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Editorials

What is Demodulation?

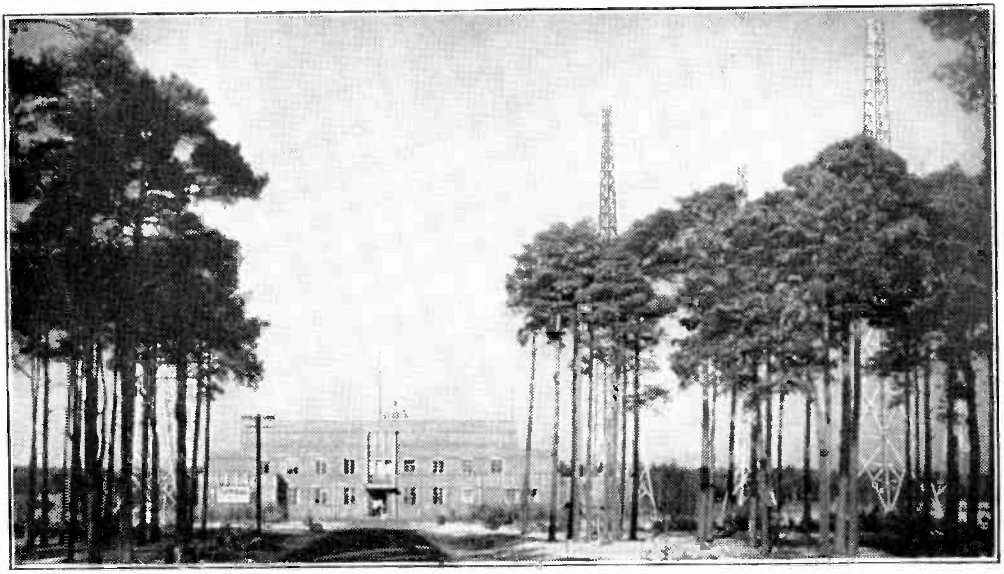
IN our correspondence columns we publish a letter from a Canadian reader with reference to the regrettable fact that the word "demodulation" is used by different people in two entirely different senses. Our correspondent plumps for the American usage, and it may be that there is something to say for it, but we certainly do not agree that "demodulation here has its logical meaning as related to modulation." In our opinion the American use of the word to mean detection or rectification is a misuse of the word; it may be a convenient misuse; it is certainly a very common one in America. Starting from an unmodulated high-frequency carrier, it is modulated by causing its amplitude to vary. What would anyone whose judgment had not been warped by continual use of the word in a special sense understand by the demodulation of this modulated carrier? Surely the restoration to the previous unmodulated state, either wholly or in part. When an ionised space is said to have been de-ionised one merely means that the space has been restored to its un-ionised condition, and, generally speaking, one does not care what has become of the ions. When a State is demilitarised, one thinks only of the restoration of the State to a non-military condition, and not the collection of the military elements for use. Similarly, if we turn to a dictionary for examples, we find decarbonise, to deprive of carbon; dechristianise, to destroy Christian elements; deconsecrate, to deprive of the character given by consecration; depopulate, to deprive of population; and so on. In every case the idea is that of the restoration or conversion to a different condition by the removal or destruction of something. In this country demodulation is used in this sense, viz.: the partial or entire removal or suppression of the modulation, thus restoring the carrier more or less to its original unmodulated condition.

If one wanted to use the water which was absorbed in a body one would speak of extracting the water and not of dehydrating the body; the latter expression would give an entirely wrong idea. In our opinion it is equally wrong and misleading to refer to a valve as a demodulating valve when its function is to extract and pass on the modulating element from the modulated carrier, the carrier itself being generally destroyed. If "rectifier" is undesirable—and our correspondent appears to dislike it in spite of the time-honoured grid-leak and anode-bend rectifiers—and it is thought necessary to include the term "modulation," we would suggest that our American friends should find something equivalent to "modulation extractor," and leave the word "demodulator" for that which really demodulates in the proper sense of the term. It would be wrong, however, to assume that everybody in America uses the term in preference to "detection" or "rectification." In *Radio Engineering*, by Terman of Stanford University, the word "Demodulation" is to be found in the index, but with the reference "see Detectors"; and it is as Detectors that they are described in the text. Our correspondent is probably correct as to the date of the coining of the term demodulation. It is not mentioned in Morecroft's *Principles of Radio Engineering* published in 1921.

The Earth Resistance of Transmitting Aerials

IN this issue we publish a letter from a correspondent suggesting that transmitting stations deteriorate rapidly after commencing operations, and that within a short time the signals which were originally loud fade away until they can only be heard with difficulty. This is referred to as a phenomenon which has been known to our correspondent for twenty years. If it is true, or even if there is any truth whatever in it, it is a very important matter which calls for immediate investigation. There should now be available ample data to prove or disprove the truth of the statement. Field strength measurements have been made on many transmitting aerials and it should be a relatively simple matter for broadcasting authorities to compare measurements made after one or two years' operation with the results obtained when the aerial was undergoing its preliminary tests. If these investigations show any appreciable variation in the radiating efficiency of the aerial we shall be very surprised, and we shall certainly be faced with a problem which will merit the serious attention of all broadcasting organisations. Our correspondent does not say whether he suspects the aerial current of falling away from its initial value—which would be detected by means of an aerial ammeter—or whether he thinks that the earth becomes so poisoned that the radiation for a given aerial current is reduced. Such points can safely be left until we know if there is any objective experimental support for the alleged phenomenon.

G. W. O. H.



The new German short-wave centre at Zeesen, near Berlin, with directional aerial "arrays" for transmission to North and South America, South Africa and the Far East. An omni-directional service is also provided for.

Ultra-short Radio Waves*

Refraction in the Lower Atmosphere

By R. L. Smith-Rose, D.Sc., Ph.D., A.M.I.E.E., and J. S. McPetrie, B.Sc., A.M.I.E.E.

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ABSTRACT.—This paper considers some aspects of the problem of the refraction of electric waves in the lower atmosphere due to the variation of density of the air with altitude. As a result of this refraction the path of waves between a transmitter and receiver is curved in a manner concave to the earth's surface. It is shown that for average atmospheric conditions the radius of curvature of this path is about six times the radius of the earth. The effective maximum range between a transmitter and receiver using waves following such a curved path is calculated for different heights of the two stations, and is shown to be materially greater than the maximum range obtainable assuming that the waves employed follow a straight line tangential to the earth's surface.

A summary of previous work is given and particular attention is drawn to the experimental evidence on wavelengths between 0.5 and 8 metres indicating possible communication ranges of nearly fifty per cent. in excess of those determined by the rectilinear or optical path.† On the basis of the calculations made in this paper, it appears that the curvature of the waves by refraction is not sufficient to explain some of the experimental results. The phenomenon of fading, which was encountered in some of the experiments, is explicable, however, as the result of convection currents in the air causing a variation in the refractive index. The possible contribution of diffraction effects around the curvature of the earth is mentioned, but is not considered in any detail.

I. General

CONSIDERABLE interest has been aroused recently as the result of successful experiments demonstrating the application of electric waves of less than one metre in wavelength to practical radio communication. In March, 1931, a demonstration was given by the International Telephone and Telegraph Laboratories of radio communication across the English Channel on a wavelength of about 17 cm.[1] More recently, Marconi[2] has obtained communication on a wavelength of 50 cms. over distances up to 168 miles from a transmitter near Rome and a receiver situated on the island of Sardinia. In each of these experiments reflectors were used at the transmitting end to concentrate the radiation into a beam, and a similar reflector was used at the receiving end to improve the efficiency of the whole system. A feature of Marconi's experiment which attracted attention was that the range obtained (168 miles) was in excess of the maximum distance (about 107 miles) at which a straight line from the transmitter, elevated to 2,460 feet, would pass tangentially along the earth's surface, and then on to the receiver at an altitude of 1,115 feet.‡ It was evident, therefore, that the waves from the transmitter were subject to a considerable deviation, which allowed them to bend round the earth's surface. This deviation could be produced either by optical diffraction of the waves round the curvature of the earth, or by the refraction of the waves in passing through the lower regions of the atmosphere. It is the purpose of this paper to discuss some aspects of the latter possibility.

II. Limitation of Range by Rectilinear Path

If the waves from a transmitter T in Fig. 1 are restricted to rectilinear paths then the maximum range obtainable will be TR_1, where R_1 is the point at which the tangent TR_1R_2 touches the earth's surface. The distance d_1 between transmitter and receiver is commonly referred to as the maxi-

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

† Since the writing of this paper, the above communication ranges have been considerably extended.

‡ In the lecture by Marchese Marconi, the optical range as determined by this rectilinear path was given as only 72 miles, which is inconsistent with the heights of transmitter (750 m.) and receiver (340 m.) described. (See *World Radio*, December 30th, 1932, p. 1,380.)

imum range obtainable by the so-called optical path. At points within the range TR_1 reception will be possible by means of waves which arrive at an angle to the earth's surface. Simple consideration of the geometry of Fig. 1 will show that the above limiting distance between transmitter and receiver is given by the expression $\sqrt{2h_1R}$ to an approximation sufficient for most practical purposes, where h_1 is the height of the transmitter above the surface and R

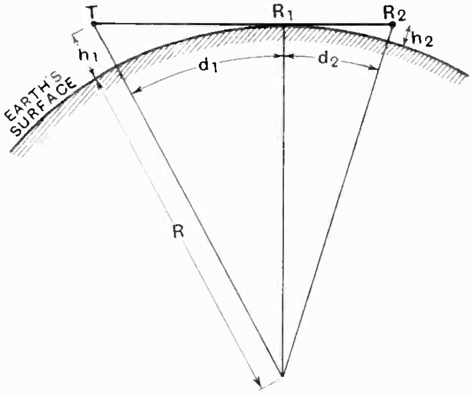

Fig. 1.—*Showing optical path of waves from a transmitter at T to receivers at R_1 and R_2.*

is the radius of the earth. If the receiver is raised to a height h_2 the range is correspondingly increased by an amount $d_2 = \sqrt{2h_2R}$, as indicated by the point R_2 in Fig. 1.

III. Practical Results with Ultra-short Waves

In addition to the results obtained by Marconi, to which reference has already been made, there are several examples of communication having been established on ultra-short wavelengths at distances considerably in excess of this rectilinear or optical range. For example, in 1926 experiments were carried out by the French Government with a view to establishing communication between France and the island of Corsica, a distance of about 130 miles.[3] With the transmitter at an altitude of 2,300 feet and the receiver at 1,740 feet above sea-level, communication was easily established over this distance on a wavelength of 3.5 metres using an input power at the transmitter of about 500 watts. Following these experiments an experimental radio channel was installed in 1929 to link up Corsica with the French land-line telephone system. By the use of parabolic reflectors at both ends, it has been found possible to reduce the power to 150 watts, and still maintain a commercial service under all conditions. With a wavelength of 5 or 6 metres, regular communication can be maintained with a power of 35 watts. Experience with this service first brought to light the fact that the distance at which the waves can be satisfactorily received is beyond the limit of the straight line optical path tangential to the earth's surface (see Fig. 1). It was also noticed that towards sunset on warm, bright days, fading occurred on the received signals. This fading was not experienced on overcast days or long after sunset. These experiences were considered to establish the fact that the short waves employed are refracted in travelling through the lower atmosphere to such an extent as to produce a total deviation in the vertical plane of about 2° from the rectilinear path. The fading effects were attributed to the variation in refraction resulting from the density variations of the air over the sea, as the latter cools down in the neighbourhood of sunset. The gain in signalling range which results from the normal steady refraction effects appears to be considerable, *e.g.*, in the case of the Corsica-France service, the optical range is about 109 miles, whereas the actual distance operated is nearly 130 miles.

In June, 1932, installations of a more complete nature were carried out with a view to providing a permanent commercial radio link in the normal telephone service[13]. In order to avoid the effect of adverse climatic conditions upon the overhead lines, the height of the station in Corsica was reduced to about 660 feet, while that on the mainland was reduced to about 1,640 feet. It was also found desirable to increase the wavelength employed, and these are now 7.6 m. for communication in one direction and 8.2 m. in the opposite direction. Under these conditions fading effects are sometimes experienced, but they are not sufficient to impede normal communication.

A year or two ago the Radio Corporation of America[4], explored the possibilities of providing radio-telephone communication between the individual islands of the

Hawaiian group in the Pacific Ocean. These islands are separated by uninterrupted sea paths varying from 20 or 30 up to 190 miles, and it was found easily practicable to establish commercial communication over these distances by installing the transmitters and receivers at suitable elevated points. At wavelengths of about 7 metres, and with the aid of directional antenna systems, the actual ranges were again found to be considerably in excess of those given by the optical or rectilinear path. For example, with transmitter and receiver at 4,800 and 1,700 feet respectively, the range obtained was 190 miles instead of 134 miles by the rectilinear path.

Extended tests showed that the signal reception was remarkably free from atmospherics and fading, and from any effect of weather or day and night conditions. As a result of these experiments a telephone network has been planned, which will link the Hawaiian islands together, using a series of wavelengths between 5.5 and 8.5 metres.

Some experiments of interest in this connection have also been carried out in Moscow with a view to ascertaining the possibilities of ultra-short waves for broadcasting and other purposes[5]. An experimental transmitter was installed on the roof of a building in Moscow, 150ft. high and operated on wavelengths of from 3.3 to 8 metres. With a radiated power of about 250 watts, and a super-regenerative receiver, good reception was obtained at distances up to 8 miles in the streets of the city, and up to about 47 miles outside Moscow. The latter distance, it will be noted, is well beyond the horizon from the transmitter, and this was attributed to diffraction of the waves round the curvature of the earth, an explanation which is apparently supported in this case by the fact that on a wavelength of 8 metres the received signals were about 50 times as strong as those on 5.6 metres.

Certain experiments carried out in this country by the Radio Research Board[6] are of interest in connection with this subject. With the co-operation of the Post Office, signals from two transmitters at Rugby on a wavelength of 5.5 metres have been received at various distances up to 44 miles. One of these transmitters was located at the top of a mast 820ft. high, and was supplied with a power of about 150 watts, while the second set supplied about 2,000 watts to its aerial at the top of a mast 40ft. high. The receiver was in the optical path of the low power, elevated transmitter, but not in that of the set of higher power, and it was observed that the signals from the two emitters were of approximately the same intensity. Special tests were carried out to confirm the absence of any down-coming radiation at the receiver; yet it was found that there was a distinct diurnal variation of signal strength, particularly on hot sunny days.

In addition to the "commercial" results described above, a certain amount of success has been achieved by amateur experimenters working in their allotted band on a wavelength of about 5 metres. Successful telephony experiments have been carried out in this country over distances up to 50 miles[7], using transportable apparatus and a power supply of less than 10 watts. In America, enthusiastic experimenters have used an aeroplane to obtain the necessary altitude for their apparatus, and communication was established with ground stations at distances up to 100 miles[8]. In this connection it may be noted that experiments from aircraft to ground have been made in Germany, in which the range obtained was over three times the limit imposed by the horizon, a further confirmation of the existence of the bending effects previously described.

It will be seen from the above brief review that there is a good deal of evidence already available to show that the range of ultra-short waves is not confined to the rectilinear optical path, as depicted in Fig. 1. Among the possible explanations which can account for this increased range, the two most likely are based upon diffraction and refraction effects respectively. The amount of diffraction of electric waves around the curved surface of the earth would be expected to decrease as the wavelength is reduced; whereas in the case of refraction through the lower regions of the atmosphere the deviation, and so the range obtained, would (in the absence of anomalous dispersion phenomena) be expected to become larger as the wavelength is decreased. Unfortunately, there does not seem to be sufficient corroborative evidence at present available to decide whether the deviation increases or decreases with the wavelength. In the following sections certain aspects of the refraction theory are discussed.

IV. The Refraction of Waves in the Lower Atmosphere

In a paper published in 1914, J. A. Fleming[9] discussed the deviation of electromagnetic waves by refraction in the atmosphere due to the decreasing density of the constituent gases with increasing height above the earth's surface. It was pointed out that a ray emitted from a source on the earth's surface, starting in a direction tangential to the surface, would be bent in passing through the atmosphere and would therefore follow a path the curvature of which would be concave to the earth. The problem had already been considered in astronomy, and it was known that incoming rays of light from stars or other celestial bodies were refracted in the atmosphere so that their apparent zenith distances were less than the true ones. At the time of publication of the above paper, the interest of investigators was chiefly concentrated upon the finding of an explanation for the transmission of electric waves, at wavelengths of several hundred metres to considerable distances, of the order of a quarter of the circumference of the earth. Fleming came to the conclusion that ordinary refraction through the atmosphere, in the absence of ionisation, would not account for such long-distance transmission. He also showed that if the atmosphere were composed of the gas krypton, waves starting out tangentially from the surface of the earth would follow a circular path of curvature equal to that of the earth, and such waves would therefore be expected to travel right round the earth to the Antipodes.

In 1927, T. Y. Baker[14] considered in some detail the problem of the refraction of electric waves through a hypothetical atmosphere, in which the direction of propagation of the waves is everywhere at right-angles to the wave-front, and the wave-velocity is inversely proportional to the refractive index. An important point that emerged from this paper was the fact that in order to compute the correct track of electric waves through the atmosphere it is necessary to know the refractive index of the atmosphere to considerable accuracy.

This matter was further discussed by J. S. McPetrie and R. M. Wilmotte[10] in 1927, who showed that if electromagnetic waves sent upwards from the earth are to return to the earth's surface, the dielectric constant of the air must vary in a particular manner with altitude. Making use of the results of recent investigation of the temperature of the atmosphere at heights up to 150 km., it was found that the required condition was not satisfied. It was concluded that for waves starting out at angles of elevation of more than about 2° to the earth's surface, ordinary atmospheric refraction plays a negligible part in the transmission of waves to long distances, which, for wavelengths in excess of 8 or 9 metres, is now generally accepted as being due to the effect of ionised layers in the upper atmosphere.

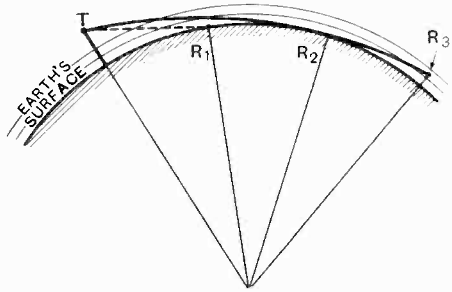

Fig. 2.—*Showing curved path of refracted wave TR_2, TR_3, compared with the optical path TR_1, from elevated transmitter at T.*

The experimental work on the propagation of ultra-short waves summarised in Section III above makes it desirable to reconsider the problem, and particularly to investigate the paths of waves which start off at angles of less than 2° above the earth's surface, and travel through the lower regions of the atmosphere at heights of only one or two kilometres.

V. Calculation of Path of Refracted Wave

It is evident on general grounds that refraction of electric waves in the lower atmosphere will increase the effective range of a transmitter. For example, in Fig. 2, TR_1 represents the limiting rectilinear path of waves from an elevated transmitter T reaching the earth's surface. Waves starting from T in a direction above TR_1 will be refracted towards the earth in passing successive regions of air of increasing density. Thus such waves would follow a curved path TR_2, reaching the earth at R_2 beyond the point R_1. To an observer at T the horizon would appear to be at R_2, whereas for rectilinear propagation it would be at R_1. In the case of light, this phenomenon is termed "depression of the horizon" and is well known to sailors. After passing the earth tangentially at the point R_2, the waves will rise again into the atmosphere, arriving at an elevated receiver at the point R_3. The path TR_2R_3 is obviously reversible for waves transmitted in the opposite direction. If the lower atmosphere is heated, the density and so the refractive index decrease, and the bending of the waves will be less marked. It is on this basis that Jouaust explained the signal-fading effects observed in the France-Corsica transmission, particularly near sunset after a hot, sunny day when heated air was rising from the sea and causing a fluctuation in the deviation produced in the waves transmitted.

The determination of the curved path of a ray starting from the earth's surface, and subject to refraction in the lower atmosphere, is the inverse of the problem of astronomical refraction which was first considered by Lord Rayleigh[11]. The calculation of the path for the case of a source of radio waves was given in Fleming's paper,[9] to which reference has already been made.

A more rigid analysis of the problem is outlined in the appendix to this paper, in which it is shown that a ray leaving a radio transmitter in any direction from a point on the earth's surface will follow a path, the radius of curvature of which is nearly six times that of the earth. As the path of the wave rises in the atmosphere, the density of the air decreases, and therefore, as seen from equation (11) in the appendix, the radius of curvature of the path increases. The following table gives the results of calculations made with the aid of equation (11), making use of the definition of the international standard atmosphere to obtain values of average atmospheric conditions. The last two columns give respectively the radius of curvature of the ray path calculated in the above manner, and the ratio m of this radius to the radius of the earth. The results are restricted to an altitude of 2,000 metres (6,560 feet), as being the limiting height of interest in this phase of radio communication at the present time.

Altitude.		Density of air gms. per c.c.	Radius of Curvature kms.	m.
Metres.	Feet.			
0	0	0.001226	37,200	5.8
500	1,640	0.001167	38,500	6.0
1,000	3,280	0.001112	40,000	6.2
1,500	4,920	0.001058	42,000	6.5
2,000	6,560	0.001007	43,300	6.7

From this table of results it is seen that as the ray travels outwards through the earth's atmosphere the radius of curvature of its path increases steadily, and for the heights with which we are chiefly concerned this radius appears to lie between about 5.8 and 6.7 times the radius of the earth. The actual values of this curvature will obviously depend upon the pressure and temperature conditions prevailing at the point in question, and these may vary considerably for different parts of the earth's surface.

In view of the somewhat indefinite nature of these atmospheric conditions, it would seem to be of little value to calculate accurately the curved path followed by the waves. It will be a sufficient approximation for the limited experimental data so far available if we assume the curvature of the ray to be constant and so follow a circular path. On this assumption the possible range of transmission d for a source at an altitude h_1, *i.e.*, the distance of the horizon for an observer at such a height, is given by

$$h_1 = R\left\{\left(\sec.\frac{d}{R} - 1\right) - m\left(\sec.\frac{d}{mR} - 1\right)\sec.\frac{d}{R}\right\}*$$

When the distance d is less than a few hundred miles, this equation reduces to

$$d = \sqrt{Rh_1\frac{2m}{m-1}}$$

which is the form given by Jouaust.† Graphs showing the relation between d and h are given in Fig. 3 for a few typical values of m. On this diagram the curve for the optical or rectilinear path is reproduced,

* Humphreys "Physics of the Air," 1920, p. 448.
† *Ref.* 3, p. 487.

this referring to a value of m equal to infinity. It is seen from this diagram that the increase in effective range for values of m greater than 6 is not large. In the case where the transmitter is also elevated to a height h_2, the corresponding range is given by the relation :—

$$d = \sqrt{Rh_1 \frac{2m}{m-1}} + \sqrt{Rh_2 \frac{2m}{m-1}}$$

The analysis provided in this section takes no account of any variation of the refractive index with wavelength. This results from the assumptions that the refractive index depends only upon the dielectric constant of the air and that its conductivity plays a negligible part at the radio frequencies under consideration.

VI. Comparison of Theoretical and Experimental Results

With the aid of the diagram forming Fig. 3, we are now able to examine the practical results already discussed on the basis of this refraction hypothesis. In the following table a summary of these results is given, and for each case the value of m has been deduced to give agreement between the theoretical range and that obtained experimentally. In considering these results it must be remembered that the experimental ranges are not definite distances at which the communication link. It is interesting to observe that Jouaust also reports that for visual observations on a light beacon made

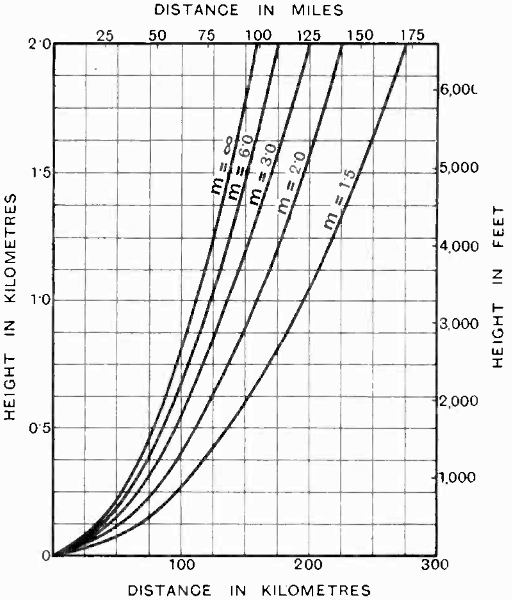

Fig. 3.—*Curves giving relation between height and distance to earth's surface, for a circular path, of radius m times radius of earth.*

in France on the Atlantic Coast over a period of several years the value of m, connecting

SUMMARY OF RESULTS OF RANGE TESTS ON ULTRA SHORT WAVES.

Date and Reference.	Location of Experiment.	Distance Covered (miles).	Height of Transmitter h_1 (ft.).	Height of Receiver h_2 (ft.).	Optical Range (miles).	Value of m required to give Distances Covered.	Wave-length (metres).
1929 Jouaust ..	Nice to Corsica.	128	2,500	1,700	109	5	5
1931 Beverage Peterson & Hansell	Oahu to Hawaii	190	4,800	1,700	134	2	7.1 and 8.2
1932 Marconi ..	Rome to Sardinia.	168	2,460	1,115	107	2	0.57

received signals were suddenly cut off. The disappearance of the signals at the limiting range is naturally a gradual process, and in all the experiments severe signal-fading was reported at these distances.

The value of $m = 5$ agrees with that deduced by Jouaust for the France-Corsica the altitude of observation with the distance of the beacon, varied from 15 in January to 7 in August.

Reverting to the above table, it is seen that in order to explain the results obtained in the Hawaiian Islands tests and in Marconi's experiments, on the basis of atmospheric refraction alone, the required value of m is 2. This would appear to be somewhat difficult to explain completely on the basis of the refraction effects discussed above. The variations in atmospheric conditions met with at different points on the earth's surface are insufficient to account for such a small value of m. The variation in water vapour content from zero to saturation provides only a small contribution towards a variation in the value of m. A possible explanation of this apparent discrepancy might be found in the contribution which diffraction effects might make to the received signal intensity. The diffraction of electric waves around the earth has been studied by G. N. Watson[12], but the subject may need further consideration in the light of modern experimental data obtained on ultra-short wavelengths. The effects of diffraction, however, will decrease as the wavelength is reduced, and they are probably insufficient in themselves to explain the fading phenomena which have been observed in the experiments recorded. If the received signals were due, in equal proportions, to waves arriving by diffraction and refraction, then a mere phase change of the latter relative to the former would account for the fading of signals from a maximum down to complete inaudibility.

The general conclusion of this section of the paper must therefore be, that while on the basis of atmospheric refraction a range of communication in excess of the optical or rectilinear path distance can be accounted for, there appear to be some discrepancies which warrant the further investigation of the subject from the theoretical and experimental aspects.

The work described above was carried out as part of the programme of the Radio Research Board and is published by the permission of the Department of Scientific and Industrial Research.

APPENDIX

Calculation of Path of Waves through the Atmosphere

(a) Variation of refractive index of air with height above the earth's surface.

It can be shown that the dielectric constant K of a substance is related to its density q by the equation*

$$\frac{K-1}{K+2} = Aq \qquad \ldots \quad \ldots \quad \ldots \quad (1)$$

where A is a constant.

* N. R. Campbell : *Modern Electrical Theory*, 1913, p. 34.

In the case of a non-conductor, this may be converted to the following form containing the refractive index μ of the material :

$$\frac{\mu^2-1}{\mu^2+2} = Aq$$

$$\text{i.e.} \qquad \frac{(\mu-1)(\mu+1)}{\mu^2+2} = Aq$$

In the case of a gas, it is known that the value of μ differs from unity by less than one part in a thousand, and we may thus write :

$$\mu - 1 = Aq \qquad \ldots \quad \ldots \quad \ldots \quad (2)$$

which is the form of Gladstone and Dale's law for the refractivity of gases.

Hence, in order to ascertain the variation of the refractive index of air with height above the earth's surface, we must know the law connecting the density of the atmosphere with altitude, which may be determined in the following manner. If p is the pressure, q the density, T the absolute temperature, and R the universal gas constant, these quantities are connected by the well-known equation :

$$p = RqT \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

Considering a vertical column of air of unit cross-section, the equation of equilibrium at any point is :

$$\frac{dp}{dh} = -gq \qquad \ldots \quad \ldots \quad \ldots \quad (4)$$

where h is the height of the point under consideration and g is the gravitational constant.

Now

$$\frac{dp}{dh} = \frac{\partial p}{\partial q}\cdot\frac{dq}{dh} + \frac{\partial p}{\partial T}\cdot\frac{dT}{dh}$$

$\therefore$ From eqn. (3)

$$\frac{dp}{dh} = RT\cdot\frac{dq}{dh} + Rq\cdot\frac{dT}{dh}$$

If we assume $T = T_0 - ah$

where T_0 is the absolute temperature at the earth's surface, and a is the rate of decrease of temperature with height h above this surface, then

$$\frac{dp}{dh} = RT\cdot\frac{dq}{dh} - Rqa \qquad \ldots \quad \ldots \quad (5)$$

Combining (4) and (5) we have :

$$-gq = RT\cdot\frac{dq}{dh} - Rqa$$

$$= R(T_0 - ah)\cdot\frac{dq}{dh} - Rqa$$

$$\therefore \quad \frac{dq}{dh} = \frac{q(Ra-g)}{R(T_0-ah)}$$

$$\frac{dq}{q} = \frac{(Ra-g)\cdot dh}{R(T_0-ah)}$$

Integrating :

$$\log q = \frac{-(Ra-g)}{Ra}\log(T_0 - ah) + B$$

where B is a constant of integration.

Inserting the limiting condition that the density is q_0 at the earth's surface, *i.e.*, for $h = 0$, we get

$$\log q = \frac{g - Ra}{Ra} \log (T_0 - ah) + \log q_0 + \frac{Ra - g}{Ra} \log T_0$$

whence $$\log \frac{q}{q_0} = \frac{g - Ra}{Ra} \log \left(\frac{T_0 - ah}{T_0} \right)$$

and ∴ $$\frac{q}{q_0} = \left(1 - \frac{ah}{T_0} \right)^{\left(\frac{g}{Ra} - 1\right)}$$

In order to reduce equation (6) to numerical values, it will be convenient to make use of the definition of an International Standard Atmosphere as adopted by the Air Ministry for the graduation of altimetres on a uniform basis*. This definition assumes that the air is dry and has a uniform composition at all altitudes. The temperature of the air at mean sea level is taken as 15°C, and the barometric height, reduced to 0°C, as 760 mm. of mercury. Under these conditions the atmospheric pressure is 1,033 gms. per sq. cm., and the density of the air is 0.001226 gms. per c.c. For any altitude up to 11,000 metres the rate of decrease of temperature under these conditions is 0.0065°C. per metre.

Inserting the above quantities in equation (6) we obtain:

$$\frac{q}{q_0} = \left(1 - \frac{0.0065h}{288} \right)^{4.26}$$

$$= (1 - 22.6 \times 10^{-6} h)^{4.26} \quad \ldots \quad (7)$$

where h is the height above sea level in metres.

In our problem we are, as already stated in the paper, only interested in heights of about 2,000 metres or less, and the values of the density of the air at heights within this limit are given in the following table:

Height (metres).	Temperature (degrees Centigrade).	Pressure (millibars).	Density in gms. per c.c. of	
			Dry Air.	Air saturated with water vapour.
0	15	1,013	0.001226	0.001219
500	11.75	954	0.001167	0.001160
1,000	8.5	899	0.001112	0.001107
1,500	5.25	846	0.001058	0.001052
2,000	2.0	795	0.001007	0.000993

Since the above definition of an international standard atmosphere assumed that the air was dry, the last column of the above table shows the altered values of the density at different heights, assuming the air to be saturated with water vapour. From these figures it will be seen that the change in density of the air with humidity is of the order of less than one per cent.

* See *Air Publication*, No. 1173 (1925), H.M. Stationery Office.

(*b*) *Radius of curvature of path of ray through air.*

Let TP, Fig. 4, represent the path of a ray starting from the point T on the surface of the earth, radius R, the point P being at a height h above the surface, where h is very small compared with R.

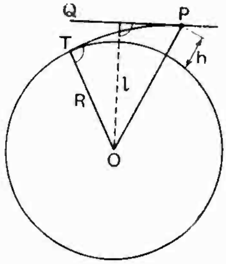

Fig. 4.

Let l be the length of the normal from the centre of the earth O on the line PQ, which is tangential to the ray path at P. We then have for any position of P along the ray path, at which the refractive index is μ

$$l\mu = C \quad \ldots \quad (8)$$

where C is a constant.

Further, the radius of curvature ρ of the ray path at the point P is given by

$$\rho = R \frac{dh}{dl} \quad \ldots \quad \ldots \quad \ldots \quad (9)$$

From this, we have

$$\rho = R \frac{dh}{d\mu} \cdot \frac{d\mu}{dl}$$

which, making use of (8), gives

$$\rho = - R \frac{dh}{d\mu} \cdot \frac{\mu}{l}$$

$$= - \mu \frac{dh}{d\mu} \quad \ldots \quad \ldots \quad (10)$$

For air the refractive index is of the order 1.0003, so that in equation (10) μ may be put equal to unity without appreciable loss of accuracy.

$$\text{Hence } \rho = - \frac{dh}{d\mu}$$

but from equations (2) and (6)

$$\frac{d\mu}{dh} = A \frac{dq}{dh} = - A q_0 \frac{a}{T_0} \left(\frac{g}{Ra} - 1 \right) \left(1 - \frac{ah}{T_0} \right) \left(\frac{g}{Ra} - 2 \right)$$

neglecting terms containing squares and higher powers of h

$$\therefore \rho = \frac{T_0}{A q_0 a} \frac{1}{\left(\frac{g}{Ra} - 1 \right) \left[1 - \frac{ah}{T_0} \left(\frac{g}{Ra} - 2 \right) \right]} \quad \ldots \quad (11)$$

Substituting the values used for obtaining the numerical equation (7) together with the value of $A = 0.227$ for air, we have for $h = 0$

$$\rho = \frac{288}{0.227 \times 0.001226 \times 0.0065} \cdot \frac{1}{4.26}$$

$$= 37.2 \times 10^6 \text{ metres.}$$

$$= 37{,}200 \quad \text{kilometres.}$$

$$= 5.8 R$$

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New Book

Photo-electric Cell Applications.

By R. C. WALKER and T. M. C. LANCE.

Pp. 193 (Figs. III.) [Pitman, 1933]. Price, 8s. 6d.

The photo-electric cell, after a long and eventful scientific history, now holds an important place among industrial mechanisms and it is the purpose of this book to describe and explain the many uses to which such light-sensitive devices can be put in the commercial world. The authors, who have gained much experience with the General Electric Co., have concentrated on practical applications: there is no mathematics and but little physics in the book. This is no drawback, since the theoretical treatment is already available in the excellent book* by Campbell and Ritchie.

The first impression produced upon the mind of the general reader is likely to be one of amazement at the way in which the scientific toy of ten years ago has become established as a reliable industrial machine. Wherever two objects differ in shape, size, or colour, one can be taken and the other left; Wherever a moving object, alive or inanimate, casts a shadow, gates can be opened, barriers closed, or warning signals set into action. It is remarkable how closely the electric eye connected to a power relay can simulate the mental and muscular processes which operate at a low level not much higher than the region of reflex action. Much of the work performed by policemen, commissionaires, sorters, inspectors, and night watchmen is of this type.

Whatever views may be taken as to the replacement of man by machinery, there is much to be said for the elimination of monotonous labour and for the discouragement of the multiplication of low types of brain, and in this respect the photo-electric cell may be regarded as a eugenic boon.

In the fundamental valve relay circuits which are described by the authors, the thyratron plays an important part, since it is capable of controlling 20 kilowatts with an input signal of only 1 microwatt. The thyratron is at its best on A-C mains for it resets itself at each cycle and can be phase controlled to give a graduated output. Relays are always designed to give warning if any part fails, thus if lights are to be switched on at sunset they will glow automatically upon the breakdown of a valve or a battery.

Counting and timing gear is extensively used for such purposes as counting newspaper bundles and timing races. The interruption of a beam is used to operate burglar alarms or to open doors or lift gates when anyone approaches. Smoke can be detected by the reduction of illumination of one cell in a balanced circuit. In the hold of a cargo boat where severe conditions would cause rapid deterioration of a cell, the air is pumped up to a central chamber and there examined. Dangerous gases can be detected by allowing them to alter the transparency of a chemical indicator.

In the advertising world, a window display may be set in motion by light reflected from a hand held in front of the window. Or a train may interrupt a beam of light so that an advertisement flashes on for 30 seconds at the side of the track. Road signs are similarly operated by motor-car headlights. In the reproduction of talking films, it is interesting to note that infra-red light is used to form the beam which is modulated by the sound track: this is because the flicker of a lamp on A-C mains which causes hum in the loud-speaker is much less pronounced in the infra-red; also in the case of tinted films the colour is practically transparent to infra-red so that the sound intensity does not vary.

Many other applications to phototelegraphy, television, and scientific instruments are adequately described.

There are a few errors which should be corrected in the 2nd edition. The footnote to p. 8 defines the lumen in terms of the standard candle and the lux in terms of the Hefner candle, but no country uses mixed units of this kind. On p. 15 the lumen is wrongly used as a unit of illumination. On p. 28 energy is given in microwatts. The differences between Figs. 3 and 4 should be more explicitly stated.

R. T. B.

* *Photographic Cells*, by N. R. Campbell and D. Ritchie [Pitman 15s.]

The Effective Resistance of Inductance Coils at Radio Frequency *

An Abstract by B. B. Austin, B.Eng., A.M.I.E.E., of a Paper by S. Butterworth

1.0.—Introduction

IN 1926 *The Wireless Engineer*, then known as *Experimental Wireless* published a most complete treatise by S. Butterworth on the " Effective Resistance of Inductance Coils at Radio Frequency." This treatise was published in four separate issues and occupied some thirty-two pages. The subject was dealt with very completely and the sources of the various losses carefully analysed.

The writer recently wished to make a considerable number of H.F. coil calculations and therefore referred to this treatise.

It soon became apparent however that it would not be possible to pick out the necessary formulae immediately and make the desired calculation. In fact the whole treatise had to be carefully read through and notes made of the parts relevant to the work in hand ; this required quite a number of hours work. The paper was thus condensed into a few pages.

As it is some time since the original paper appeared, it is thought that the republication of it in this abstract form will be of interest to readers. No original work has been done, but in one or two of the tables extensions have been made to cover coil shapes not given and which the writer required.

2.0.—General

The circular Coil being the most general shape in use, consideration is limited to this type of Coil. A multi-sided Coil (*i.e.*, one with not less than six sides) may be taken as equal to a circular Coil the diameter of which is the mean between the inscribed and circumscribed circles of the polygon.

For convenient reference a list of symbols used has been included at the end of the article.

Design Procedure

3.1.—Influence of Coil Shape

The shape of the Coil has considerable influence on the H.F. resistance. It can be shown that the best shape of all is a single layer solenoid in which the winding length is equal to one-third of its diameter. The best single layer disc Coil should have a

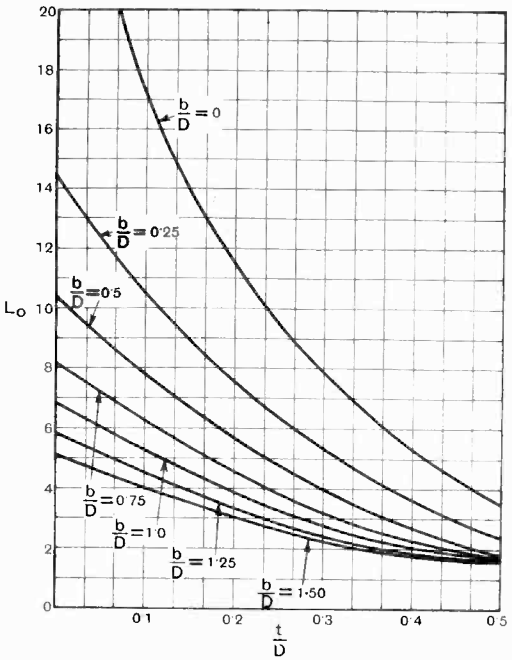

Fig. 1.

winding depth equal to one quarter the external diameter. For a multi-layer Coil there is a wide range of choice all of which would be equally efficient. If $5t + 3b = D$ the condition for maximum efficiency is never very greatly departed from.

D = External Diam. t = winding depth. b = winding length.

3.2.—Influence of Wire Diameter

The losses in a Coil at high frequencies may be divided into three parts :—

(*A*) The copper loss which would occur if the wire were straight ; this loss decreases

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

with increase of the diameter of the wire. It is denoted in the following by R_s.

(*B*) The increase of copper loss due to the wire being coiled. This loss increases with increase of wire diameter. It is denoted in the following by R_h.

(*C*) Dielectric losses. These are not likely to be serious for wavelengths above 300 metres if ordinary precautions are taken. Experiments show them to be 30–40 % of the total loss at 300 metres with coils wound on solid wood formers, while with carefully chosen dielectric the loss is from 10–20 % of the whole.

From (*C*) above it will be seen that at 300 metres the calculated value of H.F. resistance may be taken as 80 % of the total.

From (*A*) and (*B*) it will be seen that for a given shape and inductance of Coil, as the diameter of wire is increased one source of copper loss will increase and the other decrease. There is therefore a certain

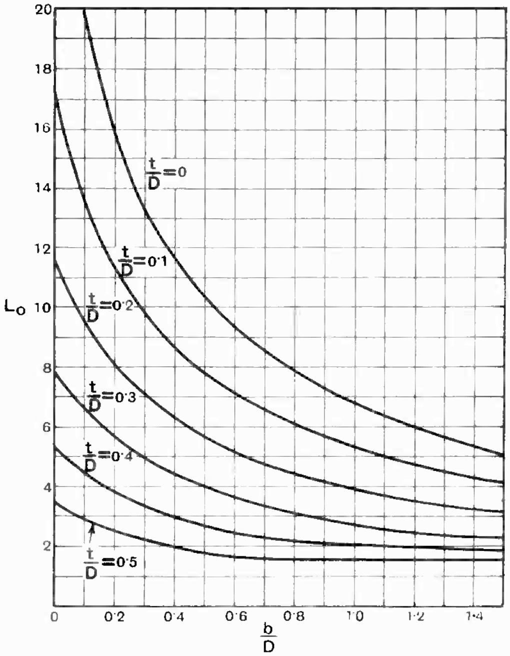

Fig. 2.

diameter of wire at which the rate of increase of one loss will equal the rate of decrease of the other, and at this diameter the total loss will be a minimum.

3.3.—Calculation of Inductance

As Coils have always to meet an inductance requirement it is necessary to be able to determine inductance for any Coil shape.

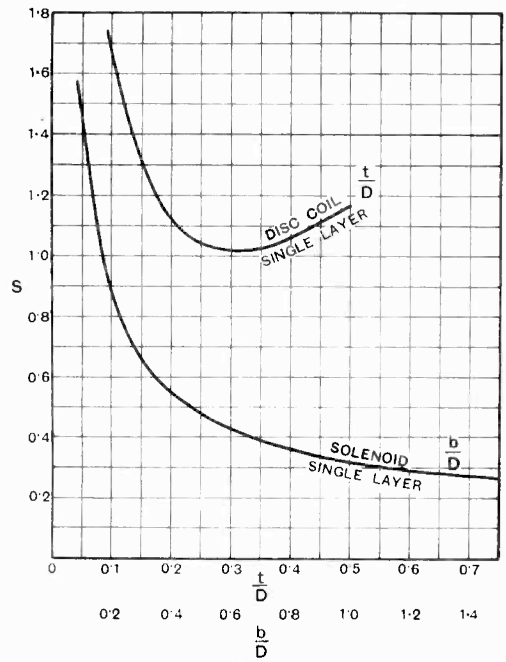

Fig. 3.

Usually this means calculating the number of turns for a pre-determined shape.

The inductance of a coil may be written as :

$$L = L_0 N^2 D/1000 \quad \ldots \quad (1)$$

where N = number of turns, D = external diam. (cm.), L = inductance in μH. and L_0 is the shape factor given by Figs. 1 and 2. Fig. 1 has $\frac{b}{D}$ as parameter and Fig. 2 has $\frac{t}{D}$ as parameter.

3.4.—Calculation of Best Wire Diameter. (Solid Wire.)

Knowing the Coil shape and number of turns the best wire diameter must now be found.

The sources of loss were indicated in paragraph 3.2. It can further be shown that if the wire diameter is chosen so that $R_s = R_h$ for any type of Coil, the least loss will never be greatly departed from. It may sometimes be an advantage to use a wire of slightly less diameter than that given by the following method. It is however an easy matter to calculate the H.F. resistance for a gauge or two on either side of that cal-

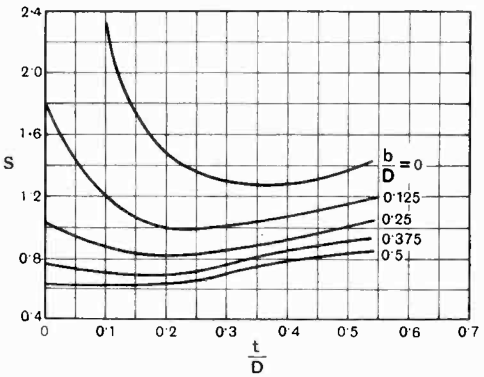

Fig. 4.

culated, and take the lowest. The value of P can be found from the expression :

$$P^2 = \frac{LS^2}{D^3} \quad \cdots \quad \cdots \quad \cdots \quad (2)$$

where S is found from Figs. 3 and 4. The value of $\frac{f}{P^2}$ can now be determined and the value of Pd read off from the curve of Fig. 5. The value of "d" is now known. In the above if $\frac{f}{P^2} < 10^4$ "d" is obtained from the expression $d^3 = \frac{7{,}600}{fP}$ and when $\frac{f}{P^2} > 10^8$ "d" settles down to the constant value of 0.165.

3.5.—Calculation of Best Wire Diameter. (Stranded Wires.)

The usual gauge of the separately insulated strands is between 36 and 44 S.W.G.

The procedure is to calculate the best

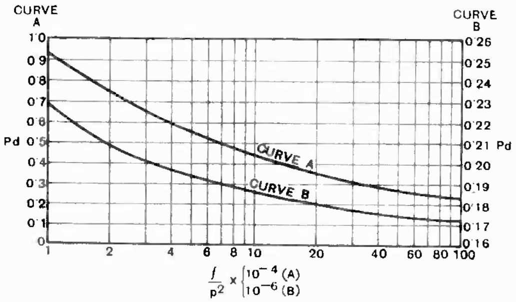

Fig. 5.

diameter of a single strand. The value of P is slightly modified and is found from the expression

$$P^2 = \sigma + \frac{n^2 S^2 L}{D^3} \quad \cdots \quad \cdots \quad (3)$$

in which σ is a function of "n" and has the

TABLE.

VALUES OF THE FUNCTIONS F AND G.

d = diameter of wire (cm.) ; ρ = resistivity (cgs units = frequency cps ; $Z = \pi d \sqrt{\frac{2f}{\rho}}$. For copper of resistivity 1,700 cgs units $d\sqrt{f} = 9.28$ or $Z = .1078 d\sqrt{f}$.

Z.	1 + F.	G.	Z.	1 + F.	G.
0.0	1.000	—	5.2	2.114	0.790
—	—	—	5.4	2.184	0.826
0.1	1.000	—	5.6	2.254	0.861
0.2	1.000	—	5.8	2.324	0.896
0.3	1.000	$Z^4/64$	6.0	2.394	0.932
0.4	1.000	—	—	—	—
0.5	1.000	0.00097	—	—	—
0.6	1.001	0.00202	6.2	2.463	0.967
0.7	1.001	0.00373	6.4	2.533	1.003
0.8	1.002	0.00632	6.6	2.603	1.038
0.9	1.003	0.01006	6.8	2.673	1.073
1.0	1.005	0.01519	7.0	2.743	1.109
1.1	1.008	0.02196	7.2	2.813	1.144
1.2	1.011	0.03059	7.4	2.884	1.180
1.3	1.015	0.04127	7.6	2.954	1.216
1.4	1.020	0.0541	7.8	3.024	1.251
1.5	1.026	0.0691	8.0	3.094	1.287
1.6	1.033	0.0863	8.2	3.165	1.322
1.7	1.042	0.1055	8.4	3.235	1.357
1.8	1.052	0.1265	8.6	3.306	1.393
1.9	1.064	0.1489	8.8	3.376	1.428
2.0	1.078	0.1724	9.0	3.446	1.464
2.1	1.094	0.1967	9.2	3.517	1.499
2.2	1.111	0.2214	9.4	3.587	1.534
2.3	1.131	0.2462	9.6	3.658	1.570
2.4	1.152	0.2708	9.8	3.728	1.605
2.5	1.175	0.2949	10.0	3.799	1.641
2.6	1.201	0.3184	11.0	4.151	1.818
2.7	1.228	0.3412	12.0	4.504	1.995
2.8	1.256	0.3632	13.0	4.856	2.171
2.9	1.286	0.3844	14.0	5.209	2.348
3.0	1.318	0.4049	15.0	5.562	2.525
3.1	1.351	0.4247	16.0	5.915	2.702
3.2	1.385	0.4439	17.0	6.268	2.879
3.3	1.420	0.4626	18.0	6.621	3.056
3.4	1.456	0.4807	19.0	6.974	3.233
3.5	1.492	0.4987	20.0	7.328	3.409
3.6	1.529	0.5160	21.0	7.681	3.586
3.7	1.566	0.5333	22.0	8.034	3.763
3.8	1.603	0.5503	23.0	8.388	3.940
3.9	1.640	0.5673	24.0	8.741	4.117
4.0	1.678	0.5842	25.0	9.094	4.294
4.1	1.715	0.601	30.0	10.86	5.177
4.2	1.752	0.618	40.0	14.40	6.946
4.3	1.789	0.635	50.0	17.93	8.713
4.4	1.826	0.652	60.0	21.46	10.48
4.5	1.863	0.669	70.0	25.00	12.25
4.6	1.899	0.686	80.0	28.54	14.02
4.7	1.935	0.703	90.0	32.07	15.78
4.8	1.971	0.720	100.0	35.61	17.55
4.9	2.007	0.738	—	—	—
5.0	2.043	0.755	Large	$(Z\sqrt{2} + 1)/4$	$(Z\sqrt{2} - 1)/8$

following values:

$n = 1 \quad 3 \quad 9 \quad 27$ large (No. of strands)
$\sigma = 0 \quad 0.9 \quad 3.3 \quad 10.4 \quad 0.4n$

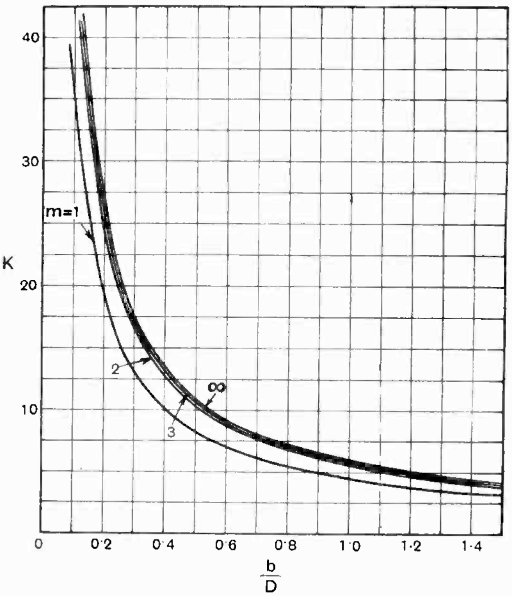

Fig. 6.

The best diameter "d" of an individual strand is then found from formula 2 and Figs. 3 and 4 exactly as for a solid wire.

3.6.—Calculation of H.F. Resistance. (Solid Wire.)

The formula for the combined copper losses may be written:

$$R_c = R_s + R_h = R\left\{1 + F + \tfrac{1}{4}\left(\frac{KNd}{D}\right)^2 G\right\} \quad (4)$$

Where

R = D.C. resistance of coil.
$I + F$ & G. are found from the Table.
D = External diam. of coil cms.
d = Diameter of wire cms. (Not including insulation.)
N = Number of turns.
K = Is found from Figs. 6, 7 and 8.

For Coil shapes other than single layer, disc or multi-layer, see S. Butterworth's paper, appendix.

3.7.—Calculation of H.F. Resistance. (Stranded Wire.)

As the best type of stranded wire contains 3, 9, 27 . . 3^r strands, the number of strands which are to be used is first settled. A practically available number of strands is thus always chosen. Formula 4 is now modified and becomes

$$R_c = R_s + R_h = R\left\{1 + F + \left(\frac{k}{d_0^2} + \frac{K^2N^2}{4D^2}\right)n^2d^2G\right\} \quad .. \quad (5)$$

where

n = number of strands.
d = diam. of one strand cms.
R = D.C. resistance of stranded conductor.
d_0 = overall diam. of conductor in mm.
= $\sqrt{.07n}$ (see following paragraph.)

k is a function of n as follows:—

$n = 3 \quad 9 \quad 27$ large
$k = 1.55 \quad 1.84 \quad 1.92 \quad 2$

A slight difficulty occurs in calculating the value of d_0 the overall diameter of the stranded conductors. As a rough approximation therefore d_0 is taken as independent of d and is given by

$$d_0^2 = 0.07n \quad .. \quad .. \quad .. \quad (6)$$

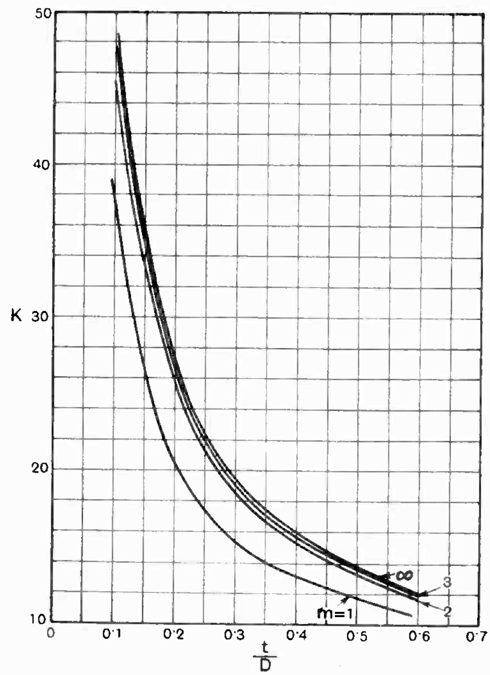

Fig. 7.

This is nearly correct for gauges between 36 and 44 S.W.G.

In general the best wire diameter will be slightly less than calculated by paragraph 3.5. Therefore, where a Coil is required to cover a range of frequencies, the best wire diameter should be found for the highest frequency, then the condition of minimum resistance will fall inside the range of the working frequency. Alternatively the H.F. resistance may be found for a gauge or two on either side of that calculated and that gauge chosen which gives the least resistance over the working range.

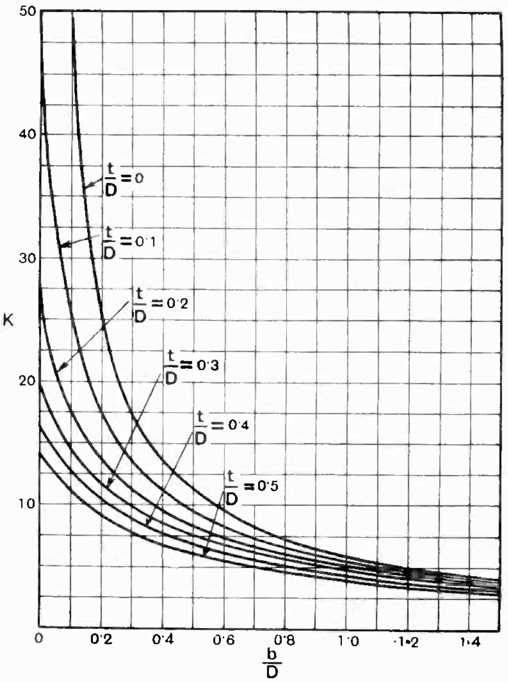

Fig. 8.

3.8.—H.F. Resistance of a Straight Wire

For a straight wire the formula becomes

$$R_c = R_s = R(1 + F) \quad .. \quad .. \quad (7)$$

where $1 + F$ is found from the Table.

3.9.—List of Symbols

D = Diameter of Coil in cms.
b = Winding length of coil in cms.
t = Winding depth of coil in cms.
R_s = Copper loss in a straight wire.
R_h = Increase in Copper loss due to coiling the wire.
R_c = Total Copper loss in ohms.
L = Inductance in microhenries.
L_0 = An inductance factor found from Figs. 1 or 2.
N = Number of turns in coil.
P = A factor found from equation 2.
f = Frequency in cycles per second.
d = Diameter of solid wire or a single strand in cms. except in Fig. 5 where it is in mm.
n = Number of wires in a stranded conductor.
S = Shape factor found from Figs. 3 or 4.
σ = Factor depending on number of strands.
R = D.C. resistance of conductor in ohms.
K = Factor given in Figs. 6, 7 or 8.
k = Factor in Formula 5 depending on number of strands.
d_0 = Overall diameter in mm. of stranded conductor (see Formula 6).

The Physical Society's Exhibition

THE Twenty-fourth Annual Exhibition of Scientific Instruments and Apparatus, arranged by the Physical Society, will be held on January 9th, 10th and 11th, 1934, at the Imperial College of Science and Technology, Imperial Institute Road, South Kensington, S.W.7. The Sessions will be as follows :—

Tuesday, January 9th, 1934 (admission by ticket only), 3 p.m. to 6 p.m. and 7 p.m. to 10 p.m.

Wednesday, January 10th, 1934 (admission by ticket only), 4 p.m. to 6 p.m. and 7 p.m. to 10 p.m.

Thursday, January 11th, 1934 (admission without ticket), 3 p.m. to 6 p.m. and 7 p.m. to 10 p.m.

The leading manufacturers of scientific instruments will be exhibiting their latest products in the Trade Section. The Research and Experimental Section will contain contributions from most of the important research laboratories in Great Britain, and there will be a special sub-section devoted to experiments of educational interest. In addition, the work submitted for the Craftsmanship Competition by apprentices and learners will be on view.

Discourses will be delivered each day at 8 p.m as follows :—

January 9th—R. S. Whipple, M.I.E.E., F.Inst.P., "The Evolution of the Galvanometer."

January 10th—J. Guild, A.R.C.S., D.I.C., F.Inst.P., "The Instrumental Side of Colorimetry."

January 11th—Sir Ambrose Fleming, D.Sc., F.Inst.P., F.R.S., "The History and Development of the Thermionic Valve."

Members of Institutions and Scientific Societies may obtain tickets from their Secretaries ; tickets may also be obtained direct from the Exhibition Secretary, 1, Lowther Gardens, Exhibition Road, S.W.7.

The Reduction of Filament-Battery Coupling in Amplifiers*

By W. L. Watton, B.Sc., A.R.C.S., D.I.C.

(The National Physical Laboratory)

SUMMARY.—A frequently unsuspected source of coupling between different stages of valve amplifiers is described. Its nature is investigated, and methods are suggested for reducing the amount of coupling from this cause. Curves are given showing the amount of reduction to be expected from any given arrangement.

Introduction

THE use of valve amplifiers to increase the sensitivity of physical measurements is steadily growing and it would be true to say that, but for the amplification afforded by such amplifiers, certain measurements now being carried out would be impossible. In the design of high-gain amplifiers many difficulties arise; but perhaps the most important of these is the undesired coupling between the different stages of the amplifier. Methods for the reduction of the coupling due to valve inter-electrode capacities and the common high-tension battery have frequently been described; but there appears to be little information upon the coupling caused by the use of a common low-tension battery for filament heating.

In the use of complicated wireless receiving sets, or when using amplifiers of very high gain, trouble has frequently been experienced due to this cause. Bainbridge-Bell† investigated this interaction and showed that it could be eliminated by one of three methods. Of these, the first method suggested, namely, that of connecting a decoupling condenser (C_2, Fig. 1) to the positive end of the filament in addition to the usual condenser to the negative end, has proved most useful in practice. It was implicitly assumed in that paper that these condensers should be equal in value; but experiments now to be described show that, in general, this is not so.

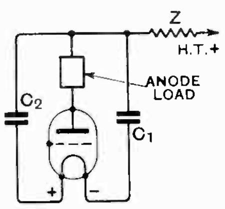

Fig. 1.

Preliminary Experiment

Preliminary experiments had shown that for minimum alternating component of voltage across the filament the values of the condensers should bear a certain relation to one another. It was found, in fact, that if $r = \frac{C_2}{C_1}$ the alternating current in the filament was eliminated for any value of C_1 from 0.01 μF. to 2 μF. provided that the ratio r was unaltered. It was found, however, that the value of r depended upon the circuit constants, and that any adjustment of these resulted in a change in the value of r. In order to study this variation, the following experiments were carried out. For simplicity, the first experiments were made upon diodes.

Experiments on Diodes

The circuit shown in Fig. 2 was set up. The valve is used as a diode with its grid and anode connected together. For these experiments there was no anode load. An 800 ~ signal of about 2 V. r.m.s. was injected into the anode circuit of the valve. The primary winding of the amplifier input transformer was connected across the filament, a large condenser C being inserted to avoid short-circuiting the low-tension accumulator.

The sensitivity was greatly increased by using for filament heating a battery having an e.m.f. 2 volts higher than the normal voltage rating of the filament. A resistance, of suitable value, connected in series with the battery and filament, served the double purpose of reducing the potential difference

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

† *Experimental Wireless*, January, 1931, p. 18.

across the filament to the normal value, and of artificially increasing the resistance of the battery circuit across which the alternating potential difference was developed. The amplifier was connected across the filament as before. It was shown by experiment that this arrangement did not alter the value of r obtained when a battery of correct voltage was used. The amplifier employed was tuned to 800 ~ and had a gain of about 70 d.b. A pair of telephones, connected in its output, served to indicate the best adjustment of C_1 and C_2. Complete silence in the telephones could not be obtained, but it was possible to detect a change in r of about 2 per cent. with a decoupling resistance of 2,000 Ω; the minimum improving with higher values of the decoupling resistance.

Method

The method employed was as follows. The condenser C_1 was fixed and of value 1.00 μF. A battery of known voltage was connected to the H.T. terminals in Fig. 2. The anode current was noted and the condenser C_2 adjusted to give minimum signal in the telephones, and its value was then observed. From a knowledge of the H.T. battery voltage, the resistance in the anode circuit, and the anode current, the actual P.D. between anode and filament (negative end) E_a, could be calculated. This was repeated for different values of the high-tension voltage and the values of r ($= C_2$ when $C_1 = 1$) plotted against the corresponding value of E_a. A curve such as that shown in Fig. 3 was obtained. Similar but not identical curves were obtained with valves of other types, which were chosen to have filaments as diverse as possible.

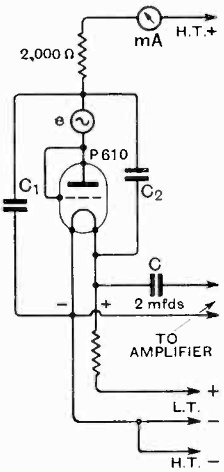


Fig. 2.

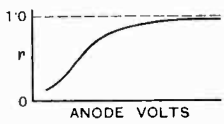


Fig. 3.

Experiments on Triodes

Experiments were now made on triodes, for which purpose the arrangement in Fig. 4 was used. A signal of only 0.2 V. r.m.s. was impressed on the grid in order to reduce, as far as possible, any effects due to the curvature of the valve characteristics.

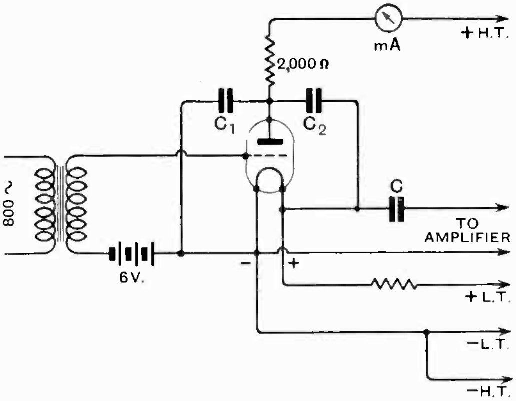


Fig. 4.

The method of operation was the same as for the diode experiments. Some experiments were also made in which the grid bias E_g was varied instead of the high-tension voltage. It was found, however, that the effect of a change in E_g was exactly the same as that of a change in E_a of an amount equal to μ times the change in grid bias (where μ is the amplification factor of the valve at that point of its characteristic). Accordingly, in the case of triodes, the value of r was plotted against the expression ($E_a + \mu E_g$)—the "lumped voltage"—which will be denoted by E_l. A curve very similar to Fig. 3 resulted.

Further experiments in which the anode load and decoupling resistance were separately varied showed that so long as the lumped voltage E_l was not altered, the value of r remained unchanged. In the case of variations of filament voltage of the valve (within necessarily small limits) it was found that the curve of r against E_l, while of the same type always, was different for different filament voltages. Fig. 5 shows curves for two different filament voltages.

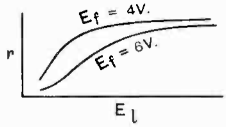


Fig. 5.

Experiments upon a valve used as an oscillator showed that the same curve was obtained for this condition as when the valve was used as an amplifier with the same operating voltages.

Discussion of Results

An examination of the (r, E_l) curves from the diode and triode experiments showed that, for the same valve, and for a fixed filament voltage, the curves were identical. We have, therefore, to explain the nature of the curve and the reason for its dependence upon the filament volts. Both the shape of the curve and its dependence upon the p.d. across the filament can be explained by the following theory.

Consider a valve in which the filament is imagined to be divided into two parts, both of which are emitting. Considering one part, this can be regarded as a complete valve having a slope resistance ρ_1. Similarly the other part forms a valve of slope resistance ρ_2, these hypothetical valves being in parallel as far as anode circuits are concerned. This is represented in Fig. 6, which includes the essential connections of Fig. 2. An examination of Fig. 6 will show that it can be redrawn as in Fig. 7.

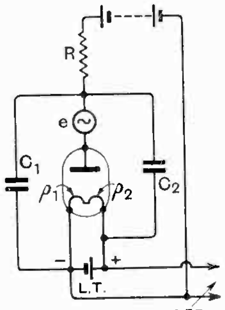


Fig. 6.

This at once explains the bad minimum mentioned on p. 18, since the resistance R is not compensated by a resistance in the opposite arm. A better minimum can be obtained by connecting the negative terminal of the H.T. battery to the slider of a potentiometer connected across the valve filament, the slider being suitably adjusted. This has the effect of connecting R in parallel with the source, where it has no effect on the balance of the bridge. Since in the experiments R was large compared with the reactance of C_1 and C_2 it can be neglected for the moment. It will be seen that Fig. 7 is a bridge network and that the current to the amplifier will be a minimum if

$$\frac{\frac{1}{j\omega C_1}}{\rho_1} = \frac{\frac{1}{j\omega C_2}}{\rho_2}$$

i.e. if

$$\frac{C_2}{C_1} = \frac{\rho_1}{\rho_2}$$

The value of r obtained represents, upon the hypothesis, the ratio of ρ_1 to ρ_2.

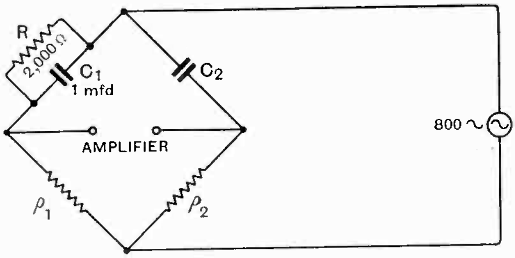


Fig. 7.

A similar bridge arrangement can be obtained if, instead of using two condensers C_1 and C_2, the condenser C_1 is connected, not to the negative filament terminal, but to the slider of a potentiometer connected across the valve filament. If r_1 and r_2 are the resistances between the tapping point on the potentiometer and its negative and positive ends respectively, then balance is obtained when

$$\frac{r_1}{r_2} = \frac{\rho_1}{\rho_2} = r.$$

This arrangement was tried experimentally and found to work as predicted by theory. In practice, however, the two-condenser method was found more convenient.

We can now explain the variation of r with lumped voltage in the case of an ordinary valve.

In Fig. 8 let the horizontal axis represent distance along the filament (assumed at a uniform temperature) and let the vertical axis represent potential with respect to the negative end of the filament.

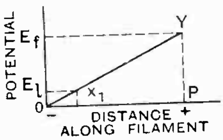


Fig. 8.

Then the line OY shows the potential at any point on the filament. Suppose the anode of a diode is given a positive potential E_l much less than E_f the filament voltage. Then only that portion of the filament Ox_1 will be negative with respect to the anode and only electrons from that portion will reach the anode.

Hence if, as before, we imagine the filament to be in two parts, in this case ρ_2 will be much larger than ρ_1. We should expect r to be very small. If now we imagine that $E_l = E_f$, the whole of the filament will be contributing to the anode current. Hence ρ_1 and ρ_2 will be of the same order of magnitude, but since at the positive end of the filament there will still be no anode current, ρ_2 is still larger than ρ_1. In general ρ_2 will always be greater than ρ_1 since there will always be a greater difference in potential between the negative end of the filament and the anode than between the positive end and the anode. As the anode volts increase, however, this difference will become *relatively* smaller and in the limit, with infinitely large anode volts, this difference will be negligible and ρ_2 will tend to the value of ρ_1. This is exactly what is observed in the curves of Fig. 5.

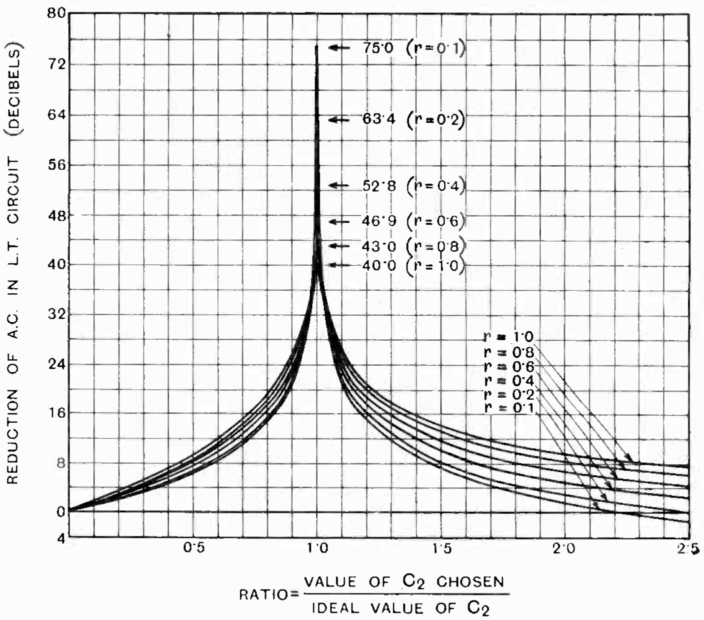


Fig. 10.—*Decoupling experiments. Decoupling resistance* 5,000 Ω, $C_1 = 2\ \mu F$.

From the explanation above we should expect that the smaller the filament voltage E_f the smaller will be the anode voltage required to make ρ_2 approach ρ_1, *i.e.* for r to approach unity. This agrees with the observed facts. The same reasoning applies to valves of different filament ratings, although in this case other factors enter to prevent quantitative information being given which would apply to all filaments.

The possibility that the variation of temperature along the filament* might be contributing to the phenomenon described was not lost sight of. It was found by test that this effect was negligible under the conditions of the experiments.

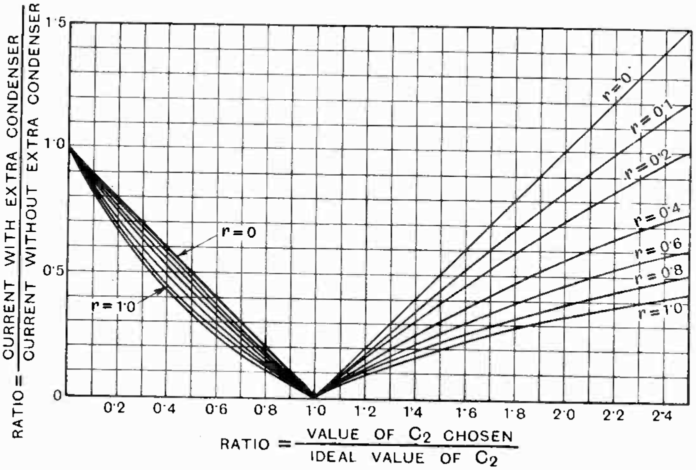


Fig. 9.—*Decoupling experiments. Values assumed (for minimum)* $C_1 = 2\ \mu F.$, $R = 5{,}000\ \Omega$, $\omega = 5{,}000\ r/s$.

Practical Application

This method of decoupling has already been used with great success at the Radio Research Station. It was desired to work an oscillator and a high gain amplifier, tuned to the same frequency, from a common low-tension battery. Trouble was experienced due to coupling between the oscillator and the amplifier, which was reduced to an imper-

* *Cf.* G. Stead, *Jour. Inst. Elect. Engrs.*, London, 1921, **59**, 427.

ceptible value when a second decoupling condenser of suitable value was used.

Reference has been made on p. 19 to the fact that the balance of the network is never perfect by reason of the resistance R. The minimum will improve, however, if R is made much larger than the reactance of the condenser C_1 (Fig. 7). Happily, this condition is that required to be satisfied for the greatest decoupling of the high-tension battery, so that, in practice, the minimum will be very good. Generally the ratio of C_2 to C_1 must be obtained from an experiment, but it is not always essential that the condensers C_1 and C_2 should be in exactly the correct ratio. Indeed, in most cases, the introduction of the second condenser C_2 of a value about four-fifths that of C_1 will reduce common filament battery coupling to an amount which is negligible. In the case where the valve is used with the grid so negative that the valve is working at the bottom bend of its anode-current/grid-volts characteristic, the value of C_2 should be about one-fifth that of C_1. In this connection curves are given in Fig. 9 showing the fractional reduction in the alternating current flowing through filament battery with such an arrangement. The curves show the reduction of current for several fixed ratios of $\frac{C_2}{C_1}$ when the valve is used under conditions such that the best minimum would be obtained when the ratio was that plotted in the x-axis. The same results are plotted on a decibel scale in Fig. 10.

Acknowledgment

This work arose in connection with the programme of the Radio Research Board and the present note is published by permission of the Department of Scientific and Industrial Research.

Background Noise in Amplifiers

The Spontaneous Action Due to Thermal Agitation and Schrott Effects

Paper by Messrs. E. B. Moullin, M.A., A.M.I.E.E., and H. W. M. Ellis, B.A., Grad.I.E.E., read before the Wireless Section I.E.E. on 6th December, 1933

Abstract

THE paper deals with the spontaneous excitation of any oscillatory system by random impulses, and, in particular, the spontaneous excitation of a circuit by the chaotic movement of the free electrons within it. The paper first discusses Brownian movements, stating the well-known physical quantity known as Boltzman's constant, $W = kt$, where k is Boltzman's constant $= 1.372 \times W^{-16}$ erg per degree C. In 1900 Drude showed that many of the observed facts of electrical conduction in metals could be explained by supposing the metal to contain a large number of free electrons moving about among the molecular interspaces. We thus picture that everywhere in a conductor there is a "gas" of free electrons which are in frequent collision with the molecules of the metal. During the flight-time between two collisions the moving electron produces a magnetic field and hence is, for such time, equivalent to a steady current in the element of circuit represented by its free path. In any finite element of circuit there are on the average as many electrons moving in any one direction as in any other, so that the net effect is zero. At any instant of time, however, there may well be some net current in any element.

Applying this reasoning to an oscillatory (LCR) circuit, it is shown that

$$LI^2 = CV^2 = kt$$

Where k is Boltzman's constant. If the condenser plates are connected to the input of a valve amplifier the voltage will be magnified sufficiently to produce an audible or visual effect. In the case of an acoustic amplifier containing no resonant circuit of radio frequency and of uniform response up to, say, 50 kc/sec., the dominant portion of the noise will be due to the circuit attached to the input grid, because this receives the full magnification of the amplifier. If this circuit has a natural frequency well within the acoustic range, the mean-square response of a telephone will be the same as that resulting from applying an audio-frequency harmonic voltage V such that $V^2 = kt/C$. The character of the noise changes as the natural frequency of the circuit is increased. It is always a scratchy, hissing noise, but the general level of

pitch rises with the frequency of the circuit. When the frequency of the circuit approaches the limit of audibility the noise-level will decrease, but the response of a thermo-galvanometer would continue to increase.

When the circuit is lightly damped the noise-level will not be measurably reduced if the amplifier characteristic is altered to that of a band-pass system giving uniform response between $\frac{1}{2} p_0$ and $2 p_0$. If the amplifier has a narrow band-width round the natural frequency of the circuit, the noise level will be reduced considerably. The total response of a resonant circuit is independent of its resistance, but the character of the noise is altered because increasing the resistance increases the relative amplitude of the lower component frequencies.

The expressions given above were subjected to experimental confirmation verifying the application of Boltzman's constant. A six-stage resistance-coupled amplifier, elaborately screened, giving an overall amplification of 2×10^6, was applied to a power stage containing a thermo-galvanometer. 100 units of galvanometer deflection was produced by an applied p.d. of about 3 volts. A resonant circuit consisting of 0.3 H and a capacity, variable in steps from 1,000 to 10,000 $\mu\mu$F, was arranged in a screened case, the condenser terminals of the condenser being connected to the input grid. Fig. 3 shows galvanometer deflection plotted against 1/C. The bend is due to the characteristic of the amplifier falling at high frequencies, and it is shown in the paper that correction for this gives the linear relation illustrated. The paper also describes further measurements from which the value of Boltzman's constant is carefully determined.

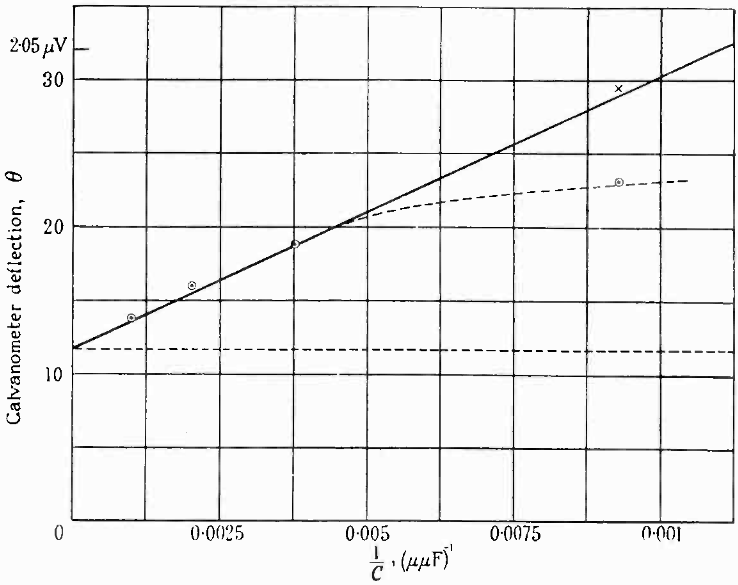


FIG. 3.

The effect of temperature is also shown in the paper, Curve A of Fig. 9 showing galvanometer deflection against frequency, again confirming the relation stated above.

The second part of the paper discusses the Schrott effect which is due to the passage and arirval of individual electrons from filament to anode. As a result, there is a p.d. across the anode-circuit impedance due to the arrival of discrete electrons and additional to that resulting from thermal agitation.

From expressions derived for the value of the Schrott effect, it is shown that the Schrott voltage is directly proportional to the charge of an electron and also to the mean anode current. It is shown in the paper that the agitation voltage in the circuit is negligible compared with the Schrott voltage in the same circuit. When a triode is working with full space-charge limitations, however, the Schrott voltage is usually small compared with the voltage in the same circuit due to the thermal-agitation effect which occurs in the circuit connected between the grid and filament. If a given potential is maintained at the anode and the filament current is increased from a low value up to the rated conditions, it is found that the Schrott effect rises and then falls off to a limiting value, which obtains when the valve is working in rated conditions. The paper then proceeds to develop expressions for the Schrott voltage in working conditions, from which it appears that the Schrott effect is likely to be more important than that of thermal agitation. The signal/noise ratio can be improved by increasing the mutual conductance of valves provided that the increase is not accompanied by an increased anode current.

Lastly, the paper discusses the interaction of spontaneous oscillations with a carrier voltage, *i.e.*, as an effective modulation. From the analysis which is derived it appears that the thermal-agitation voltage in the input circuit produces a negligible effect in combination with the carrier as compared with the effect of the Schrott voltage in the first anode circuit. The authors are unable, however, to say whether this accords with experience. The signal/noise ratio can be improved by increasing the radio-frequency magnification and will tend to a value which is independent of the magnification and depends chiefly on the Schrott effect in the anode circuit of the first h.f. valve. It is suggested that the most effective way to improve the ratio is to modify the construction of screened-grid valves so as to provide greater values of mutual conductance with decreased anode current. It is also suggested that the random phase of spontaneous oscillation will help to make the noise voltage much less when rectification is by a linear detector. Until such an investigation has been carried out it is useless to discuss the

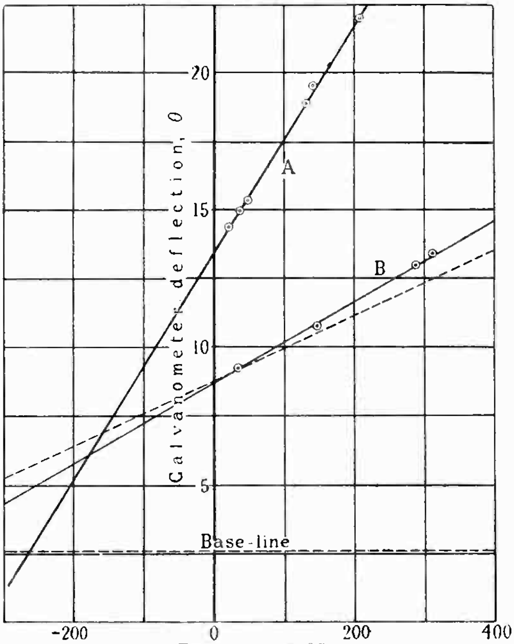


Fig. 9.

signal/noise ratio in a superheterodyne receiver or in an ultra-selective tone-corrected receiver.

Discussion

Dr. Rawlinson, in opening the discussion, criticised the mechanical analogy of random motion which the authors used in the paper. He queried the conclusions about reduction of noise with band-width and said that he had not found this in experience. He also sought information on the increase of background noise which occurs when a separate-heterodyne oscillator is switched in.

Mr. B. S. Gossling referred to the fundamental manner in which the work had begun, and illustrated a theorem by Dr. N. R. Campbell, giving an expression for the distribution of random phenomena.

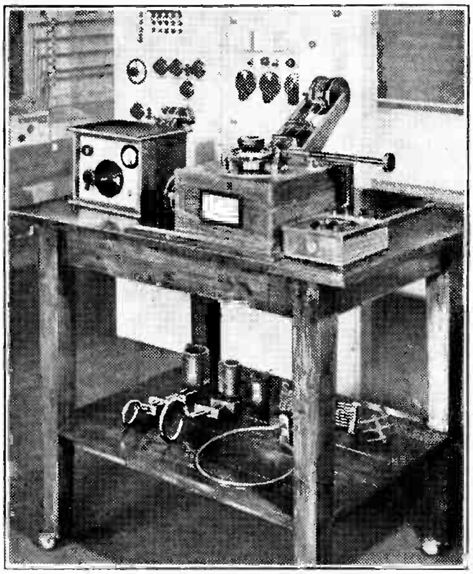
Mr. B. Williams suggested a modified form for the Schrott voltage applied to the grid of a valve, quoting measurements on high-gain amplifiers which gave good agreement with the expression derived.

Mr. Hirschman referred to the work of Llewellyn mentioned in the paper and to recent work of Ballantyne tracing a proportion of noise to ionisation effects. He described a comparative method of noise measurement which was in use for the testing of receivers, and suggested that the problem of linear detection was less difficult than the authors indicated.

Mr. F. Nancarrow did not agree with the authors' estimate of the relative practical importance of the Schrott and thermal-agitation effects. In his experience most noise originated in the input circuit and it was normal to find the noise-level reduced by 6 to 10 db by detuning the first circuit. Similar views were expressed by the next two speakers, Mr. Blumlein and Mr. A. Mumford.

After the authors had briefly replied to the discussion, the meeting terminated with a vote of thanks proposed by the chairman, Mr. G. Shearing, O.B.E.

B.B.C. Checking Station



Although primarily intended for checking the wavelengths of the European broadcasting stations, the Tatsfield receiving station of the B.B.C. also covers the short-wave bands. The wavemeter in the photograph has a range of between 10 *and* 100 *metres.*

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.

Do Transmitting Stations Get Tired?

To the Editor, The Wireless Engineer

SIR,—In the October 27th issue of *The Wireless World*, "D. Exer," a contributor, refers to the mystery of stations that lose power; within a few weeks or months of their opening, signals fade slowly away until they can no longer be heard, or heard only with difficulty.

This is a phenomenon with which I have been familiar for twenty years. It affects all types of radio stations—spark, C.W., telegraph or broadcasting, on any wavelength. The initial range of the station when first opened, slowly decreases after a few months, and is never regained at any subsequent date unless major changes are made in equipment.

In the July 14th, 1926, issue of *The Wireless World*, under the heading: "Do Transmitting Stations Suffer from Fatigue?" I described my observations in detail. I quote from that letter:

"There are only two possible variables in a transmitting station which cannot be closely checked up. One is the surface condition of the aerial wire, and the other is the earth connection and the condition of the surrounding soil. . . .

"As regards the earth connection, ordinary soil is not accustomed to having umpteen kilowatts of current pumped steadily into it. After a few weeks of such treatment, what sort of electrolytic actions take place, and in what way does that soil become decomposed or altered in character in the immediate vicinity of the earth plates? Has anybody ever investigated that point?"

I don't think the surface condition of the aerial makes any material difference, but I am still curious about the earth connection—the only part of a transmitter which has not, to my knowledge, been closely investigated. It is perhaps significant that, during the course of many years of close association with ship transmitters as a seagoing operator, *I have never yet known a ship transmitter whose range fell off after the first few weeks or months of operation.* Provided that no major changes are made in the installation, and provided also that the installation is efficiently maintained, its range remains constant year after year. It is very difficult, of course, for an observer ashore to check the range of a constantly moving ship; that can only be done accurately by the ship's operators.

The important point is that *a ship's earth connection is constantly being renewed.*

Several other correspondents agreed with my observations in 1926, but still, nearly eight years later, the mystery apparently remains unsolved. May I commend this problem to the serious attention of adequately equipped research organisations?

A. DINSDALE.

New York.

What is Demodulation?

To the Editor, The Wireless Engineer

SIR,—A rather interesting case of a word with two meanings has recently become of some moment. However unimportant, or even commendable, such a state of affairs may be in literary circles, in the technical press the situation is much less desirable. The word in question is "demodulation," which apparently has one meaning in America and another in Great Britain.

As used in Great Britain, demodulation means a decrease in depth of modulation, the opposite to rise in modulation. A typical example of the use of the word occurs in E. V. Appleton and D. Boohariwalla, "The Mutual Interference of Wireless Signals in Simultaneous Detection," *The Wireless Engineer*, page 137, March, 1932:

> "If strong and weak signals of carrier frequency intensities S and W respectively are simultaneously received with a linear detector, the modulation of the weak signal is reduced to a fraction $\frac{1}{2}\frac{W}{S}$ of its original value. . . . The *demodulation* influence of the weak signal on the strong signal is . . . small."

On page 150 of the same issue of *The Wireless Engineer*, P. G. Davidson says in a letter to the editor:

> "It is to be noted that demodulation of the interfering transmission has, in a sense, taken place, for only one of the necessary three components has survived.
>
> "I suggest that the error Dr. Robinson makes lies in the idea that the whole process of demodulation is effected by the detector."

A large number of other instances of the use of the word with this meaning have occurred in the British radio journals since 1928.

In America, on the other hand, *demodulation* is used to mean the reverse of *modulation*, and is therefore equivalent to *detection*. This definition of the word is given by Brainerd and McIlwain, "High Frequency Alternating Currents," John Wiley and Sons, New York, page 2:

> "When this modulated signal reaches its destination, its frequency must be lowered to its original frequency in order that the original sound may be reproduced by the receiver. This process is termed *detection*, or *demodulation*."

And even J. A. Fleming in "The Propagation of Electric Currents," Constable and Co., 1927, page 399, says:

> "In the plate circuits of these last valves we have coupled ordinary telephone receivers, which are acted upon by the voice currents disentangled by these *demodulating* valves from their respective carrier currents."

Fleming almost certainly took this use of the word from the original article describing Bell System developments in carrier telephony, "Carrier Current Telephony and Telegraphy," by Colpitts and Blackwell, *Trans. A.I.E.E.*, Vol. XL., pp. 205–296, 1921. Probably the word was coined by Bell System engineers for this use, and has gradually spread outside of that organisation. Apparently the word appeared in British literature some years later, independently of its employment in America, with the difference in meaning noted above. In Canada, as a result, we have been blessed with both meanings.

The existing situation clearly should not continue. It remains then for the technical press to agree to drop one or the other usage. The present writer votes emphatically to retain the meaning of *detection*. Demodulation here has its logical meaning as related to modulation. This usage of the word is widespread in both commercial and technical fields. At the same time, the word fills a real need. "Detection" is a word of which the literal meaning and the technical meaning have now nothing in common, and is merely a relic of pre-valve days. It merits only an early oblivion. The fact that the British tendency has been to substitute so unsuitable a word as "rectification" for "detection" strengthens this point.

Demodulation, as used to mean decrease in depth of modulation, on the other hand, has little to recommend it. So far as the writer is aware, the word has been thus used only in connection with the phenomena involved in the simultaneous detection of two modulated waves. "Masking" or "masking effect" seem excellent alternatives. In any case, it seems highly undesirable to coin a specific technical word to describe an effect relatively so unimportant, which is so readily described by the use of ordinary terms.

Montreal, Canada. C. B. Fisher.

Valves or Stages ?

To the Editor, The Wireless Engineer.

Sir,—From the time when the thermionic valve was first used in a radio instrument it has been the practice of radio engineers to classify receivers and amplifiers by the number of "valves" employed. This was a satisfactory mode of classification as long as power was derived from batteries, and while one valve was used for one purpose only.

With the use of the power rectifier valve for supplying operating power a difficulty arose as to whether that valve should be included in the receiver description for the purposes of classification, and, quite wisely, most engineers and physicists decided that it should be excluded. It is well-known that manufacturers have, in the past two or three years, included this rectifier in the classification—solely for advertising reasons, however.

From time to time much has been written on this matter in *The Wireless World* and elsewhere. The latest development (which has evoked this letter) is an announcement by E. K. Cole, Ltd., that their instruments are now classified according to the number of "stages" they incorporate. A "stage" is defined by them as representing roughly "the amount of work done by a single valve in the days before 'complications set in'."

Such a move has been long overdue, and it is to be hoped that other manufacturers will abandon the "number of valves" designation. A "stage" should be defined with scientific accuracy, however.

It is difficult, indeed impossible, to define a "stage" without reference to highly technical concepts and without recourse to scientific language. Further, I consider that, for the purposes of classification, certain stages of an instrument should be omitted in the description.

I would exclude any stage which acts purely as a rectifying stage. That is to say, I would exclude the power rectifying stage in A.C. mains operated instruments and H.F. rectifying stages (which might be called demodulating stages, but for the unfortunate misuse of this word). Leaky-grid, power-grid and anode-bend rectifying stages would be included, however, for they are not rectifying stages only: the modulation of the signal undergoes amplification in all these three cases, subsequent to rectification. The only H.F. rectifiers to be excluded therefore, are the diode thermionic valve rectifier, and the metal H.F. rectifier, where the signal "amplification" is less than unity. I would also exclude the local-oscillator stage of a superheterodyne receiver, but would include the "mixer" or "frequency-changing" stage.

I would further exclude any rectifying circuits and thermionic valves (or metal rectifiers) employed for automatic gain control purposes, and would reckon, also, every push-pull stage (Class A, Class B, or Q.P.P.), and also valves operated in parallel, as a single stage.

Thus, an A.C. mains operated instrument, comprising two screened-grid H.F. stages, power-grid detector, pentode power-output stage, and thermionic valve power-rectifier, would be classed as a four-stage instrument. If the detector valve were replaced by a double-diode triode valve, and an automatic gain control circuit added, the instrument would still be a four-stage instrument. Neither the separation of the functions of demodulation and amplification at modulation frequency, nor the use of automatic gain control, constitutes the introduction of an additional "stage" in the true interpretation of the word.

I should define a "stage," therefore, in the following terms:—

A radio receiver or gramophone amplifier has n stages when it incorporates n valve-circuits, excluding the circuits of power rectifiers, thermionic-diode or metal rectifiers, used for H.F. rectification only or for automatic gain control purposes, and local oscillator valve-circuits in superheterodyne instruments: groups of valves in a push-pull circuit (Class A, Class B, and Q.P.P.), and valves connected in parallel, to be reckoned as one stage only.

W. F. Floyd,
Technical Editor *The Music Seller & Radio Music Trader.*

London, W.C.1.

The Beat Frequency Oscillator

To the Editor, The Wireless Engineer

Sir,—Arising from the article on the above subject in the September issue of this Journal, the following points may be worth noting. They occurred during the writer's investigation of the problem under Professor Fortescue at the City and Guilds College. In the experimental setting up of the best oscillator, owing to uniform response being required over rather high beat frequencies (20,000 to 40,000 c/sec.), due regard had to be paid to the exact principles involved.

Two high-frequency voltages

$$v_1 \cos \omega_1 t$$
$$\text{and } v_2 \cos \omega_2 t$$

are simultaneously applied to the detector. The resultant input may be written*

$$v_1 \cos \omega_1 t + v_2 \cos (\omega_1 + \overline{\omega_2 - \omega_1})t$$
$$= (v_1 + v_2 \cos \overline{\omega_2 - \omega_1 t}) \cos \omega_1 t - (v_2 \sin \overline{\omega_2 - \omega_1 t}) \sin \omega_1 t$$
$$= \sqrt{v_1^2 + v_2^2 + 2v_1 v_2 \cos \overline{\omega_1 - \omega_2 t}}, \ \cos (\omega_1 t + \psi)$$
$$\text{where } \psi = \tan^{-1} \frac{v_2 \sin \overline{\omega_2 - \omega_1 t}}{v_1 + v_2 \cos \overline{\omega_2 - \omega_1 t}}$$
$$= V \cos (\omega_1 t + \psi)$$

The beat response for a square-law detector is proportional to V^2, *i.e.*, to both v_1 and v_2 $(2v_1v_2)$, and since one of these is to be variable it does not suit our purpose from the point of view of constancy of output over the best frequency range.

For a linear detector, however, the response is proportional to V, *i.e.*, to

$$\sqrt{v_1^2 + v_2^2}\left(1 + \frac{v_1 v_2}{v_1^2 + v_2^2} \cos \overline{\omega_2 - \omega_1} + \frac{(\frac{1}{2})(-\frac{1}{2})}{1 \cdot 2}\left(\frac{2v_1 v_2 \cos \overline{\omega_2 - \omega_1 t}}{v_1^2 + v_2^2}\right)^2 + \ldots\right)$$

which contains the full range of harmonics. If, however, $v_1 >> v_2$, we may neglect v_2^2 compared with v_1^2, and we get response is proportional to

$$v_1\left(1 + \frac{v_2}{v_1} \cos \overline{\omega_2 - \omega_1} \, . \, t\right)$$
$$\textit{i.e.} \quad (v_1 + v_2 \cos \overline{\omega_2 - \omega_1 t})$$

Thus the beat note output contains harmonics which can be made as small as we please by reduction of v_2 compared with v_1. The pure beat note output is then proportional to v_2, the weak h.f. signal, but is independent of v_1, the strong h.f. signal. Hence, the weak signal is provided by the fixed oscillator.

In practice, considerable care must be taken to see that v_2 (measured at the rectifier terminals) remains fixed when the condenser belonging to the strong oscillator is varied. This must be tested with the strong oscillator off (say by disconnecting its filament supply). More often then not, owing to the comparatively large coils associated with the coupling of a large signal to the detector, it will be found that v_2 is affected. To remedy this, a periodic, or rather untuned, coupling is essential. Failure to observe this practical point may result in considerable annoyance in accounting for unexpected results.

As pointed out by Kirke†, a further necessary requirement for the purity of the beat wave is that one of the h.f. signals is pure. Under these conditions we cannot get harmonics of the fundamental beat wave. This may conveniently be effected by passing (say) the weaker signal through a single tuned circuit.

With the above precautions, it may be assumed that a range of beat frequencies of constant amplitude can be produced with as small a percentage of harmonics as may be desired. The kind of linear detector and low pass filter circuit following it need a little consideration.

Diode detection (with positive volts on the grid) would give a very good linear characteristic under correct conditions, but is not recommended owing to lack of sensitivity. Anode-bend detection is perferable, and by means of a high resistance in the anode circuit the characteristic may be made linear. From a number of valves tested, an AC/P with 100,000 Ω as the anode resistance was found most suitable for this purpose and for acceptance of the large signal v_1 without grid current. The bias to be applied is -15 V.

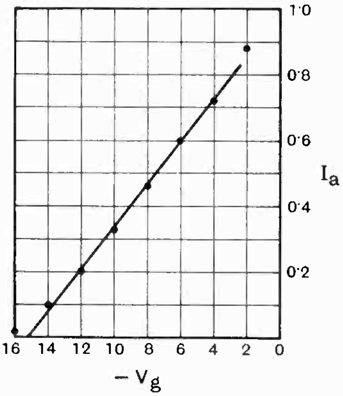


Fig. 1.—*Anode current-grid voltage characteristic of AC/P valve with anode resistance* = 100,000 Ω *and H.T. battery* = 120 *volts.*

As regards the filter, originally the writer, too, as did the authors of the September article, decided to have a properly terminated network designed to cut off above the highest beat frequency required. Calculation gives L of the order of a henry, depending upon the terminating impedances and the cut-off frequency. It is not easy to construct such a large-valued inductance without introducing sufficient self-capacity to upset the original design. Of course, a more complicated network in which the inductance is tuned could be worked out, but this is undesirable. On second thoughts, it is seen that a filter to cut off at the upper beat frequency is not required, since, having followed out the above directions, no harmonics of the beat frequency are present. Instead, only the signal high frequencies are to be cut off, and in this case a much lower value of L (order of mH.) is required. This is easy to construct without any upsetting self-capacities.

Much of the bother connected with constant-amplitude, variable-frequency heterodyne oscillators may be avoided by paying due consideration to the above points. M. SLAFFER, B.Sc.

Distortion in Public Address Loud Speakers

To the Editor, The Wireless Engineer

SIR,—In the design of apparatus for radio and acoustical purposes care is required to reduce alien

* Butterworth, *E.W.*, 1929, p. 620, eqns. (1) to (5).
† Kirke, *E.W.*, 1927, p. 68.

frequencies to a negligible amount. There is no truly linear characteristic in practice. When the amplitude, whether electrical or mechanical, exceeds a certain limit, alien frequencies become troublesome. It is usual to tacitly assume that if a diaphragm vibrates sinusoidally, the sound is everywhere of this waveform, *i.e.*, the medium (air) itself acts linearly. This is a natural assumption, since the theory of sound is based on infinitesimal pressures, which are accordingly inaudible. During the passage of a wave the air pressure varies, but the density of the medium is (in theory) assumed constant. Near a powerful source, the density at the wave crests exceeds that at the troughs. Consequently the former travel more rapidly than the latter and tend to overtake them. Thus the wave alters in shape as it progresses, its slope tending to become perpendicular to the direction of transmission. This aspect of *plane* wave propagation is fully discussed in Rayleigh's Sound (vol. 2, section 249 *et seq.*, 1894). The fact that no change in waveform has been reported in loud speaker work is doubtless due to the use of waves which *expand* from the source outwards. In a plane wave there is no expansion, the only correcting influence being that of viscosity which is very small.

Some time ago in studying the theory of horns, I computed throat pressures of the order 1/25th atmosphere with a public address speaker. It was thought that alien frequencies might occur in the output beyond the mouth. I have been unable to test this experimentally, but an analytical investigation by S. Goldstein and myself indicates that, provided the throat pressure does not exceed a certain large value, expansion of the waves prevents the alien frequencies from being large relative to the main frequency.

The general equation for the propagation of sound waves of finite amplitude in a straight horn of infinite length, having any cross-section (similar throughout the length), can be shown to be

$$\xi'' + \frac{\chi'}{\chi}(1 + \xi') - \frac{(1 + \xi')^{\gamma+1}\chi^{\gamma-1}\ddot{\xi}}{c^2} = 0 \quad \ldots \quad (1)$$

where ξ = particle amplitude at any axial distance $x + \xi$ from the throat ;

$$\xi' = \frac{\partial\xi}{\partial x};\ \xi'' = \frac{\partial^2\xi}{\partial x^2};\ \ddot{\xi} = \frac{\partial^2\xi}{\partial t^2};\ \chi = \frac{A_2}{A_1}$$

$$= \frac{\text{Area at } (x + \xi)}{\text{Area at } x};\ \chi' = \frac{\partial\chi}{\partial x}$$

$\gamma = 1.41$ for air ; c = velocity of sound.

For an exponential horn $A_2 = A_0e^{\beta(x+\xi)}$, $A_1 = A_0e^{\beta x}$, so $\chi = e^{\beta\xi}$ and $\chi' = \beta e^{\beta\xi}\xi'$. Substituting these quantities in (1) we obtain the differential equation of an exponential horn when the sound pressure is *finite*. Thus

$$\xi'' + \beta\xi'(1 + \xi') - \frac{(1 + \xi')^{\gamma+1}e^{(\gamma-1)\beta\xi}\ddot{\xi}}{c^2} = 0 \quad (2)$$

ξ being the particle amplitude at the *variable* abscissa $(x + \xi)$. For infinitesimal pressures $\xi << 1$, so $\xi' << 1$ and (2) degenerates to

$$\xi'' + \beta\xi' - \frac{\ddot{\xi}}{c^2} = 0 \quad \ldots \quad \ldots \quad (3)$$

For sinusoidal motion $\ddot{\xi} = -\omega^2\xi$, so (3) can be written

$$\xi'' + \beta\xi' + k^2\xi = 0 \quad \ldots \quad (4)$$

where $k = \omega/c$. The well-known exponential horn equation has this form, but the velocity potential ϕ is used in place of ξ. In this case ϕ and ξ are linearly related.

London. N. W. McLachlan.

Book Review

Sub-Harmonics in Forced Oscillations in Dissipative Systems

By P. O. Pedersen. 86 pp. *G.E.C. Gad.*, Copenhagen. 8 kr.

Professor Pedersen is the Principal of the Royal Technical College in Copenhagen and is well known to older radio engineers as the fellow-pioneer with Poulsen in the development of the arc generator. Six years ago he published a comprehensive volume on the propagation of radio waves. The monograph under review shows the same mathematical thoroughness. Although there is a section entitled "experimental investigations," the book is mainly a mathematical investigation of the properties which the coefficients of the differential equations must possess in order that an applied force of a given frequency may set up oscillations of a half or quarter of that frequency. This is an important question in connection with loud speakers and one on which letters have appeared in our correspondence columns in the past.

The conclusion arrived at by Prof. Pedersen is that in systems with one degree of freedom second sub-harmonics may occur, but that with two degrees of freedom the second sub-harmonic may set up a fourth sub-harmonic. This can arise with a loud speaker diaphragm which must be regarded as possessing several degrees of freedom. This fourth sub-harmonic needs very careful tuning for its production and is destroyed by very slight changes, even a change in the humidity of the room being enough to prevent it—which is very fortunate. Second sub-harmonics are, however, of common occurrence and should be given special attention not only in technical acoustics but also in physical and physiological acoustics.

This is a book which can be recommended to those who are interested in the mathematical treatment of this important question.

It is written in English—and very good English.

G. W. O. H.

Abstracts and References

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PROPAGATION OF WAVES

ON TWO METHODS OF IONOSPHERIC INVESTIGATION.—E. V. Appleton. (*Proc. Phys. Soc.*, 1st Sept., 1933, Vol. 45, Part 5, No. 250, pp. 673–688.)

The two methods of ionospheric investigation, results of which are described in this paper, are (1) a rapid series of measurements of the equivalent path P' of atmospheric waves for different frequencies f and the construction therefrom of a (P', f) curve, and (2) a series of $(P', t$ [time]) curves for different frequencies over the period when each frequency becomes critical for the extraordinary wave for F layer; this gives a curve showing the connection between time and the maximum number of electrons per cc in F layer. From the examples chosen to illustrate the methods "the following deductions and measurements concerning ionospheric characteristics are made:—(*a*) Magneto-ionic double refraction is caused by region E; this shows, as was previously demonstrated in the case of region F, that free electrons are the effective electrical agents. (*b*) For daytime conditions, and more frequently in summer than in winter, evidence of the existence of a protuberance or 'ledge' on region F is found, which most probably indicates that under direct solar influence this region is sometimes composite. Evidence of the existence of ionisation between regions E and F ('intermediate region') has also occasionally been obtained at noon, so that the whole ionospheric configuration may be regarded as a composite structure of four components. From the point of view of practical radio communication, however, it is sufficient to regard the ionosphere as divisible into two main regions, E and F, but where it is necessary to consider further the ionospheric fine structure it is proposed to name the four components, at successive increasing equivalent heights, regions E^{I}, E^{II}, F^{I} and F^{II}. Usually only regions E^{I} and F^{II} are of importance." The term Region e is suggested for the abnormal ionised region produced by corpuscles at or slightly below the height of the normal Region E due to ultra-violet light. The occurrence of Region e has been found by Naismith and the author to be correlated either with magnetic storms or with thunderstorms. The deductions from the curves obtained, of which examples are given in this paper, have already been mentioned in 1933 Abstracts, pp. 494 and 558–559: *cf.* also Schafer and Goodall, p. 558.

RADIO OBSERVATIONS DURING THE [Second] INTERNATIONAL POLAR YEAR (1932–3).—E. V. Appleton. (*World-Radio*, 10th and 17th Nov., 1933, Vol. 17, Nos. 433 and 434, pp. 613–614 and 654–655.)

The substance of the R.I. discourse. *See* also *Nature*, 4th Nov., 1933, Vol. 132, pp. 703–704. A preliminary account was dealt with in 1933 Abstracts, p. 613.

IONISATION OF THE IONOSPHERE.—K. A. Norton. (*Nature*, 28th Oct., 1933, Vol. 132, p. 676.)

This letter supports the suggestion of Tonks (1933 Abstracts, p. 559) that the relation between ionisation density N and critical frequency f should be $N = \frac{\pi m f^2}{e^2}$ rather than $\frac{3}{2} \cdot \frac{\pi m f^2}{e^2}$. The writer finds that each electron moves through a distance very large compared to the average electron spacing in a time short compared with that of the radio wave, so that the space average field is applicable to the problem, giving the value $N = \frac{\pi m f^2}{e^2}$.

IONISATION DENSITY AND CRITICAL FREQUENCY.—L. Tonks. (*Nature*, 4th Nov., 1933, Vol. 132, p. 710–711.)

This letter supports a previous letter of the writer (*see* preceding abstract). The writer considers an elastic force of the form $-ar$ acting on a bound electron, which he replaces by a Coulomb force due to the ion when the electron is regarded as free. He calculates this by supposing the positive ion to be uniformly distributed throughout a sphere of volume $\frac{1}{N}$ and finds a restoring force $-\frac{4\pi}{3} . Ne^2r$ to replace the $-ar$ used for the bound electron. He thus arrives at the conclusion that the polarisation term disappears and that the valid formula is as stated.

SHORT WAVE PROPAGATION IN THE EARTH'S MAGNETIC FIELD [Theoretical Investigation].—K. Försterling and H. Lassen. (*Ann. der Physik*, 1933, Series 5, Vol. 18, No. 1, pp. 26–60.)

The writers give the well-known investigation on classical lines of the propagation of a plane homogeneous wave in a homogeneous ionised gas, for an arbitrary direction of propagation relative to an external magnetic field. They neglect the Lorentz polarisation term: "since the free charges (ions, electrons) are irregularly distributed and their distribution is unchanged by the field of the wave, they exert on the average no force on one another. Since, further, the electrical polarisation of the gas molecules has no effect, owing to the small density, the total electric force acting on an electron is $e\left(E + \frac{1}{c}(v.\ H)\right)$". They find expressions for the refractive indices of the medium and discuss them for waves of length less than 200 m, neglecting the effect of collisional friction; the positions of the zeros and infinities of the refractive index μ are found. The effect of a small amount of friction in the neighbourhood of the infinities is considered. A dispersion curve is given for $\lambda = 84$ m, angle α between direction of propagation and magnetic field $= 65°$. Curves are also given showing μ^2 as a function of height above the ground for three different laws of variation of ionisation with height, for $\alpha = 25°$, $\lambda = 84$ m. The polarisations corresponding to the two values of μ are considered. The effect of collisional friction is neglected and the polarisation of the waves at the earth's surface, assumed to be the limiting value given by $N \rightarrow 0$, is found to be circular: the sense of rotation is such that, for downcoming waves in the northern hemisphere, the slower wave is of left-handed polarisation. Reflection and refraction at a plane boundary are considered and determinantal expressions for the reflected and refracted waves obtained. These are discussed in various degenerate cases, including those of propagation transverse and longitudinal to the field, of electron density tending to zero, of frequency tending to infinity, and of the two media differing only slightly from one another. Circular polarisation of all waves, and a vanishingly small magnetic field, are also assumed. Under these conditions it is found that no splitting of one of the two circularly polarised waves takes place on crossing the plane boundary, and the reflected energy is very small. Propagation in a medium with continuously varying refractive index is dealt with by summing the effect of a number of the slightly differing layers referred to above. With the assumption that μ varies very little in a wavelength, it is found that practically no reflected energy is split off from the main wave during its passage through the medium. Total reflection takes place where the wave is at grazing incidence to the stratification. At perpendicular incidence reflection takes place where $\mu = 0$. When the electron density is very small the wave undergoes no change. [For an account of magneto-ionic theory and its application to wireless studies of the ionosphere, *see* Appleton, 1933 Abstracts, p. 30.]

CONTINUOUS MEASUREMENTS OF THE VIRTUAL HEIGHTS OF THE IONOSPHERE [on a Frequency of 4 100 kc/s].—T. R. Gilliland. (*Proc. Inst. Rad. Eng.*, October, 1933, Vol. 21, No. 10, pp. 1463–1475.) *See* 1933 Abstracts, p. 614.

AUTOMATIC RECORDING OF THE HEAVISIDE LAYER [Heights and Echo Amplitudes].—H. E. Hollmann and K. Kreielsheimer. (*E.N.T.*, October, 1933, Vol. 10, No. 10, pp. 392–396.)

Description of the Heinrich-Hertz Institute equipment used for the Polar Year observations in Norway. The pulse transmission is controlled by a magneto-ignition-system rotating cam driven by a synchronous motor; at each rotation of the cam the high negative grid bias blocking the oscillator is removed, so that the oscillator is in action for 3/10 000 sec. at intervals of 1/25 sec. At the recording equipment another cam controls the discharging of the time-base circuit capacity: by means of the "spark advance/retard" mechanism an accurate and convenient phase regulation is possible: thus in the record of Fig. 5, between the 1st and 2nd hour this adjustment was made and the ground-wave track brought into the picture. This record was a straightforward echo-time record, using the "negative" process in which the significant features are the white tracks produced by the gaps "between the feet" (as it were) of the signal peaks.

Later, however, the records were made to include not only the echo-time (*i.e.* layer-height) indications, but also echo-amplitude indications. This was accomplished by inclining the co-ordinate system of the fluorescent screen at a fixed angle (*e.g.* 30°) to the time axis of the recorder. The white "negative" tracks are still made, to represent the times of the signals and echoes; but, in addition to these, the bright summits of the deflections (where the ray has to reverse its direction) are now "positively" projected on to the moving strip in the form of dark lines. The distance between such a line and the middle of the corresponding white track, measured at the correct angle (Fig. 6) gives a measure of the signal amplitude. Fig. 7 is an example of such a double record, taken in Norway.

MEASUREMENTS OF THE HEIGHT OF THE KENNELLY-HEAVISIDE LAYER.—G. J. Elias, C. G. A. von Lindern and G. de Vries. (*E.N.T.*, October, 1933, Vol. 10, No. 10, pp. 400–404.)

Shorter version (without description of apparatus) of the Dutch paper dealt with in 1933 Abstracts, p. 496.

MEASUREMENTS OF HEIGHTS OF THE KENNELLY-HEAVISIDE LAYER IN JAPAN. I.—AUGUST, 1932, TO JANUARY, 1933 [Beginning of Polar Year Programme].—T. Minohara and Y. Ito. (*Rep. of Rad. Res. in Japan*, June, 1933, Vol. 3, No. 1, pp. L-1—L-31: in English.)

A series of monthly reports. The apparatus employed will be described in a later issue (*see* next abstract). No deductions are made. For previous measurements by the same workers *see* 1932 Abstracts, p. 515.

MEASUREMENTS OF THE IONISED LAYER HEIGHTS IN JAPAN [Description of Equipment for Pulse-Method Measurements].—T. Minohara and Y. Ito. (*Rep. of Rad. Res. in Japan*, September, 1933, Vol. 3, No. 2, pp. 99–113.)

For previous work, using the frequency-change method, *see* 1932 Abstracts, p. 515. In English.

EFFECT OF THE LEONID METEOR SHOWER ON THE IONISED UPPER ATMOSPHERE.—T. Minohara and Y. Ito. (*Ibid.*, pp. 115–125.)

Observations, with the equipment referred to above, on echoes during the showers in November, 1932. Conclusions reached are that meteors greatly increase the number of echoes: the latter "come down in rapid succession, and the chain of echoes continues for 1/100 sec. or more." The meteors form ion clouds: "small meteors ionise the atmosphere in the upper region, and the large meteors do likewise in the relatively lower region. The ion clouds caused by large meteors would be one of the causes of the great diversity in the degree of ionisation in the upper atmosphere and of the variations in the mode of propagation of radio waves." In English.

JAPANESE URSIGRAM. I.—FROM SEPTEMBER, 1932, TO MAY, 1933.—(*Rep. of Rad. Res. in Japan*, June, 1933, Vol. 3, No. 1, pp. U-1—U-13: in English.)

SOLAR ACTIVITY AND RADIO RECEPTION.—H. T. Stetson. (*Sci. Abstracts, Sec. B*, July, 1933, Vol. 36, No. 427, pp. 465–466.)

RADIO TESTS IN CANADA DURING THE SOLAR ECLIPSE OF 31ST AUGUST, 1932.—J. T. Henderson. (*Hochf:tech. u. Elek:akus.*, September, 1933, Vol. 42, No. 3, pp. 79–85.) *See* 1933 Abstracts, pp. 264 (Henderson) and 264–265 (Henderson and Rose); *also* 264 (Rose).

LOW-FREQUENCY [Long-Wave] RADIO RECEIVING MEASUREMENTS AT THE BUREAU OF STANDARDS IN 1931 AND 1932 [with Correlation between Sunspot Numbers and Average Transatlantic Signals, Atmospherics, and Polarisation of Reflected Wave: etc.].—E. B. Judson. (*Proc. Inst. Rad. Eng.*, September, 1933, Vol. 21, No. 9, pp. 1354–1363.)

SHORT-WAVE COMMUNICATION BETWEEN AIR LINERS OVER 2 000 MILES. (*World-Radio*, 8th September, 1933, Vol. 17, No. 424, p. 303: paragraph only.)

CALCULATION OF SHORT-WAVE FIELD STRENGTHS: COMPARISON WITH OBSERVED VALUES.—Nakai: Namba and Tsukada. (*See* end of abstract under "Directional Wireless.")

NIGHT TRANSMISSION OF MEDIUM-FREQUENCY [Broadcast] WAVES BETWEEN 40 AND 2 000 KILOCYCLES.—S. Namba and S. Ueno. (*Rep. of Rad. Res. in Japan*, September, 1933, Vol. 3, No. 2, Abstr. Sec. p. 7.)

Short abstract only of paper in Japanese on field-strength measurements on U.S.A. and European broadcasting stations (distances 500–10 000 km). Curves give the relation between distance and night intensity.

ATTENUATION OF OVERLAND RADIO TRANSMISSION IN THE FREQUENCY RANGE 1.5 to 3.5 MEGACYCLES PER SECOND.—C. N. Anderson. (*Proc. Inst. Rad. Eng.*, October, 1933, Vol. 21, No. 10, pp. 1447–1462.) The I.R.E. Convention paper, an abstract of which was dealt with in 1933 Abstracts, p. 439.

REPORT OF COMMITTEE ON RADIO PROPAGATION DATA [Field Strength Graphs, Atmospheric Noise Level Curves, Fading, etc.: Extension of Madrid Committee Data].—(*Proc. Inst. Rad. Eng.*, October, 1933, Vol. 21, No. 10, pp. 1419–1438.)

The frequency range covered is 150 to 1 700 kc/s: distances extend up to 5 000 km.

THE PROPAGATION OF MICRO-WAVES TO CONSIDERABLE DISTANCES.—G. Marconi. (*La Ricerca Scientifica*, 15th/31st Aug., 1933, 4th Year, Vol. 2, No. 3/4, pp. 71–72.) Announcement of the results dealt with in 1933 Abstracts, p. 615, r-h column.

SOME CHARACTERISTICS OF ULTRA-HIGH-FREQUENCY [5.1 Metre] TRANSMISSION.—H. Muyskens and J. D. Kraus. (*Proc. Inst. Rad. Eng.*, September, 1933, Vol. 21, No. 9, pp. 1302–1316.)

Experiments at the University of Michigan. A field-strength contour map of the neighbourhood is given, the receiving and calibrating methods being briefly described. The attenuation constant is found to be 0.36. Tests on receiving-aerial lengths show the importance of a properly resonant receiving aerial; other tests were made in which the transmitting aerial (full-wave dipole) was rotated in various planes, and the results indicate that horizontally polarised radiation is more rapidly attenuated than vertically polarised (*cf.* Trevor and Carter, 1933 Abstracts, p. 334: *see* also Esau and Köhler, p. 381).

ULTRA-SHORT-WAVE TRANSMISSION [with Curves of Aeroplane and Motor-Car Reception on 4.5 Metres, and Calculated Curves].—C. R. Englund. (*Bell Lab. Record*, November, 1933, Vol. 12, No. 3, pp. 66–71.)

EXPERIMENTS IN ULTRA-HIGH-FREQUENCY COMMUNICATION [on 3–10 Metre Waves, including Transmissions from Summit of Mt. Fuji].—T. Nakai, R. Kimura and S. Ueno. (*Rep. of Rad. Research in Japan*, June, 1933, Vol. 3, No. 1, pp. 7–17: in English.) Abbreviated translation of the paper dealt with in 1933 Abstracts, p. 173, r-h column.

LUMINOUS DISCHARGE BETWEEN LECHER WIRES IN A PARTIALLY EVACUATED TUBE [and Its Use for Visual Study of Micro-Wave Circuits].—Hershberger, Zahl and Golay. (*Physics*, September, 1933, Vol. 4, No. 9, pp. 291–293.) *See* 1933 Abstracts, p. 498, l-h column.

ELECTROMAGNETIC WAVES IN A WIRE, WITH CONCENTRATED ENERGY SOURCE.—W. Kessenich. (*Journ. of Tech. Phys., Moscow*, No. 5/6, Vol. 2, 1932, pp. 398–411: in Russian.)

Author's summary:—The theoretical foundation of practical methods of calculating radiating systems is discussed. The necessity of a strict investigation of electromagnetic waves in open conductors, for concentrated energy sources, is pointed out, and the general formulation of the problem given. A solution is found for each of two cases, an infinitely small and an infinitely large wire radius, giving spherical and cylindrical energy dispersion in propagation along a wire.

CONTRIBUTION TO THE STUDY OF THE [Seismic] WAVE *P*.—P. Caloi. (*La Ricerca Scientifica*, 15/31st Aug., 1933, 4th Year, Vol. 2, No. 3/4, Supp. pp. 25–46.)

VELOCITY OF ELASTIC WAVES IN GRANITE AND NORITE.—L. D. Leet. (*Physics*, October, 1933, Vol. 4, No. 10, pp. 375–385.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

CORRELATION OF RADIO ATMOSPHERICS WITH METEOROLOGICAL CONDITIONS.—T. Nakai. (*Rep. of Rad. Res. in Japan*, September, 1933, Vol. 3, No. 2, pp. 155–175.) The full English version of the Japanese paper dealt with in 1932 Abstracts, pp. 335–336.

SURVEY OF THUNDERSTORMS—2ND ANNUAL REPORT.—(*Electrician*, 27th Oct., 1933, Vol. 111, No. 17, p. 528.)

ELECTRICAL DISTURBANCES APPARENTLY OF EXTRA-TERRESTRIAL ORIGIN [" Static Hiss " Type Atmospherics].—K. G. Jansky. (*Proc. Inst. Rad. Eng.*, October, 1933, Vol. 21, No. 10, pp. 1387–1398.) *See* preliminary letter, 1933 Abstracts, p. 561, l-h column.

AUDIO-FREQUENCY ATMOSPHERICS [Swishes, Tweeks, etc.: Their Habits and Origins].—E. T. Burton and E. M. Boardman. (*Proc. Inst. Rad. Eng.*, October, 1933, Vol. 21, No. 10, pp. 1476–1494.)

The writers' observations lead them to the conclusion that Barkhausen's " multiple reflection " theory (1931 Abstracts, p. 376) fails for swishes, but is satisfactory for tweeks. It is suggested that swishes may be related to the occasionally observed phenomenon of swinging and flashing auroral beams (*cf.* Garber, next column).

ON THE ELECTRIC CHARGE COLLECTED BY WATER DROPS FALLING THROUGH IONISED AIR IN A VERTICAL ELECTRIC FIELD.—J. P. Gott. (*Proc. Roy. Soc.*, Oct., 1933, Vol. 142, No. A 846, pp. 248–268.)

The experiments here described (with one size of drop only) give results in accordance with C. T. R. Wilson's theory of the mechanism of thunderstorms and the electric charge brought down by rain.

DEVELOPMENT OF THE LIGHTNING DISCHARGE.—Ashmore. (*Nature*, 23rd Sept., 1933, Vol. 132, p. 477.)

A note recording a suggestion due to S. E. Ashmore that Schonland and Collens' letter on the development of the lightning discharge (November Abstracts, p. 616) receives confirmatory evidence from the noise heard in a wireless receiver during a storm. The first " click " may be due to the preliminary downward avalanche of electrons and the lightning flash " heard " afterwards may be that progressing by thermal ionisation.

COSMIC RAYS AND LIGHTNING [Suggestion that Penetrating Particles make Conducting Paths].—J. Tandberg. (*Nature*, 4th Nov., 1933, Vol. 132, p. 712.)

ON THE REALITY OF THE RESIDUE OF SPHERICAL LIGHTNING.—E. Mathias. (*Comptes Rendus*, 30th Oct., 1933, Vol. 197, No. 18, pp. 962–964.)

BALL LIGHTNING [with Photographs].—J. C. Jensen. (*Physics*, October, 1933, Vol. 4, No. 10, pp. 372–374.)

BREAKDOWN AT LIGHTNING ARRESTERS ON H.T. LINES OCCURRING AT SUNRISE [Ionising Effect].—F. Ringwald. (*E.T.Z.*, 31st Aug., 1933, Vol. 54, No. 35, p. 856.) *See* also 1932 Abstracts, pp. 89 and 577, George and Brownlee: Menge.

LIGHTNING ARRESTERS FOR THE PROTECTION OF AIRCRAFT WIRELESS EQUIPMENT, INVESTIGATED WITH THE CATHODE-RAY OSCILLOGRAPH.—H. Viehmann. (*E.T.Z.*, 5th Oct., 1933, Vol. 54, No. 40, pp. 956–958.)

The paper deals chiefly with the DVL homogeneous-field air-gap protector based on the writer's previous investigations (1931 Abstracts, p. 377, r-h col.) which is provided with tungsten ionising points: when the transmitter is in action these points give a glow discharge which strongly ionises the main gap, while if the transmitter is not working the arrival of the surge produces a similar effect. It is suggested that this method of pre-ionisation should be useful also in power engineering. A final section deals with glow-discharge-tube arresters. The introductory section mentions a Telefunken suggestion of connecting the aerial, before it enters the aircraft, through a coupling coil to the main body of the aircraft, the radio apparatus being coupled inductively and with the introduction of sufficiently high insulation. This plan is admitted to provide excellent protection, but the necessary matching involves almost a re-design of the apparatus.

CORONA DUE TO SURGES [Investigation by use of Dust Figures].—Y. Toriyama. (*E.T.Z.*, 21st Sept., 1933, Vol. 54, No. 38, pp. 909–910.)

THE METEOR SHOWERS OF 9TH OCTOBER, 1933.—E. Esclangon. (*Comptes Rendus*, 16th October, 1933, Vol. 197, No. 16, pp. 801–804.)

OBSERVATION AND PHOTOGRAPHY OF THE METEORS OF 9TH OCTOBER, 1933.—G. C. Flammarion and F. Quénisset. (*Comptes Rendus*, 30th Oct., 1933, Vol. 197, No. 18, pp. 978–979.)

ON THE AUDIBILITY OF THE AURORA BOREALIS [Observations from a Height of 2 000 Feet: Streamers take 6–8 Seconds to pass Overhead at about 100 Feet Height, with Crackling Sound: Draperies emit Sound for Minute or more on end].—C. M. Garber. (*Science*, 8th Sept., 1933, Vol. 78, No. 2019, pp. 213–214.)

OBSERVATIONS ON POLAR AURORAS AT SCORESBY SOUND DURING THE POLAR YEAR [including Phase Opposition between Sunspot Curves and Auroral and Magnetic Curves].—A. Dauvillier. (*Comptes Rendus*, 30th Oct., 1933, Vol. 197, No. 18, pp. 997–1000.)

The writer concludes :—" Time differences of some tens of hours with respect to the passage of a focus of solar activity across the central meridian have often been reported, but this is the first time that a displacement of a half-period of solar rotation has appeared so clearly. This result is of the greatest importance. Not only does it ruin the theories attributing the auroral and magnetic phenomena to ultra-violet rays emitted by the sun, by attributing the observed delays to the passage time of the electrified particles, but it also proves that it is the fine equatorial coronal jets which are the sole cause of these phenomena. The study of eclipses has actually shown that the most intense coronal jets are not radial and that they spring, not from the edges of the solar disc, but in front of or behind this. In a period of solar minimum the electronic jets coming from an active focus have an energy sufficiently reduced for them to be bent, by the solar magnetic field of M. Deslandres, to such an extent that they reach the earth in a direction opposite to that of their emission, like a wide cometary tail, diffuse and bent back."

CONTINUOUS PHOTOELECTRIC RECORDING OF POLAR AURORAS [and the Variation of Intensity in the Ratio 1 : 10^4].—A. Dauvillier. (*Comptes Rendus*, 9th October, 1933, Vol. 197, No. 15, pp. 780–781.)

These first records show a fluctuation of 1 : 10^4 in a period of minimum solar activity. "There is no connected geophysical phenomenon susceptible to variations of such proportions." The international notation (0–4) represents practically the logarithm of intensity. The importance of such quantitative measurements is stressed.

MAGNETIC OBSERVATIONS AT SCORESBY SOUND DURING THE POLAR YEAR.—J. P. Rothé. (*Comptes Rendus*, 6th Nov., 1933, Vol. 197, No. 19, pp. 1057–1059.)

Among the results mentioned, a periodicity of about 28 days, both for very disturbed days and for calm days, occurred regularly throughout the year: the beginning of the disturbance of 30th April, 1933, was particularly clearly marked at Scoresby Sound, and an examination of the hours of arrival indicates that this beginning was not simultaneous over the whole earth, but that the disturbance travelled from the magnetic North, eastwards, taking about 1 minute to encircle the globe.

CONTRIBUTION TO THE CHARACTERISATION OF MAGNETIC AGITATION [Measuring the Actual Length of the Recorded Curves Day by Day by means of a Curvimeter].—Y. Labrouste. (*Comptes Rendus*, 25th Sept., 1933, Vol. 197, No. 13, pp. 653–655.)

ON THE TERRESTRIAL REPERCUSSIONS OF VARIATIONS OF SOLAR ACTIVITY [and the Preponderant Importance of the Invisible Active Foci].—A. Nodon. (*Comptes Rendus*, 23rd October, 1933, Vol. 197, No. 17, pp. 907–908.)

ON CERTAIN REGULARITIES WHICH APPEAR IN THE SUCCESSION OF SOLAR PHENOMENA.—H. Deslandres. (*Comptes Rendus*, 11th Sept., 1933, Vol. 197, No. 11, pp. 589–593.)

NEW CYCLE OF SUNSPOTS MAY BEGIN IN NEXT FEW MONTHS.—(*Sci. News Letter*, 28th Oct., 1933, Vol. 24, No. 655, p. 276.)

GLOW DISCHARGE AT HIGH PRESSURES [10 to 760 mm Hg].—A. von Engel, R. Seeliger and M. Steenbeck. (*Zeitschr. f. Physik*, 1933, Vol. 85, No. 3/4, pp. 144–160.)

THE EFFECT OF ULTRAVIOLET ILLUMINATION ON THE ELECTRIC SPARK.—J. Claussnitzer. (*Physik. Zeitschr.*, 1st Nov., 1933, Vol. 34, No. 21, pp. 791–807.)

THE NATURE OF GAS IONS.—O. Luhr. (*Phys. Review*, 15th Sept., 1933, Series 2, Vol. 44, No. 6, pp. 459–462.)

"The mass of gas ions formed in a glow discharge and aged up to 10^5 impacts was determined by a Dempster type of mass-spectrograph. . . . Air ions include all possible nitrogen and oxygen ions, the aged air ions consisting principally of N_3^+, N_4^+ and O_2^+ together with the oxides of nitrogen."

METEOROLOGICAL AND SOLAR INFLUENCES ON THE INTENSITY OF COSMIC RADIATION.—V. F. Hess and others. (*Helvet. Phys. Acta*, Fasc. 7, Vol. 6, 1933, pp. 480–482.)

PENETRATING POWER AND ABSORPTION COEFFICIENT OF COSMIC RADIATION.—E. Lenz. (*Zeitschr. f. Physik*, 1933, Vol. 85, No. 7/8, pp. 435–438.)

THE ELECTRICAL CONDUCTIVITY OF THE LOWER ATMOSPHERE PRODUCED BY COSMIC RADIATION.—E. Lenz: Regener. (*Helvet. Phys. Acta*, Fasc. 7, Vol. 6, 1933, p. 479.)

Summary only of results derived from Regener's measurements. The maximum value of ionising power was at a height of 13 km, the value being 45 I/cm³sec. compared with 12 I/cm³sec. at 25 km. At the latter height the ion content was 1×10^4 I/cm³ and the conductivity 50×10^{-12} ohm^{-1} cm^{-1}. It was found also that the latitude-dependence of the cosmic radiation at sea level showed a complete symmetry with regard to the geographical equator.

THE ABSORPTION CURVE OF THE COSMIC RADIATION AND ITS SIGNIFICANCE.—E. Regener. (*Helvet. Phys. Acta*, Fasc. 6, Vol. 6, 1933, pp. 450–456.) Additional to the paper dealt with in 1933 Abstracts, p. 442, r-h column.

ON THE TECHNIQUE AND DESIGN OF WILSON CLOUD-CHAMBERS.—O. Dahl, L. R. Hafstad and M. A. Tuve. (*Review Scient. Instr.*, July, 1933, Vol. 4, No. 7, pp. 373–378.)

A PORTABLE DOUBLE GEIGER COUNTER.—R. D. Bennett, J. C. Stearns and W. P. Overbeck. (*Ibid.*, pp. 387–390.)

THE MECHANISM OF THE GEIGER-MÜLLER COUNTER [for Cosmic Rays].—W. Christoph and W. Hanle. (*Physik. Zeitschr.*, 15th Aug., 1933, Vol. 34, No. 16, p. 640.)

ON THE POSSIBILITIES OF APPLICATION OF A NEW PROPORTIONAL AMPLIFIER [for Cosmic Rays].—G. Hoffmann. (*Naturwiss.*, 8th September, 1933, Vol. 21, No. 36, p. 662.)

PROGRESS OF WORLD-SURVEY OF COSMIC RAYS.—A. H. Compton. (*Trans. Am. Geophys. Union*, *14th Annual Meeting*, April, 1933, pp. 154–158.)

PROPERTIES OF CIRCUITS

THE EFFECT OF INDUCTANCE ON THE INTERMITTENT GLOW DISCHARGE [and Applications as Constant-Frequency Sine-Wave Generator for Bridge Measurements, Electrical Music, etc.].—W. E. Kock. (*Physics*, October, 1933, Vol. 4, No. 10, pp. 359–361.)

The insertion of an inductance in the condenser arm of an intermittent glow-discharge circuit was found to change the voltage/frequency curve: the wave form of the voltage across the condenser became sinusoidal, and other new wave forms were introduced. Within a certain range, the frequency was practically independent of voltage, resistance or tube characteristics.

SELF-EXCITED NON-LINEAR VALVE OSCILLATIONS [Relaxation Oscillations: Comparison between "Capacity" and "Self-Inductance" Connections, etc.].—H. Straub. (*Helvet. Phys. Acta*, Fasc. 6, Vol. 6, 1933, pp. 385–410: in German). Conclusion of the paper referred to in 1933 Abstracts, p. 620, r-h column.

ON SOME GENERAL PROPERTIES OF RESONANCES IN NON-LINEAR MECHANICS.—N. Kryloff and N. Bogoliùboff. (*Comptes Rendus*, 23rd Oct., 1933, Vol. 197, No. 17, pp. 908–910.) For previous work of these authors *see* 1932 Abstracts, p. 403.

ALL-PASS NETWORKS [Attenuation Constant Zero at All Frequencies: for Delay or Phase-Correcting Networks].—K. Nagai. (*Rep. of Rad. Res. in Japan*, September, 1933, Vol. 3, No. 2, Abstr. Sec. p. 9: abstract only of paper in Japanese: in English.)

"NETWORK SYNTHESIS."—C. M. Gewertz. (Book Review in *Proc. Inst. Rad. Eng.*, October, 1933, Vol. 21, No. 10, p. 1498.)

THE CALCULATION OF MODULATION PRODUCTS [for Valve Characteristics].—Bartlett. (*See* under "Valves and Thermionics," p. 40.)

THE MUTUAL REACTION OF ANODE AND GRID CIRCUITS IN AMPLIFIERS AND BROADCAST RECEIVERS [Simplified Treatment with Curves and Tables].—W. Kautter. (*E.T.Z.*, 21st Sept., 1933, Vol. 54, No. 38, p. 922: summary only.)

TRANSMISSION

A MAGNETOSTATIC OSCILLATOR FOR THE GENERATION OF 1 TO 3 CM WAVES.—C. E. Cleeton and N. H. Williams. (*Phys. Review*, 1st Sept., 1933, Series 2, Vol. 44, No. 5, p. 421.)

The writers have produced continuous waves of length about 1 cm, using tubes of the split anode type, of very small dimensions. The letter describes their measurement by means of a simple grating spectrometer consisting of two parabolic brass mirrors, about 1 m in diameter, and an echelette grating.

RADIATION RESISTANCE OF CONCENTRIC-CONDUCTOR TRANSMISSION LINES [and Comparison with Parallel Lecher Wires: for use in Micro-Wave Oscillator Circuits].—R. Whitmer. (*Proc. Inst. Rad. Eng.*, September, 1933, Vol. 21, No. 9, pp. 1343–1353.)

For wavelengths below 1 m it is customary to use a short segment of transmission line in place of a tuned circuit. Parallel wires are generally preferred, for ease of construction and adjustments but the writer (using Pistolkors' method) obtain, an expression for the total radiation resistance of a concentric line and, applying this to a specific case, finds a value of only 0.086 ohm compared with 3.02 ohms for open wires.

PRODUCTION AND UTILISATION OF MICRO-RAYS [including Mathematical Treatment of Retarding-Field Oscillator: Constant (Optimum) Frequency Curves and Their Importance for Amplitude Modulation: etc.].—A. G. Clavier. (*Electrical Communication*, July, 1933, Vol. 12, No. 1, pp. 3–11.)

REMARKS ON THE MODULATION OF ULTRA-SHORT WAVES [Two Optimum Values of Anode Potential for Pierret Circuit Modulation].—E. Pierret. (*Journ. de Phys. et le Rad.*, No. 4, Vol. 4, 1933, pp. 79–80 s.)

A SPECIAL TYPE OF MAGNETRON OSCILLATION [fulfilling the Barkhausen-Kurz Formula].—A. A. Slutzkin and P. P. Leljakow. (*Physik. Ber.*, 1st Aug., 1933, Vol. 14, Vol. 15, p. 1266.)

ON THE THEORY OF THE ELECTRON-SPACE-CHARGE OSCILLATIONS [Retarding-Field Circuit: the Advantages of a Graphical Treatment].—M. Dick. (*Helvet. Phys. Acta*, Fasc. 7, Vol. 6, 1933, pp. 486–488: German summary only.)

ULTRA-SHORT [Micro-] WAVES IN OPPOSED-PHASE EXCITATION [Retarding-Field Oscillator: the Grid Electrode Circuit as Frequency-Determining Element: Effects of Anode Diameter: Design of Special Valves for a *Continuous* Range of Wavelengths from 13.5 to 17.5 cm].—J. Müller. (*Helvet. Phys. Acta*, Fasc. 7, Vol 6, 1933, pp. 491–493: in German.) *See* also 1933 Abstracts, pp. 443–444.

FREQUENCY MULTIPLICATION AT ULTRA-HIGH FREQUENCIES BY CATHODE-RAY SWEEPING OVER TOOTHED DISC.—S. L. Ting. (*Wireless Engineer*, October, 1933, Vol. 10, No. 121, pp. 555–556.)

MICRO-WAVES AND THEIR USE IN RADIO-COMMUNICATION [Survey of Circuits for Transmission and Reception: Royal Naval Institute Researches: List of Shortest Wavelengths reached by Various Workers: etc.].—N. Carrara. (*Alta Frequenza*, August, 1933, Vol. 2, No. 3, pp. 465–496.)

FEATHERWEIGHT SETS FOR THE ULTRA-HIGH FREQUENCIES [56 and 28 Mc/s: especially for Soaring Planes (Gliders)].—R. A. Hull. (*QST*, September, 1933, Vol. 17, No. 9, pp. 27–31.)

FREQUENCY STABILISATION OF TRANSMITTER BY TWO LUMINOUS QUARTZ RESONATORS EACH CONTROLLING A PHOTOCELL.—Lorenz Company: Gerth. (German Pat. 568 795, pub. 24.1.1933.) For a method also using luminous quartz resonators but employing the gaseous conductivity at resonance, *see* Pat. 568,794, pub. 24.1.1933, Lorenz: Herzog.

A STUDY OF THE FREQUENCY VARIATION OF VALVE GENERATORS (VI)—OSCILLATION CHARACTERISTICS OF B-BATTERY-LESS OSCILLATORS.—S. Ishikawa. (*Rep. of Rad. Res. in Japan*, June, 1933, Vol. 3, No. 1: Abstracts Section, p. 3: short English summary of Japanese paper.)

"For use with a heterodyne wavemeter, a B-battery-less oscillator is recommended, because of its simplicity of operation and because of absence of frequency variation due to fluctuations in the plate supply source. The paper describes the oscillation characteristics of such an oscillator, and also compares it with other normal or dynatron oscillators as regards frequency stability." For previous work *see* 1933 Abstracts, p. 37, r-h column.

DEVELOPMENT OF THE QUARTZ CONTROL OF TELEFUNKEN HIGH-POWER STATIONS.—R. Bechmann. (*Telefunken-Zeit.*, April, 1933, Vol. 14, No. 63, pp. 17–29.)

Including a description of the new, self-contained "vacuum quartz" with continuous temperature regulation (*see* under "Measurements and Standards") and the bridge circuit in which it is used. This combination is employed at the Langenberg and Breslau, and the Zeesen short-wave, broadcasting stations. The mean and maximum deviations of Langenberg and Breslau are less than 50 c/s (constancy at least 5×10^{-5}).

THE TECHNIQUE OF LONG-DISTANCE RADIO COMMUNICATION [Survey of Transmitters, Modulation Methods, Frequency Stabilisation, Beam Aerials, etc.].—V. Gori. (*Alta Frequenza*, August, 1933, Vol. 2, No. 3, pp. 377–420.)

TRITET MULTI-BAND CRYSTAL CONTROL: A UNIVERSAL FIVE-BAND [1.75–28 Mc/s] TRANSMITTER EXCITER UNIT.—J. J. Lamb. (*QST*, October, 1933, Vol. 17, No. 10, pp. 9–15.)

FADING ELIMINATION BY ROTATING POLARISATION OF DIRECTED BEAM: ROTATION FREQUENCY LOWER THAN OSCILLATING FREQUENCY: SIMULTANEOUS "DIRECTION WOBBLE."—(*Hochf:tech. u. Elek:akus.*, August, 1933, Vol. 42, No. 2, p. 75: U.S.A. Pat. No. 1 898 058, pub. 21st Feb., 1933, RCA and Lindenblad.)

THE SINGLE SIDE-BAND SYSTEM APPLIED TO SHORT-WAVE TELEPHONE LINKS.—A. H. Reeves. (*Journ. I.E.E.*, September, 1933, Vol. 73, No. 441, pp. 245–279.) The full paper, a summary of which was dealt with in 1933 Abstracts, p. 391, l-h col.

PRIVACY SYSTEMS FOR RADIO TELEPHONY.—A. J. Gill.—(*P.O. Elec. Eng. Journ.*, October, 1933, Vol. 26, Part 3, pp. 224–230.)

Switched-channel system: masking speech by other noises (impracticable): frequency-transposing (plain inversion, spread sideband, and split band systems—"scrambling"): systems introducing delay (with transposition of order of sounds): phase-change or frequency-change signalling (dubious) and periodic variation of carrier frequency (impracticable): single side-band and quiescent carrier (valuable in combination with other systems as adding to privacy, apart from other merits).

SUPPRESSION OF TRANSMITTER HARMONICS: CORRECTION.—Dietsch. (*Electronics*, July, 1933, Vol. 6, No. 7, p. 199.) Correction to the article referred to in 1933 Abstracts, p. 565, l-h column.

THE CALCULATION OF HARMONIC PRODUCTION IN THERMIONIC VALVES WITH RESISTIVE LOADS [up to Sixth Harmonic].—D. C. Espley. (*Proc. Inst. Rad. Eng.*, October, 1933, Vol. 21, No. 10, pp. 1439–1446.)

GRID-MODULATED VALVE TRANSMITTERS [Square-Topped H.F. Modulating Voltage].—Telefunken: Buschbeck. (German Pat. 577 871, pub. 6.6.1933: *Hochf: tech. u. Elek: akus.* October, 1933, Vol. 42, No. 4, p. 147.)

"All grid modulation methods involve a movement of the working point of the h.f. grid a.c. potential in time with the modulation frequency: as a result, in addition to the height of the anode-current curve being altered, its breadth also is changed, giving—even with a rectilinear valve characteristic—a non-linear modulation characteristic. According to the invention the h.f. modulating potential is given a rectangular wave form, so that the breadth of the anode-current impulse remains constant."

ON THE ADJUSTMENT OF [the Choke Coils and the Neutralisation and Balancing of the Push-Pull Circuits of Short-Wave] POWER AMPLIFIERS.—S. Amari. (*Rep. of Rad. Res. in Japan*, June, 1933, Vol. 3, No. 1: Abstracts Section p. 4: summary only of Japanese paper: in English.)

THE INVERTED ULTRAUDION AMPLIFIER: WORKING THE TRIODE AS A SCREEN-GRID TRANSMITTING AMPLIFIER.—H. Romander. (*QST*, September, 1933, Vol. 17, No. 9, pp. 14–18.)

APPLICATIONS OF THE DYNATRON [to Receivers, Wavemeters, Standard Signal Generators, Audio Oscillators: to Measurement of R.F. Resistance, Power Factor, Admittance, etc.: Precautions for obtaining Full Advantages].—M. G. Scroggie. (*Wireless Engineer*, October, 1933, Vol. 10, No. 121, pp. 527–540.)

With a bibliography of 35 items. The writer concludes:—"The dynatron is, as has been seen, useful. It might be still more useful if the valve manufacturers cease to regard it as an accident."

RECEPTION

THE RECEPTION OF ULTRA-SHORT [Decimetre] WAVES WITH THE RETARDING-FIELD AUDION.—H. E. Hollmann. (*Hochf:tech. u. Elek:akus.*, September, 1933, Vol. 42, No. 3, pp. 89–99.)

A full account of the researches dealt with in Abstracts, 1933, p. 621. Reference is made to Carrara's paper (1933, p. 38, r-h col.) "which in certain points arrived at analogous results, without however drawing from them all the conclusions here treated."

A New Regenerative Detector Circuit for Ultra-Short Waves [Regeneration depending on Capacitive Impedance common to Grid and Plate Circuits: "the Cathode Impedance Ultraudion"].—R. Hilferty. (*QST*, November, 1933, Vol. 17, No. 11, pp. 15–17.)

C.w. telegraphy may be received at 56 Mc/s as on lower frequencies. The receiver may be made to function super-regeneratively by increasing the s.g. voltage to the point of "squegging." "Contrary to expectations, however, it has been found that there is little to be gained by super-regeneration excepting in the case of a badly frequency-modulated carrier. For an excellently stable carrier, straight regeneration produces the more satisfactory results."

Comparison between Super-Regenerative and Regenerative Reception.—Hilferty. (*See* preceding abstract.) *Cf.* Reinartz, p. 36.

Featherweight Sets for the Ultra-High Frequencies [56 and 28 Mc/s: especially for Soaring Planes (Gliders)].—R. A. Hull. (*QST*, September, 1933, Vol. 17, No. 9, pp. 27–31.)

Ultra-Short-Wave Superheterodynes [Adaptor for 5–7 m Waves].—W. T. Cocking. (*Wireless World*, 24th November, 1933, Vol. 33, pp. 406–407.)

The Need for the Suppression of Motor-Car Interference with Ultra-Short-Wave Reception.—(*QST*, November, 1933, Vol. 17, No. 11, p. 9.)

VDE Commission on Broadcast Interference: Proposed Regulations for Prevention of Man-Made Static.—(*E.T.Z.*, 28th September, 1933, Vol. 54, No. 39, pp. 945–951.) With numerous diagrams relating to the various types of electrical apparatus and the recommended methods of treatment.

Asphalt Emulsion reduces [High-Voltage] Insulator Radio Troubles [Interference].—F. O. McMillan. (*Elec. World*, 5th August, 1933, Vol. 102, No. 6, pp. 185–187.)

Interference from Steam Trains [and Steam Blasts from Cylinders as a Possible Cause]: Correspondence.—(*World-Radio*, 20th and 27th October, and 3rd November, 1933, Vol. 17, pp. 515, 551 and 586.)

[Man-Made] Electrical Interference.—A. Morris. (*World-Radio*, 17th and 24th Nov., 1933, Vol. 17, Nos. 434 and 435, pp. 651, 653 and 691–692; to be continued.)

The Reactance of Broadcast Receiving Aerials and Its Influence on the Functioning of Absorption and Rejector Circuits.—Klutke. (*See* under "Aerials and Aerial Systems".)

An Outline of the Action of a Tone-Corrected Highly Selective Receiver.—E. B. Moullin. (*Proc. Inst. Rad. Eng.*, September, 1933, Vol. 21, No. 9, pp. 1252–1264.)

The writer concludes:—"Since we find ultimately that the permissible difference of frequency between stations depends only on the acoustic reproducer, we might suspect that the highly selective circuit and tone corrector are not necessary. But this is not so, because the whole effect depends on the action of a linear detector in shifting the acoustic spectrum: the detector has this property only if the desired r.f. voltage dominates the undesired voltage. This automatic domination can be secured only by means of a receiver which has a very narrow band width to radio frequency. This narrow band width will necessitate a tone-correcting system: this system is simplest when it has to correct the resonance curve of a simple resonant circuit."

Tone Correcting Amplifiers [and the "Stenode Radiostat" Receiver].—G. Priechenfried. (*Wireless Engineer*, September, 1933, Vol. 10, No. 120, pp. 487–490.)

The Effect of the Rectifier and Circuit Selectivity on Interference.—F. M. Colebrook. (*World-Radio*. 8th and 15th Sept., 1933, Vol. 17, Nos. 424 and 425, pp. 298, 300 and 333–334.)

A Note on Demodulation under Practical Conditions ["Apparent" Demodulation of a Weak by a Stronger Station].—M. V. Callendar. (*Wireless Engineer*, September, 1933, Vol. 10, No. 120, pp. 480–483.) Experimental investigation of the phenomenon discussed by Butterworth, Appleton, Colebrook, Lewis and others (Abstracts, 1931, p. 440; 1932, p. 523; 1933, p. 96; etc.).

Demodulation which is Little Affected by Fading: Its Occurrence in Super-Regenerative Reception.—H. O. Roosenstein. (*Hochf:tech. u. Elek:akus.*, Sept., 1933, Vol. 42, No. 3, pp. 85–89.)

The writer points out that while modern high-grade broadcast receivers are provided with special devices to compensate for fading, the super-regenerative circuit has the innate property of equalising signal amplitudes differing in the ratio of as much as a thousand to one. "Since this remarkable fact, so far as the writer is aware, has never been the subject of a theoretical investigation, the following paper gives an explanation of the phenomenon." It is shown that for such "fading-free" reception it is necessary and sufficient for the demodulation characteristic (field-strength/rectified current) to have a logarithmic form corresponding to $I = \log_{nat} E + B$: then if the field strength is modulated between the limits E_1 and E_2, the current fluctuation $I_1 - I_2 = A\log_{nat} E_1/E_2$, which depends only on the ratio E_1/E_2 (*i.e.* on the degree of modulation) and not on the absolute values of E_1 and E_2, *i.e.* on the fading.

Tests on super-regenerative receivers (on a 3.8 m wave, with an aerial power of 1 watt) showed that there was neither an appreciable change in telephone signal strength, nor distortion, when the distance between aerials was decreased from 2 000 m to 2 m. This held good when the telephones were connected directly behind the leaky-grid detector, so that the result could not be due to the limiting action of over-loaded amplifier valves. The demodulation characteristic of such a receiver was then plotted, the current in the transmitting aerial (for a 7-metre wave) being varied from 0.04 to 4 amperes and the rectified current changes in the audion anode circuit, produced by switching-on the unmodulated transmitter, being measured. *The resulting characteristic was found to be almost exactly logarithmic* (Fig. 2). In his next section the writer analyses the super-regenerative process to see how this characteristic arises. Finally he shows that although with such a receiver non-linear distortion is bound to occur, it is hardly more serious (for transmitter modulation percentages up to 50 %) than that given by a square-law detector: while complete freedom from distortion can be obtained by giving the transmitter an exponential modulation characteristic. A patent for such a process has been applied for.

A Type of Super-Regenerative Receiver using a "Squegging" Ultra-High-Frequency Oscillator to give the Interruption Frequency, and operating well on C.W. Signals.—Reinartz. (*QST*, September, 1933, Vol. 17, No. 9, p. 66.) *Cf.* Hilferty, p. 35.

Note on the Mode of Action of Super-Regenerative Receivers [Correspondence].—Y. Marrec: P. David. (*L'Onde Élec.*, June, 1933, Vol. 12, No. 138, pp. 326–328.)
Argument on David's paper on the three types of super-regenerative reception (1928 Abstracts, p. 519).

Automatic Fading Compensation in Broadcast Receivers [using Variable-Mu Valves: Short Survey, including Magnetron Method].—(*E.T.Z.*, 26th Oct., 1933, Vol. 54, No. 43, pp. 1043–1045.)

Automatic Volume Control, "Crack Killer" and Fading Compensator, using a Selenium Photocell.—H. Thirring. (*Funk-Magazin*, August, 1933, Vol. 6, No. 8, pp. 484–485.)

Fading Elimination by Controlling Local Note-Generator by Combined Output of Receivers fed from Spaced Aerials.—RCA. (German Pat. 574 178, pub. 10.4.1933.)

On the Application of Neon Tubes in a Limiter [for Fading Compensation in Telegraphic Reception: Very Successful up to 200 w.p.m. or over].—K. Ono and H. Seki. (*Rep. of Rad. Res. in Japan*, September, 1933, Vol. 3, No. 2, Abstr. Sec. p. 13: abstract only of paper in Japanese.)

Glow-Discharge-Tube Coupling for Amplifiers.—H. Smith and E. E. Hill: Peek. (*Wireless Engineer*, September, 1933, Vol. 10, No. 120, p. 492). *See* 1933 Abstracts, p. 212: the present writers quote an earlier patent for such a coupling.

Automatic Gain Control for the ["Single-Signal"] Superhet [Adaptation of System used in RCA Diversity Reception].—J. J. Lamb. (*QST*, November, 1933, Vol. 17, No. 11, pp. 32–33 and 35.)

Developments in Crystal Filters for S.S. ["Single-Signal"] Superhets.—J. J. Lamb. (*QST*, November, 1933, Vol. 17, No. 11, pp. 21–24.)

S.-G. Valve as Superhet Detector [Mathematical Analysis and Deductions].—C. B. Fisher: White. (*Wireless Engineer*, October, 1933, Vol. 10, No. 121, pp. 541–542.)
"The analysis of the general case establishes these results [White, 1933 Abstracts, p. 99] except that modulation is shown to be due to the variation of the plate resistance with grid-voltage, and not to variation of μ as stated by White, and shows other desirable operating conditions."

Detector Circuit with Screen-Grid Valve: Damping Adjustment without Change of Tuning.—Philips' Company. (German Pat. 567 859, pub. 17.5.1933: *Hochf:tech. u. Elek:akus.*, Oct., 1933, Vol. 42, No. 4, p. 148.)
The input circuit of the tetrode is connected across the control grid and cathode, the output comes from the screen grid. In the anode circuit there is a closed circuit tuned to the signal: it is not back-coupled to the grid circuit, the damping reduction being accomplished by change of anode voltage.

Audion [Leaky-Grid Detector] without Blocking Condenser or Leak.—Loewe and Rothe. (German Pat. 576 035, pub. 6.5.1933.)
Those parts of the control electrode exposed to electron bombardment are coated with a badly conducting substance, and the electrode is given a positive bias. Owing to the collecting of electrons on the badly conducting coating the arrangement behaves as an audion.

Constantly Illuminated Photocell as Detector in Mains-Driven Receiver, to avoid Mains Noises.—Radio Patents Corporation. (German Pat. 575 554, pub. 29.4.1933.)

[Complete Elimination of] "Hum" in [Mains-Driven] Short-Wave Receivers.—(*World-Radio*, 17th Nov., 1933, Vol. 17, No. 434, p. 660.)

Amplifier with Variable Band Breadth, using a Variably Coupled Absorbing Circuit.—RCA. (German Pat. 574 567, pub. 18.4.1933: *Hochf:tech. u. Elek:akus.*, September, 1933, Vol. 42, No. 3, p. 112.)

Selective Reception using Long Closed Loop earthed at Both Ends, with Several Amplifiers Distributed at Intervals: Outputs combined after Phase Adjustment.—J. H. Hammond. (U.S.A. Pat. 1 900 283, pub. 7.3.1933: *Hochf:tech. u. Elek:akus.*, September, 1933, Vol. 42, No. 3, p. 112.)

A STUDY OF RECEPTION FROM SYNCHRONISED BROADCAST STATIONS [Common-Wave Broadcasting].—C. B. Aiken. (*Proc. Inst. Rad. Eng.*, September, 1933, Vol. 21, No. 9, pp. 1265–1301.)

Giving the practical results of an extensive analysis of the detection of two modulated waves of identical carrier frequency. Experimental work confirms the theoretical results, *e.g.* that time-delays of the order of 200 microseconds may produce serious distortion, and that a delay as small as 50 microseconds requires a 2 : 1 carrier ratio to prevent distortion. The investigation leads to the suggestion of supplying service to an urban area by a number of low-power transmitters : to avoid the severe requirements of audio-frequency programme distribution to these transmitters, the carrier would be modulated at a central point and the modulated wave distributed over r.f. transmission lines of equal lengths, or directly by radiation.

RADIO RECEIVERS [Survey of Broadcast, Commercial and Naval Receiver Circuits, etc.].—M. Boella. (*Alta Frequenza*, August, 1933, Vol. 2, No. 3, pp. 421–464.)

PRACTICAL HEXODE CIRCUITS.—R. Wigand. (*Radio, B., F. für Alle*, Sept., 1933, pp. 397–404.)

AN ULTRA-SELECTIVE HEXODE SUPERHETERODYNE RECEIVER FOR 15–2 000 METRES.—H. von der Bey. (*Funktech. Monatshefte*, September 1933, No. 9, pp. 367–371.)

REDUCTION OF QUIESCENT ANODE CURRENT BY RECTIFYING PART OF INCOMING A.C. AND USING AS EXTRA GRID BIAS.—RCA. (German Pat. 574 457, pub. 13.4.1933.)

HINTS ON SHORT-WAVE RECEIVER DESIGN.—(*World-Radio*, 29th September, 1933, Vol. 17, No. 427, pp. 406 and 408 : to be continued.)

WHY NOT TRY THE DIODE ? [Additional Advantages, besides Tonal Quality, compensating for Need of an Extra Valve].—(*World-Radio*, 10th Nov., 1933, Vol. 17, No. 433, pp. 617–618.)

WHAT IS AN "EXPANDING" RECEIVER ? [3-Circuit 3-Valve Receiver convertible to 3-Circuit 4-Valve by switching-in a Second R.F. Stage].—Schaub. (*Radio, B., F. für Alle*, October, 1933, pp. 476–477.)

THE WIRELESS WORLD A.V.C. THREE.—(*Wireless World*, 13th and 20th October, 1933, Vol. 33, pp. 298–301 and 318–320.)

Difficulties in applying A.V.C. to receivers with only a single r.f. stage are here overcome by the employment of the delayed amplified system of A.V.C.

WHY TUNE BY WAVELENGTH ?—R. W. Hallows. (*Wireless World*, 20th October, 1933, Vol. 33, pp. 316–317.)

The writer maintains that so long as stations remain closely identified with their wavelengths or frequencies, confusion is bound to arise when wavelength changes, even of a minor nature, occur ; he therefore puts forward a scheme for the abolition of the familiar scale in favour of numbered channels.

TUNING SCALES ON BROADCAST RECEIVERS.—E. Schwandt. (*Funktech. Monatshefte*, September, 1933, No. 9, pp. 347–350.)

THE WIRELESS WORLD D.C. SUPERHET [4-Valve].—W. T. Cocking. (*Wireless World*, 29th September and 6th October, 1933, Vol. 33, pp. 262–265 and 292–294.)

The principal features are a single-valve frequency changer and a duo-diode second detector in which metal rectifiers (Westectors) are employed.

BATTERY ECONOMY WITH THE "WESTECTOR" [applied to Existing Receiver].—W. T. Cocking. (*Wireless World*, 24th November, 1933, Vol. 33, p. 405.)

DETECTOR INTERACTION [Causes and Elimination of Certain Whistles in Superheterodynes].—G. J. Redfern. (*Wireless World*, 17th November, 1933, Vol. 33, p. 398.)

BUILDING A WHISTLE FILTER.—W. T. Cocking. (*Wireless World*, 10th November, 1933, Vol. 33, pp. 372–373.)

HARMONIC DISTORTION.—D. A. Bell. (*Wireless World*, 10th November, 1933, Vol. 33, pp. 378–379.)

A BICYCLE CRYSTAL SET.—(*World-Radio*, 8th Sept., 1933, Vol. 17, No. 424, p. 301.)

THE LOUDSPEAKER IN THE HOME : ALTERNATIVE USE OF HEADPHONES.—(*The Times*, 23rd Oct., 1933, p. 25.)

In the course of this short article the Wireless Correspondent remarks : "That the British wireless manufacturer does not generally provide a set in which the loudspeaker and telephones can be used alternatively is really very remarkable."

AERIALS AND AERIAL SYSTEMS

THE REACTANCE OF BROADCAST RECEIVING AERIALS AND ITS INFLUENCE ON THE FUNCTIONING OF ABSORPTION AND REJECTOR CIRCUITS [Wave Traps : Apparent Amplifying Effect close to the True Adjustment : etc.].—F. Klutke. (*Hochf:tech. u. Elek:akus.*, September, 1933, Vol. 42, No. 3, pp. 99–105.)

In many cases where wave traps are employed the interfering signal strength is increased just before the correct adjustment is reached. Sometimes this maximum occurs when the wave-trap condenser is at a value greater than that for the true wave-trap action ("positive sign effect"), sometimes when it is smaller ("negative sign effect"). Observations over the whole broadcast scale show that, in general, with the lower frequencies the "negative sign" is in evidence, unaffected by more or less accurate tuning ; with the high frequencies the same is true of the "positive sign" ; while with the intermediate frequencies the sign can be changed at will by alteration of the tuning. The writer gives a theoretical and experimental investigation of these phenomena and draws certain practical conclusions of interest for reception and test-room purposes.

It has formerly been maintained that the effects could be explained by a magnetic coupling between the inductance of the wave-trap and the receiving circuit. Although this would, in certain circumstances, yield a voltage amplification, in most cases the possible coupling is too small to cause such marked effects; moreover, a decrease of such coupling (*e.g.* by screening) has no appreciable influence on the result. The writer's explanation, that *the voltage rise is due to the introduction of a series resonance between the various reactances in the aerial circuit*, is consistent with all the observed results. He first gives the theoretical basis of this hypothesis, and then describes its experimental confirmation. One practical consequence of the work is to bring into prominence a method of increasing the selectivity of a simple receiver by the simultaneous use of an absorption (or a rejector) circuit and a reactance circuit in series with the aerial. Another, and more important application, is in measuring technique: "it is shown in section V that the current strength (and thus the voltage drop across a fixed resistance), in a circuit containing only dissipative resistances in addition to an absorption or rejector circuit, is (as follows from equation 9) a function of C (or $1/C$) which is symmetrical with respect to the resonance point of the wave-trap. It is thus possible to ascertain the disappearance of the reactance of a circuit without laborious phase measurements, simply by examining the current strength as a function of C or of $1/C$ for symmetry with respect to the resonance point of the wave trap: this can be done easily and with great accuracy."

BROADCASTING TRANSMITTING AERIALS WITH VERTICALLY CONCENTRATED RADIATION [Low-Angle Radiation to avoid Near Fading: Zeesen Short-Wave, Disc, Cylinder (Polygon) and One-Wire (Breslau) Medium-Wave Aerials].—O. Böhm. (*Hochf:tech. u. Elek:akus.*, October, 1933, Vol. 42, No. 4, pp. 137–145.)

See many past abstracts. With regard to the Zeesen aerial the writer suggests that such aerials should be very useful for ultra-short (4–8 m) waves.

HORIZONTAL AERIAL SYSTEM WITH THE ADVANTAGE OF HORIZONTAL POLARISATION [reducing Zone of Silence] BUT WITHOUT MARKED DIRECTIVE EFFECT.—SFR: Gouriaud. (French Pat. 749 288, pub. 21.7.1933: *Rev. Gén. de l'Élec.*, 28th Oct., 1933, Vol. 34, No. 17, p. 134 D.)

A square of four insulated half-wave horizontal aerials, fed at the ends of one diagonal.

THEORY OF THE COMPLEX [Short-Wave Beam] ANTENNA.—K. Tani. (*Rep. of Rad. Res. in Japan*, June, 1933, Vol. 3, No. 1, pp. 19–88: in English.)

From author's summary:—"In this paper is proposed a general theory of the beam antenna of straight wires, based on the views as set forth by Léon Brillouin and developed by A. A. Pistolkors. Useful tables for the design of beam antennas are added. . . . The paper emphasises the following points: (1) The theory is applicable regardless of the phase relation of the antenna current. (2) It suggests that in the problem of the short-wave antenna, radiation *reactance* is no more negligible than is radiation *resistance*. (3) By introducing two quantities R_{AB} and X_{AB} [*see* 1932 Abstracts, p. 167, l-h col.] the solution of various problems relating to the antenna system is greatly facilitated." The radiation reactance mentioned above affects both the velocity constant and the damping constant of the wave on the antenna wire. Experiments with a crystal-controlled generator are described which confirm this theoretical result; also tests with aerials situated above ordinary ground and above ground artificially metallised, showing that ordinary moist ground may be taken as a conductive surface for short waves so far as "such aggregating quantities as radiation resistance and reactance are concerned."

ON THE CALCULATION OF THE TOTAL RADIATION RESISTANCE IN A SHORT-WAVE DIRECTIVE ANTENNA [with Reflector].—H. Takeuchi. (*Rep. of Rad. Res. in Japan*, June, 1933, Vol. 3, No. 1: Abstracts Section p. 2: short summary only of Japanese paper.) *See* also Kato and Takeuchi, 1933 Abstracts, p. 505.

THE FUNCTION OF THE REFLECTOR IN A SHORT-WAVE DIRECTIVE ANTENNA.—Y. Kato and H. Takeuchi.

(*Ibid.*, p. 2.) "The formulas given are useful in determining the necessity or not of feeding the reflector in any directive antenna."

THE SURGE IMPEDANCE OF A HALF-WAVE DIPOLE OF A BEAM ANTENNA.—T. Mizuhashi. (*Ibid.*, pp. 2–3: summary only of Japanese paper.)

The surge impedance is treated electrodynamically. "Considering all the current elements of half-wave dipoles as Hertzian oscillators, the electric force induced in each element is integrated along the axis of the half-wave dipole from its mid-point, which is in zero potential, to one end of it. The surge impedance is derived directly from this integrated voltage. The calculated value for the surge impedance of a half-wave dipole is

$$30 \sin h^{-1}(\lambda/d) - 49.47 + j54.95$$

ohms, where λ is the wavelength and d the diameter of the wire used in the dipole. The effects due to the presence of other half-wave dipoles have also been considered, and the results of calculations shown."

NOTE ON DIPOLE RADIATION THEORY.—W. H. Wise. (*Physics*, October, 1933, Vol. 4, No. 10, pp. 354–358.)

"By fitting certain general asymptotic series solutions of the wave equation to known expressions for wave-function components at the surface of the ground and on the upper infinite hemisphere, recurrence relations between the successive terms of the asymptotic series for some of the dipole wave-function components are obtained."

ON THE CALCULATION OF RADIATION RESISTANCE OF ANTENNAS AND ANTENNA COMBINATIONS: ERRATUM.—Bechmann. (*Proc. Inst. Rad. Eng.*, September, 1933, Vol. 21, No. 9, p. 1367.) Correction to an equation in the paper dealt with in 1931 Abstracts, p. 556.

THEORY AND PRACTICAL APPLICATION OF DIRECTED RADIATION.—Ochmann and Rein. (*Hochf: tech. u. Elek:akus.*, August, 1933, Vol. 42, No. 2, pp. 68–72.)

Second and final part of the survey dealt with in

Oct. Abstracts, p. 567, l-h col. The Telefunken "fir tree," Marconi-Franklin, Sterba, Chireix-Mesny and other aerial systems are treated briefly. A section deals with reflectors, another with the influence of the ground on the directive effect. In the two parts together more than a hundred literature and patent references are listed.

SHORT-WAVE AERIAL GIVING INCREASED GROUND WAVE [Vertical Series of Sections, the Lowest a Quarter-Wave Earthed Aerial, the Remainder Half-Wave Dipoles]—Lorenz Company. (German Pat. 577 349, pub. 29.5.1933: *Hochf:tech. u. Elek:akus.*, Oct., 1933, Vol. 42, No. 4, p. 147.)

SHORT-WAVE AERIALS FOR THE TRANSMISSION OF CIRCULARLY POLARISED WAVES. — Telefunken and Hagen: Salto. (German Pats. Nos. 568 346 and 569 073, pub. 18.1.1933 and 28.1.1933: *Hochf:tech. u. Elek:akus.*, June, 1933, Vol. 41, No. 6, p. 223.)

EFFECTIVE HEIGHT OF TRAILING AIRCRAFT AERIALS AS AFFECTED BY SPEED: COMPARISON WITH FIXED AERIALS.—Fassbender. (*See* abstract under "Miscellaneous.")

BERYLLIUM AS MATERIAL FOR AIRCRAFT AERIALS.—Fassbender. (*Ibid.*)

TESTS ON TRANSMITTING AND RECEIVING AERIALS FOR ULTRA-SHORT [5.1 Metre] WAVES.—Muyskens and Kraus. (*See* abstract under "Propagation of Waves," p. 30.)

EXPERIMENTS WITH SHORT-WAVE AERIALS [Matching Aerials and Receiver Input Circuit: Comparison of Signal Strengths with Inverted-L and Dipole Aerials: etc.].—Microm. (*World-Radio*, 27th Oct. and 3rd Nov., 1933, Vol. 17, Nos. 431 and 432, pp. 549 and 585.)

SCREENED AERIAL LEADS FOR BROADCAST RECEPTION.—A. Forstmeyer and W. Wild. (*T.F.T.*, September, 1933, Vol. 22, No. 9, pp. 219–225.)

Various types of construction are discussed: curves show the variations of capacity with different factors (including the amount of eccentricity of the central conductor): etc., etc.

THE RECEIVING AERIAL AND ITS SCREENING.—W. Kautter. (*Funktech. Monatshefte*, October, 1933, No. 10, pp. 381–387.)

QUICK AND NEARLY ACCURATE METHOD OF CALCULATING THE ELEMENTS OF A CATENARY.—E. Mathieu. (*Rev. Gén. de l'Élec.*, 23rd Sept., 1933, Vol. 34, No. 12, pp. 371–373.)

VALVES AND THERMIONICS

VOLTAGE AMPLIFICATION USING SCREEN-GRID VALVES WITH FULL UTILISATION OF THE AMPLIFICATION FACTOR [" Constant Anode Current Method": particularly suitable for Cathode-Ray Oscillography].—R. Sewig and W. Kleinschmidt. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 14, 1933, pp. 388–390.)

Rudolph's method (Abstracts, 1931, pp. 41–42) of obtaining maximum voltage amplification with a triode, by connecting a saturated diode in the triode anode circuit and thus keeping the anode current constant, does not obtain the full effect because the filament battery for the diode introduces a capacity to earth. The present writers replace the diode by a caesium photocell with a saturation voltage of about 30 v and an emission, when illuminated by a 40-watt lamp, of 0.1–1.0 mA (Sewig, 1932, pp. 469–470). They also use a screen-grid valve instead of a triode. With a Telefunken RES 044 the calculated amplification is 590: owing to the incomplete saturation of the photocell the actual value obtained was some 5% lower. The anode current was 0.3–0.5 mA, which the photocell yielded easily for many hundreds of hours. The range of anode-voltage variation was 150 v—enough for the control of a hot-cathode cathode-ray tube. The circuit is particularly suitable for this purpose, owing to its small dependence on frequency. A still more suitable valve is the RENS 1264, indirectly heated, with a penetration coefficient of only 0.1% compared with the 0.2% of the other valve.

TRANSMITTING VALVES FOR ULTRA-SHORT WAVES.—Kohl and Pintsch. (German Pats. Nos. 569 745 and 569 876, pub. 7.2.1933 and 9.2.1933.)

The first patent deals with the use of an insulating or semi-conducting anode in a retarding-field valve, to reduce the grid/anode capacity. In the second patent a spiral grid is closed by a strap to form an oscillatory circuit: between this grid and the outer concentric retarding cylinder lies a circle of hot cathodes or a single spiral cathode. At the centre there is either another hot cathode or a cold electrode at a small positive or negative potential.

TRIODE FOR ULTRA-SHORT-WAVE GENERATION [particularly for Retarding-Field Circuit: Grid wound on itself to form Closed Oscillatory Circuit].—Te-Ka-De: Pintsch. (German Pat. 576 870, pub. 17.5.1933: *Hochf:tech.u.Elek:akus.*, Oct., 1933, Vol. 42, No. 4, p. 148.)

SPECIAL VALVES FOR GENERATING A CONTINUOUS RANGE OF MICRO-WAVES FROM 13.5 TO 17.5 CENTIMETRES. — Muller. (*See* reference under "Transmission," p. 33.)

NEW INTERMEDIATE-POWER TRANSMITTING TUBES [Types RK-18, 800 and 830].—G. Grammer. (*QST*, September, 1933, Vol. 17, No. 9, pp. 33–34 and 68.)

Of the RCA-800 it is mentioned that it is conservatively rated at 35 w output up to 60 Mc/s; it will oscillate at 1.5 m in regular circuits.

A TRANSMITTING VALVE FOR ULTRA-SHORT WAVES.—Grammer. (*See* above abstract, and below.)

PUTTING THE TYPE 800 TRANSMITTING TUBE TO WORK: HOW TO USE IT IN R.F. [Full Rating at 5 Metres Wavelength] AND CLASS B AUDIO CIRCUITS.—J. L. Reinartz. (*QST*, November, 1933, Vol. 17, No. 11, pp. 27–30.) *See* also above.

THE SELECTION OF TYPES OF VACUUM TUBES AS SOURCES OF HIGH-FREQUENCY POWER [including Ultra-Short Waves].—W. C. White. (*Gen. Elec. Review*, September, 1933, Vol. 36, No. 9, pp. 394–397.)

NEW INFORMATION ABOUT THE COLD-CATHODE VALVE.—H. Keller: Hund. (*Radio, B., F. Für Alle*, October, 1933, pp. 449–450.)

For previous references to the Hund valve *see* 1933 Abstracts, pp. 328 (r-h) and 274 (l-h column). The cathode consists of the glow-discharge electrodes inside a perforated cylinder. The glow-discharge potential is about 35 v for a rare gas filling, about 100 v for air filling. The cylinder potential is about 150 v higher. One or more grids, concentric with the cylinder, and a concentric anode with a star-shaped cross section ("to avoid asymmetries"), complete the valve. The material and surface of the electrodes have no effect on the action: even iron may be used.

A COLD-CATHODE AMPLIFIER TUBE [Glow-Discharge Tube with Amplification Factor about 4: suitable for A.F. Amplification or Photocell Control].—H. J. Reich and W. M. Hesselberth. (*Electronics*, October, 1933, p. 282.)

THE CONSTITUTION OF GLOW DISCHARGES [Application to Thyratrons].—H. Rothe and W. Kleen. (*Naturwiss.*, 27th Oct., 1933, Vol. 21, No. 43, p. 772.)

A high-frequency modulation of the stationary discharge current has been observed in thyratrons in the region of the pre-glow discharge, when working with direct voltage. This seems to show that the dependent or semi-dependent discharges are built up of a number of electron groups.

IONISATION TIME OF THYRATRONS [and the Factors controlling It].—L. B. Snoddy. (*Physics*, October, 1933, Vol. 4, No. 10, pp. 366–371.)

NEW VALVES AND THEIR USES [Double-Diode-Triodes, H.F. Pentodes, Class B Valves].—(*World-Radio*, 3rd Nov., 1933, Vol. 17, No. 432, pp. 577–578.)

THE CATKIN IN THE MAKING. (*Wireless World*, 3rd November, 1933, Vol. 33, pp. 358–360.)

RECENT ADVANCES IN THE CONSTRUCTION OF THERMIONIC VALVES [Transmitting, Receiving, and Rectifying].—C. Matteini. (*Alta Frequenza*, August, 1933, Vol. 2, No. 3, pp. 346–376.)

THE LIEBEN VALVE PATENTS [and Their Expiration].—(*E.T.Z.*, 16th Nov., 1933, Vol. 54, No. 46, pp. 1119–1120.)

A MAINS-DRIVEN VALVE TESTING INSTRUMENT FOR ALL TYPES OF VALVES.—A. Hamm. (*Funktech. Monatshefte*, September, 1933, No. 9, pp. 357–362.)

GRAPHICAL DETERMINATION OF THE DETECTION CHARACTERISTICS OF A TRIODE [and Its Special Superiority over Analysis when Signals are Very Large].—Y. Fukuta and E. Kido. (*Rep. of Rad. Res. in Japan*, September, 1933, Vol. 3, No. 2, Abstr. Sec. pp. 8–9: abstract only of paper in Japanese.)

A STUDY OF VACUUM TUBE CHARACTERISTICS [and the Computation and Measurement of Fundamental and Second Harmonic Coefficients, etc.].—S. Chiba and T. Sugi. (*Rep. of Rad. Res. in Japan*, September, 1933, Vol. 3, No. 2, Abstr. Sec. p. 8: abstract only of paper in Japanese: in English.)

THE CALCULATION OF HARMONIC PRODUCTION IN THERMIONIC VALVES WITH RESISTIVE LOADS [up to Sixth Harmonic].—D. C. Espley. (*Proc. Inst. Rad. Eng.*, October, 1933, Vol. 21, No. 10, pp. 1439–1446.)

THE CALCULATION OF MODULATION PRODUCTS [for Valve Characteristics].—A. C. Bartlett. (*Phil. Mag.*, Oct., 1933, Series 7, Vol. 16, No. 107, pp. 845–847.)

Author's summary:—A modified form of Taylor's Theorem is derived which allows functions of cosines to be developed directly in series of cosines of multiple angles. This is applied to the determination of the modulation frequencies in a non-linear device such as a thermionic valve.

SURFACE CONDITIONS AND STABILITY OF CHARACTERISTICS IN SCREENED-GRID TUBES.—P. L. Copeland. (*Journ. Franklin Inst.*, Oct., 1933, Vol. 216, No. 4, pp. 417–426.)

This paper emphasises the influence of secondary emission on the characteristics of screen-grid valves; instability of characteristics is caused by the marked change in secondary emission with surface contamination.

THERMIONIC CATHODES FOR GAS-FILLED TUBES [Crimped Ribbon in Various Forms].—E. F. Lowry. (*Electronics*, October, 1933, pp. 280–281.)

CONTRIBUTIONS TO THE TUNGSTEN-THORIUM PROBLEM (Activation of Tungsten with Thorium Content).—E. Chalfin. (*Hochf: tech. u. Elek: akus.*, September, 1933, Vol. 42, No. 3, p. 105: summary only.)

An experimental checking and extension of Langmuir's researches. The assumption that at maximum emission a monatomic layer is present (maximum atomic heat of evaporation) is confirmed. Comparative measurements of the activation- and evaporation-velocities of thorium, at the same temperature, show that the number of evaporating atoms for $\theta = 1$ is only about 5–15% of the number of atoms reaching the surface for $\theta = 0$: whereas Langmuir's "induced evaporation" theory demands equality. Other results not conforming with the theory are found.

THE EVAPORATION OF ATOMS, IONS AND ELECTRONS FROM CAESIUM FILMS ON TUNGSTEN.—J. B. Taylor and I. Langmuir. (*Phys. Review*, 15th Sept., 1933, Series 2, Vol. 44, No. 6, pp. 423–458.)

"Precision methods for measuring the number of caesium atoms adsorbed on tungsten are described. With these methods for determining θ (the fraction of the tungsten surface covered with cs), the rates of atom, ion and electron emission are measured as functions of θ and T, the filament temperature." The rate of atom evaporation, the heat of evaporation, the production of electron and ion emission for zero field, the work function, the condensation coefficient, surface migration, the mechanism of evaporation and condensation, and transient effects are discussed and a "surface phase postulate" is set up, "according to which all the properties of the adsorbed film are uniquely determined by θ and T."

EMISSION CHARACTERISTICS OF TUNGSTEN FILAMENTS [Temperature and Emission Ripples due to A.C. Heating: by Cathode-Ray Oscillograph Method].—T. Kuno. (*Rep. of Rad. Res. in Japan*, September, 1933, Vol. 3, No. 2, pp. 181–194.)

FLUCTUATION NOISE DUE TO COLLISION IONISATION IN ELECTRONIC AMPLIFIER TUBES [Theoretical and Experimental Investigation].—S. Ballantine. (*Physics*, September, 1933, Vol. 4, No. 9, pp. 294–306.)

THE THERMIONIC EFFECT AND ITS LAWS.—B. Rossi. (*Alta Frequenza*, August, 1933, Vol. 2, No. 3, pp. 327–345.)

From the author's summary:—"Considering the electrons liberated from a metal as constituents of a perfect gas, and applying to them the Fermi statistics, an emission formula is obtained which is in perfect agreement with experimental results. The action of superficial impurities is traced to the formation of an electrical double layer which facilitates or impedes the escape of the electrons, according as its positive face is turned towards the outside or the inside of the metal."

A NEW [Experimental] METHOD FOR DETERMINING THE THERMIONIC WORK FUNCTIONS OF METALS, AND ITS APPLICATION TO NICKEL.—G. W. Fox and R. M. Bowie. (*Phys. Review*, 1st Sept., 1933, Series 2, Vol. 44, No. 5, pp. 345–348.)

THE CALCULATION OF THE WORK FUNCTION FROM SIMPLE CONSTANTS OF THE MATERIAL.—F. Rother and H. Bomke. (*Zeitschr. f. Physik*, 1933, Vol. 86, No. 3/4, pp. 231–240.)

A formula is found which gives a good quantitative representation of all work functions so far measured.

MEASUREMENTS ON CONTACT POTENTIAL DIFFERENCE BETWEEN DIFFERENT FACES OF COPPER SINGLE CRYSTALS.—B. A. Rose. (*Phys. Review*, 1st Oct., 1933, Series 2, Vol. 44, No. 7, pp. 585–588.) *See* also Farnsworth and Rose, 1933 Abstract, p. 631.

WORK FUNCTION AND DISTANCE BETWEEN ATOMS.—W. Distler and G. Mönch. (*Zeitschr. f. Physik*, 1933, Vol. 84, No. 5/6, pp. 271–275.)

REMARK ON THE PAPER BY J. H. DE BOER AND M. C. TEVES: THERMAL AND PHOTOELECTRIC EMISSION FROM CAESIUM/CAESIUM-OXIDE CATHODES AND THE INFLUENCE EXERTED BY INCLUSION OF CAESIUM ATOMS IN THE DIELECTRIC [and a New Method of Manufacture].—P. Görlich: de Boer and Teves. (*Zeitschr. f. Physik*, 1933, Vol. 85, No. 1/2, pp. 128–130.)

For the paper in question see 1933 Abstracts, p. 573, l-h col. The present note shows "that, by the inclusion of caesium atoms in thick layers of caesium oxide, a considerably greater emission can be obtained than from caesium oxide layers with caesium ions adsorbed on the surface. A new method of manufacturing Cs_2O layers containing caesium atoms is given."

DIRECTIONAL WIRELESS

[Long-Distance] FIELD-STRENGTH MEASUREMENTS AND DIRECTIONAL OBSERVATIONS OF SHORT WAVES.—T. Nakai: Tsukada. (*Rep. of Rad. Research in Japan*, June, 1933, Vol. 3, No. 1, pp. 89–98: in English.)

Short description (to be amplified later) of a field-strength measuring equipment with a frequency range of nearly 4 to 15 Mc/s, together with an account of its calibration. In conjunction with a vertical aerial it is used for measurements on English, American and Australian stations, while with Tsukada's improved goniometer-type direction finder (1933 Abstracts, p. 102, r-h col.), using an aerial system consisting of "two sets of elemental Adcock aerials each having a vertical part of 4 metres and a horizontal part of 6 metres in length," and a hut raised off the ground, "directions may usually be determined within an error of about $\pm 2°$ and even in the most unsatisfactory condition within $\pm 5°$," the stations used in these tests being Rocky Point and New Brunswick, Rio de Janeiro, and Buenos Aires.

In field-strength measurement the deflection of the final detector plate meter may be taken if signals are strong enough. Otherwise an audibility meter is used. With a non-modulated signal no difference is found on the whole between the two methods; with a modulated wave the values obtained by the audibility meter are smaller, by an average of 5 db, than those given by the plate-circuit meter. For the records taken with the apparatus here described, during the first period Sept. to Dec., 1932, see *ibid.*, F-00 to F-24. These include dotted curves giving the predicted field-strength values calculated by the method of Namba and Tsukada (Abstracts, 1933, p. 497, l-h column, Namba). Observations of "Polar echo" are also recorded (1932, p. 516, Namba). For the second part of this paper see *ibid.*, September, 1933, Vol. 3, No. 2, pp. F-23–F-52.

HYSTERESIS OF THE VALVE GENERATOR AT DIFFERENT HEIGHTS OF FLIGHT [in Airships, etc.].—H. Löwy. (*Physik. Zeitschr.*, 1st Oct., 1933, Vol. 34, No. 19, pp. 730–731.)

The writer has previously made use of hysteresis and unstable oscillations in valve circuits, described by Appleton and Van der Pol (*Phil. Mag.*, 1922), to determine the distance of airships from the ground (*Physik. Zeitschr.*, 1925, Vol. 26, p. 649). In the present paper he extends the study to the discovery of the presence of water beneath the airships to a depth of 100 m if the airship is at a height of 250 m above the ground. The phenomenon is due to the change of capacity of the antenna with height above the ground and with the electromagnetic constants of the ground. *See* also Abstracts, 1930, pp. 55–56, and 1933, p. 640, l-h column.

MEASUREMENTS OF DISTANCE FROM A REFLECTING WALL, BY MODULATED TRANSMISSIONS.—R. Hell. (German Pat. 564 802, pub. 3.5.1933: *Hochf: tech. u. Elek: akus.*, Oct., 1933, Vol. 42, No. 4, p. 148.)

DIRECTION FINDER WORKING ON AUDIBLE OR INDICATED MAXIMUM [Maximum Difference of Rectified Signals from Directional and Non-Directional Aerials].—R. Hell. (German Pat. 577 644, pub. 2.6.1933: *Hochf: tech. u. Elek: akus.*, Oct., 1933, Vol. 42, No. 4, p. 148.)

DVL WORK ON AIRCRAFT DIRECTION FINDING.—DVL: Fassbender. (*See* abstract under "Miscellaneous.")

A METHOD OF PROVIDING COURSE AND QUADRANT IDENTIFICATION WITH THE RADIO RANGE BEACON SYSTEM.—F. W. Dunmore. (*Bur. of Stds. Journ. of Res.*, September, 1933, Vol. 11, No. 3, pp. 309–325.)

By cardioid directional identification signals (from the beacon's "transmission-line" aerial system) such as 1 dot in westerly direction, 2 dots in easterly, and so on.

EQUI-SIGNAL GUIDING BEAM BY ALTERNATE KEYING OF PASSIVE DIPOLES ON EITHER SIDE OF EXCITED DIPOLE [as used for Ultra-Short-Wave Aircraft Beacon].—Lorenz Company. (German Pat. 577 350, pub. 30.5.1933: *Hochf: tech. u. Elek: akus.*, Oct., 1933, Vol. 42, No. 4, p. 148.) *See* 1933 Abstracts, p. 162, l-h column.

RADIO BEACONS IN THE SERVICE OF AERIAL NAVIGATION [Survey: including Interlocking Signal, Rotating Field, Variable Speed Rotating Fields (Loth), Aicardi, and Leader Cable Systems].—Mioche. (*Ann. des P.T.T.*, October, 1933, Vol. 22, No. 10, pp. 841–873.)

RADIO-BEACON ORGANISATION ON THE NORTH EUROPEAN COASTS.—G. Meyer. (*Telefunken-Zeit.*, April, 1933, Vol. 14, No. 63, pp. 5–11.)

DESCRIPTION OF THE RADIO APPARATUS FOR RADIO BEACONS AND FOR THEIR RECEPTION BY SHIPS AT SEA.—A. Leib. (*Ibid.*, pp. 11–16.)

ACOUSTICS AND AUDIO-FREQUENCIES

THE ACOUSTIC PROPERTIES OF BROADCASTING STUDIOS.—G. Lubszynski and H. Weigt. (*Hochf: tech. u. Elek: akus.*, October, 1933, Vol. 42, No. 4, pp. 127–135.)

(1) Loudness [comparison of conditions at the microphone and at the ear]: (2) persistence [contrasted with reverberation time, which is of much less importance in practice]: (3) the placing of the microphone: (4) damping: (5) distribution of damping: (6) stationary waves: (7) frequency dependence of damping: (8) types of microphone: (9) practical applications of results to the design of "talks" studios, medium, large and extra large studios.

A TRANSPORTABLE APPARATUS FOR THE MEASUREMENT OF REVERBERATION TIME AND SOUND INTENSITY.—J. Holtsmark and V. Tandberg. (*E.N.T.*, October, 1933, Vol. 10, No. 10, pp. 389–392.)

A return to the principle of the earliest method—the direct measurement of the time taken for the full sound to decrease to a value lower by a definite amount. The new equipment functions as follows:—the sound from the loud speaker is received on a condenser microphone: the voltages are amplified and rectified, and taken to a relay. When the current through the relay reaches a certain value the armature moves over, with the result that (1) the loud speaker is cut off, (2) the amplification is increased by a definite and fixed amount, and (3) a time-measuring instrument is introduced and measures the time till the relay armature falls back. When the sound has decayed so much that the armature is no longer held over even with the increased amplification, the armature falls back and (4) cuts out the timing instrument, (5) restores the amplification to its original lower value, and (6) again starts up the loud speaker; thus the whole cycle begins again.

The time measurement is carried out electrically, by measuring the potential across a condenser charging through a resistance. In the circuit diagram of the whole apparatus, the last two valves on the right, and the circuits between them, constitute this timing circuit: the last valve has only the task of indicating, by its anode-circuit milliammeter, the mean of a number of observations. This same milliammeter is used to measure the sound intensity when the apparatus is converted, by the turning of a switch, into an intensity meter.

REVERBERATION MEASUREMENTS WITH A COMPLETELY AUTOMATIC APPARATUS.—M. J. O. Strutt. (*Rev. d'Acoustique*, January, 1933, Vol. 2, pp. 1–26.) *See* 1932 Abstracts, p. 529.

PERFORATED STEEL SHEETS PASS SOUND WAVES [Optically Reflecting but Sound-Passing Domed Ceiling for Planetarium].—(*Electronics*, August, 1933, Vol. 6, No. 8, pp. 222–223.)

A COMPACT, ALTERNATING-CURRENT OPERATED SPEECH INPUT EQUIPMENT [for Broadcasting: with M.C. Microphone, Copper-Oxide Rectifier for Volume Indication, etc.].—W. L. Black. (*Proc. Inst. Rad. Eng.*, October, 1933, Vol. 21, No. 10, pp. 1409–1418.)

BEAT-FREQUENCY OSCILLATOR: A MAINS-OPERATED INSTRUMENT PRIMARILY DESIGNED FOR TESTING TALKING-PICTURE RECORDING APPARATUS AND COMMERCIAL AMPLIFIER EQUIPMENT.—M. F. Cooper and L. G. Page. (*Wireless Engineer*, September, 1933, Vol. 10, No. 120, pp. 469–476.)

[Two Simple] AUDIO-FREQUENCY VALVE OSCILLATORS FOR THE LABORATORY.—G. R. Todd. (*Journ. Scient. Instr.*, October, 1933, Vol. 10, No. 10, pp. 327–328.)

[Stretched Steel] STRING-CONTROLLED ALTERNATING-CURRENT SOURCE [using Special Carbon-Disc Modulator].—L. H. Stauffer. (*Review Scient. Instr.*, September, 1933, Vol. 4, No. 9, pp. 483–485.)

A MAGNETOSTRICTION FILTER [70 c/s Band with 20 000 c/s Resonant Frequency].—H. H. Hall. (*Proc. Inst. Rad. Eng.*, September, 1933, Vol. 21, No. 9, pp. 1328–1338.)

For use in a harmonic analyser. Monel metal was used: the effects of different heat treatments are discussed, and the design of coils and shields. A single rod, supported at its mid-point, gave a band about 70 c/s wide, 30 db up from the minimum: two rods in series, coupled by a valve, gave a curve of the same width as much as 60 db up from the minimum.

A SIMPLE FREQUENCY BRIDGE.—Davies. (*See* under "Measurements and Standards," p. 48.)

ELECTRICAL METHODS FOR THE PRODUCTION AND MEASUREMENT OF MUSICAL FREQUENCIES [particularly the Use of the "Robinson" Bridge].—P. Nicolas. (*Sci. Abstracts, Sec. A*, September, 1933, Vol. 36, No. 429, p. 1029.)

A PHONIC MOTOR [for Frequencies up to 7 500 c/s].—Ikebe. (*See* under "Subsidiary Apparatus and Materials," p. 52.)

ANALYSIS AND STUDY OF MACHINE NOISES.—J. F. Bouscasse. (*Sci. Abstracts, Sec. A*, August, 1933, Vol. 36, No. 428, pp. 909–910.)

THE VOLTAGE-TRANSFORMER IN THE L.F. AMPLIFIER [Input and Inter-Stage Transformers]. R. Gürtler. (*Telefunken-Zeit.*, April, 1933, Vol. 14, No. 63, pp. 29–53.)

Author's summary:—Voltage transformers ("grid" transformers), which in a l.f. amplifier have to amplify a broad frequency band, can be represented, as is well known, by three equivalent circuits: (1) at low frequencies, as an open-circuited transformer, (2) at medium frequencies as a parallel-resonance connection and (3) at high frequencies as a series resonance connection, of the leakage inductance and transformer- and valve-capacities. From these equivalent circuits equations are derived showing the relation between the constants of the amplifier stage and of the transformer on one hand, and the linear (amplitude) distortions on the other. These equations are suitable both for the design calculation and the analysis of transformer stages. The most important formulae are reproduced in curve tables for practical use.

Certain special cases are also dealt with: transformer stages with series grid resistance, frequency curves without peaks (without positive linear distortions) and with very high peaks. It is shown that for a given stage and a given permissible distortion at the upper and lower limits of frequency, there is an (electrically) optimum transformer with minimum primary inductance and maximum turns ratio (and therefore maximum voltage magnification). The design equations for such an optimum transformer are derived, and a typical design calculation worked out. As an example, the analysis of a measured frequency curve is then given; the satisfactory agreement between calculation and measurement demonstrates the usefulness of the equations and curve tables contained in the paper.

DISTORTION CANCELLATION IN AUDIO AMPLIFIERS [Input and Output connected through High Resistance: Voltage between Point on this and "Earthy" Point amplified and fed back to Input Circuit].—W. Baggally. (*Wireless Engineer*, August, 1933, Vol. 10, No. 119, pp. 413–419.)

THE ACOUSTICAL PERFORAMNCE OF A CONE-TYPE [Inductor Dynamic] LOUD SPEAKER.—D. A. Oliver: GEC. (*Wireless Engineer*, August, 1933, Vol. 10, No. 119, pp. 420–429.) An investigation on the lines discussed in a previous paper (1931 Abstracts, p. 101).

A PIEZOELECTRIC LOUD SPEAKER FOR THE HIGHER AUDIO FREQUENCIES [using Sawyer's "Bimorph" Rochelle Salt Units: for Composite Reproducing Systems].—S. Ballantine: Sawyer. (*Proc. Inst. Rad. Eng.*, October, 1933, Vol. 21, No. 10, pp. 1399–1408.) For Sawyer's work *see* Abstracts, 1932, p. 101, and 1933, p. 332.

LOUD SPEAKER WITH AUXILIARY WINDING IN SERIES WITH M.C. AND CLOSELY COUPLED TO FIELD WINDING: TO ELIMINATE MAINS NOISES.—Magnavox Company. (U.S.A. Pat. 1 901 331, pub. 14.3.1933: *Hochf: tech. u. Elek:akus.*, September, 1933, Vol. 42, No. 3, p. 112.)

APPLICATION OF KENNELLY'S METHOD TO ELECTRODYNAMIC LOUD SPEAKERS.—G. le Guen. (*Sci. Abstracts, Sec. A*, August, 1933, Vol. 36, No. 428, p. 909.)

A NEW ALTERNATION PHONOMETER [for Studying Conditions for Apparent Equality of Loud Speaker Output, etc.: Analogous to Flicker Photometer].—H. P. Knauss and F. E. Hale. (*Review Scient. Instr.*, August, 1933, Vol. 4, No. 8, pp. 447–448.)

THE GREAT TELEFUNKEN LOUD SPEAKER EQUIPMENT ON THE TEMPELHOFER FIELD, BERLIN [for a Crowd of 1½–2 Millions].—(*Telefunken-Zeit.*, April, 1933, Vol. 14, No. 63, pp. 53–55.)

LOUD SPEAKER COST *versus* QUALITY [Comparison of 5″ and 12″ Types].—H. S. Knowles. (*Electronics*, September, 1933, pp. 240–242, 256 and 260.) *See* also 1933 Abstracts, p. 447, l-h column, "Back to Quality . . .".

AN ARTIFICIAL EAR FOR RECEIVER TESTING: AN ARTIFICIAL VOICE FOR TRANSMISSION STUDIES.—F. L. Crutchfield: E. W. Holman. (*Bell Lab. Record*, November, 1933, Vol. 12, No. 3, pp. 81–84: 85–88.)

RECENT DEVELOPMENTS IN HEADPHONE DESIGN. PART 2 [Ribbon and M.C. Types].—F. M. Colebrook. (*World-Radio*, 20th and 27th October, 1933, Vol. 17, Nos. 430 and 431, pp. 505, 507 and 542–543.)

A NEW CONDENSER MICROPHONE FOR MEASURING AND RECORDING.—von Ardenne Laboratory. (*Hochf:tech. u. Elek:akus.*, April, 1933, Vol. 41, No. 4, p. 152.)

ELECTROSTATIC MICROPHONE WITH SOLID ELECTRODE WITH NUMEROUS HOLES OF SUCH DEPTH THAT THE AIR COLUMNS HAVE A FREQUENCY ABOVE 10 000 CYCLES/SECOND.—G. Neumann. (German Pat. 574 428, pub. 12.4.1933: *Hochf:tech. u. Elek:akus.*, September, 1933, Vol. 42, No. 3, p. 112.)

THE CALIBRATION OF ELECTROSTATIC MICROPHONES.—(*Génie Civil*, 16th Sept., 1933, Vol. 103, No. 12, 288: summary only.)

THE CONDENSER MICROPHONE [Equivalent Circuits: Mathematical Theory of Sensitivity, etc.: Experimental Confirmation].—K. Kobayasi. (*Rep. of Rad. Res. in Japan*, September, 1933, Vol. 3, No. 2, pp. 194–207.)

NON-LINEAR DISTORTIONS OF [Carbon] MICROPHONES.—H. J. von Braunmühl and W. Weber. (*E.T.Z.*, 2nd Nov., 1933, Vol. 54, No. 44, pp. 1068–1070.)

The tests here described lead to the conclusion that, for a description of the performance and the judging of the merit of a microphone, it is not sufficient to give the strength of the combination tones for a few arbitrary primary frequencies: the non-linearity must be known over the complete range of frequencies and intensities.

THE PRESENT POSITION OF HOME-RECORDING OF GRAMOPHONE RECORDS.—H. Kluth. (*Funktech. Monatshefte*, September, 1933, No. 9, pp. 351–354.)

"SOUND HANDWRITING" [Synthetic Sound].—W. Saraga: Pfenniger: Fischinger. (*Funktech. Monatshefte*, October, 1933, No. 10, pp. 403–406.) *See* also 1933 Abstracts, p. 332 (two).

AEF PROVISIONAL RESOLUTIONS ON ACOUSTICAL TERMS AND DEFINITIONS.—(*E.T.Z.*, 10th August, 1933, Vol. 54, No. 32, pp. 783–784.)

Including definitions of "Reflexionsgrad," "Schluckgrad" (degree of "swallowing-up"), "Absorptionsgrad" and "Durchlassgrad." These are respectively the ratios of the *reflected* sound energy, the energy *not returned*, the *absorbed* energy, and the *transmitted* energy, all to the incident energy.

CONTRIBUTIONS TO THE THEORY OF OLD AND NEW TYPES OF PIANO [particularly the Sound Qualities given by various Hammer Actions, including the "Micro-Hammers" used in the Neo-Bechstein].—S. Sawade: Nernst. (*Zeitschr. f. tech. Phys.*, No. 9, Vol. 14, 1933, pp. 353–362.)

PHOTOTELEGRAPHY AND TELEVISION

THE SERIOUSNESS OF HALATION [Lichthofstörung] IN CATHODE-RAY TUBES, AND ITS ELIMINATION.—M. von Ardenne. (*Hochf:tech. u. Elek:akus.*, October, 1933, Vol. 42, No. 4, pp. 113–115.)

The halation round the luminous spot on the usual fluorescent screen is a purely optical effect due to total reflection at the glass/air surface of separation. Its effect in television is very serious: the writer shows that in an ordinary tube it may limit the obtainable contrast to a ratio 1 : 2 or 1 : 3 at best. Two principles for overcoming the difficulty are discussed: to make the circle of halation so small that it is practically of the same size as the spot itself, and to make it larger than the useful part of the screen. Dealing first with the second plan, the writer points out that for a glass/air surface the limiting angle for total reflection is about 45°, so that the radius of halation is about twice the thickness of the glass wall; thus to make the halation diameter equal to the usual screen diameter would involve the use of a wall about 4 cm thick. Such a wall of glass would hardly be practicable, but the ordinary wall could be thickened externally by a layer of liquid of about the same refractive index as glass, the final outer wall being again of thin glass (Fig. 3).

The first plan, to make the halation very small in diameter, is impossible where the fluorescent material is fused deep into the glass or spread with the usual binding material: a modern spot is of the order of 0.5 to 1.0 mm, and therefore a wall thickness of about 0.1 mm would be necessary, which would not stand atmospheric pressure. This difficulty can be overcome by depositing the screen not on the glass wall, but on a very thin transparent carrier (*e.g.* a mica disc) close to, but separated from, the glass wall. Old methods of using such a separate screen carrier gave a gap of several mm and produced distortions due to slight flaws in the glass wall: it was, indeed, for this reason that in recent tubes the screen has been deposited on the glass itself. But by making the gap very small, only just large enough to prevent actual contact, this trouble is avoided and halation overcome (Fig. 4). Such a method is not only more practical than that of Fig. 3 but is also optically superior, since the light ray after passing through the wall takes up its original line, so that a much higher percentage of the total luminous output reaches the aperture of an external lens.

A "compromise solution" of the halation difficulty is given by keeping the fluorescent particles to the surface of the glass wall instead of fusing them into it (*cf.* Figs 5a and b). For many purposes sufficient freedom from halation is given by depositing the particles "loosely" on the surface of a thin binding layer with a refractive index as small as possible: this plan has for some years been used in the writer's television receiver tubes. Finally, halation troubles can be avoided by making the screen transparent: in this case the light totally reflected from the glass/air surface either penetrates the screen or is again totally reflected by it, and in the latter case (if the screen refractive index is suitably chosen) is prevented, by multiple total reflections, from producing halation trouble. Unluckily up to the present no transparent screen (*e.g.* uranium glass) of high efficiency has been found. The writer concludes by pointing out that the troubles discussed do not exist, or can always be overcome, in screens which are viewed directly: thus screens deposited on metal are completely free from halation (*see* next two abstracts).

A NEW HIGH-EFFIC CY CATHODE-RAY TUBE: APPLICATION A PROJECTING OSCILLOGRAPH [Sh ay Path to avoid Electron "Stray ses": Conducting Screen conne Anode, to avoid Loss of unting Screen for Frontal and Projection].—M. von *Wireless Engineer*, November, Vel, No. 122, pp. 592–595.)

Ç IN THE FIELD OF CATHODE- PMENTS FOR MEASURING PUR- TELEVISION.—M. von Ardenne. . *Monatshefte*, September, 1933, 333–340.)

n of deflection due to earth's by slight magnetisation of the anode rode of magnetic material): elimina- -point error" (thus removing one of ms of the high-vacuum tube in com- gas-concentrated tubes): cathode y use of platinum as carrier, and design give very sharply defined spot: a new ket tube (Figs. 2, 3 and 4): new tubes for al observation and projection without dis- ortion (*see* two preceding abstracts): etc., etc.

"LINE MODULATION" [Thun Variable Spot-Speed Modulation Method] IN TELEVISION.—(*Funk-Magazin*, August, 1933, Vol. 6, No. 8, pp. 521–525.) *See* also von Ardenne, 1933 Abstracts, pp. 46–47.

NOTES ON TELEVISION DEFINITION [Number of Lines needed for Various Scenes under Various Conditions].—W. H. Wenstrom. (*Proc. Inst. Rad. Eng.*, September, 1933, Vol. 21, No. 9, pp. 1317–1327.)

Using Gannett's method of analysis (1931 Abstracts, p. 331, r-h col.) extended to higher orders of definition and to more comprehensive scenes. Among the conclusions arrived at are:—80–120-line two-way telephone television is now technically possible and adequate for the purpose: this applies also to 120–200-line theatre projection of electrically transmitted news films. 400–800-line theatre television, equivalent to the standard cinema, appears to be a practical impossibility at present: this applies also to 200–400-line home television, suitable for continued universal entertainment, though 120-line home television appears technically possible now for short ranges, and gives fair to good results for faces, small groups, etc.

TELEVISION TRANSMISSION OVER A LIGHT BEAM AT BRITISH ASSOCIATION MEETING.—Marconi Company. (*Electrician*, 8th Sept., 1933, Vol. 111, No. 2884, p. 299.)

TELEVISION PROGRESS.—(*Wireless World*, 6th and 13th October, 1933, Vol. 33, pp. 288–290 and 302–304.)

TELEVISION AT THE BERLIN RADIO EXHIBITION, 1933.—G. Kette. (*Funktech. Monatshefte*, October, 1933, No. 10, Supp. pp. 53–61.)

THE FERNSEH COMPANY'S CONTINUOUSLY WORKING INTERMEDIATE-FILM TELEVISION PROJECTION RECEIVER FOR 3×4-METRE PICTURES. —G. Schubert. (*Ibid.*, pp. 62–63.)

NOISE AS A LIMITING FACTOR IN AMPLIFIER DESIGN.—O. E. Keall. (*Marconi Review*, Sept./Oct., 1933, No. 44, pp. 5–12.)

Completion of the paper dealt with in 1933 Abstracts, p. 631, l-h column. Measurements on a 10 c/s–100 kc/s television amplifier are included, and there is a long appendix on the shot effect.

THE KERR CELL AND ITS APPLICATION TO TELEVISION [and the Marconi Company's Multiple Kerr Cell and Optical System for Projector Receiver].—N. Levin. (*Marconi Review*, Sept./Oct., 1933, No. 44, pp. 13–21.) Further development of the system referred to in 1933 Abstracts, p. 573, l-h column.

KERR CELL BIASED BY DOUBLY REFRACTING MICA SCREEN.—Hoyer: Pungs and Vogler. (*See* under "Measurements and Standards.")

IMPROVED KERR CELL FOR PROLONGED WORKING. —T. W. Case. (French Pat. 748 285, pub. 1.7.1933: *Rev. Gén. de l'Élec.*, 28th Oct., 1933, Vol. 34, No. 17, p. 133 D.)

THE CRYSTAL CELL.—E. H. Traub: von Okolicsanyi. (*Wireless World*, 20th Oct., 1933, Vol. 33, pp. 323–324.)

Description of the new zinc sulphide crystal light modulator which has been developed for television purposes by von Okolicsanyi (1933 Abstracts, p. 630, r-h col.). A summary of its advantages over the ordinary nitro-benzol Kerr cell is also given.

NOTE ON NEW METHODS TO MODULATE LIGHT.—G. Wataghin and R. Deaglio. (*Proc. Inst. Rad. Eng.*, October, 1933, Vol. 21, No. 10, pp. 1495–1496.) *See* 1933 Abstracts, p. 106.

GAS DISCHARGE TUBES AND THEIR APPLICATION TO TELEVISION: WITH DISCUSSION.—N. L. Harris: GEC. (*Journ. Television Soc.*, March, 1933, Series 2, Vol. 1, Part 7, pp. 217–226.) The full paper, a summary of which was referred to in 1933 Abstracts, p. 278, r-h column.

TRANSMISSION OF LIGHT BY A FLEXIBLE UNIT OF QUARTZ.—H. Dejust and E. Perrin. (*Sci. Abstracts, Sec. A*, July, 1933, Vol. 36, No. 427, p. 793.)

INVESTIGATIONS ON CUPROUS OXIDE PHOTOCELLS. A CONTRIBUTION TO THE PROBLEM OF THE BARRIER-LAYER PHOTOELECTRIC EFFECT.—W. Bulian. (*Physik. Zeitschr.*, 15th Oct., 1933, Vol. 34, No. 20, pp. 745–756.)

Author's summary:—The factors to be considered in the use of cuprous oxide photocells for practical measurements (spectral sensitivity, maximum efficiency factor and temperature dependence) are discussed and investigated. The nature of the metal of the electrode from which the current is taken has no influence on the position of the selective maximum of the effect. Gold-sputtered cells are used to show that the direction of the photoelectric current depends on the wavelength of the incident light. The most favourable thickness of the copper oxide layer for an optimum current yield is found to be 0.1 mm for all wavelengths in the visible spectrum. It is possible to exert an arbitrary influence on the temperature characteristic of the photoelectric current by choosing different metals for the electrode. Complete independence of the temperature may be attained in a wide range of temperature.

PREDICTION OF THE PHOTOELECTRIC POWER OF CERTAIN BODIES FROM THE STRUCTURAL NUMBER ATTACHED TO THE FORMULA OF THESE BODIES.—H. Spindler and R. Coustal. (*Comptes Rendus*, 30th Oct., 1933, Vol. 197, No. 18, pp. 982–984.)

In spite of the similar natures of CuCl, CuBr and CuI, only the second displays a clear photoelectric effect analogous to that of Cu_2O in the usual copper/copper-oxide cell. This result is explained by the writers according to Spindler's table of elements, resembling the periodic table, but with atomic indices quite different from the atomic numbers. The CuBr cell has a sensitivity about three-fifths of that of a good Cu_2O cell of the same size, but deteriorates under prolonged action of light.

BARRIER-LAYER PHOTOELECTRIC EFFECT AND EINSTEIN'S RELATION.—F. von Körösy and P. Selényi. (*Physik. Zeitschr.*, 15th Sept., 1933, Vol. 34, No. 18, pp. 716–718.)

The writers have previously found that differently coloured illuminations produce different effects on barrier-layer photoelectric cells (Abstracts, 1932, pp. 231–232 and 469). Other writers have not found this (Goldmann and Lukasiewitsch, 1933, pp. 220–221 and 221 : Gleason, 1933, p. 47, l-h column). In this note the writers discuss the conditions under which the effect is to be expected.

LOW-RESISTANCE SELENIUM PHOTOCELL : VERY THIN METALLIC AND INSULATING RIBBONS WOUND AND DIPPED IN SHELLAC, ONE EDGE THEN POLISHED.—C. Chilowsky. (French Pat. 747 791, pub. 23.6.1933 : *Rev. Gén. de l'Élec.*, 30th Sept., 1933, Vol. 34, No. 13, p. 103 D.)

CONTRIBUTIONS TO THE CRYSTAL PHOTOELECTRIC EFFECT [Preliminary Communication].—G. Mönch. (*Naturwiss.*, 20th Oct., 1933, Vol. 21, No. 42, pp. 751–752.)

The writer did not observe the crystal photoelectric effect with artificial, glass-clear single crystals of cuprous oxide. All natural substances investigated in which the crystal photoelectric effect was observed, with the exception of cinnabar, had the negative pole for the thermo-element, while with artificially treated substances the positive pole was the warm one.

REMARK ON THE PAPER BY R. DEAGLIO : "PHOTOELECTRIC EFFECT IN SINGLE CRYSTALS OF CUPRITE."—G. Mönch and R. Stühler : Deaglio. (*Zeitschr. f. Physik*, 1933, Vol. 85, No. 1/2, pp. 131–134.)

For Deaglio's paper *see* 1933 Abstracts, p. 573, r-h col. Also *cf.* Joffé, *ibid.*, just above, and the back references there given ; also Nasledow and Nemenow, *ibid.*, p. 400. The writers of the present note have made experiments on the variation with time of the magnitude of the crystal photoelectric effect in single crystals of cuprite ; these do not agree with Deaglio's result, that crystals become electrolytic conductors under ...on of light.

THE ELECTRICAL CONDUCTIVI... CRYSTALS [for Photoelectric...]—W. Lehfeldt. (*Zeitschr.* ... Vol. 85, No. 11/12, pp. 717...

MEASUREMENTS ON CONTACT POTE... ENCE BETWEEN DIFFERENT... COPPER SINGLE CRYSTALS.—B... (*Phys. Review.*, 1st Oct., 1933, Vol. 44, No. 7, pp. 585–588.) Farnsworth and Rose, 1933 Abstract...

THE GLOW-DISCHARGE LAMP AS A PHOTOELECTRIC CELL.—K. Mahlmann. (*Radio, B., F. Alle*, November, 1933, pp. 502–506.)

PHOTOCELLS IN THEIR TECHNICAL FIELDS OF APPLICATION, *and* INDUSTRIAL PLANTS USING PHOTOCELLS.—L. Weisglass : H. Keller. (*Funk-Magazin*, August, 1933, Vol. 6, No. 8, pp. 486–491 : 492–498.)

The first paper includes a description of the Geiger ion-counter provided with a photosensitive layer (Rajewsky, 1931 Abstracts, p. 276, l-h col.), and used as a light detector with a sensitivity 10 000 times as great as that of the eye.

COMBINED PHOTO AND AMPLIFIER TUBES.—H. A. McIlvaine. (*Electronics*, August, 1933, Vol. 6, No. 8, p. 224.)

REMARK ON THE PAPER BY J. H. DE BOER AND M. C. TEVES : THERMAL AND PHOTOELECTRIC EMISSION FROM CAESIUM/CAESIUM-OXIDE CATHODES AND THE INFLUENCE EXERTED BY INCLUSION OF CAESIUM ATOMS IN THE DIELECTRIC [and a New Method of Manufacture].—Görlich. (*See* under "Valves and Thermionics," p. 41.)

GENERAL PROPERTIES OF PHOTOELECTRIC CATHODES [Survey, including Recent Types of Photocell : with Characteristic Curves].—G. Déjardin. (*Rev. Gén. de l'Élec.*, 21st and 28th Oct., 4th and 11th Nov., 1933, Vol. 34, Nos. 16, 17, 18 and 19, pp. 515–526, 555–566, 591–607 and 629–637.)

THE CAESIUM-OXYGEN-SILVER PHOTOELECTRIC CELL [Properties and Method of Manufacture].—M. J. Kelly. (*Bell Lab. Record*, October, 1933, Vol. 12, No. 2, pp. 34–39.)

MEASUREMENTS AND STANDARDS

THE VISUAL RECORDING OF RESONANCE CURVES [of Broadcast Receiver Circuits or Complete Amplifiers].—G. Ulbricht : Schuck. (*Hochf: tech. u. Elek:akus.*, October, 1933, Vol. 42, No. 4, pp. 135–137.)

The writer first gives an outline of the RCA-Victor apparatus described by Schuck (1933 Abstracts, p. 39, l-h col.) : this may employ an oscillograph, though the writer indicates that in Germany it is more usual to rely on maximum meter readings. He considers the equipment rather complicated and expensive, and goes on to describe a simpler arrangement employing a cathode-ray oscillograph without the usual elaborate relaxation-oscillation time base. This latter device is only necessary when the frequency-controlling rotating condenser varies its capacity in proportion to time, so that to obtain stationary images a time-proportional horizontal-axis deflection is required. By driving the rotating condenser by a synchronous motor, and by suitably designing the shape of its rotating plates so that the capacity varies sinusoidally with time, the writer is able to use the 50 c/s mains voltage to provide the horizontal deflection. Or a rotary converter driven off d.c. mains may have the "sine-wave" condenser plates mounted on its axis, while it also provides the sinusoidal voltage for the horizontal deflection.

THE DELINEATION OF RESONANCE CURVES BY A MIRROR OSCILLOGRAPH AND A SECOND MIRROR MOUNTED ON THE SPINDLE OF THE VARIABLE CONDENSER OR VARIOMETER.—A. Meir and R. Hinkelmann. (*E.T.Z.*, 26th Oct., 1933, Vol. 54, No. 43, pp. 1051–1052.)

A CONTINUOUS [Mains-Driven] RECORDER OF RADIO FIELD INTENSITIES.—K. A. Norton and S. E. Reymer. (*Bur. of Stds. Journ. of Res.*, September, 1933, Vol. 11, No. 3, pp. 373–378.)

Using a potentiometer recorder (Brown, or Leeds and Northrup) in a bridge circuit, to record the plate resistance of the first valve in the i.f. amplifier of a superheterodyne receiver with AVC. To eliminate variations due to power-supply voltage fluctuations, one of the three bridge-arm resistances is the plate resistance of a similar valve. Some specimen results on broadcast transmissions are given. The paper was read at the 1933 URSI Meeting.

FIELD-STRENGTH MEASURING [and the B.B.C. "Counting Recorder" giving Total Time during which Signal Strength exceeds Each of Ten Predetermined Values].—(*World-Radio*, 6th October, 1933, Vol. 17, No. 428, pp. 433–434.)

[Long-Distance] FIELD-STRENGTH MEASUREMENTS AND DIRECTIONAL OBSERVATIONS OF SHORT WAVES.—Nakai: Tsukada. (*See* under "Directional Wireless.")

PIEZOELECTRIC OSCILLATOR, PIERCE'S CIRCUIT [Linear Theory, and Practical Discrepancies due to Grid/Cathode Capacity Variations produced by Space Charge].—K. Heegner. (*E.N.T.*, Sept., 1933, Vol. 10, No. 9, pp. 357–371.)

"To sum up it can be stated that for a Pierce oscillator, according to the linear theory, a valve of steep slope and small penetration coefficient is desirable. But the steeper the slope the more marked is the grid/cathode capacity variation produced by the space charges in the valve. Loose coupling between anode circuit and grid circuit improves, to a limited extent only, the dependence of the frequency on the tuning of the anode circuit [under some conditions a reduction of the anode/grid capacity may actually cause a deterioration of frequency constancy, and a certain strength of coupling is necessary to counteract the effect of small changes in the damping of the crystal on the amplitude of the vibrations].

It still remains to design an oscillator which shall possess a definite frequency independent of the electrode capacities and valve emission and independent also of the crystal damping." *See* also next abstract.

NEW TEMPERATURE-COMPENSATED QUARTZ OSCILLATORS [with Temperature Indicating and Regulating Coils inside the Evacuated Container].—R. Bechmann: Telefunken Company. (*E.N.T.*, September, 1933, Vol. 10, No. 9, pp. 371–376.)

The oscillators here described are of the type used in the Langenberg broadcasting station (Semm, 1933 Abstracts, p. 54, l-h col.) The writer shows first that the ordinary Pierce oscillator circuit is subject to frequency fluctuations, due to small voltage changes, which can be kept down to below 2×10^{-6}. In the Heegner two-valve circuit (Fig. 3) a frequency is excited for which the crystal has a minimum resistance, and the effects of capacities parallel to the crystal are eliminated (Telefunken Pat., 1933 Abstracts, p. 576, l-h col.); but even this circuit is subject to the above-mentioned variations. The dependence on anode voltage, however, is decreased by keeping the oscillator damping low; for this reason, among others, the quartz container is evacuated. Frequency fluctuations due to vibration or jars are reduced below 2×10^{-7} by the stable method of mounting the quartz plate. By means of the special thermostatic arrangement surrounding the crystal and inside the container (Telefunken and Bechmann, 1933 Abstracts, p. 280, l-h col.) and the bridge and amplifier circuits with which it combines to give continuous regulation, the temperature is kept constant within about 1/20°C. "By special measures not dealt with here the temperature constancy can be made appreciably greater even than this." With the usual type of crystal, cut perpendicular to the electrical axis, and having a temperature coefficient of 20×10^{-6} per 1°C, this regulation gives a constancy better than 1×10^{-6}.

PIEZOELECTRIC CRYSTAL MOUNTING WITH TEMPERATURE COMPENSATION [Electrodes held apart by Ring of Greater Expansion Coefficient].—Bechmann and Osnos. (German Pat. 574 456, pub. 18.4.1933: *Hochf:tech. u. Elek:akus.*, September, 1933, Vol. 42, No. 3, p. 111.)

PIEZOELECTRIC QUARTZ OSCILLATORS WITH ARBITRARY TEMPERATURE COEFFICIENTS, IN PARTICULAR ZERO.—R. Bechmann. (*Naturwiss.*, 20th Oct., 1933, Vol. 21, No. 42, p. 752.)

The oscillators are cut with calculable angles of inclination of the normals to the surfaces to the optical axis of the crystal.

ON TOURMALINE OSCILLATORS.—S. Matsumura and S. Ishikawa. (*Rep. of Rad. Res. in Japan*, June, 1933, Vol. 3, No. 1, pp. 1–5: in English.)

"For high-frequency use it is best to cut a thin plate so that its surfaces shall be perpendicular to the optic axis, and to apply the alternating electric field along the *Z*-axis." In this case, resonance oscillation will occur with longitudinal mode of vibration, its frequency being given by $f = 1/2 l_z \cdot \sqrt{c_{33}/\rho}$, where l_z and c_{33} are the length and the adiabatic elastic constant in the direction of the Z-axis, and ρ is the density (*cf.* Koga, 1933 Abstracts, p. 50). "The physical properties of the tourmaline may differ slightly with the variety of the crystal. Although their numerical values as a whole cannot be given here, if we take $c_{33} = 160.63 \times 10^{10}$ dynes/cm² and $\rho = 3.12$, the wave constant, that is the ratio of the wavelength in metres to the thickness in millimetres, may be found from the above formula to be about 83.62 m/mm, which is smaller than that of the X-wave in X-cut quartz plates."

With a 7-metre push-pull oscillator (crystal between the grids) the frequency variation with change of filament voltage from 3.6 to 6 v, or change of plate voltage from 150 to 90 v, was within the order of 0.001%. The frequency changes slightly with the capacity of the tuning circuit, the variation increasing as the capacity gets large. The frequency also varies (by about -32×10^{-5}) when a condenser introduced in parallel with the crystal is increased from 6 to 13 $\mu\mu$F: the amplitude decreases simultaneously. Care must therefore be taken to avoid unnecessary capacity here. The temperature coefficient is -0.004% between 20° and 48°C. *See* also 1933 Abstracts, p. 514, r-h column—two.

FREQUENCY STANDARDISATION BY INTERNATIONAL COMPARISON.—A. Wainberg. (*Sci. Abstracts, Sec. B*, September, 1933, Vol. 36, No. 429, p. 587.)

A PRECISION METHOD OF ABSOLUTE FREQUENCY MEASUREMENT.—H. Kono. (*Rep. of Rad. Res. in Japan*, September, 1933, Vol. 3, No. 2, pp. 127–136.) The full paper, in English, a summary of which was referred to in 1933 Abstracts, p. 49, r-h column.

A SIMPLE FREQUENCY BRIDGE [Modified Hughes Balance].—R. M. Davies. (*Journ. Scient. Instr.*, September. 1933, Vol. 10, No. 9, pp. 274–276.)

Author's abstract:—It is shown that a simple modification of the well-known Hughes balance leads to a useful frequency bridge, which, under certain conditions, can be balanced by a single adjustment. The bridge was tested against a phonic motor, and the results obtained are within the limits of accuracy of the apparatus, namely 1 part in 1 000.

AUTOMATIC TEMPERATURE COMPENSATION FOR THE ["Micrometer"] FREQUENCY METER.—G. F. Lampkin. (*QST*, October, 1933, Vol. 17, No. 10, pp. 16–19, 58 and 60.)

B-BATTERY-LESS OSCILLATORS FOR USE WITH HETERODYNE WAVEMETERS. — Ishikawa. (*See* abstract under "Transmission.")

MODULATED PENTODE OSCILLATOR.—(*Wireless World*, 25th August, 1933, Vol. 33, p. 183.)

ULTRA-SHORT WAVES: 60 CM ZERO-SHUNT CIRCUIT—NEW METHODS FOR MEASUREMENT—CONTROL BY RADIOMETRIC CONDENSERS AND INDUCTANCES.—G. G. Blake. (*Electrician*, 8th Sept., 1933, Vol. 111, No. 2884, pp. 279–280.)

The zero-shunt circuit referred to is a modification of that used by Dowling in his ultra-micrometer: the galvanometer is in the anode circuit of a retarding-field micro-wave generator, and an opposing e.m.f. is derived from a potentiometer across the filament battery instead of from the additional battery used by Dowling. The writer's method of measuring the micro-waves is to set up stationary waves between the dipole and a reflecting sheet of metal, and to explore the field with a mounted resonator rod: as this passes from antinode to antinode, large galvanometer deflections occur in a very sharply defined way, and the wavelength is found by measuring the intervals. The potential antinodes can also be indicated by a loud-speaking telephone connected across an adjustable voltage-regulating resistance inserted, for instance, in the positive h.t. lead to the grid. The writer goes on to describe the use of various types of radiometric condensers and inductances (using a mercury thermometer or thermostatic bimetal strip) which can be placed close to the oscillating dipole. Heat radiations then have the effect of gradually throwing the resonator into tune, producing a maximum of galvanometer deflection.

RADIATION RESISTANCE OF CONCENTRIC-CONDUCTOR TRANSMISSION LINES [and Comparison with Parallel Lecher Wires: for use in Micro-Wave Oscillator Circuits].—Whitmer. (*See* under "Transmission.")

AN EXTENSION OF A MAXWELL MUTUAL-INDUCTANCE FORMULA TO APPLY TO THICK SOLENOIDS.—H. B. Dwight and S. H. Chen. (*Physics*, September, 1933, Vol. 4, No. 9, pp. 323–326.)

THE HIGH-FREQUENCY MAGNETIC FIELD OF A FLAT SPIRAL COIL [compared with the D.C. Field].—S. Githens, Jr., and O. Stuhlman, Jr. (*Review Scient. Instr.*, October, 1933, Vol. 4, No. 10, pp. 542–545.) Extension of the work dealt with in 1933 Abstracts, p. 35, l-h column.

A QUASI-STATIONARY CALCULATION OF THE NATURAL WAVELENGTHS OF SINGLE-LAYER FLAT AND CYLINDRICAL COILS.—H. Zuhrt. (*Archiv f. Elektrot.*, 4th Oct. 1933, Vol. 27, No. 10, pp. 729–742.)

Completion of the paper referred to in Nov. Abstracts, p. 633, r-h col.

SELF-INDUCTANCE IN THE CASE OF DISTORTION OF THE CONDUCTING CIRCUIT. — R. Rühle: Dunton. (*E.T.Z.*, 17th and 31st Aug., 1933, Vol. 54, Nos. 33 and 35, pp. 796–798 and 843–845.)

NOTE ON A MODIFIED REACTANCE/FREQUENCY CHART [modified by Addition of Inverted Scale graduated in Micromhos for reading Susceptances].—J. R. Tolmie. (*Proc. Inst. Rad. Eng.*, September, 1933, Vol. 21, No. 9, pp. 1364–1366.)

MEASURING INDUCTANCE WITH A RESISTOR [Owen Bridge, with Resistance in One Ratio Arm and Capacitance in the Other, brought into Commercial Use by Design of Reactance independent of Frequency and by Screening Scheme]. — T. Slonczewski. (*Bell Lab. Record*, November, 1933, Vol. 12, No. 3, pp. 77–80.)

THE MEASUREMENT OF VERY SMALL INDUCTANCES [0.1 Microhenry, with Inaccuracy not exceeding ½%, in spite of presence of Resistances as high as 4 or 5 Ohms: Substitution Method, using 25 Mc/s Frequency].—C. L. Fortescue. (*Journ. Scient. Instr.*, October, 1933, Vol. 10, No. 10, pp. 301–305.)

ON A METHOD OF DETERMINING THE COEFFICIENT OF MUTUAL INDUCTION, MEASURED AS SELF-INDUCTION.—L. M. Chatterjee. (*Physik. Zeitschr.*, 15th Sept., 1933, Vol. 34, No. 18, pp. 711–712.)

The principle of the method here shortly described is that the primary coil is connected in a bridge and its (*a*) inductance and (*b*) resistance are measured with the secondary coil (1) open and (2) short-circuited. The secondary coil is then connected in the bridge and the process repeated with the primary coil in the place of the secondary. The mutual induction may then be deduced.

A METHOD OF MEASURING THE SELF-CAPACITANCE OF COILS [Only Reading needed being a Capacitance Difference three times as great as Required Capacitance].—M. G. Scroggie. (*Wireless Engineer*, September, 1933, Vol. 10, No. 120, pp. 477–479.)

A NEW CAPACITY-METER.—W. L. Beck. (*Proc. Phys. Soc.*, 1st Nov., 1933, Vol. 45, Pt. 6, No. 251, pp. 765–767.)

The measurement of capacity is based on the comparison of the impedance of the condenser under test with a calibrated standard impedance in a differential rectifier circuit, of which a description is given; the balance is indicated by a d.c. galvanometer. The meter simplifies the comparison of capacities over a wide range of values.

A DIRECT-READING CAPACITY METER [suitable for Rapid Routine Testing: Fleming Commutator Principle, but using Vibrator Contact].—D. C. Gall. (*Journ. Scient. Instr.*, October, 1933. Vol. 10, No. 10, pp. 326–327.)

CALCULATION OF THE CAPACITY OF A CIRCULAR PLATE CONDENSER WHOSE PLATES ARE INCLINED AT AN ANGLE TO ONE ANOTHER.—H. Nitka. (*Zeitschr. f. Physik*, 1933, Vol. 85, No. 7/8, pp. 504–510.)

A NEW RADIO-FREQUENCY PHASE METER [Original Voltages heterodyned to Convenient Audio-Frequencies for Phase Measurement: of Higher Accuracy than Cathode-Ray Oscillograph].—R. R. Law. (*Review Scient. Instr.*, October, 1933, Vol. 4, No. 10, pp. 537–539.)

A NEW CIRCUIT ARRANGEMENT IN THE USE OF THE WHEATSTONE BRIDGE.—E. Hasché. (*Physik. Zeitschr.*, 15th Sept., 1933, Vol. 34, No. 98, pp. 718–720.)

The present note describes an extension of an arrangement of a Wheatstone bridge, two of whose arms consist of two equal amplifier valves (for the elimination of valve disturbances), to a form containing a sensitive galvanometer in the anode current circuit of the valves (*i.e.* connecting the two anodes), whose deflection is compensated by a suitably chosen, constant bias. The arrangement can be conveniently used for the analysis of disturbances and these may be still further eliminated by the introduction of a differential galvanometer.

THE ELECTRO-OPTICAL KERR EFFECT AS A MEANS OF MEASURING VOLTAGE AND CURRENT AT VERY HIGH FREQUENCIES [Wavelengths down to about 14 Metres].—H. Hoyer: Pungs and Vogler. (*Archiv f. Elektrot.*, 4th Oct., 1933, Vol. 27, No. 10, pp. 691–708.)

Investigation and further development of the Pungs-Vogler method (1931 Abstracts, p. 567, l-h col.). The sensitivity is increased by biasing the working point to the straight part of the characteristic not by applying a d.c. potential (as in sound-film procedure) but by the use of an auxiliary double refraction produced by a crystal (mica) screen. The operation of the apparatus is simplified by the use of a Pulfrich (Zeiss) comparison photometer. The limitations of the method are discussed. A frequency of 3×10^7 c/s is still well below the region of dielectric-constant change in nitrobenzol, which for the pure liquid should be around 10^9 c/s. But the process of cleaning is so difficult that it is desirable not to rely on too great a purity, but to minimise the action of the impurities by keeping the field strength down to about 2 kv/cm and thus reducing the heating. This is made possible by the increased sensitivity given by the biasing mica. At first it was found that this device introduced trouble connected with refraction effects in the liquid flow, between the plate electrodes, arising from the slight unavoidable warming. This trouble was eliminated by replacing the plate electrodes by "comb" electrodes (Fig. 14).

A NEW FORM OF CURRENT-MEASURING SYSTEM IN THE CATHODE-RAY OSCILLOGRAPH.—Matthias, von Borries and Ruska. (*See* under "Subsidiary Apparatus and Materials.")

A NEW HIGHLY SENSITIVE MAINS-DRIVEN VALVE VOLTMETER [for Voltages of the Order of 0.01–1.0 Volts].—M. von Ardenne. (*Funk-Magazin*, August, 1933, Vol. 6, No. 8, pp. 517–520.)

THE "SHADOW CROSS" METER [Circular Scaled Instrument with Shadow Pointers giving Simultaneous Readings of Real and Apparent Powers, Power Factor, etc.].—P. M. Pflier. (*E.T.Z.*, 14th Sept., 1933, Vol. 54, No. 37, pp. 887–889.)

THE MEASUREMENT OF CRITICAL POTENTIALS WITH A SCREENED GRID VALVE.—F. L. Arnot. (*Journ. Scient. Instr.*, September, 1933, Vol. 10, No. 9, pp. 294–295.)

"THE STRING ELECTROMETER."—T. Wulf. (Book Review in *Journ. Scient. Instr.*, September, 1933, Vol. 10, No. 9, p. 297.)

THE EFFECTIVE CAPACITY OF THE LINDEMANN ELECTROMETER.—J. J. McHenry. (*Journ. Scient. Instr.*, October, 1933, Vol. 10, No. 10, pp. 305–310.)

NOTE ON THE CONSTRUCTION AND USE OF THE THERMAL WATTMETER [for Frequencies up to 10^7 c/s: Accuracy within 1%].—B. A. Sharpe. (*Journ. Scient. Instr.*, October, 1933, Vol. 10, No. 10, pp. 318–321.)

Practical tests on a wattmeter using the circuit here employed were described by Zickner and Pfestorf (1931 Abstracts, p. 107, l-h col.). The present paper includes methods of correcting the inaccuracies due to imperfect matching of commercial components.

ABSORPTION AND REJECTOR [Wave Trap] CIRCUITS AND THEIR USE IN MEASURING TECHNIQUE. —Klutke. (*See* abstract under "Aerials and Aerial Systems.")

THE STANDARD-CELL COMPARATOR, A SPECIALISED POTENTIOMETER [Measuring the Small Difference between E.M.Fs of Cell under Test and Reference Cell, but with Mechanical Computing Feature which automatically Adds this Difference to the Reference E.M.F., thus giving Direct Reading].—H. B. Brooks. (*Bur. of Stds. Journ. of Res.*, August, 1933, Vol. 11, No. 2, pp. 211–231.)

EARTH-RESISTANCE MEASURING APPARATUS FOR SINGLE READING WITHOUT CALCULATION.—Trub, Tauber & Company. (*Electrician*, 8th Sept., 1933, Vol. 111, No. 2884, pp. 294–295.)

AEF PROPOSALS ON STANDARD SIGNS AND SYMBOLS. (*E.T.Z.*, 27th July, 1933, Vol. 54, No. 30, pp. 736–739.)

AEF PROPOSALS ON THE REPRESENTATION OF DIELECTRIC LOSSES.—(*E.T.Z.*, 17th Aug., 1933, Vol. 54, No. 33, p. 809.)

SUBSIDIARY APPARATUS AND MATERIALS

THE DESIGN AND EXAMPLES OF SYMMETRICAL FILTER CIRCUITS BY THE METHOD OF W. CAUER.—E. Glowatzki. (*E.N.T.*, September and October, 1933, Vol. 10, Nos. 9 and 10, pp. 377–386 and 404–415.)

The writer asserts that the instructions given in Cauer's book (*see* David, 1933 Abstracts, p. 443) have not unfairly been criticised as too short. In view of the great practical value of the contents of the book the writer here reproduces some of the more important tables (some of them in an extended form) and explains the method of using them. For a correction to Part I *see* bottom of p. 415.

FILTERS IN ACTION [Action of a 7-Stage Band-Pass Filter demonstrated visually by a Series of Pendulums].—C. E. Lane. (*Bell Lab. Record*, September, 1933, Vol. 12, No. 1, pp. 2–7.)

AN IMPROVED D.C. AMPLIFYING CIRCUIT [Development of Soller's Single-Valve Balanced Circuit].—L. A. Du Bridge and Hart Brown. (*Review Scient. Instr.*, October, 1933, Vol. 4, No. 10, pp. 532–536.)

Soller's circuit (1932 Abstracts, p. 654, l-h col.) balances out e.m.f. changes: the new circuit is less critical in adjustment and also neutralises changes in emission current by balancing the plate current against the current to the space-charge grid.

THE USE OF VALVES FOR THE AMPLIFICATION OF FEEBLE CURRENTS [Photoelectric or Ionic: the Much Greater Sensitivity of the "Bridge" or Differential Circuit].—K. Zuber. (*Helvet. Phys. Acta*, Fasc. 7, Vol. 6, 1933, pp. 495–503: in German.)

RECENT PROGRESS IN THE FIELD OF CATHODE-RAY EQUIPMENTS FOR MEASURING PURPOSES AND TELEVISION.—von Ardenne. (*See* under "Phototelegraphy and Television.")

THE SERIOUSNESS OF HALATION IN CATHODE-RAY TUBES, AND ITS ELIMINATION.—von Ardenne. (*Ibid.*)

A NEW HIGH-EFFICIENCY CATHODE-RAY TUBE: APPLICATIONS AS A PROJECTING OSCILLOGRAPH.—von Ardenne. (*Ibid.*)

THE CATHODE-RAY TUBE.—M. von Ardenne. (Book Review in *Electrician*, 24th Nov., 1933, Vol. 111, No. 2895, p. 643.)

CATHODE-RAY OSCILLOGRAPH TIME-BASE EQUIPMENT USING GLOW-DISCHARGE TUBE WITH EXTERNAL SYNCHRONISING ELECTRODE.—von Ardenne Laboratory. (*Hochf:tech. u. Elek:akus.*, April, 1933, Vol. 41, No. 4, p. 152.) *See* also next abstract.

A SYNCHRONISABLE STROBOSCOPIC LIGHT SOURCE FOR VIBRATION INVESTIGATIONS [of Loudspeaker Systems, Sound-Film Mechanism etc.].—von Ardenne Laboratory. (*Hochf:tech. u. Elek:akus.*, April, 1933, Vol. 41, No. 4, p. 152.)

Using the glow-discharge tube with external synchronising electrode employed in the oscillograph time-base equipment referred to above. The sprayed-on metal coating half surrounding the tube, and forming the external electrode, acts simultaneously as a light screen for the observer and as a reflector for the glow-discharge light.

MODERN APPLICATIONS OF THE CATHODE-RAY OSCILLOGRAPH [including Recording and Demonstration of Valve Characteristics and Acoustic Frequency Curves].—J. Kammerloher. (*E.T.Z.*, 19th Oct., 1933, Vol. 54, No. 42, pp. 1019–1021.)

With specimen oscillograms taken with a von Ardenne tube.

A CATHODE-RAY OSCILLOGRAPH FOR RECORDING RESONANCE CURVES, USING A SINUSOIDAL TIME BASE.—Ulbricht. (*See* abstract under "Measurements and Standards.")

THE CATHODE-RAY OSCILLOGRAPH.—A. L. M. Sowerby. (*Wireless World*, 3rd November, 1933, Vol. 33, pp. 356–357.)

VOLTAGE AMPLIFICATION USING SCREEN-GRID VALVES WITH FULL UTILISATION OF THE AMPLIFICATION FACTOR ["Constant Anode Current Method": particularly suitable for Cathode-Ray Oscillography].—Sewig and Kleinschmidt. (*See* under "Valves and Thermionics.")

A NEW FORM OF THE CURRENT-MEASURING SYSTEM IN THE CATHODE-RAY OSCILLOGRAPH.—A. Matthias, B. von Borries and E. Ruska. (*Zeitschr. f. Physik*, 1933, Vol. 85, No. 5/6, pp. 336–352.)

The writers have brought the current deviating coil into the evacuated space in the cathode-ray tube and given it the form of a long pyramid-shaped box, with spaces for the passage of the electron beam. This gives a very sensitive measuring system of small inductance, which increases the sensitivity of current measurement by several orders of magnitude. The constants of such coils are calculated and reproductions of oscillograms of transients are given which agree well with the results of calculation.

ON THE USE OF CATHODE-RAY TUBES [and the Correction of Errors due to External Magnetic and Electrostatic Fields].—K. Nentwig. (*Funktech. Monatshefte*, October, 1933, No. 10, pp. 391–393.)

THE SPLITTING OF FILAMENTARY ELECTRON BEAMS [Fadenstrahlen] AT A CYLINDRICAL PROBE.—W. Rollwagen. (*Zeitschr. f. Physik*, 1933, Vol. 86, No. 3/4, pp. 157–160.)

ON THE IMMERSION OBJECTIVE OF GEOMETRICAL ELECTRON OPTICS.—H. Johannson. (*Ann. der Physik*, 1933, Series 5, Vol. 18, No. 4, pp. 385–413.)

The "immersion objective" of geometrical electron optics consists of an arrangement of two plane stops of diameter about 1 mm, raised to different potentials, through which the electron beam passes. The properties of such a system are investigated in analogy to the properties of objectives in geometrical optics, and the influence of various geometrical dimensions and voltage combinations is examined. Comparison of different systems leads to the discovery of an optimum type of system and to a rule for the choice of size of the system in order to obtain a desired magnification in the region of optimum images.

LOW-VOLTAGE IMPULSE CIRCUITS [using Thyratrons: for Cathode-Ray Oscillographs].—L. B. Snoddy. (*Physics*, September, 1933, Vol. 4, No. 9, pp. 327–331.)

A CONTROL PANEL FOR AN OSCILLOGRAPH LABORATORY.—R. T. Pennoyer and S. O. Evans. (*Gen. Elec. Review*, September, 1933, Vol. 36, No. 9, pp. 389–393.)

THE PRODUCTION OF STRONG, CELLULOSE ACETATE FILMS [*e.g.* 1×10^{-4} cm Thick withstanding 1 Atmosphere].—L. Harris and F. A. Johnson. (*Review Scient. Instr.*, August, 1933, Vol. 4, No. 8, pp. 454–455.)

COPPER TO GLASS SEALS.—H. de Laszlo. (*Journ. Scient. Instr.*, September, 1933, Vol. 10, No. 9, pp. 296–297.)

PHOTOGRAPHIC PLATES FOR USE IN SPECTROSCOPY AND ASTRONOMY. III.—C. E. K. Mees. (*Journ. Opt. Soc. Am.*, July, 1933, Vol. 23, No. 7, pp. 229–233.) Continuation of the work referred to in 1932 Abstracts, p. 418, r-h column.

CONTRIBUTIONS TO THE STABILISATION OF VOLTAGES BY GLOW-DISCHARGE LAMPS [and the Great Superiority of the "Glow Discharge Bridge" Circuit over the usual "Stabilisator" Potentiometer Circuit].—K. Lämmchen: Körös. (*Hochf:tech. u. Elek:akus.*, October, 1933, Vol. 42, No. 4, pp. 119–126.)

Author's summary:—This work investigates a bridge circuit with a glow-discharge lamp, for the stabilisation of mains voltage. Theoretically the arrangement gives an absolute voltage constancy, but in practice this is only approximately attained, since the lamp characteristic is not strictly linear and also shows hysteresis loops. The effect of these phenomena on the stabilisation is examined experimentally for various conditions of load, using 200 and 205 v d.c. mains. It is found that the bridge circuit is from 10 to 50 times as good as the potentiometer circuit also investigated, even when [the special] stabilisator tubes were used. Smaller variations are given even than with a cascade arrangement requiring two lamps.

The use of the glow-discharge bridge involves no special design of glow-discharge tubes with small a.c. resistance, since this is compensated for. Combinations of series and bridge arrangements are found to be specially advantageous. In this case the glow-discharge lamps are only lightly modulated, so that the best use is made of the approximately linear characteristic. It is also shown, by superposition of a.c., that the bridge connection works better than the potentiometer connection in filtering the d.c. ripple. The value of this smoothing action is limited by the frequency-dependence of the glow-discharge lamp [its a.c. resistance increasing by about 25 % for a frequency rise from 50 to 500 c/s]. Finally, the use of the glow-discharge bridge for a mains-driven audion voltmeter is discussed, and the merit of the stabilisation shown by comparison with direct connection to the mains.

STABILISING ANODE VOLTAGES IN MAINS-DRIVEN RECEIVERS [the "Smoothing Tube" and the Glow-Discharge "Stabilisator"].—K. Nentwig. (*Radio, B., F. für Alle*, November, 1933, pp. 481–485.)

The "Glättungsrohre," with its one plane electrode inside a second U-shaped electrode, is only suitable where no voltage higher than 150 v is required. The "Stabilisator" potential divider (*see* many past Abstracts) is free from this limitation.

THE CALCULATION OF SERIES RESISTANCE AND CURRENT SOURCE FOR [Glow-Discharge] STABILISER TUBES.—J. von Frommer. (*E.T.Z.*, 31st Aug., 1933, Vol. 54, No. 35, pp. 839–841.) Calculations regarding the multiple-electrode voltage dividers referred to in 1933 Abstracts, p. 577, r-h column ("Stabilovolt" Patent).

THE [Glow-Discharge Tube] STABILISATOR AS TIME-MARK RECORDER FOR LOOP OSCILLOGRAPHS.—K. Franz. (*E.T.Z.*, 28th Sept., 1933, Vol. 54, No. 39, p. 938.) *See* also preceding abstract.

THE MARCONI STABILOVOLT CURRENT SUPPLY SYSTEM.—(*Marconi Review*, Sept./Oct., 1933, No. 44, pp. 22–26: to be continued.)

THE GLOW DISCHARGE AT ATMOSPHERIC PRESSURE.—H. Thoma and L. Heer. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 14, 1933, pp. 385–388.) Further development of the work referred to in Abstracts, 1933, p. 112, l-h column. *See* also Heer, 1933, p. 578, l-h column.

VOLTAGE-REGULATION OF A.C. GENERATORS [by the Use of Glow-Discharge Potential Dividers and Valves].—W. Druey. (*Helvet. Phys. Acta*, Fasc. 7, Vol. 6, 1933, pp. 488–490: in German, with circuit diagram.)

NEW GLOW-DISCHARGE TUBES [" Universal," for Resonance Indication, Generation of Oscillations, etc.: " Amplitude," for Limiting: " Smoothing: " etc.].—C. W. A. Pasewaldt. (*Funk-Magazin*, April, 1933, Vol. 6, No. 4, pp. 255–259.)

THE USE OF TRIODE VACUUM TUBE RECTIFIERS TO SUPPLY CONSTANT VOLTAGE.—L. A. Richards. (*Review Scient. Instr.*, September, 1933, Vol. 4, No. 9, pp. 479–482.) *See* 1933 Abstracts, p. 636, r-h column.

INITIAL IMPULSE INDICATOR [for Determining Which of a Series of Rapidly Occurring Events happened First: Arc-Back Indication in Mercury-Vapour Rectifier Sets, etc.].—O. W. Livingston and H. W. Lord. (*Electronics*, September, 1933, pp. 257 and 260.)

A PHONIC MOTOR [for Frequencies up to 7 500 c/s (4 500 r.p.m.): Free from Hunting: Uniformity in Pole Pitch and Form obtained by Spur-Gear Design of Rotor].—T. Ikebe. (*Rep. of Rad. Res. in Japan*, September, 1933, Vol. 3, No. 2, pp. 177–180.)

THE DIRECT SUPPLY OF MULTIPLE TELEPHONE SYSTEMS BY " TELEPHONIC " GENERATORS [48-Volt Dynamos requiring No Floating Batteries or Filters].—H. Fontaine. (*Ann. des P.T.T.*, October, 1933, Vol. 22, No. 10, pp. 874–908.)

THE APPLICATION OF X-RAYS TO THE STUDY OF THE ACTIVE MATERIALS IN LEAD ACCUMULATORS.—G. Génin. (*Rev. Gén. de l'Élec.*, 26th Aug., 1933, Vol. 34, No. 8, pp. 235–243.)

EXPERIMENTAL DETERMINATION OF THE EDGE CORRECTION FOR PLATE CONDENSERS OF RELATIVELY SMALL DIAMETER AND LARGE THICKNESS.—F. Keller and W. R. Lehmann. (*Zeitschr. f. Physik*, 1933, Vol. 85, No. 3/4, pp. 253–256.)

Tables and curves are given from which the amount by which the measured capacity differs from that calculated from the usual formula may be read off, for circular plate condensers of area 1.77 to 100 sq. cm and distance between plates of 1 to 6 mm. The edge correction, in percentage of the measured capacity, is found to be independent of the dielectric constant.

CALCULATION OF THE CAPACITY OF A CIRCULAR PLATE CONDENSER WHOSE PLATES ARE INCLINED AT AN ANGLE TO ONE ANOTHER.—H. Nitka. (*Zeitschr. f. Physik*, 1933, Vol. 85, No. 7/8, pp. 504–510.)

BY-PASS CONDENSERS FOR 5-METRE [Ultra-Short-Wave] WORK.—(*Wireless World*, 29th September, 1933, Vol. 33, pp. 266–267.)

The performance of by-pass condensers on the ultra-short wavelengths has not hitherto received much attention. Measurements are here given of the impedance of fixed condensers of various different types and capacities at 60 Mc/s.

ON SOME MECHANICAL AND THERMAL PROPERTIES OF ELECTRICAL INSULATING MATERIALS (NATURAL AND CERAMIC).—U. Retzow. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 14, 1933, pp. 424–427.)

EFFECT OF TEMPERATURE AND FREQUENCY ON THE DIELECTRIC CONSTANT, POWER FACTOR, AND CONDUCTIVITY OF COMPOUNDS OF PURIFIED RUBBER AND SULPHUR.—A. H. Scott, A. T. McPherson and H. L. Curtis. (*Bur. of Stds. Journ. of Res.*, August, 1933, Vol. 11, No. 2, pp. 173–209.)

PROPERTIES OF MYCALEX [with Electrical Data up to 100 Mc/s].—W. W. Brown. (*Proc. Inst. Rad. Eng.*, September, 1933, Vol. 21, No. 9, pp. 1338–1342.)

THE LOW-LOSS STEATITE MATERIALS FREQUENTIT AND FREQUENTA [including Dielectric Loss Data at Wavelengths down to 6 Metres].—E. Albers-Schönberg. (*Zeitschr. V.D.I.*, 30th Sept., 1933, Vol. 77, No. 39, pp. 1077–1078.)

THE DIELECTRIC LOSSES OF INSULATING OILS AT VERY HIGH FREQUENCIES [10^7–10^8 c/s].—H. Beck. (*Physik. Zeitschr.*, 1st Oct., 1933, Vol. 34, No. 19, pp. 721–729.)

DIELECTRIC CONSTANTS OF AQUEOUS SOLUTIONS AT VERY HIGH FREQUENCIES [$\lambda = 60$ cm].—E. Plötze. (*Ann. der Physik*, 1933, Series 5, Vol. 18, No. 3, pp. 288–298.)

LAMINATED OR NON-LAMINATED HIGH-FREQUENCY CORES? *and* IRON-POWER CORES [Ferrocart].—A. Schneider: G.W.O.H. (*Wireless Engineer*, September, 1933, Vol. 10, No. 120, pp. 491–492 and 467–468). Continuation of the discussion dealt with in 1933 Abstracts, p. 515, l-h column.

THE FER-X RADIO-FREQUENCY TRANSFORMER.—R. Wittwer. (*Radio, B., F. für Alle*, October, 1933, pp. 455–456.) *See* also 1933 Abstracts, p. 579, l-h column.

NIRESIST, A HIGH-QUALITY CAST IRON [alloyed with Monel Metal and Ferrochrome].—R. Hanel and R. Müller. (*Zeitschr. V.D.I.*, 21st Oct., 1933, Vol. 77, No. 42, p. 1142.)

COMPENSATION OF THE D.C. MAGNETISATION IN IRON-CORED CHOKING COILS.—F. Vilbig. (*T.F.T.*, September, 1933, Vol. 22, No. 9, pp. 237–238.)

THE USE OF POLARISED-GRID VALVES [Thyratrons] AS PROTECTING RELAYS.—R. Wideröe: AEG. (*Rev. Gén. de l'Élec.*, 19th Aug., 1933, Vol. 34, No. 7, pp. 197–202.)

STATIC CHARACTERISTICS OF HOT-CATHODE THYRATRONS [Important Anomalies: the Effect of a Magnetic Field].—Y. Watanabe and T. Takano. (*Journ. I.E.E. Japan*, August, 1933, Vol. 53 [No. 8], No. 541: English summary pp. 62–64, Japanese paper pp. 673–679.)

Among other results, it is found that when the magnetic field is suddenly made or broken the arc may start even with a high negative grid bias. "These experiments lead us to consider that an electron emitted from a hot cathode can obtain a velocity high enough to start ionisation, on account of an e.m.f. due to the sudden change of a magnetic field."

A THYRATRON LABORATORY RECTIFIER [with Grid Bias from Regulating Device consisting chiefly of Resistance in series with Neon Lamp].—R. M. Kime. (*Electronics*, August, 1933, Vol. 6, No. 8, p. 219.)

THE PARALLEL OPERATION OF GRID-CONTROLLED RECTIFIERS.—E. Uhlmann. (*Archiv f. Elektrot.*, 1st Aug., 1933, Vol. 27, No. 8, pp. 586–596.)

CURRENT DIRECTORS: A.C. RECTIFIERS AND A.C. FREQUENCY TRANSFORMERS.—O. Löbl. (*Zeitschr. V.D.I.*, 24th June, 1933, Vol. 77, No. 25, pp. 684–690.)

THE THEORY OF THE DIRECT CONVERSION OF POLYPHASE TO SINGLE PHASE CURRENT BY MERCURY-VAPOUR CONVERTERS.—R. Feinberg. (*Archiv f. Elektrot.*, 1st Aug., 1933, Vol. 27, No. 8, pp. 539–557.)

A NEW BARRIER-LAYER RECTIFIER [CuS/Cu_2S between Copper Electrodes].—M. Anastasiadès. (*Comptes Rendus*, 2nd Oct., 1933, Vol. 197, No. 14, pp. 677–678.)

NEW STATICAL ELECTRICAL MACHINES: OF CONSTANT POLARITY, AND PRACTICALLY INDEPENDENT OF ATMOSPHERIC CONDITIONS: OUTPUT 3 WATTS.—P. Jolivet. (*Comptes Rendus*, 9th Oct., 1933, Vol. 197, No. 15, pp. 744–746.)

EDGES IN HIGH-VOLTAGE TECHNIQUE.—H. Kropp. (*Archiv f. Elektrot.*, 4th Oct., 1933. Vol. 27, No. 10, pp. 681–690.)

LACQUER-COATED RESISTORS OF HIGH RESISTANCE.—Bureau of Standards. (*Journ. Franklin Inst.*, October, 1933, Vol. 216, No. 4, p. 542.)

A preliminary note on a method of preparation of reliable resistors of high resistance of the order of 10^8 to 10^{12} ohms. A pyrex rod is coated with graphite and the rod, thus prepared, is coated with glyptal lacquer.

A CONTINUOUSLY VARIABLE RHEOSTAT DISPENSING WITH SLIDING CONTACTS [Wire-on-Drums Principle in Practical Form, with Single-Knob Control].—L. H. Bainbridge-Bell. (*Journ. Scient. Instr.*, September, 1933, Vol. 10, No. 9, pp. 295–296.)

SKIN EFFECT IN RECTANGULAR CONDUCTORS.—Forbes and Gorman. (*Elec. Engineering*, September, 1933, Vol. 52, No. 9, pp. 636–639.)

ADJUSTING THE INDUCTANCE OF SCREENED COILS BY PERMANENT DEFORMATION OF SCREEN.—Philips Company. (German Pat. 573 635, pub. 4. 4.1933.)

THE THYRATRON TUBE AS A STROBOSCOPE.—B. L. Robertson and T. A. Rogers. (*Gen. Elec. Review*, October, 1933, Vol. 36, No. 10, pp. 455–457.)

A COMBINED TESLA COIL AND VACUUM TUBE [Oil-Immersed H.F. Resonance Coil with Its High-Potential End forming Inner Electrode of a Vacuum Tube].—C. C. Lauritsen and R. Crane. (*Review Scient. Instr.*, September, 1933, Vol. 4, No. 9, pp. 497–500.)

A SIMPLE CONSTANT-TEMPERATURE CONTROL CIRCUIT.—H. Clarke. (*Journ. Scient. Instr.*, October, 1933, Vol. 10, No. 10, pp. 329–330.)

SPECIAL TELEPHONY SLIDE RULES [" Reactance" and " Cross-talk Transmission Equivalent "].—(*E.N.T.*, October, 1933, Vol. 10, No. 10, pp. 422–423.)

A SIMPLE METHOD OF ANALYSING STRIP RECORDS OF REGISTERING APPARATUS: A CRITICISM AND REPLY.—H. Häussler: Dalchau. (*E.T.Z.*, 21st Sept., 1933, Vol. 54, No. 38, p. 926.) *See* 1933 Abstracts, p. 285, l-h column.

STATIONS, DESIGN AND OPERATION

THE [Police] RADIO PATROL SYSTEM OF THE CITY OF NEW YORK.—F. W. Cunningham and T. W. Rochester. (*Proc. Inst. Rad. Eng.*, September, 1933, Vol. 21, No. 9, pp. 1239–1251.)

EXPERIMENTS IN ULTRA-HIGH-FREQUENCY COMMUNICATION [on 3–10 Metre Waves,including Transmissions from Summit of Mt. Fuji].—T. Nakai, R. Kimura and S. Ueno. (*Rep. of Rad. Res. in Japan*, June, 1933, Vol. 3, No. 1, pp. 7–17: in English.) Abbreviated translation of the paper dealt with in 1933 Abstracts, p. 173, r-h column.

A STUDY OF RECEPTION FROM SYNCHRONISED BROADCAST STATIONS [Common-Wave Broadcasting].—Aiken. (*See* under " Reception," p. 37.)

EXPERIMENTS WITH A RADIO BROADCASTING SYSTEM UTILISING THE NETWORK OF DISTRIBUTION LINES OF AN ELECTRIC SUPPLY.—I. Miura. (*Rep. of Rad. Res. in Japan*, September, 1933, Vol. 3, No. 2, pp. 137–154.) The full paper, in English, dealt with in 1933 Abstracts, p. 639, l-h column.

KETTERING'S RADIO RELAY SYSTEM [" Wired Wireless "].—T. H. Hall. (*Elec. Review*, 15th Sept., 1933, Vol. 113, No. 2912, p. 345.)

RADIO RELAY SYSTEMS.—(*Ibid.*, 29th Sept., 1933. Vol. 113, No. 2914, pp. 414–415.)

DISCUSSION ON " SUPERVISORY AND CONTROL EQUIPMENT FOR AUDIO-FREQUENCY AMPLIFIERS " [and the Bell System Volume Indicators with " Duration Characteristic " of the Ear].—A. F. Rose: Sohon. (*Proc. Inst. Rad. Eng.*, October, 1933, Vol. 21, No. 10, p. 1497.) For Sohon's paper *see* 1933 Abstracts, p. 286.

GENERAL PHYSICAL ARTICLES

DIELECTRIC CONSTANT AND IONISATION VOLTAGE OF GASES [and a Formula Connecting Them].—A. Güntherschulze. (*Zeitschr. f. Physik*, 1933 Vol. 86, No. 3/4, pp. 249–252.)

INVESTIGATIONS OF THE INFLUENCE OF A MAGNETIC FIELD ON THE DIELECTRIC CONSTANT OF ARGON AND OXYGEN, BY A NEW RESONANCE METHOD.—H. Voss. (*Zeitschr. f. Physik*, 1933, Vol. 85, No. 3/4, pp. 172–179.)

A resonance method (Gerlach) is used to show that "a magnetic field of 1 080 gauss has, for a wavelength of 30 m, no influence on the dielectric constant ϵ of argon and of oxygen which is larger than $\triangle\epsilon = 4.6 \times 10^{-7}$ for argon and $\triangle\epsilon = 3.1 \times 10^{-7}$ for oxygen."

THE ELECTRICAL DIFFUSION OF IONS IN GASES CONTAINING CHARGED IONS OF BOTH SIGNS.—N. Wolodkewitsch. (*Zeitschr. f. Physik*, 1933, Vol. 84, No. 9/10, pp. 593–609.)

Theory and experiment show that the variation with time of the charge density in a gas containing ions of both signs is given by the same formula as that in a gas with ions of one sign only.

THE MOBILITY OF POSITIVE IONS IN GASES [Theoretical Investigation].—T. Edqvist. (*Physik. Zeitschr.*, 15th Aug., 1933, Vol. 34, No. 16, pp. 618–623.)

ELECTRICAL AND OPTICAL MEASUREMENTS OF HIGH FREQUENCY GAS DISCHARGES.—L. Rohde and H. Schwarz. (*Zeitschr. f. Physik*, 1933, Vol. 85, No. 3/4, pp. 161–171.)

The writers find that, at very high frequencies, the resistance of the gaseous column may be regarded as constant over a period. They give an equivalent circuit whose properties reproduce those of the discharge.

ON THE THEORY OF THE DIFFUSION OF HIGH-VOLTAGE ELECTRONS.—J. Winter. (*Comptes Rendus*, 16th October, 1933, Vol. 197, No. 16, pp. 828–829.)

MISCELLANEOUS

[Short] YEARLY REPORT OF THE ELECTRICAL ENGINEERING AND RADIO DIVISION OF THE GERMAN AIRCRAFT RESEARCH ESTABLISHMENT [DVL].—H. Fassbender. (*E.T.Z.*, 14th Sept., 1933, Vol. 54, No. 37, pp. 885–887.)

Researches on selective fading: "alternate aerial" transmission (1933 Abstracts, pp. 557–558): effective height of trailing aerial as affected by speed (even at 350 km/h the standard trailing aerial has an effective height twice as great as that of a soundly designed fixed aerial): beryllium as a substitute for phosphor-bronze: noise exclusion by flying helmet with telephones: direction-finding work (including investigation of twilight errors, u.s.w. rotating-frame tests, tests of Telefunken target-flight indicator): fog landing (including improved aerial designs for reception of landing-beam signals): tests of GEC and Siemens & Halske acoustic height-meters: cathode-ray oscillograph: glow-discharge-tube indicator for high-speed engines: instrument for indicating the beginning of ice formation: etc., etc.

POST OFFICE RESEARCH.—(*Electrician*, 27th Oct. and 3rd Nov., 1933, Vol. 111, pp. 497–498 and 554.)

THE RESEARCH WORK OF THE MARCONI COMPANY [Critical Review of Eccles's "Wireless"].—(*Marconi Review*, Sept./Oct., 1933, No. 44, pp. 1–4.)

"ABSORBOMICROMETRIC MEASUREMENTS [with the Absorption Ultra-Micrometer] AND THEIR PRACTICAL APPLICATIONS IN CIVIL ENGINEERING" [Book Notice].—P. Santo Rini. (*E.T.Z.*, 16th. Nov., 1933, Vol. 54, No. 46, p. 1131.) *See* 1932 Abstracts, p. 361, r-h column.

A TELEGRAPH DISTORTION MEASURING SET [with Low-Voltage Cathode-Ray Tube].—V. J. Terry and C. H. W. Brookes-Smith. (*Elec. Communication*, July, 1933, Vol. 12, No. 1, pp. 15–23.)

RADIO MANUFACTURERS ASSOCIATION ACCEPTS NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION CODE.—(*Electronics*, September, 1933, pp. 238–239.)

THE VII INTERNATIONAL HIGH VOLTAGE CONFERENCE IN PARIS, 1933. PART III [including Lightning Protection and Broadcast Interference].—H. Feiner. (*E.T.Z.*, 2nd Nov., 1933, Vol. 54, No. 44, pp. 1062–1065).

BERLIN RADIO EXHIBITION, 1933—ELECTRICAL MUSIC: HOME RECORDING: TELEVISION: NOVELTIES OF RECEIVER DESIGN: COMPONENTS.—(*Radio, B., F. für Alle*, September, 1933, pp. 419–438.)

THE OFFICIAL [Post Office, Air Ministry, Navy, etc.] SPECIAL EXHIBITS AT THE 10TH GERMAN RADIO EXHIBITION.—G. Kette. (*E.T.Z.*, 9th Nov., 1933, Vol. 54, No. 45, pp. 1085–1088.)

THE 10TH PARIS RADIO EXHIBITION.—M. Adam. (*Génie Civil*, 23rd Sept., 1933, Vol. 103, No. 13, pp. 304–308.)

THE EMISSION OF A VERY SOFT RADIATION FROM ELECTRIFIED DIELECTRICS, *and* STUDY OF THE RADIATION OF SEMI-CONDUCTING CELLS BY MEANS OF A SPECTROGRAPH *in Vacuo*.—G. Reboul: G. Déchêne. (*Comptes Rendus*, 26th June, 1933, Vol. 196, No. 26, pp. 1987–1989: 1989–1991.)

M-RAYS [Mitogenetic Rays] AFFECT FULL-GROWN AS WELL AS YOUNG CELLS.—Kowarzyk. (*Sci. News Letter*, 10th June, 1933, Vol. 23, No. 635, p. 361.) For previous work on these rays *see* Magrou, Abstracts, 1932, p. 301, and 1930, p. 177, r-h columns.

ELECTRICAL DEVICE FOR MEASURING MITOGENETIC RAYS [Modified Geiger Counter].—Rajewsky. (*Science*, 14th July, 1933, Vol. 78, No. 2011, Supp. p. 6.)

PHOTOCELLS IN THEIR TECHNICAL FIELDS OF APPLICATION [including Modified Geiger Counter] *and* INDUSTRIAL PLANTS USING PHOTOCELLS.—Weisglass: Keller. (*See* under "Phototelegraphy and Television.")

INVESTIGATION ON MITOGENETIC RADIATION BY MEANS OF A PHOTOELECTRIC COUNTER TUBE.—E. Lorenz. (*Phys. Review*, 15th Aug., 1933, Series 2, Vol. 44, No. 4, pp. 329–330: abstract only.)

THE EMISSION OF RADIATION BY CHEMICAL REACTIONS.—R. Audubert and Van Doormaal. (*Comptes Rendus*, 19th June, 1933, Vol. 196, No. 25, pp. 1883–1885.)

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.

BINAURAL SYSTEMS

Application date, 14th December, 1931. No. 394325

The action of the ears in determining the direction of a source of sounds depends in part upon phase-difference and in part upon relative intensity. For the lower frequencies, phase is the predominant factor, and, in general, for a given obliquity of sound the phase-difference is approximately proportional to frequency. For higher frequencies the head begins to function as a "baffle" and causes appreciable intensity-differences which are interpreted in terms of direction.

To reproduce binaural effects in sound-transmission, at least two directionally sensitive microphones are suitably spaced to represent the ears, and are then connected to a number of loud speakers through circuits comprising amplifiers, whereby the relative volume of the loud-speaker output is automatically controlled by the direction of the source of sound relative to the microphones. At low frequencies, differences of phase in the microphones are also reproduced as differences in volume at the loud-speaker. The invention is applicable to radio transmission and reception, and to the recording and reproduction of sounds for talking motion pictures.

Patent issued to A. D. Blumlein and Electric and Musical Industries, Ltd.

SIGNALLING SYSTEMS

Convention date (U.S.A.), 19th December, 1931. No. 395242

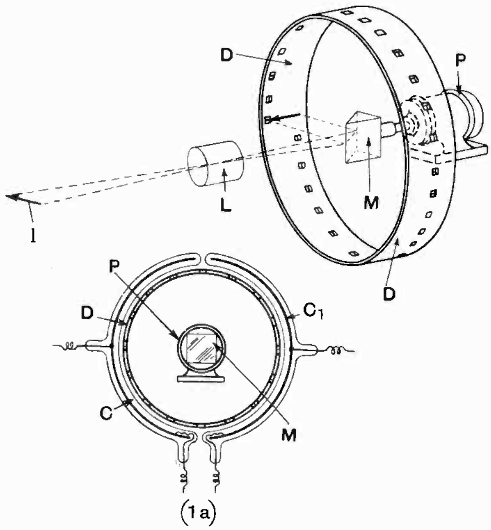
To reduce mutual interference and faulty reception due to reflection from the Heaviside layer, short-range broadcasting and television programmes are distributed through beams of light modulated by the radio-frequency signals. The transmitters consist of elevated beacons, fitted with high-intensity arc-lamps. The electrodes of the latter are screened, since only the light coming from the incandescent gas between the electrodes will respond to the HF oscillations impressed upon the lamp current. At the receiving end a lens mounted in a rotatable tube is directed on to the particular beacon transmitter selected. The received rays are directed by the lens on to a valve amplifier with a photo-electric input.

Patent issued to British Thomson Houston Co., Ltd.

TELEVISION SYSTEMS

Convention date (Germany), 14th April, 1931. No. 394446

An image I is focused by a lens L on to a mirror M which is rotated by a motor P so as to throw the reflected light in succession over a series of spiral holes arranged around the periphery of a stationary drum D. On the outside of the drum is arranged a pair of semi-circular light-sensitive cells C, C_1, shown separately in Fig. (1a), which perform the necessary transformation of the varying light-values into equivalent electric currents. The photo-electric cells C, C_1 are replaced by glow-lamps when used for reception. The advantage



No. 394446.

lies in rotating the comparatively light and compact mirror M instead of the larger and heavier perforated scanning drum D.

Patent issued to I. M. K. Syndicate, Ltd.

Convention date (Germany), 12th December, 1931. No. 394883

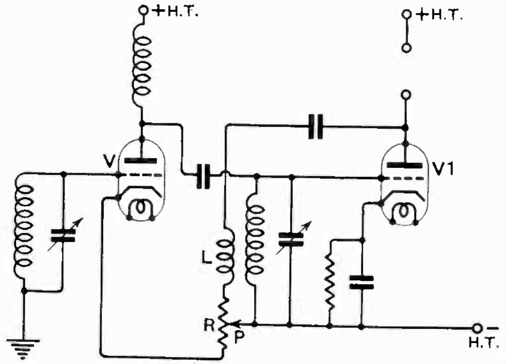
After the transmission of each scanning line, a short interval occurs during which a synchronising impulse is sent. To prevent the operation of the "spill-over" circuit used for line control, say by a picture signal instead of by the special synchronising impulse, the release valve (such as a thyratron or glow-discharge tube) is normally subjected to a paralysing bias, which is removed at the end of each line by the action of a straight-wire electrode inside the cathode-ray tube. This electrode, which is of the same height as the picture, receives a progressive charge from the cathode ray as it traverses the viewing screen. At the end of each traverse, the accumulated charge is just sufficient to offset the initial bias and release the "spill-over" device.

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

REACTION CONTROL

Convention date (Germany) 1st December, 1931.
No. 392466

The back-coupling coil L of the detector valve $V1$ is connected in series with a resistance R and the cathode of the preceding HF amplifier V. Control of reaction is effected by a tapping P



No. 392466.

connected to the cathode of the detector. Simultaneously a compensating bias is applied to the grid of the HF amplifier which tends to offset any variation in amplification caused by the change in reaction.

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

AUTOMATIC VOLUME CONTROL

Convention date (U.S.A.), 23rd October, 1931.
No. 391373

To increase the sharpness of control, on any fluctuation of the carrier wave, an auxiliary valve is shunted across the input to the ordinary detector valve, and acts (*a*) to rectify part of the incoming signal voltage, and (*b*) to amplify the direct-current component in the output from the detector valve, thus increasing the biasing voltage used to control the "gain" of the preceding H.F. stages.

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

Convention date (Germany), 6th June, 1931.
No. 393415

In a receiver for modulated carrier-wave energy, a rectifier valve having a characteristic curve of substantially logarithmic form (over a range of input amplitudes of about 1 : 10) is utilised to give an output which is independent of the amplitude of the carrier-wave within these limits, but which varies directly as the percentage modulation of the carrier. A mathematical analysis is given, and the arrangement as a whole is distinguished from the known super-regenerative circuit,—in which the rectifier characteristic also approximates to a logarithmic curve.

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

Convention date (U.S.A.), 16th February, 1932.
No. 393550

An auxiliary pentode valve is fed with an input voltage derived from the rectified carrier-wave, and delivers an amplified DC voltage to control the gain of the HF stages. The advantage of using a pentode valve as control lies in the high D.C. translation gain given by a relatively-small increase in the total HT supply to the set. The arrangement is particularly suitable for portable, midget, and other compact types of receiver.

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

DETERMINING DISTANCES

Convention date (U.S.A.), 26th December, 1930.
No. 393344

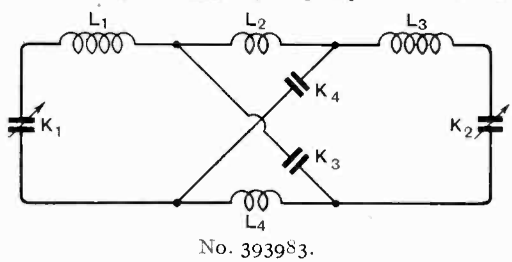
A navigator is enabled to determine his distance from a fixed transmitter, radiating waves of the same frequency but varying characteristics, by ascertaining the difference between these characteristics as a measure of the distance sought. For instance one set of waves is radiated from an open aerial and the other from a closed loop; or two radiation fields of different attenuation, or predetermined range, are transmitted. At the receiving end, the signals may be arranged to give a visual indication, with or without the use of a locally-generated oscillation; or "null" or balanced methods of reception may be used to give the desired information.

Patent issued to E. G. Gage.

DOUBLE-RESONANCE CIRCUITS.

Application date, 17th November, 1931. No. 393983.

A complex coupling-circuit of the band-pass type, tunable over a range of frequencies, and having at each tuning point two resonant values separated by a constant amount, is characterised by the feature that mutual inductance is eliminated, the double-hump response being due entirely to the self-inductance and capacity of the component elements. The circuit shown in the Figure, for instance, has one resonant frequency due to the elements K_1, L_1, L_2, L_3, K_2, L_4 in series, and



No. 393983.

another due to the figure-of-eight path K_1, L_1, K_3, K_2, L_3, K_4, back to K_1. The condensers K_1, K_2 are ganged. The arrangement may be used as an input or intervalve coupling, or for linking the local oscillator with the HF input in a superhet receiver. The position of certain of the reactances may be interchanged.

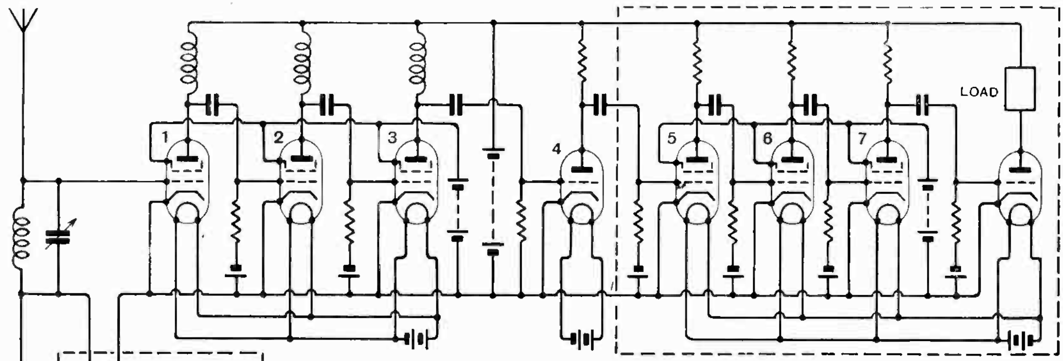
Patent issued to N. P. Hinton.

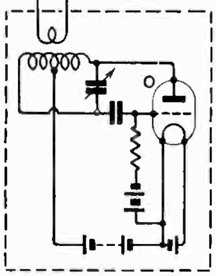
SHORT-WAVE RECEIVERS

Convention date (Germany), 18th June, 1931. *No.* 393755

The Figure shows a circuit designed primarily for the reception of short-wave television signals covering a bandwidth of from three to fifteen million cycles, the incoming signals being heterodyned by a local oscillator *O*. The relatively large loading capacity of the anode circuit of the screen-grid valve 1 allows it to act as a first detector, passing the intermediate frequency to subsequent screen-grid stages 2 and 3. The output from the latter is fed to a second detector 4 and then through an aperiodic amplifier comprising resistance-capacity coupled stages 5---7. Typical values for the circuit elements are given in the specification.

Patent issued to M. von Ardenne.





No. 393755.

CATHODE-RAY TUBES

Convention date (Germany), 13th December, 1930. *No.* 393651

When the cathode is directly heated, observation shows that the spot of light formed by the impact of the ray against the fluorescent screen is of uneven intensity. This is due to the influence of the magnetic field from the heating current which causes the individual electrons to oscillate within the path of the stream. According to the invention the cathode is constructed so as to have an emissive surface of restricted area which is shielded from the magnetic field in question. The modulating or accelerating electrode is also screened so as to apply only a "point" electric field to the stream.

Patent issued to U. W. Doering.

Convention date (Germany), 9th October, 1931. *No.* 393826

Between the anode and the fluorescent screen are two auxiliary electrodes in the form of frusto-conical rings, or metallic deposits laid on the internal surface of the glass, each being electrically separate and charged with increasing voltages designed to accelerate the electron stream. For instance, the lower ring near the cylindrical anode carries a voltage of 200 and the upper ring, nearer the fluorescent screen, a voltage of 500. The anode proper is at 300 volts relative to the cathode. The usual deflecting or scanning plates are arranged in or about the centre of the 200-volt ring.

Patent issued to International General Electric Co., Inc.

Convention date (Germany), 30th November, 1931. *No.* 394580

In order to avoid disturbing luminous phenomena in a cathode-ray tube for receiving television, the usual incandescent cathode is replaced by a hollow cylinder having a highly-emissive coating on its external surface. This is heated to a temperature not exceeding a dull red by electronic bombardment from an internal oxide-covered filament. The cathode-cylinder is, of course, kept at a positive potential relatively to the filament, and the same voltage-source may be used to bias the usual Wehnelt electrode.

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

POWDER-CORE INDUCTANCES

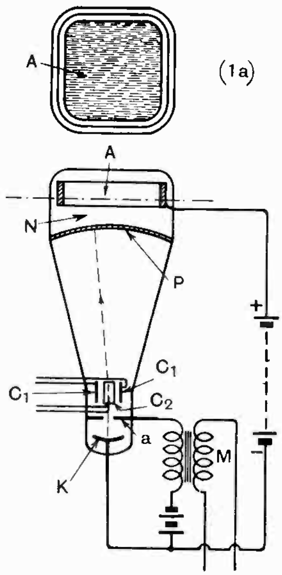
Application date, 15th December, 1931. *No.* 394327

Use is made of a known type of spraying-gun to cover a coil of wire with magnetic powder, the particles of which have previously been coated with an insulating film of oxide produced by spraying through a suitable medium such as oxygen, steam, or water. Alternatively, the magnetic powder and an insulating solution of synthetic resin may be simultaneously sprayed on to the coil. The wire may originally be treated in the form of a flat helix, and a number of these subsequently assembled to form an inductance of the desired value.

Patent issued to B. S. Cohen; F. O. Barralet; and E. D. Hebden.

TELEVISION RECEIVERS

Convention date (France), 20th December, 1930. *No.* 394341



No. 394341.

A cathode - ray tube comprises a cathode K, an anode a to which the incoming signals are applied through a coupling M, and scanning electrodes C_1, C_2. The ordinary fluorescent screen is, however, replaced by a partition P of thin sheet glass, covered or impregnated with a coating of metallic oxide (or a thin slice of agate). This in effect divides the cathode tube proper from a second gas-filled chamber or glow-tube N containing a second anode A, shown in cross-section in Fig. (1a), which forms a viewing screen. As the cathode ray sweeps over the surface of the partition A, it causes each elementary portion of the latter to act momentarily as an individual cathode and so to project a point of light through the glow-lamp chamber N on to the viewing-screen.

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

Application date, 1st January, 1932. *No.* 394710

An auxiliary scanning-device, driven synchronously with the main scanner, is provided to build up a second image. The latter enables a skilled operator to "monitor" the main image, *i.e.*, to perform the synchronising and framing adjustments necessary to enable an unskilled observer, or audience, to view the principal picture under the best conditions.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.; H. M. Dowsett; and D. L. Plaistowe.

TELEVISION APPARATUS

Application date 16th December, 1931. *No.* 393978

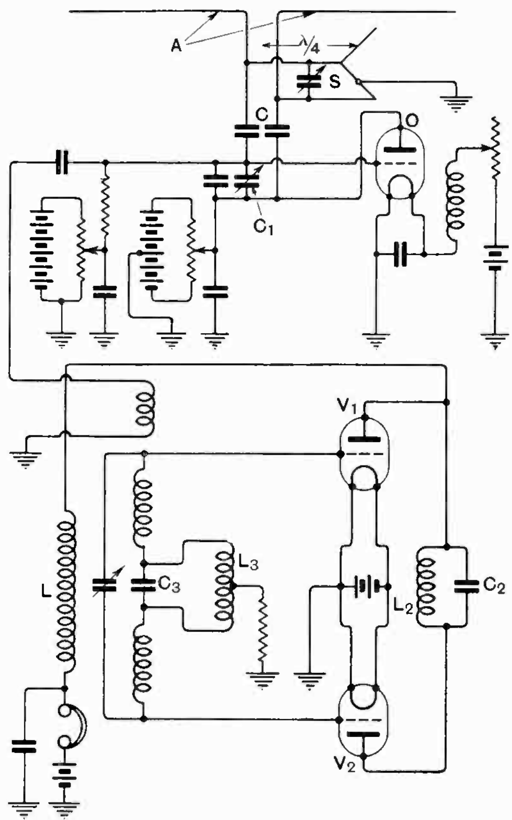
In a mirror-wheel used for television scanning each individual mirror is mounted upon a ball-seated carrier, designed to fit into a cupped recess in the wheel or disc and to be locked in position at any desired angle to the surface or periphery. The arrangement lends itself to mass manufacture, and allows of easy adjustment without throwing any strain on the mirror elements.

Patent issued to Marconi's Wireless Telegraph Co., Ltd., and R. J. Kemp.

HETERODYNE S.W. RECEIVERS

Convention date (U.S.A.), 16th January, 1932. *No.* 394267

The Figure shows a circuit designed to receive wavelengths of the order of one centimetre to half a metre. The signal energy is received on a dipole aerial A, with a parallel tuned Lecher-wire shunt S to ground, and is applied through blocking condensers C to the plate and grid of a Barkhausen-Kurz oscillator O. For a half-metre wave the oscillator is tuned by the condenser C_1 to 603 megacycles, and the resulting beat frequency of 3 megacycles is passed through a condenser to a combined super-regenerative, second-detector, and amplifier combination. This comprises two push-pull valves V_1, V_2 back-coupled to a split input-circuit through a coil L. The valve V_1 acts as a regenerator and the valve V_2 as a combined "degenerator" and low-frequency quenching-oscillator. The plate circuit L_2, C_2, is tuned to the quenching frequency,



No. 394267.

and is back-coupled at this frequency to the coil L_3. Both L_2, C_2 and L_3, C_3 act as short circuits for the high signal frequency.

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