBSTANCES IN THE REGION OF UNDAMPED ULTRA-SHORT WAVES OF 1–10 METRES.—E. May and H. Schaefer. (*Physik. Ber.*, 1st Jan., 1934, Vol. 15, No. 1, p. 35.)

SHORT WAVES IN MEDICINE [with Literature References].—H. O. Hartleb. (*Funktech. Monatshefte*, January, 1934, No. 1, p. 8.)

THE FUNDAMENTAL GERMAN PATENTS IN RADIO ENGINEERING.—(*Funktech. Monatshefte*, January, 1934, No. 1, pp. 9–10.)

SHOULD ENGINEERS TAKE UP ESPERANTO?—P. Dejean. (*Rev. Gén. de l'Élec.*, 10th Feb., 1934, Vol. 35, No. 6, pp. 197–199.)

THE PHYSICAL SOCIETY'S EXHIBITION: MATTERS OF WIRELESS AND ALLIED INTEREST.—(*Wireless Engineer*, February, 1934, Vol. 11, No. 125, pp. 76–81.)

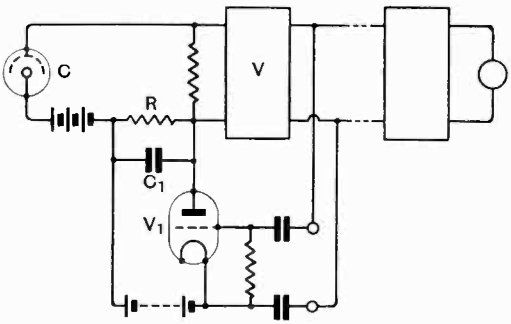
Some Recent Patents

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.

FILM TELEVISION SYSTEMS

Convention date (Germany), 12th March, 1931. No. 398242

Means are provided for automatically regulating the amplification at the transmitting end, so as to compensate for the varying "contrast" values of different films. In this way one film which may have duller light-and-shade values than another is reproduced at the receiving end with equal clarity.



No. 398242.

The scanning beam actuates a photo-electric cell *C* coupled to an amplifier *V*, the input circuit of which also includes a resistance *R* in the plate circuit of a regulating valve *V*1. When a film with high light-and-shade contrast is being transmitted the voltages applied to the grid of the valve *V*1 from the output of the amplifier *V* are comparatively large, so that the current through the resistance *R* drops, and reduces the effective polarising voltage applied to the photo-electric cell *C*. In the case of a film with low contrasts the action is reversed and the sensitivity of the cell is increased. A condenser *C*1 prevents too rapid a response and ensures that the gain regulation is kept constant throughout the transmission of a single film.

Patent issued to Fernseh Akt.

TELEVISION APPARATUS

Application date, 11th March, 1932. No. 398247

A mirror drum for scanning in television is characterised by the use of a series of "paired" mirrors, instead of the usual single mirrors, so that the incident ray of light is subjected to a double reflection before taking the return path to the photo-electric cell. Each double mirror may be replaced by a solid prism, which is formed with a lens on the surface of incidence so that the latter does not act as a reflector. The advantage is that for a given size of drum the angle between the first and last spot on a scanning line is increased, thereby allowing the distance between the scanning drum and the screen to be shortened. This produces an increase in the effective intensity of illumination.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.; N. Levin, and L. E. Q. Walker.

MODULATING SYSTEMS

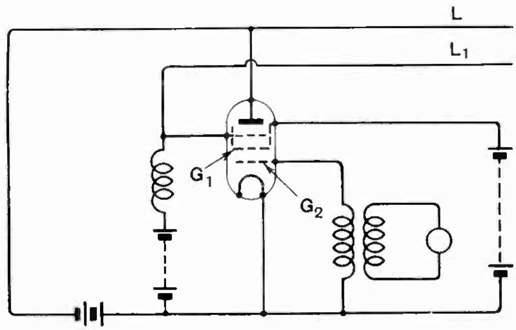
Application date, 22nd March, 1932. No. 398853

To ensure a wide range of percentage modulation at maximum overall efficiency, and without distortion, two separate amplifier-channels are provided, one for handling signal-voltages above carrier-level, and the other for handling signal voltages below that level. The two amplifier channels are inserted in parallel between the source of carrier oscillations and the transmitting aerial, but are separated by a decoupling circuit. One channel comprises a voltage-limiter, which prevents the output from rising above carrier-level, whilst the second amplifier is biased so that it only passes current when the applied voltage exceeds the normal. In a modified arrangement series modulation is used, one amplifier being operative on positive and the other on negative half-cycles of modulation.

Patent issued to Marconi's Wireless Telegraph Co., Ltd., and W. T. Ditcham.

Convention date (Germany), 1st February, 1932. No. 399074

When modulating voltages are applied to the grid of a short-wave oscillator operating in the Barkhausen-Kurz manner they vary not only the amplitude but also the frequency of the generated wavelength. To avoid this double effect a multi-



No. 399074.

grid valve is employed. A high voltage is applied to the grid *G*, and oscillations are generated in the Lecher-wire output *L*, *L*1. Modulating voltages are applied to the grid *G*2 nearest the cathode, whilst the third grid serves as a screen.

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

DIRECTION-FINDING

Application date, 25th February, 1932. *No.* 397524

Accuracy in direction-finding is frequently handicapped by the so-called "repetition" effect, caused by the same signal-impulse taking different paths through the ether and so reaching the receiver at different times. For a range of 200 miles the interval (due to reflections from the Heaviside layer) is of the order 0.00015 second, and since successive impulses are usually differently polarised, the D.F. observations show wide variations. To overcome this defect the transmitter is caused to emit a succession of similar but short impulses, each of which occupies a period of time less than the "interval" period mentioned, and the receiver is arranged so that only the first impulse is effective so far as D.F. observation is concerned, any subsequent "repetitions" being rendered ineffective. This is ensured by providing an interrupter switch at the receiver, driven synchronously with a similar switch at the transmitter, and observing successive "primary" impulses by means of a neon lamp and stroboscopic disc.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.; S. B. Smith; and T. L. Eckersley.

DRY-CONTACT RECTIFIERS

Convention date (U.S.A.), 27th May, 1931. *No.* 398202

A dry-contact rectifier viewed from the low-resistance direction simulates a capacity reactance in parallel with a resistance. At radio frequencies the capacity reactance falls so low that in order to ensure efficiency it is desirable to provide special means for maintaining a relatively high current-density through the rectifier. According to the invention the detector input is shunted by an inductance of such value as to render the whole system (including the detector and shunt inductance) non-reactive at the applied frequency. The shunt inductance may be variable or it may be connected in parallel with a tuning-condenser.

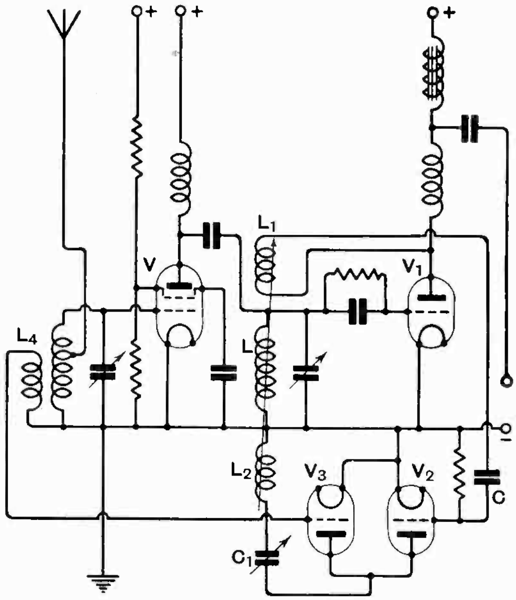
Patent issued to The Westinghouse Brake and Saxby Signal Co., Ltd.

REACTION CONTROL

Application date, 1st March, 1932. *No.* 398170

In order to maintain reaction at an optimum value, short of self-oscillation, individual control is exercised over both the input and output circuits of a back-coupled valve. As shown in the figure, the detector valve V_1 is fed from a high-frequency amplifier V. The input coil L is coupled (*a*) to a coil L_1 connected through a condenser C_1 to the grid of a control valve V_2, and (*b*) to a coil L_2 connected through a variable condenser C_1 to the common output of the valve V_2 and a second control valve V_3. The grid-cathode circuit of the latter also includes the input coil L_4 of the H.F. valve V. In operation, signal voltages applied to the input of the valve V_1 boost the back-coupling currents through the coil L_2 via the valve V_3. But if the valve V_1 tends to oscillate, the H.F. output operates through the valve V_2 to apply a reverse feed-back through the coil L_2, thus stabilising the system.

Patent issued to J. Robinson and British Radiostat Corporation.



No. 398170.

WIRELESS PERSONAL EQUIPMENT

Application date, 21st April, 1932. *No.* 397959

Relates to portable wireless equipment adapted to be carried by a policeman or soldier whilst on duty. A single valve and accessory components are mounted inside the crown of a helmet, preferably on a detachable baseplate. The aerial consists of a metal gauze or wire-fabric lining, which is earthed through a small metal plate making contact with the head of the wearer. The tuning and reaction-control knob is provided on the outside of the helmet. High and low tension batteries are fitted in suitable compartments in a waist-belt.

Patent issued to B. J. R. McDermottroe and W. T. Emberson.

SHORT-WAVE OSCILLATORS

Convention date (Germany), 23rd March, 1931. *No.* 398263

Two parallel conductors, forming a tuned Lecher-wire system, are directly connected to the nodal point of the grid of a valve, preferably operating on the Barkhausen-Kurz principle. The Lecher wires form the main oscillating circuit and also serve to supply the energising voltage. Similar stationary-wave circuits may be connected to other elements of the electrode system in order to increase the power output. The arrangement may also be applied to valves of the magnetron type.

Patent issued to Radio Patents Corpn. and H. E. Hollmann.

AUTOMATIC VOLUME CONTROL

Convention date (U.S.A.), 15th September, 1931.
No. 399016

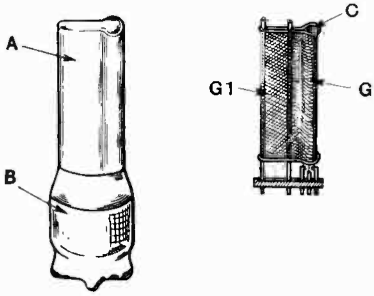
The main air-gap of either a moving-iron or moving-coil loud speaker is shunted by a second or auxiliary gap containing a choke coil in the output circuit of the last amplifier. As the output from the amplifier increases, the choke automatically increases the shunt effect of the second gap on the first by varying the effective flux-density. The arrangement constitutes a magnetic form of automatic volume control so far as the speaker output is concerned. It may be combined with ordinary automatic gain control applied to the H.F. stages.

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

METAL VALVES

Application date, 6th June, 1932. *No.* 398607

Relates to receiving valves of the kind in which a metal portion *A* forming the anode is welded to a glass base *B*. According to the invention the external anode *A* is shaped so as to have a "keyhole" cross-section, the circular portion



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housing an indirectly heated cathode *C* and a gauze grid *G* fitted with a cooling extension *G*1. The latter is accommodated in the corresponding flattened portion of the metal anode, which acts as a cooling chamber.

Patent issued to The M.O. Valve Co., Ltd.; C. J. Smithells and G. W. Warren.

PUSH-PULL AMPLIFIERS

Convention date (Germany), 25th February, 1932.
No. 399098

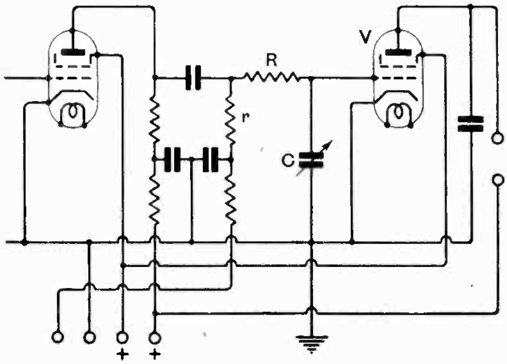
In a push-pull amplifier of the "quiescent" type in which the valves are biased to a point near the bottom bend, the anode current under maximum grid voltage may become excessive, particularly if the amplifier is coupled to a moving-coil speaker whose effective impedance is subject to wide variation. According to the invention, a damping resistance or equivalent impedance is inserted in the output circuit of the amplifier so as to ensure that the effective load can never fall below a minimum "safe" value.

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

TONE CONTROLS

Convention date (Germany), 20th January, 1932.
No. 398704

A tone-control, which also serves to cut out heterodyne "whistle" and atmospheric disturbances, comprises a resistance *R* inserted in the grid



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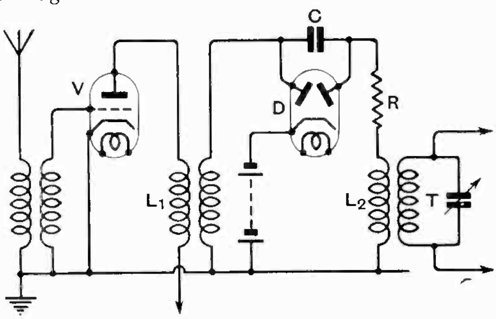
circuit of a low-frequency amplifier *V*, following the intervalve coupling which may be of the resistance-capacity type as shown. Bias for the grid of the L.F. amplifier is derived from the resistance *r*. The resistance *R* is of the order of half a megohm, whilst the shunt condenser *C* has a maximum value of 0.001 mfd.

Patent issued to Dr. G. Seibt Akt.

ELIMINATING STATIC

Convention date (Belgium), 2nd February, 1932.
No. 398715

A gas-filled double-diode valve *D* is inserted as a coupler between an aperiodic H.F. amplifier *V* and the tuned circuit *T* of a succeeding stage. The output coil *L*1 of the amplifier *V* is coupled to one anode of the diode *D*, the other being coupled through a coil *L*2 and resistance *R* to the circuit *T*.



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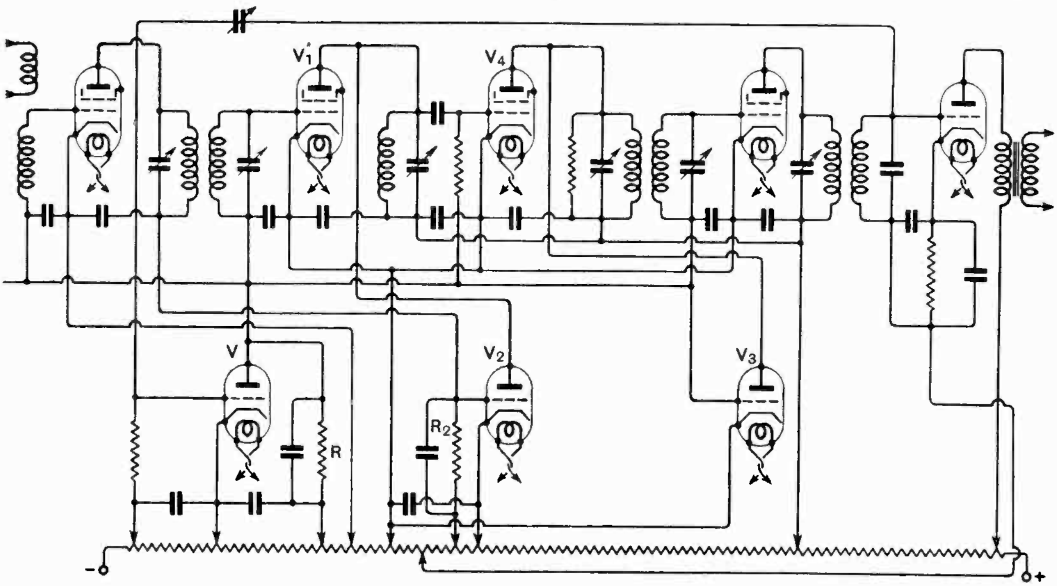
The two anodes are connected through a condenser *C*. Static or other disturbances exceeding a certain voltage across the condenser *C* are discharged to earth *via* the anodes and cathode of the valve *D*, which acts as a current-limiter. The resistance *R* serves to divert disturbances away from the tuned circuit *T* into the limiter *D*.

Patent issued to G. de Monge.

CONTROLLING GAIN AND SELECTIVITY

Convention date (U.S.A.), 26th January, 1932. No. 399068

Automatic H.F. gain control is combined with means for simultaneously regulating the selectivity of the tuned circuits in response to changes of signal strength, so that nearby stations are reproduced at optimum quality, whilst for distant stations the circuits are adjusted to maximum selectivity without creating an unpleasant amount of background "noise." As shown applied to a superhet set, an auxiliary valve *V* develops a voltage across a resistance *R* which is applied to the grid of the intermediate frequency valve *V*1 in the usual way. In addition, two selectivity-control valves *V*2, *V*3 are provided. The anode-cathode resistance of one of these valves is shunted across the tuned output circuit of the amplifier *V*1, whilst the other is across the tuned output of the amplifier.



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For weak signals the voltage across the resistance *R*2 in the output circuit of the first valve is such that the auxiliary valve *V*2 passes no current, and selectivity is high; but as signal strength increases the valve damps the tuned circuits and so broadens the tuning.

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

TELEVISION APPARATUS

Application date, 24th March, 1932. No. 399154

The mirror drum or similar scanning device of a television receiver is prevented from "hunting" about a mean "phase" position by coupling it to the driving motor through an elastic member designed to exert a torque which increases with the angle of displacement. A first bush on the shaft of the motor is fitted with a second bush, which carries the scanning device and is connected to the first bush through an elastic radial link.

Patent issued to C. L. Richards and Baird Television, Ltd.

CATHODE-RAY TUBES

Convention date (Germany) 23rd December, 1930. No. 399160

It is found that the means used to control the intensity of the ray, in response to the incoming signals, is liable to produce an undesirable variation in the shape and size of the "image" point on the fluorescent screen. To obviate this defect the ray is first concentrated by a negatively biased Wehnelt cylinder, and its intensity is then controlled by deflecting plates operating in conjunction with a gap in the screen through which the ray passes. In addition, a concentrating and centralising field is applied through a second Wehnelt cylinder located in front of the deflecting plates.

Patent issued to M. von Ardenne.

GRAMOPHONE PICK-UPS

Application date, 5th April, 1932. No. 399231

A pick-up of the type embodying a single armature mounted on a stylus arm and adapted to vibrate in front of the pole-pieces is characterised (*a*) by the fact that the stylus arm is supported on two oppositely disposed pivots in such a way that it is free to rock in one plane only and (*b*) by the provision of means adjustable from the exterior and located near the pivotal axis of the arm for positioning the armature relatively to the poles.

Patent issued to D. M. Mackie and A. MacWilliam.

RECTIFYING SIGNALS

Convention date (U.S.A.), 1st April, 1931.
No. 398882

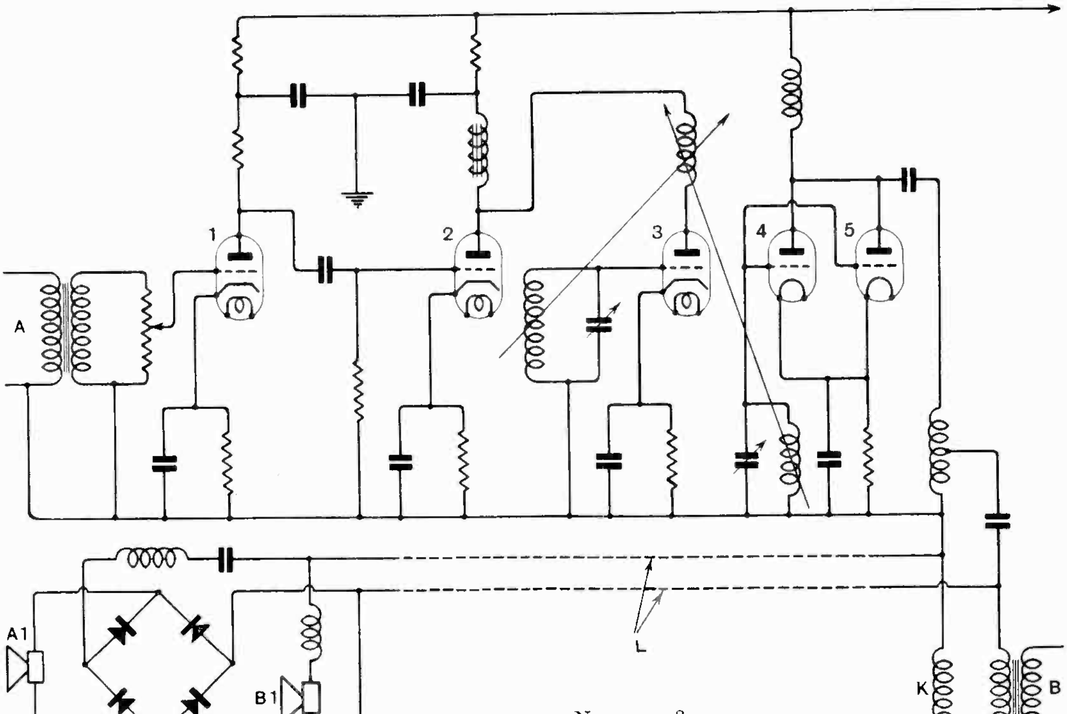
A rectifying circuit is designed (*a*) to preserve a strictly linear relation between signal voltage and the D.C. output component, (*b*) to give undistorted reproduction in the rectified output of the "envelope" of the applied modulated carrier, (*c*) to prevent undesirable overload limitations, (*d*) to simplify operation by the absence of polarising voltages. The arrangement is suitable either for detecting ordinary wireless signals or in connection with automatic volume control. The essential components are a diode valve (or a triode used as such) inserted in series with a condenser across the input circuit and a high resistance shunted either across the diode or the condenser. The rectified voltage so developed may be applied both to preceding H.F. stages and to succeeding L.F. stages for automatic volume control.

Patent issued to Hazeltine Corporation.

RELAYING BROADCAST PROGRAMMES

Application date, 4th January, 1932. No. 399478

Subscribers to a "wired wireless" relay system are given the choice of two programmes, one transmitted over the line as a low-frequency current, and the other in high-frequency form. Programme A is fed at first in low-frequency form to two L.F. amplifiers 1, 2, and is then modulated by a high-frequency generator 3. The output is passed to the subscriber's line *L* through two H.F. amplifiers 4, 5 in parallel. It is rectified at the receiving end and reproduced by the speaker *A*1. Programme B is fed directly to the line *L* through a high-frequency choke *K* and is reproduced by a separate speaker *B*1.



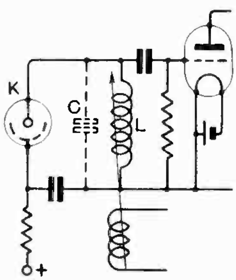
No. 399478.

Patent issued to General Electric Co., Ltd., and W. H. Peters.

PHOTO-ELECTRIC AMPLIFIERS

Convention date (Germany), 2nd May, 1931.
No. 399393

To reduce loss of the higher frequencies when amplifying photo-electric currents a choke *L* is shunted across the cell *K* to form with the inter-electrode capacities (and an auxiliary condenser *C* if necessary) a resonant circuit, which "lifts" the characteristic curve at the high-frequency end, and so ensures a more uniform over-all response. In addition, when modulated light is applied to the amplifier, a frequency corresponding to that of the circuit *L C* is applied to one of the deflecting plates of the Kerr cell (not shown).



No. 399393.

Patent issued to M. von Ardenne.

MICROPHONES

Convention date (Holland), 5th December, 1931.
No. 399340

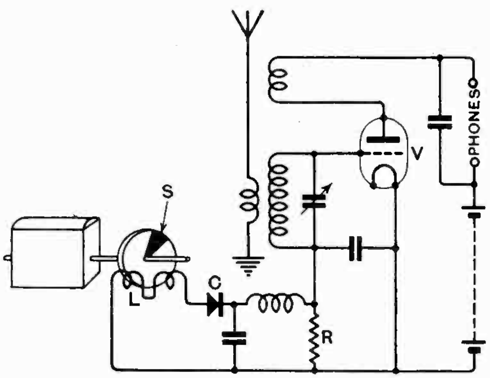
To impart a directional effect, and also to remove distortion due to the relative size of the microphone in the field of sound, two or more microphone units are arranged at the corners of a solid cube, say, of alabaster. The units are interconnected so that they may be used in series or in parallel, or in series-parallel. The arrangement gives a directional effect when the original sound comes either from one definite point, or from a number of different points in space. The characteristic "hissing" noise of the carbon type of microphone is also reduced by the arrangement.

Patent issued to N. V. Philips Gloeilampen-Fabrieken.

ELIMINATING "MAGNETO" INTERFERENCE

Application date, 7th April, 1932. No. 399549

The effect of magneto induction on a wireless receiver, particularly in the case of aircraft, is substantially eliminated by rendering the receiver circuits insensitive during the short periods of time when "sparking" occurs, and restoring them to normal during the intervening periods. A twelve-cylinder engine operating at 3,000 revs. per minute will spark 300 times per second. The actual time occupied by the "firing" is, however, only 8 per cent. of the total time, leaving the remainder available for reception. In general, the receiving circuits are thrown periodically out of action by a suitable damping device which is operated synchronously with the ignition system, as shown in the diagram. Here the quenching frequency of a receiver of the super-regenerative type is applied as a periodic voltage derived from the magneto shaft through an insulating disc carrying a magnetic



No. 399549.

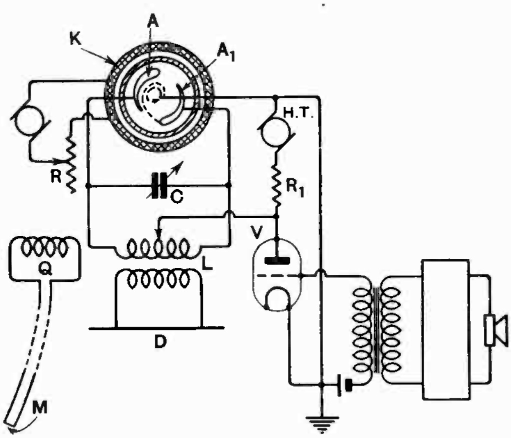
inset *S*. The transient voltage induced in the coil *L* is rectified at *C* and applied to the grid of the super-regenerative valve *V* through a resistance *R*.

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

HIGH-FREQUENCY GENERATORS

Convention date (U.S.A.), 8th May, 1931.
No. 399579

To render a magnetron oscillator of the split-anode type self-starting, the transverse magnetic control-field from the coil *K* is initially set at a low value, which is subsequently increased by means



No. 399579.

of a resistance *R*. Or the plate voltage from the generator H.T. may be similarly regulated through a resistance R_1 as the oscillations become stabilised. The two anodes *A*, A_1 are of the shape shown in cross-section, and are connected across the main oscillatory circuit *L C*, which is coupled to a half-wave aerial *D*. Modulation is effected by a valve *V*, whilst the generated frequency is held constant by means of an auxiliary Lecher-wire transmission line *Q* tuned by a slider *M* to an integral number of half wavelengths.

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

SHORT-WAVE TRANSMITTERS

Convention date (Germany), 16th September, 1932.
No. 399770

Relates to directive systems of the kind in which a main oscillator dipole, located at the focal point of a parabolic reflector, is "backed" by an auxiliary reflector which throws back into the main beam radiation-energy which would otherwise be lost. According to the invention the auxiliary reflector takes the form of a second dipole; or, where the main oscillator is a "magnetic" or closed circuit dipole, the auxiliary reflector may be of the same type, orientated at right-angles to the first. Alternatively, an electric dipole may be backed by a magnetic dipole acting as reflector.

Patent issued to Naanlooze Vennootschap Machinerieen-en Apparaten Fabrieken.