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EXPERIMENTAL WIRELESS

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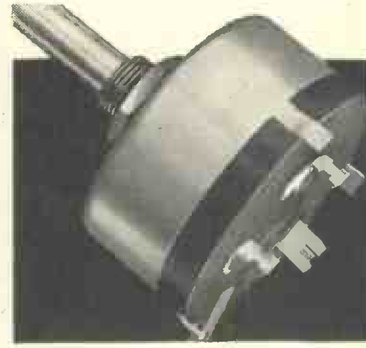

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THE

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Editorial.

Iron Powder Compound Cores for Coils.

THE use of cores of very finely divided iron pressed into a solid mass with a suitable insulating binding material, has been standard practice for many years in the construction of loading coils for telephone lines. The advantages of this material were most pronounced at telephonic frequencies. At lower frequencies laminated iron appeared to be preferable, and at higher frequencies air-cored coils were considered preferable. Attention has recently been redirected to the subject by the claims made for the material known as Ferrocart, which was developed in Germany by Hans Vogt, and which has recently been described in the *Wireless World*.* It is claimed that by using cores of this material the size of coils for wireless purposes can be greatly reduced. The current number of *Elektrische Nachrichten Technik* contains a long article on the same subject without any mention, however, of this latest development.

The calculation of the magnetic properties of such a material is practically impossible, because, whatever the properties of the iron or iron alloy might be in bulk, we have little idea of how these properties are modified in the process of reducing the metal to the form of a fine powder.

Several formulae have been developed for calculating the permeability of the pressed mass from the assumed permeability of the iron, for different space factors, *i.e.*, different ratios of iron volume to total volume.† In one of these formulae the iron particles are assumed to be ellipsoids, and one writer‡ says that the particles would certainly have their longer axes in the direction of the field, although he does not explain whether this would be due to some mysterious foreknowledge with which the particles were endowed before being compressed into the mass or to some movement of the particles when the field was applied. The latter seems rather unlikely, although measurements of the losses in such cores have suggested to some workers§ that they could not all be ascribed to hystereses and eddy currents, and mechanical movement of the particles in the insulating matrix has been regarded as a possible cause.

The Effective Permeability.

In view of the uncertainties of the fundamental properties of the material, these formulae are mainly of academic interest, and one is justified in adopting a much simpler mode of attack in order to obtain

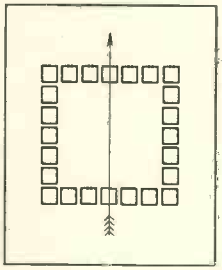
* Sept. 16th, 1932, p. 272.

† Doebke, *Zeit. techn. Phys.*, 1930. Ollendorff, *Arch. f. Elek.*, 1931.

‡ Deutschmann, *E.N.T.*, 1932, p. 423.

§ Jordan, *E.N.T.*, 1924.

an idea of what one can expect from such cores. If we assume, for example, that the iron is all in the form of minute cubes arranged as shown in the figure, and that *linearly* the cube occupies α of the available space, then the cross-section of iron will be α^2 of the gross cross-section and the volume space-factor will be α^3. If the magnetic field be assumed to act along the line of a row of cubes, as shown by the arrow, and if μ_1 be the permeability of the iron, then, owing to the presence of the interstices, which are filled with an insulating material of unit permeability, the total flux will be reduced from ϕ to $\phi\left[\alpha^2 + \frac{1}{\mu_1}(1 - \alpha^2)\right]$. It is assumed here that the magnetic induction B in the iron itself remains unchanged. On account of the interstices the applied magneto-motive force will have to be increased in order to maintain this magnetic induction in the iron, and it is easy to show that the new magneto motive force must be $\alpha + \mu_1 (1 - \alpha)$ times the value for the solid material.



The combined effect of the decreased flux and the increased magneto-motive force is to decrease the permeability from μ_1 to μ where

$$\mu = \mu_1 \cdot \frac{\alpha^2 + \frac{1}{\mu_1}(1 - \alpha^2)}{\alpha + \mu_1(1 - \alpha)} = \frac{\alpha^2\mu_1 + (1 - \alpha^2)}{\mu_1 - \alpha(\mu_1 - 1)}$$

If we put $\alpha^3 = 1 - \delta$, δ will be the fraction of the total volume occupied by insulating material, and as this is probably less than 10 per cent. we can put $\alpha = 1 - \frac{\delta}{3}$ and $\alpha^2 = 1 - \frac{2}{3}\delta$, and we then have for the permeability

$$\mu = \frac{\mu_1 - \frac{2}{3}\delta(\mu_1 - 1)}{1 + \frac{\delta}{3}(\mu_1 - 1)}$$

Substituting reasonable values for δ and μ_1 gives some interesting results. It is seen at once that if μ_1 exceeds 100 or 200, it makes little difference how large it is. Even if μ_1 be taken as infinity and $\delta = 0.1$, that is, if 90 per cent. of the volume be material of infinite permeability, the permeability of the mass will only be 28—a very striking result. By increasing the magnetic material to 95 per cent. ($\delta = 0.05$), μ is only increased to 58. On reducing the permeability of the iron from infinity to 100, these figures become 21.7 and 36.5 respectively. These results are borne out by experimental results which show that the permeability of the mass cannot be increased above about 80, even by using permalloy.

The increase of permeability from unity to even 30 is, however, abundantly worth while, if it can be obtained without counteracting disadvantages.

The actual iron in the mass is only worked at low values of the magnetic induction near the origin of the magnetisation curve, and experiments show that the effective permeability increases linearly over the ordinary working range. In an actual test quoted by Deutschmann (*loc. cit.*) μ increased from 40 to 70 as H was increased from 0 to 40 c.g.s. units. Under some circumstances this change of μ with magnetising current might prove disadvantageous.

Losses in the Cores.

With regard to the losses in the cores, the hystereses loss is not directly affected by the fine subdivision of the iron, and any effect due to the mechanical forces to which the material may be subjected in the process of reducing it to powder could be removed by subsequent annealing.

The reduction of the eddy-current losses is, of course, the reason for the fine subdivision, for upon this and the specific resistance of the material the eddy-current loss depends. From what we have seen above it will be obvious that there is no point in using a material of very high permeability, and it may be advisable to sacrifice permeability if by so doing we can increase the resistance of the material of which the powder is made.

No accurate calculation can be made, but a rough idea of the influence of the various factors can be obtained by assuming each particle to be a small cylinder with its axis along the field. The eddy current loss per cubic cm. of iron is easily shown to be proportional to $f^2B^2d^2/\rho$ where d is the assumed diameter of the cylinders and ρ the specific resistance. This simple formula is based on the assumption that the eddy currents do not appreciably affect the magnetic field, which will be true even at radio frequencies if d^2/ρ is small enough. To obtain low losses the particles should be as small as possible, but this would probably mean a low space factor of the iron and a consequently reduced permeability. The ideal core would consist of very fine insulated iron wire wound continuously in the direction of the magnetic flux. The reduction of permeability would then be due only to the decrease of effective cross-section. The effective permeability would be so much greater than with iron powder that a much smaller cross-section could be employed, so that, even if the loss per unit volume were greater, the total loss might not be any greater than with the powder cores. Whether fine enough iron wire could be made, insulated and wound into cores at a competitive price, is another matter.

As we stated at the beginning, interest in the subject has been stimulated by the announcements with regard to Ferrocart and we look forward to the publication of further experimental data of the properties of this material.

G. W. O. H.

Capacitive or Capacitative?

IN reviewing a Report issued by the Radio Research Board, we commented in our November number on the use of the adjective "capacitative" and suggested that it should be "capacitive." In our last number we published two letters from correspondents commenting adversely on this suggestion. We wish to make it quite clear, however, that we have no objection to the introduction of the longer form in any non-electrical application, although it is surely quite unnecessary, seeing that there is already the good old English adjective "capacious." This is the only adjectival form given in Chambers' Twentieth Century Dictionary; it denotes the passive property of possessing capacity. The suggested adjective "capacitative" suggests a connection with the transitive verb "to capacitate," and we have no objection, whatever, to either of our correspondents giving the other an "incapacitative" blow.

The development of electrical science has necessitated the giving of names to a number of conceptions. These names are to some extent words which were already in existence and to some extent new words devised for the purpose—notably by Oliver Heaviside. A number of these names and the corresponding adjectives are as follows:—

resistance—resistive
inductance—inductive
conductance—conductive
reactance—reactive
susceptance—susceptive
admittance—admittive
capacitance—capacitive
impedance—impedive.

Some apology may be due to the etymologists for the last three adjectives, which we frankly confess to have manufactured, but several of the substantives are not to be found in the dictionary, and if names have been specially devised and have all been given the ending "ance" for the sake of uniformity, we are surely not only at liberty to devise the corresponding adjectives, but are also under an obligation to build them in conformity with the other adjectives in the list. We submit, therefore, that electrical circuits should be admittive and not admissible, capacitive and not capacious or capacitative, and finally, impedive and not impeditive or impedimental.

G. W. O. H.

A Note on the

Theory and Practice of Tone-correction.*

By F. M. Colebrook, B.Sc., A.C.G.I.

(Wireless Division, National Physical Laboratory).

ABSTRACT.—The side-band attenuation and consequent audio-frequency output amplitude distortion due to the reception of radio-telephony in circuits of low decrement, can be corrected by means of suitably designed audio-frequency amplifying stages.

The present paper describes briefly the nature of the side-band attenuation which will occur in practice, the corresponding correcting audio-frequency amplification required, and shows by theory and experiment how such amplification can conveniently be realised.

The possible sources of harmonic distortion in this type of reception are discussed, and it is shown that only one of these is likely to be of importance in practice, namely, the curvature of the characteristic of the valve in the tone-correcting stage. The means of reducing the harmonic distortion from this cause to less than 5 per cent. are described.

A summary of the main results obtained is given in the final section of the paper.

Tone-correction.

1. Object and Scope of the Paper.

It is well known that the selective reception of an amplitude modulated continuous wave (*e.g.*, a broadcast telephony transmission) by means of any receiver of which the carrier or intermediate-frequency circuits give a symmetrical single peaked resonance curve of width, in cycles per second, appreciably less than the frequency range covered by the carrier-wave and side waves of the transmission, results in an effect known as side-band cutting or side-band attenuation. The practical consequence of this effect is an amplitude distortion of the received as compared with the transmitted modulation, the distortion consisting of a reduction of the relative amplitudes of the higher modulation frequency components, the reduction increasing, in general, with increase of modulation frequency.

It is also known [1] that this undesirable consequence of reception on a relatively sharply tuned resonant system can be avoided, without loss of selectivity in relation to the unwanted modulation of transmissions on neighbouring carrier frequencies, by using in conjunction with such systems an audio-frequency amplifier having a rising frequency characteristic of appropriate shape. An amplifying stage of this character will be referred to as a tone-correcting stage, and the process will be referred to as tone-correction.

The object of the present paper is to describe the type of tone-correction required in practice and to show theoretically and experimentally how the appropriate characteristics can be obtained. In addition, the process of tone-correction will be discussed in relation to audio-frequency harmonic distortion.

2. Types of Tone-correcting Characteristic Required.

It can be shown [1] that for any symmetrical overall radio-frequency resonance curve such that the maximum height (at resonance) is unity, and the height at n cycles per second away from resonance is $1/f(n)$, the audio-frequency amplification at frequency n required for perfect tone-correction is proportional to $f(n)$. The following are the chief types of $1/f(n)$ and $f(n)$.

(*a*) *Single circuit of low decrement.*

For a single circuit of low decrement $1/f(n)$ will be of the form

$$\frac{1}{\sqrt{1 + a^2n^2}}$$

where a^2 may have any value up to about 4×10^{-4}. This reduces to

$$\frac{1}{an}$$

very approximately for all except the lowest values of n, but the low frequency region, where the exact expression is required, is of great importance in practice and requires corresponding care in the design of the tone-correcting stage.

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

Curve (*a*) in Fig. 1 shows the form of the side-band attenuation function $(1 + a^2n^2)^{\frac{1}{2}}$ for $a^2 = 4 \times 10^{-6}$ (*i.e.*, a circuit power factor $R/\omega L$ of 10^{-3}), and curve (α) shows the corresponding tone-correction characteristic required for full correction up to 10 kc/s. Curve (α') shows the same characteristic on a more open scale.

(b) Multi-circuit arrangements.

Selective receivers of the kind here considered will usually embody more than one tuned carrier or intermediate-frequency circuit. Assuming that all such circuits of a receiver are so loosely coupled as to give only a single peaked resonance curve, then the overall side-band attenuation will be very approximately the product of the effects of each circuit separately. As a typical case,

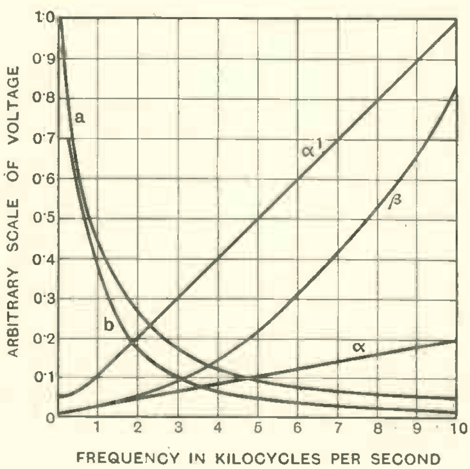


Fig. 1.

two circuits characterised by the attenuation constants *a* and *b* would give an overall side-band attenuation of the form

$$\frac{1}{\sqrt{1 + a^2n^2}} \cdot \frac{1}{\sqrt{1 + b^2n^2}}$$

It is desirable to emphasise the fact that each circuit produces its own full attenuation effect, regardless of the relative magnitudes of *a* and *b*. Assuming one circuit to be of abnormally low decrement and the other of normal decrement, it might be thought that correction for the abnormally low decrement circuit would be sufficient, the effect of the other being negligible by comparison, but this is not the case. Curve (*b*) of Fig. 1 shows the effect of combining with the circuit of abnormally low decrement (curve (*a*)) another circuit of normal decrement ($R/\omega L = 5 \times 10^{-3}$, or "magnification factor" $\omega L/R = 200$, giving $b^2 = 16 \times 10^{-8}$). Curve (β) of the same figure shows the tone-correction characteristic required for this case, for comparison with (α), which refers to the single circuit of abnormally low decrement. Correcting for the latter only would obviously give an unsatisfactory response. Incidentally, the case given as an example illustrates the value of the additional circuit, even though it is not of very low decrement. At 10 kc/s. from resonance, the combination gives a response only about one-quarter of that for the single low decrement circuit. In virtue of linear detector "demodulation" or of the square law effect of a parabolic detector, this will amount to a reduction of about 1/16 in voltage, *i.e.*, about 24 db down in power, of the interfering modulation of a transmission 10 kc/s. removed from the wanted transmission.

Perfect correction for the two-circuit attenuation requires, theoretically, two correcting circuits giving characteristics $\sqrt{1 + a^2n^2}$ and $\sqrt{1 + b^2n^2}$ respectively. This complication is not required in practice, however, for, as will be shown later, there are single stage arrangements available which give the appropriate rising characteristic with a controllable upward curvature and which can be made to satisfy the practical requirement sufficiently closely. This is facilitated by the fact that the attenuation function, for any practical values of *a* and *b*, will tend to proportionality to $1/n^2$ for all except the lowest modulation frequencies.

(c) Tone-correction of limited audio-frequency range.

In practice it may not be desirable that the modulation frequency response of a receiver shall be uniform up to or beyond 10 kc/s. With a 9 kc/s. separation between broadcast transmissions it may be necessary to reduce the extent of the heterodyne interference, against which no known and practicable form of radio-frequency selectivity offers any remedy, by limiting the receiver response to 7 or 8 kc/s. This result is not difficult to obtain in the type of highly selective receiver under consideration, for in the absence of adequate correction, the radio-frequency selectivity will itself have this effect. Thus, the audio-frequency characteristic need not actually fall at or after the highest frequency required. It will probably be sufficient if it ceases to rise, though a fall will of course give additional sharpness to the cut-off. The curve (*a*) of Fig. 8, which is a measured characteristic, of which more will be said later, shows a cut-off of this kind.

3. The Basic Tone-correction Circuit.

An arrangement capable of giving theoretically perfect tone-correction for the side-band attenuation due to a single circuit of low decrement was described and patented by Willans in 1924 (Brit. Pat. 233,417). It is illustrated in Fig. 2. A popular account of this circuit has been given by the present writer [(2)].

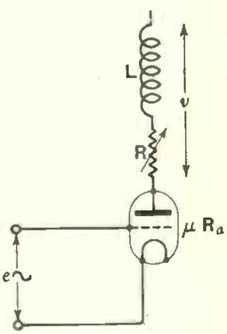


Fig. 2.

The amplification given by the stage (*i.e.*, v/e) is

$$\frac{\sqrt{R^2 + \omega^2 L^2}}{\sqrt{(R + R_a)^2 + \omega^2 L^2}}\mu$$

and to the degree to which ωL is small compared with $R + R_a$, this approximates to

$$\frac{\sqrt{R^2 + \omega^2 L^2}}{R + R_a}\mu = \sqrt{1 + a_1^2 n^2} \cdot \frac{R}{R + R_a}\mu$$

where

$$a_1 = \frac{2\pi L}{R}\ ;\ n = \omega/2\pi$$

Two points should be noted. In the first place, the condition that ωL shall be small compared with R_a at the highest frequency involved, say 10 kc/s., fixes the appropriate value of L. The actual behaviour will depart from the approximated theory by less than 15 per cent. if ωL is less than 0.6 R_a. Assuming $\omega L = 0.6\ R_a$ at 10 kc/s., the highest amplification, corresponding to this frequency, is given very approximately by 0.5 μ. This leads to the second of the two points referred to, namely, that high voltage factor valves will be most suitable for the present purpose.

The use of this tone-correcting circuit in conjunction with a low decrement coil causing a side-band attenuation of the

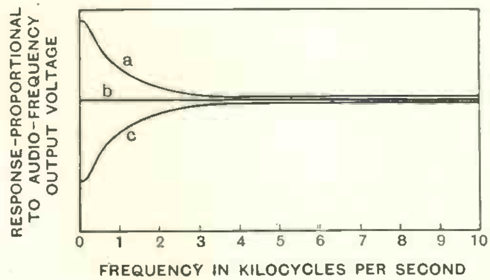


Fig. 3.—(*a*) *R too large*, (*b*) *R adjusted for tone-correction*, (*c*) *R too small.*

form $1\sqrt{1 + a^2 n^2}$ will give an overall response proportional to

$$\frac{\sqrt{1 + a_1^2 n^2}}{\sqrt{1 + a^2 n^2}}$$

By adjustment of R, a_1 can be made equal to a. This adjustment is only required to give proper correction for low values of n, for at the higher values of n the response will be proportional to a_1/a and is therefore independent of n. If R is too small the low frequencies will be inadequately amplified, and if too large the low frequencies will be excessively amplified, as shown qualitatively in Fig. 3.

4. Experimental Confirmation of the Basic Circuit.

For this, and for all the measurements to be described in the paper, the circuit under investigation was supplied with audio-frequency input voltages of sine wave form, obtained from a beat-tone oscillator which provided an adjustable current in a known small resistance connected between the grid and filament of the valve. The output voltage was measured by a valve-voltmeter and was kept constant at about one volt by adjustment of the input voltage.

The details of the basic circuit used for the test are shown in Fig. 4. The practical advantages of the shunt disposition of the correcting circuit are obvious. Curves (*a*) and (*b*) of Fig. 5 show the measured characteristics for $R = 5000$ and $R = 0$ respectively.

A number of similar arrangements with other valves and appropriate inductances were measured, but the one illustrated gave the highest maximum amplification (at 10 kc/s.)

Two such stages could of course be used for the required correction of a two-circuit side-band attenuation, but the alternatives now to be described are more convenient and economical in practice.

5. Single Stage Tone-correction Circuits Suitable for Higher Degrees of Side-band Attenuation.

(*a*) *Capacity in parallel with correcting inductance.*

An obvious means of obtaining a characteristic rising more steeply with frequency is to connect a capacity in parallel with the correcting inductance. The characteristic will then tend to rise more steeply than as the first power of the frequency, towards the resonant frequency of the combination, which can be fixed at, say, 10 kc/s. or beyond this, as the case may be.

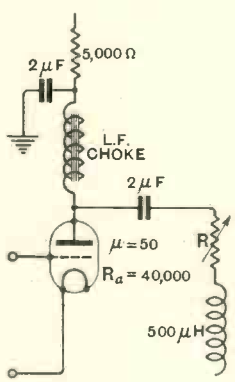


Fig. 4.

Curve (*a*) of Fig. 6 shows the measured characteristic for the circuit described in Section 4, with a 5,000 series resistance, and with a capacity of about 0.0005 μF. connected in parallel with the inductance, tuning it to about 10 kc/s. Curve (*b*) refers, for comparison, to the same circuit without the parallel tuning capacity. Any variation between these limits would be obtainable by adjustment of the parallel capacity.

In the case illustrated, the correcting characteristic is flattened at the top. This, in conjunction with the side-band attenuation of the radio-frequency circuits, will give a cut-off in the region of 10 kc/s. in the overall response. This cut-off could be made more sharp and brought lower in the scale by using a larger tuning capacity, giving a resonance at, say, 8 kc/s.

There is no need for any detailed practical investigation of this type of correcting circuit, as the theory is simply that of a parallel tuned anode circuit, slightly modified by the variable series resistance.

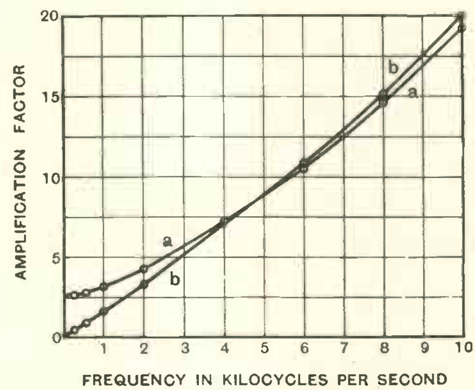


Fig. 5.

It might be feared that the use of a resonant circuit in this manner in the tone-correcting stage would lead to undesirable transient effects. The circuit was actually applied to the reception of a broadcast transmission. The addition of the capacity gave a detectable change in the quality, of the kind indicated by the theory, but there was no detectable effect of any transient behaviour. This test is admittedly qualitative and aesthetic, but is nevertheless appropriate to the practical aspect of the matter in question.

(*b*) *Application of audio-frequency transformer resonance.*

In the article listed as No. 3 in the bibliography, W. T. Cocking refers to the use of

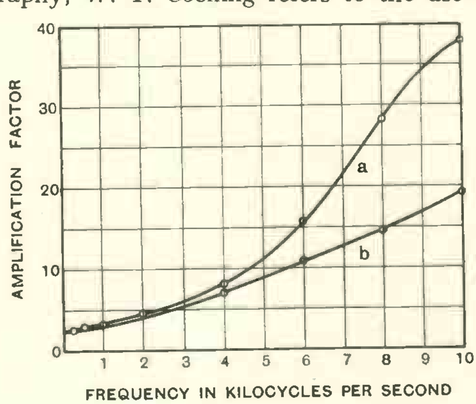


Fig. 6.

tone-correcting circuits of the basic type, or modified by parallel capacity, connected across the primary winding of an intervalve transformer which is connected in the anode circuit of a valve. He implies that the behaviour of the tone-correcting circuit used in this way will not be essentially different, except as to the step-up ratio of the transformer, from its behaviour in the normal connection. This is not quite correct. The resulting characteristic is very profoundly modified by the natural resonance of the transformer. It is well known that such a resonance exists in the ordinary connections of such transformers, but the resonance is then so flattened by the high series resistance of the associated valve as to produce no very pronounced effect on the audio-frequency response. The case is quite different when the high valve resistance is short-circuited by a comparatively low resistance tone-correcting circuit, as shown in Fig. 7. The transformer resonance now plays a large part in the nature of the response. Curve (*a*) of Fig. 8 shows the measured response for the case illustrated in Fig. 7. Curve (*b*) of Fig. 8 shows, for comparison, the characteristic of the same correcting circuit alone shunt-connected as in Fig. 4. It will be seen that while at low frequencies, the only effect of the transformer is to give its normal $3\frac{1}{2}:1$ step up in voltage, at the higher frequencies the behaviour is essentially that of a resonant circuit. Thus at 9 kc/s. the amplification is about nine times that of the correcting circuit alone, reaching the very high figure of 65. This form of correction characteristic would probably be very suitable for certain types of receiver, particularly in view of the sharp cut-off beyond the resonant frequency. The latter could be brought lower in the scale if required by connecting a small capacity across the secondary. The steepness of the resonance is also controllable to some extent by connecting a variable high resistance (up to one megohm or so) across the secondary. It should be noted that the normal requirement in relation to audio-frequency transformers, *i.e.*, a primary impedance high compared with the valve resistance, is not necessary in the present application, though it is necessary that the primary impedance shall be high compared with that of the correcting inductance. This makes it possible to use valves of considerably higher voltage factor than would normally be permissible. As an extreme case, a valve with a voltage factor of 50 (a.c. resistance about 40,000 ohms) was used, with a correcting circuit consisting of an inductance of 500 mH. in series with 5,000 ohms connected across the primary winding of a $3\frac{1}{2}:1$ transformer. The resulting characteristic was of the same type as curve (*a*) in Fig. 8, and the maximum amplification reached the high figure of 80. The resonant frequency was rather low, however, *i.e.*, 6,500 c/s., and a receiver embodying this stage would therefore show a rather sharp cut-off from about 6,000 c/s. onwards.

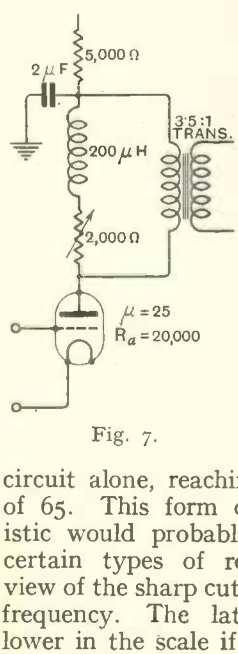


Fig. 7.

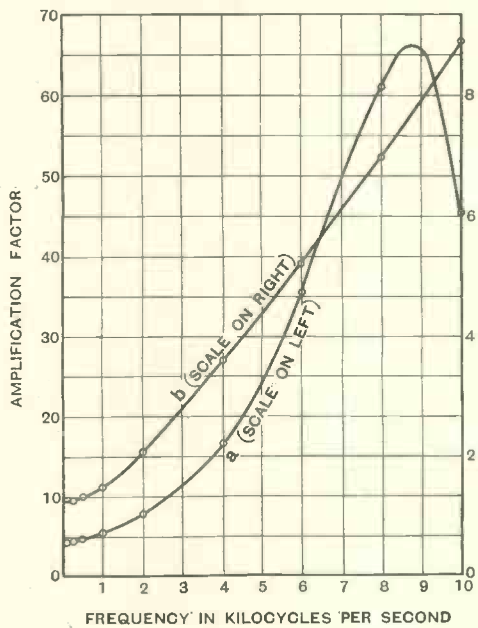


Fig. 8.

In the above transformer circuits it was found that the interpolation of a 2 μF. condenser between the correcting circuit and the primary winding of the transformer, eliminating the d.c. anode current from this winding, produced no appreciable effect in the response.

The transformers used in the above measurements were of well-known commercial types intended for use in normal audio-frequency amplification. It is possible that some difference in design would be appropriate to the present application, but this matter has not been considered in the course of the present work. While it is possible that a suitable modification of design would make permissible a higher ratio than the usual $3\frac{1}{2}:1$, such higher ratios would probably lead to a correspondingly greater susceptibility to secondary capacity. A commercial $7:1$ intervalve transformer was actually tested in a circuit of the kind under consideration, but found quite unsuitable, as the resonance occurred as low as 4,000 cycles. A number of output transformers, with lower primary impedances, were also tried, but it was found that the primary impedance was too low compared with that of the correcting circuit to give the desired type of characteristic. Of the commercial types now available, it appears that the standard $3\frac{1}{2}:1$ is the most suitable, and, in conjunction with a valve of voltage factor about 30, will give a tone-correcting characteristic of shape appropriate to a two-circuit side-band attenuation with a maximum amplification of about 60 and a cut-off at about 8 kc/s.

6. Harmonic Distortion in Tone-corrected Reception.

The steeply rising audio-frequency characteristic of a tone-correcting stage of amplification makes necessary a very careful consideration of the question of harmonic distortion. In the article listed as No. 4 in the bibliography, Dr. N. McLachlan described the possible disastrous consequences of tone-correction in this respect.

It will now be shown that given due care in design, a tone-corrected type of receiver may be expected to be quite satisfactory in the matter of harmonic distortion, and may even be claimed to have some advantages in this respect over receivers of ordinary type.

(a) Harmonics arising from detector action.

Dr. McLachlan has called particular attention to the effect of the rectifier in tone-corrected receivers, and describes a truly linear rectifier as being "absolutely essential" if serious harmonic distortion is to be avoided. On the contrary, a tone-corrected receiver may be expected to be unusually free from the distortion consequences of rectifier curvature as compared with receivers in which side-band attenuation does not occur. This follows from the fact that any given degree of tone-correction implies a corresponding degree of side-band attenuation at the modulation frequency concerned. This again implies a corresponding reduction in effective modulation percentage at the rectifier input and a more than proportional reduction of harmonic production in consequence.

Consider, for example, the well-known second harmonic production by a square law detector. It is known that the relative (percentage) intensity of second harmonic to fundamental will be about one-quarter of the modulation percentage. Given a side-band attenuation function $1/f(n)$, the original modulation percentage M at frequency n becomes $M/f(n)$ at the rectifier. This, with a square law rectifier, will give a second harmonic percentage of about $M/4f(n)$. The tone-correction factors for fundamental and harmonic will be respectively $f(n)$ and $f(2n)$. The resulting percentage second harmonic distortion after tone-correction will therefore be

$$\frac{f(2n)}{\{f(n)\}^2}\,\frac{M}{4}$$

and the ratio of this to the distortion given by an ideally flat receiver will therefore be

$$\frac{f(2n)}{\{f(n)\}^2}$$

Fig. 10 shows the variation of this factor with n for some cases of single circuit selectivity. It will be seen that the tone-corrected receiver may be expected to be very much superior in this respect to the "flat" receiver at all except the very lowest frequencies, when the difference is in favour of the flat receiver but is not of any significant magnitude.

A detailed examination will show that similar conclusions will apply in general to tone-correction of higher order.

It appears, therefore, that instead of a linear detector being "absolutely essential" for this type of reception, the consequences of rectifier curvature will tend to become of less and less importance the higher the selectivity and the higher the corresponding degree of tone-correction.

(b) Harmonic distortion arising from asymmetry of radio-frequency resonance.

It is known that any disturbance of the phase and amplitude symmetry of the side waves of a pure tone modulated continuous wave introduces harmonic distortion into the envelope, which harmonic distortion will be present in the rectified response to an extent depending on the type of rectification. It might be anticipated that appreciable harmonic distortion could arise from this cause in tone-corrected receivers, due to asymmetry in the radio-frequency resonance curve.

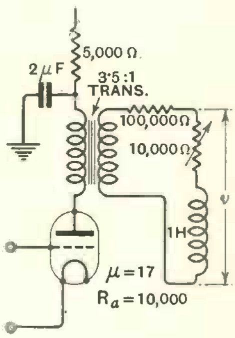


Fig. 9.

For the linear rectifier, the total suppression of one side wave can be taken as representing an extreme case of asymmetry and consequent distortion. The problem then reduces to the rectification of a heterodyne combination. This matter is discussed in very full detail in the paper listed as No. 5 in the bibliography. From the date given in this paper it will be apparent that the reduction of modulation percentage due to the side-band attenuation results in a very small harmonic content in the envelope of the heterodyne combination. Thus, for example, with 10 per cent. modulation at the rectifier, the second harmonic will only be 2 per cent. of the fundamental, the third 0.1 per cent., and so on. Bearing in mind that the total suppression of one side wave by asymmetry in resonance will be an extreme case not likely to arise in practice, it will be seen that such asymmetry as may actually occur is not likely to give rise to any serious degree of harmonic distortion.

(c) Harmonic distortion arising from curvature in the characteristic of the tone-correction valve.

In ordinary audio-frequency amplification the impedance of the load in the anode circuit is made large compared with the a.c resistance of the valve. In consequence, the variation of the latter with amplitude, arising from curvature of the valve characteristic, produces a much less than proportional variation in the wave form of the amplified voltage. This saving condition does not apply in the case of the tone-correction characteristics so far described, and the harmonic distortion arising from this cause and exaggerated by the frequency characteristic of the load is certainly an important factor of which account must be taken in the design of tone-corrected receivers.

In order to determine the magnitude of the harmonic distortion due to this cause, a number of measurements were made of the total harmonic content of the amplified voltage given by typical tone-correction circuits of the kinds described in the preceding sections. The measurements were made by means of the harmonic content bridge, of which a description is given in the paper listed as No. 7 in the bibliography. Of the numerous arrangements measured, the following are quoted as typical examples :

Case.	Valve.	Anode Circuit Load.
A	μ 50 R_a40,000	a.f. choke, with parallel circuit consisting of 500 mH. in series with 5,000 ohms.
B	,, ,,	,, ,, ,, with 500 $\mu\mu$F. in parallel with the inductance.
C	μ 17 R_a10,000	a.f. transformer, 3½ : 1 ratio, with 100 mH. and 1,000 ohms in series across primary.

Of these, A gave a characteristic of the type of curve (*b*) of Fig. 5, and B and C a more steeply rising characteristic of the type of curve (*a*) of Fig. 5.

The results of the measurements are given in the following table. The input voltages were measured in the manner already described, and the output voltages calculated from the previously measured amplification characteristics of the circuits concerned. The harmonic content is given as the R.M.S. value of the total harmonic expressed as a percentage of the R.M.S. value of the full wave.

It will be observed that the harmonic content does not depend appreciably on frequency but is mainly determined by the output voltage. If the latter is kept below about 2 volts R.M.S. the harmonic content will not exceed about 5 per cent.

Case.	Frequency : c/s.	Input Voltage.	Output Voltage.	Percentage Harmonic Content.
A	1,000	0.47	1.41	3.2
		0.77	2.21	5.8
		1.12	3.36	9.85
		1.34	4.02	13.0
A	500	0.41	1.07	2.2
		0.69	1.79	4.1
		1.06	2.76	7.5
		1.33	3.46	10.3
B	1,000	0.41	1.23	2.75
		0.69	2.07	5.15
		1.12	3.36	10.15
		1.34	4.62	13.5
C	500	0.41	1.93	1.5
		1.06	2.86	4.1
		1.33	3.59	5.5
		1.61	4.35	8.05
C	2,000	0.28	1.77	2.6
		0.67	4.32	7.0
		1.08	6.94	13.4

It appears, therefore, that if the tone-correcting stage is followed by a single amplifying stage giving an amplification of, say, 30, an output voltage of up to about 60 volts should be permissible without introducing excessive harmonic content on account of the tone-correcting stage. This leaves a very wide margin on normal practical requirements. Provided, therefore, that the tone-correction stage is not called upon to supply a loud-speaker output valve directly, there seems no reason to anticipate excessive harmonic distortion due to the curvature of the tone-correction valve characteristic.

7. An Alternative Form of Transformer Tone-correction Circuit.

The consequences of valve characteristic curvature discussed in the preceding section could be minimised by using a circuit in which a high impedance load was maintained in the anode circuit at all audio-frequencies. Such an arrangement is illustrated in Fig. 9. This circuit was tested for harmonic distortion, and found to be about twice as good in this respect as those already described, *i.e.*, an output voltage of up to 4 volts could be obtained with a total harmonic content of less than 5 per cent. It gave a characteristic of the linear type of curve (*a*) of Fig. 5, in accordance with theory, and would probably give the more steeply rising characteristic of the type of curve (*a*) of Fig. 6 with suitable tuning of the inductance. On the other hand, the amplification was low—only about 8 at the maximum value. This could doubtless be increased up to 15 or 20 by using a higher inductance than the 1 Henry shown, but this would mean either a rather bulky or a rather high resistance coil, since an iron core would introduce harmonic distortion of its own. Thus, though superior in respect of harmonic distortion, this circuit is somewhat expensive and inefficient in amplification and is, therefore, unlikely to find much practical application.

8. Summary and Conclusions.

The foregoing description of tone-correction circuits is not claimed to be in any sense exhaustive. It is realised that there are many alternatives to the circuits described [6]. In particular, the use of coupled circuit or filter circuit impedances for giving high degrees of tone-correction has not been explored, since one of the objects of the work was to find the simplest and most convenient ways of obtaining suitable characteristics.

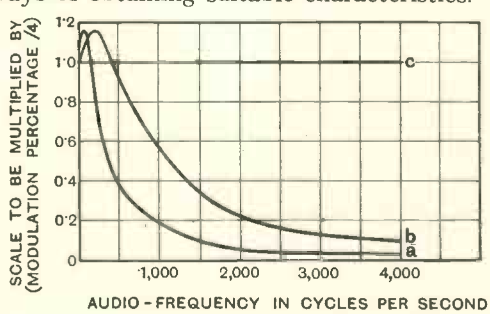


Fig. 10.—*Curves showing percentage 2nd harmonic distortion due to square-law rectification for :—(a) very highly selective circuit ($R/\omega L = 10^{-4}$) with tone correction, (b) highly selective circuit ($R/\omega L = 10^{-3}$), with tone correction, (c) "flat" circuit ($R/\omega L = \infty$), with uniform audio amplification.*

It has been shown that with the comparatively simple circuits described, a linear or single circuit tone-correcting amplification up to about 20, and a more steeply rising or double circuit tone-correcting amplification up to about 60, can be obtained in a single stage. In the latter case the circuit can be designed so as to give a fairly sharp cut-off at 8 or 9 kc/s., a condition which is probably desirable for most cases of broadcast reception.

The circuits described have all been tested qualitatively under actual conditions of broadcast reception and appear to behave in accordance with the theory stated, without any noticeably undesirable effects attributable to transient states.

In the matter of harmonic distortion, it has been shown that the high selectivity tone-corrected type of receiver may be expected to be comparatively free from harmonic distortion arising from rectifier action and from asymmetry in the radio-frequency resonance curve, but liable to some degree of harmonic distortion due to the curvature of the valve characteristic of the tone-correcting stage. This element of distortion can be restricted to less than 5 per cent. by a suitable limitation of the output voltage of the tone-correcting stage.

The work described was carried out in the Wireless Division of the National Physical Laboratory, under the supervision of Dr. R. L. Smith-Rose. It arose in connection with an investigation of highly selective tone-corrected receivers, directed by a Committee of the Radio Research Board, under the Chairmanship of Professor E. V. Appleton. It is published by permission of the Department of Scientific and Industrial Research.

* Since the above was written a paper by M. V. Callender, "Problems in Selective Reception," has been published (*P.I.R.E.*, Sept. 1932, Vol. 20, pp. 1427–1455). This paper gives additional information on some of the matters considered above, particularly in relation to combination tones produced by rectifier action.

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A New Abac for Single-layer Coils.*

By Hideo Seki.

THE formula for calculating the self-induction of single-layer coils by means of Nagaoka's constant K, which is a function of d/l, is satisfactory. But there is still a need for methods of calculating inductance rapidly and more simply. Abacs for calculating the inductance of a coil were published by A. Fischer (*Wireless Engineer*, p. 450 of August, 1931 Abstract) and a method of calculating the diameter of a coil with a given inductance (page reference as before) was published by A. Müller. More recently W. G. Hayman has published *Approximate Formulae for the Inductance of Solenoids and Astatic Coils* (*Wireless Engineer*, p. 570 of October, 1931 Abstract). The author has constructed an alignment chart for finding rapidly the diameter of a coil having any length and inductance. The chart is shown in the figure, where:

L = inductance of the coil.

d = diameter of the coil in cm.

l = length of the coil in cm.

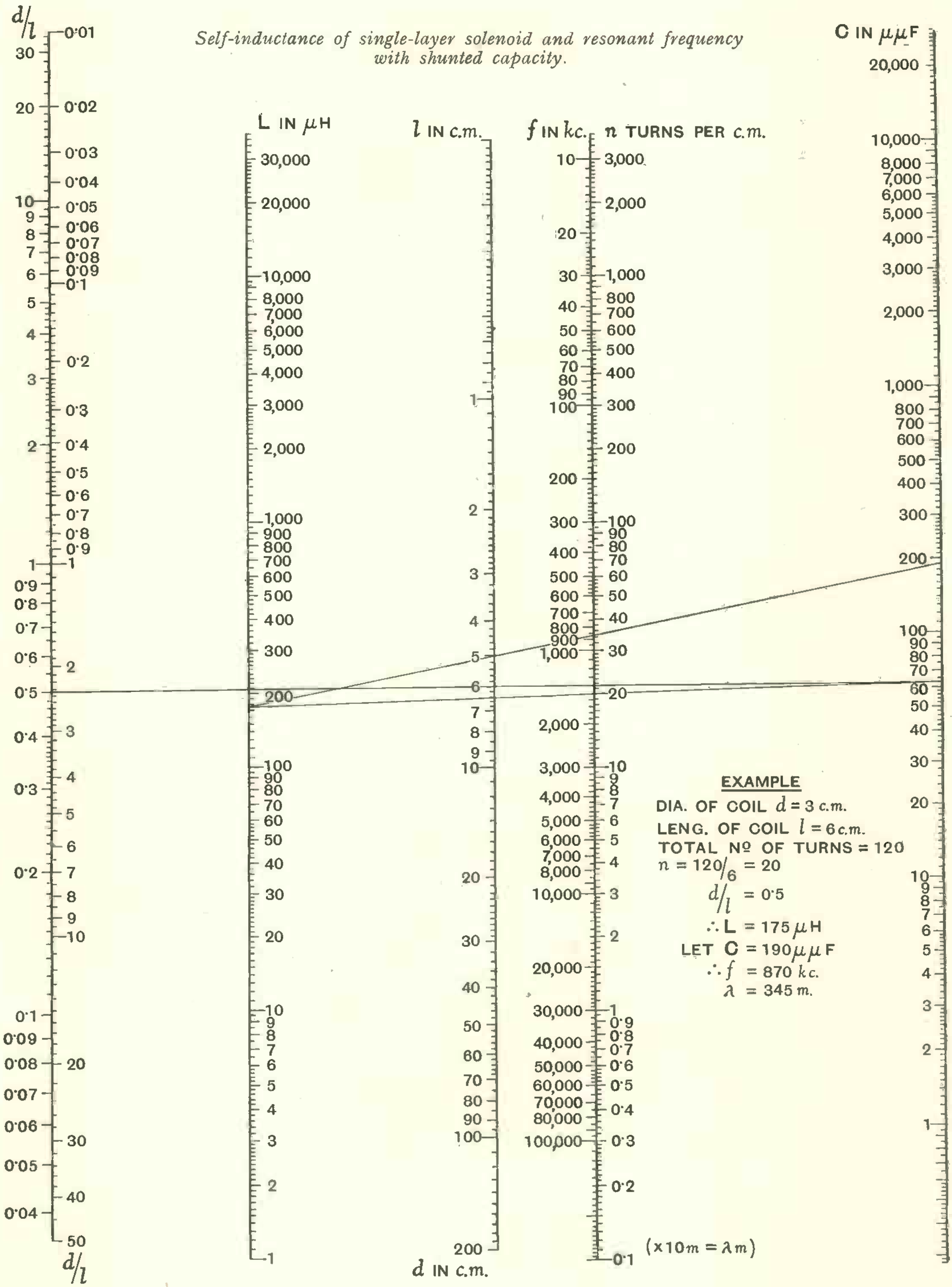
n = number of turns of wire per cm. of axial length.

The numerical example shows the method of utilising this chart. It should be noticed that the middle scale must be considered the l (cm.) scale, if the left-hand side of d/l scale be used, and the d (cm.) scale, if the right-hand side of d/l scale be used.

Finally, the calculation of the resonant frequency with the shunted capacity C $\mu\mu$F. can also be determined from the chart.

* MS. received by the Editor, June 1932.

Self-inductance of single-layer solenoid and resonant frequency with shunted capacity.



Recording Field Strength.*

Equipment Used by the B.B.C. for Automatic Measurement.

By C. H. Smith, B.Sc., A.M.I.E.E.

(Research Department, British Broadcasting Corporation).

EXTENSIVE investigations of night fading phenomena in which simultaneous measurements on certain transmitters are taken in various parts of Europe by the respective broadcasting organisations have been organised by the Union Internationale de Radio-diffusion. The British Broadcasting Corporation took part in these tests and, since continuous observations for a period of six hours were required, a field-strength measurer capable of operating a recording milliammeter had to be constructed. Several features were incorporated which may be of interest to other engineers.

The desirable characteristics of any such set are that it should be selective, easily tuned, simple to calibrate, and stable in operation. In the present case, however, it was necessary to have sufficient selectivity to be able to receive without interference weak foreign stations on frequency channels adjacent to those of British transmitters, and to allow for possible changes of field strength by as much as 50 to 1 during the course of an evening. The period over which the records were to be taken was from 6 to 12 p.m. B.S.T., and it was therefore necessary to construct apparatus in which the calibration would remain unchanged during this period and which could be calibrated during the daylight period when the transmitter to be recorded gave a signal too weak to read, or was inaudible.

To satisfy these requirements it was decided to depart from the usual superheterodyne practice and construct an audible heterodyne receiver working on a frequency of 1,500 cycles per second with sharply tuned low-frequency intervalve couplings to give selectivity, and a calibrated L.F. volume control to extend the range of the set during fading periods. An occasional observation of the heterodyne note in the telephones served as a satisfactory check

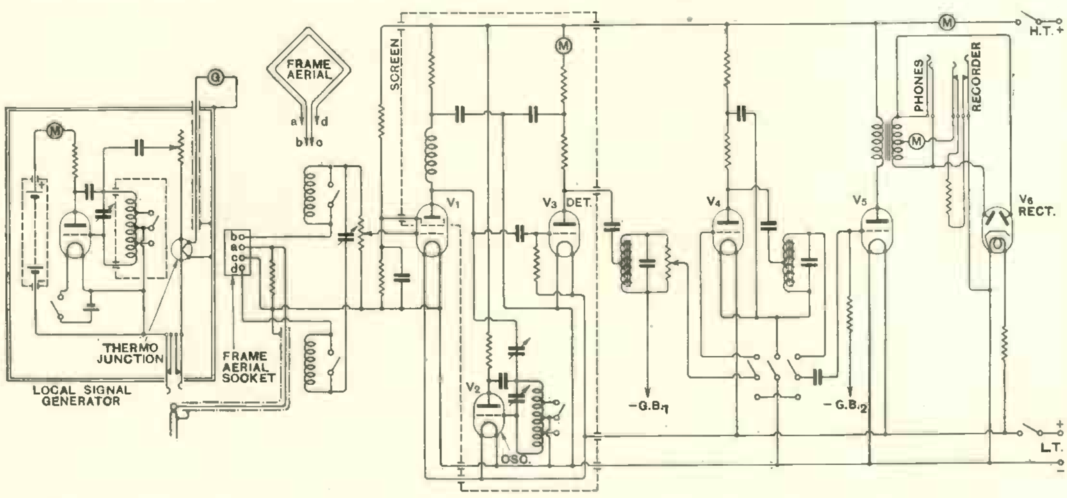


Fig. 1.—*The local signal generator and amplifier which, together, form the essential apparatus for the field strength recorder.*

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

on the correct functioning of the set. The local signal generator conformed to standard practice, but the method of calibrating the set is unusual and is of interest in view of its directness in subsequent operation.

The detailed circuit of the amplifier is shown in Fig. 1. The frame aerial consists of six turns of approximately one metre square and is wound in two sections. Across the outer terminals of the frame is connected a non-inductive resistance of about one ohm consisting of about one inch of No. 44 s.w.g. Eureka wire which is used for calibrating purposes, and one side is earthed. The tuning condenser is connected across the two inner terminals of the frame, and one side is connected through a 100,000-ohm potentiometer (the purpose of which will be explained later) to the grid of an S610 valve. A loading coil is provided with a switch for wavelength changing.

The anode impedance of the first valve consists of an H.F. choke (0.1 henry). A tuning circuit is dispensed with in this stage for the sake of simplicity; its absence is, however, compensated for by the fact that since the anode load is capacitive throughout the medium wave-band the amplification will be inversely proportional to frequency, whereas the effective height of the frame aerial is directly proportional to frequency, so that the overall sensitivity of the set is maintained approximately constant.

The detector valve (H610 or LS5B), operating on the grid-leak principle, is also connected through a small condenser of 25 $\mu\mu$F. maximum capacity to a heterodyne oscillator V_3 (H610 or LS5B), which is normally tuned to beat with the incoming signal with a frequency separation of about 1,500 cycles per second. The coupling condenser between the oscillator and detector valves is so set that the input to the detector brings the operating point to the middle of the straight part of the detector characteristic (about 1.5 volts). The heterodyne output is then practically independent of changes of the strength of the local oscillator due to battery variations, and demodulation and wipe-out effects are at a maximum. This adjustment holds reasonably well over the whole of the tuning range, which is 200 to 500 and 800 to 2,000 metres.

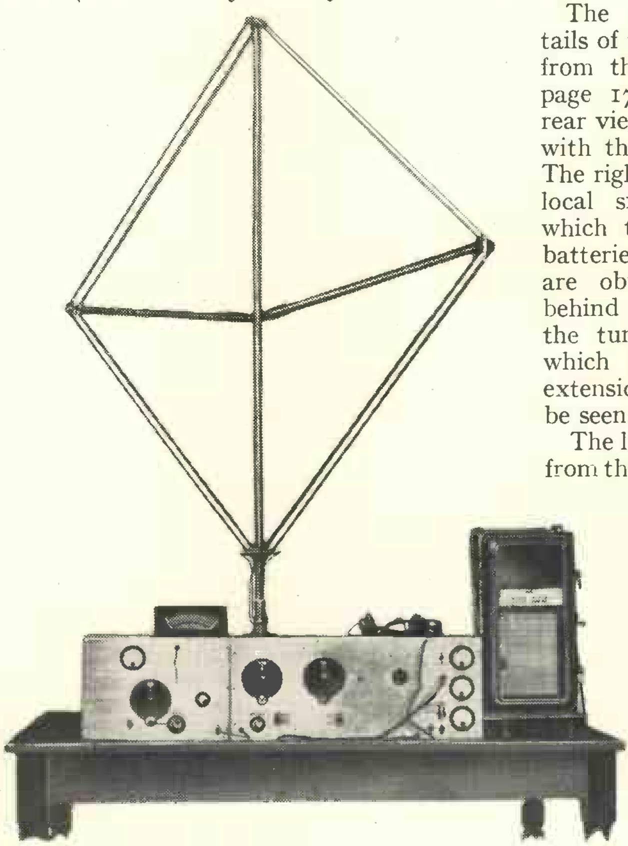
The detector valve is followed by a two-stage audio-frequency amplifier V_4, V_5, of which the first valve is of the high-magnification type (H610 or LS5B) and the second is of the power type (LS5 or PM256). The coupling chokes are wound to 14 henrys inductance on a stalloy core, air gapped to improve the phase angle, and tuned each by a 0.0008-μF. fixed condenser to resonate sharply at 1,500 cycles per second. The anode tap is made to include one-third of the total turns of the choke.

Each coupling choke is followed by a 200,000-ohm resistance, the first of which is made in the form of a potentiometer connected to a stud switch so that the amplification of the set can be reduced in the ratios 2, 5, 10, or 20. This, together with the switch which throws one of the amplifying stages out of circuit, gives a total change of amplification of about 800 : 1.

The output of the second stage is connected through a step-down transformer with a centre-tapped secondary to a UU60/250 mains rectifying valve, and the meter is inserted as shown between the centre point of the transformer secondary and the rectifier filament negative. This meter is mounted on the front of the panel, and the recorder is inserted in a series break-jack which, when the recorder plug is removed, inserts an equivalent resistance in circuit. A listening plug across the transformer secondary to take 2,000-ohm telephones completes the vital parts of the circuit.

The rectifier valve used is of the indirectly heated type, and can be made to give a remarkably straight characteristic. The cathode is connected internally to one side of the filament, and it is this filament pin which must be made the L.T. negative connection in order to get a satisfactory rectification characteristic. Unfortunately, however, no rule can be given concerning this connection, for in different batches of valves the cathode connection is made variously to either filament pin, and the correct connection can only be found by experiment. It may be determined by observation of the standing current of the valve when in circuit without signal. The standing current should be such as would be produced by an effective positive bias of one volt. It is a fortunate accident that with this valve and circuit the straight part of the rectification characteristic is such that it would, if extended, pass through the origin of co-ordinates, as shown in Fig. 2, and it follows, therefore, that output currents above a certain minimum value will be directly proportional to the input voltages which produce them.

The local signal generator for calibrating purposes is in a screening box of ⅛in. aluminium on the left of the set. Screening is made as complete as possible by enclosing the coil in an inner screening box of copper, and by enclosing both H.T. and L.T. batteries (a 60-volt dry battery and a 2-volt



Recording Field Strength Measurer in operation.

accumulator) in the outer case. Across the tuning circuit of the oscillator is connected in series a 0.0001-μF. fixed condenser, a variable 100,000-ohm resistance, a thermo-couple convenient for reading about 1 milli-ampere, and a break-jack, one side of which is earthed. Connection to the receiver is made by inserting into the break-jack a plug terminating a single-wire copper-braided cable, the braiding of which forms the return path. This lead is connected across the 1-ohm resistance at the centre of the loop, the braiding being connected to the earth side of the resistance and the earthed side of the socket in the local-signal generator panel. A galvanometer which is housed in a recess in the top of the box is connected to the thermo-couple by a similar braided cable, which is also earthed.

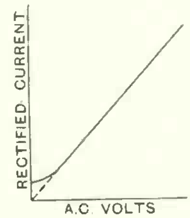


Fig. 2.—*The characteristics of the indirectly heated mains rectifier—the UU60/250.*

The constructional details of the set can be seen from the photograph on page 17, which shows a rear view of the apparatus with the covers removed. The right-hand unit is the local signal generator in which the H.T. and L.T. batteries and the valve are obvious. The box behind the valve and L.T. battery contains the tuning coil and wave-change switch, which is operated from the front by an extension handle. The thermo-couple can be seen in the left-hand corner.

The layout of the amplifier is also apparent from the photograph. On the right-hand side can be seen the four-pole telephone socket into which the frame aerial plugs, the thrust being taken by a bearing in the lid. The next compartment, which is normally closed by an inner copper screen, contains the first detector and the local oscillator valves.

The small neutralising condenser mounted on the baseboard is the coupling condenser from oscillator to first detector, and a similar one mounted on the panel acts as vernier to the oscillator tuning condenser.

In the left-hand compartment of the set can clearly be seen the L.F. potentiometer, one of the coupling chokes with the tuning condensers mounted above, and the final amplifier and second detector valves below the grid bias battery.

The external appearance of the set can be seen from the photograph on this page. The left-hand unit is the local signal generator, the knobs being, reading from left to right, L.T. switch, tuning condenser, wave-change switch, and output control. The galvanometer operated by the thermo-couple is shown half out of the recess in which it is normally housed.

The braided cable by which the local signal is injected can be seen emerging through a bushed hole in the bottom left-hand corner of the amplifier, and plugging into a socket in the bottom right-hand corner of the local signal generator.

The two large dials on the amplifier are frame and local oscillator tuning condensers. The lower left-hand knob is the H.F. volume control, and to the right of this are the wave-change switches. The small knob to the right of the oscillator tuning condenser is the vernier, and to the right again is the L.F. potentiometer. There are, then (reading downwards), two plugs for inserting the recorder and telephones, a switch for cutting one valve out of circuit, and the H.T. and L.T. main switches. The three meters indicate rectified current, first detector feed, and total feed. The recording milliammeter stands on the extreme right. The framework of the loop is made of ash, and is collapsible. The weight of the aerial is taken by a bearing on the lid, but the framework terminates in a four-pole plug, which connects with a socket mounted inside the amplifier.

When using the instrument for measuring and recording field strengths no attempt is made to equate the output of the local signal generator to received signal. Instead, adjustments are preceded by a calculation as follows :—

Let r = calibrating resistance at the centre of the loop,

A = area of loop,

N = number of turns,

λ = wavelength of station to be measured,

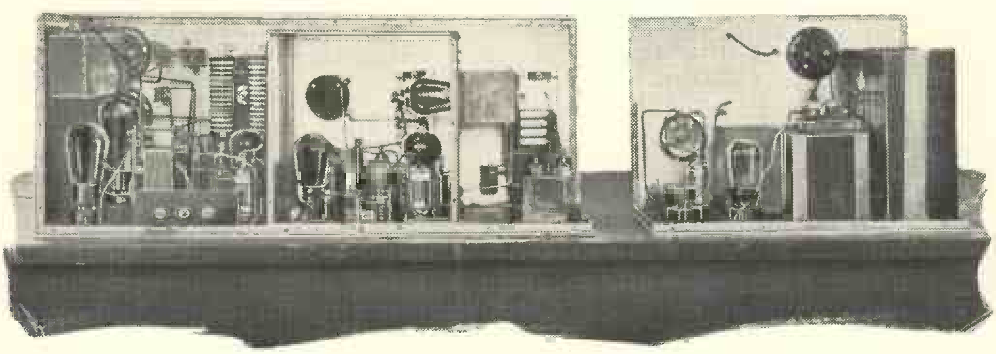
i = current through thermo-couple and calibrating resistance,

and let E represent field strength in milli-volts per metre.

Then a current i through the calibrating resistance will produce a voltage ri in the aerial circuit, and a field strength E will produce a voltage $\frac{E \,.\, NA \,.\, 2\pi}{\lambda}$. If these two sources of signal produce equal deflections on the recording milliammeter, we may write :

$$ri = \frac{E \,.\, NA \,.\, 2\pi}{\lambda}, \text{ or } i = \frac{2\pi EN \,.\, A}{\lambda r}$$

In this formula a value for E is substituted, which is a round number of milli-volts per metre (usually 10) corresponding to a value of i in the neighbourhood of 1 milli-ampere, and the corresponding value of i is calculated.



Rear view of Field Strength Measurer with covers removed.

The local signal generator is now tuned to the same frequency as the station to be recorded. If the transmitter is operating or is audible, the local signal generator can be tuned to exact synchronism, but this is by no means necessary, as the sensitivity of the set changes very slowly with wave-length.

The output of the local signal generator is adjusted to the previously calculated value and the set carefully tuned to give maximum output, the loop being turned in the direction of minimum pick-up from the transmitter if any appreciable interference occurs.

With the L.F. volume control on stud 3 (1/10 scale) the H.F. volume control is adjusted until a full scale deflection on the recording meter is obtained. We are now in a position to say that since a full scale deflection on range 10 corresponds to 10 millivolts per metre, a full scale deflection on range 1 corresponds to 1 millivolt per metre, and so on.

The local oscillator is now switched off, the L.F. volume control restored to range 1, and the set carefully tuned to the required transmitter with the frame aerial pointing in the direction of maximum pick-up. The recorder will now be operating with a full scale deflection of 1 millivolt per metre, and if during the course of a record the received signal fades up above this value the amplification of the set can be immediately changed by means of the L.F. potentiometer to give a full scale deflection of 2, 5, 10, or 20 millivolts per metre, as required.

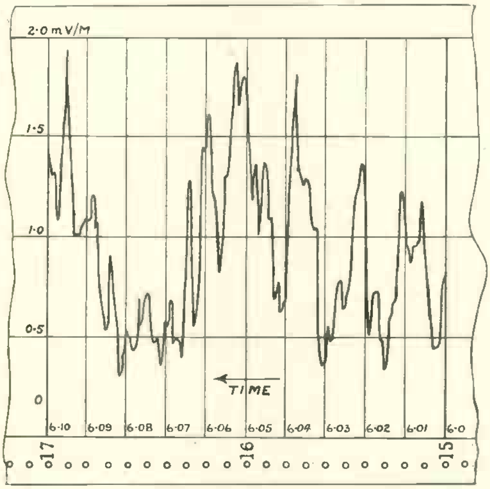


Fig. 3.—*Part of the actual record taken between 6 p.m. and 6.10 p.m. on the North National transmitter during the evening of October 22nd, 1931.*

The first model made to this design was arranged to cover the waveband of 200 to 550 and 1,000 to 2,000 metres. The apparatus has been in almost continuous use now for some months, and field strength records for periods of six hours have been taken of many European broadcasting stations on the medium and long waves. A sample chart is shown in Fig. 3 which represents a portion of a record taken on the North National transmitter at Tatsfield during the evening of October 22nd, 1931. The complete chart shows the following cycle of field strength values :—

Time.	Maximum Field Strength (mV/metre).
Midday	0.1
5 to 6 p.m.	1.9
6 to 7 p.m.	3.5
7 to 8 p.m.	6.6
8 to 9 p.m.	3.0
9 to 10 p.m.	2.1
10 to 11 p.m.	2.1

Experience has shown that by taking records over a period instead of a number of individual readings much more information can be obtained with much less labour, and since the principles on which the apparatus has been designed have proved to be satisfactory in practice a second field strength measurer has been constructed on similar lines to cover the wavelengths between 50 and 250 metres.

The U.S.A. Patent "Pool."

THE legality of the patent position built up under the control of the Radio Corporation of America has been in dispute for some considerable time. Two and a half years ago a writ was issued against the Corporation on the ground that the wholesale concentration of patent rights in their hands constituted an abuse of the limited monopoly contemplated by patent law. It was alleged that the position so created was a breach of the Sherman Anti-trust law, and prejudicial to the interest of the wireless industry as a whole.

That allegation has now been justified so far as one can judge from the terms of a "consent decree" which has just been accepted by the principal patentee companies concerned, namely the R.C.A., the G.E.C., and the Westinghouse Electric and Manufacturing Co. The principal effect of the decree is to break up the existing partnership, and with it the patent "pool."

The two latter companies are to distribute to their shareholders half their present holdings in the Radio Corporation within three months, and the remaining half within the next three years. To meet their resulting liabilities, the R.C.A. in return have agreed to transfer to their former partners in the "pool" certain freeholds, together with an issue of ten-year bonds to the value of over four million dollars.

The R.C.A. are associated with the Victor Talking Machine Co., and through them with the Columbia Graphophone Co., Ltd., and the Electrical and Musical Industries, Ltd. The decision has already given rise to considerable repercussion in the States, and is not without interest to the radio industry in this country.

The Use of Triode and Tetrode Valves for the Measurement of Small D.C. Potential Differences.*

By T. P. Hoar, B.A., B.Sc.

1. Introduction.

THAT the thermionic valve offers a convenient means of measuring potential difference has long been recognised (1), and recently a large and widely diffused literature dealing with valve potentiometers and electrometers has appeared. It is the purpose of this article to summarise the various modifications which have been proposed, to indicate some of the practical difficulties which arise, and to suggest suitable circuits for use in particular problems.

2. Principle of the Method.

For a given P.D. between the grid and filament of a triode, a definite anode current flows. Fig. 1 shows the early circuit of Goode (2), in which the unknown E.M.F., *X*, is placed in the grid circuit, and the corresponding anode current read on the galvanometer *G*. By means of a suitable shunt and/or a back E.M.F. in the anode circuit, *G* can be made to have any desired scale, and may be calibrated to read *X* directly in volts.

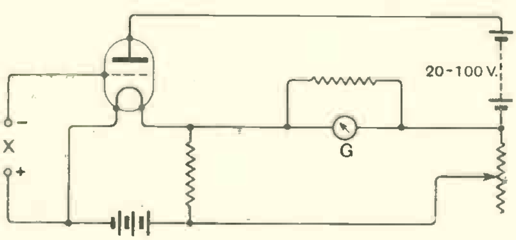


Fig. 1.

Since *X* is in the grid circuit, the current taken from it is almost zero; thus the arrangement possesses the advantages of a direct-reading voltmeter without taking the comparatively large current required by such an instrument.

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

The original simple circuit presents three main drawbacks:

(1) The sensitivity is not great (the accuracy is thus limited to $\pm$ 0.006 volts).

(2) The grid current through *X*, though small ($< 2.5 \times 10^{-6}$ amps.) is finite, and may be of major importance in many cases.

(3) There is a "zero drift," which makes frequent calibration necessary and automatic recording over long periods impossible.

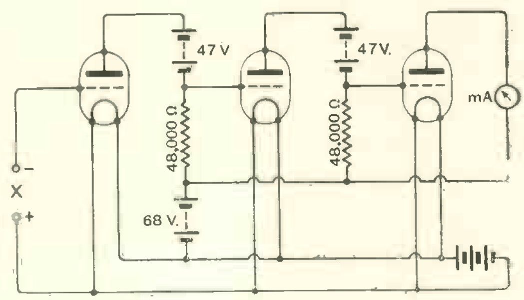


Fig. 2.

These difficulties may be separately overcome in a variety of ways, and are dealt with in what follows.

3. Sensitivity.

The most obvious way of increasing sensitivity is to use a one- or two-stage amplifier with resistance coupling (Fig. 2), as proposed by Goode (3) in a further paper; Goode obtained a sensitivity of 4 ma. in the final anode circuit per volt change in *X*. But since the zero drift is necessarily magnified as well, not much improvement in accuracy is to be expected.

For accurate work, it is necessary to sacrifice the direct-reading character of the apparatus and use a null method. The balanced circuit due to Morton (4) is shown in Fig. 3. With the switch *S* at (*a*), the sliders on R_1 and R_2 are adjusted so that no current flows through the sensitive galvanometer *G*. *S* is then thrown over to (*b*) to bring the unknown E.M.F. *X* and an opposing E.M.F. from the calibrated potentiometer *P* into the grid circuit, and *P* is adjusted until there is again no deflection of *G*. When this balance is obtained, the potential drop

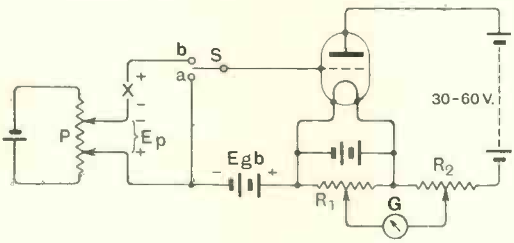


Fig. 3.

across *P* is equal and opposite to *X*, and may be immediately read.

The ingenious "null ballistic" circuit of Morton (5) avoids anode circuit balancing altogether by the use of a large capacity condenser *C* in series with the galvanometer (Fig. 4). In general, the opening and closing of *S* will alter the grid potential, and the fluctuation of the anode current caused thereby will produce a kick in G. The grid circuit balancing potentiometer *P* is therefore adjusted until *G* gives no kick when S is opened or closed; *P* is then giving an E.M.F. equal and opposite to *X*. This circuit ensures complete absence of zero drift, but employs a special type of "electrometer" valve (see later) and does not allow of very rapid readings being taken.

Both these types of null method enable a galvanometer such as will give a high degree of sensitivity to be used, as it does not have

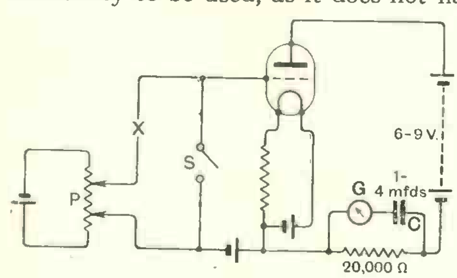


Fig. 4.

to carry the main anode current. Accuracy is thus limited only by the rate of zero drift and the degree of fineness of adjustment of the balancing potentiometer *P*, and, apart from considerations to be advanced in the next section, may be as good as ± 0.0001 volt.

4. Grid Current.

We must now consider the errors introduced by the current in the grid circuit, which, though small, is finite. In practice, the unknown E.M.F. *X* is often that of a cell of high resistance (*e.g.*, a glass-electrode cell), say of the order of 100 megohms. If the grid current i_g ampere is flowing through this, it will produce a potential drop of $10^8 i_g$ volt across the cell, and the observed voltage will be in error by this amount. Now the grid current of the average hard valve when used under the conditions of Fig. 3 to measure the E.M.F. of such a cell is about 10^{-9} ampere, so the error is as great as 0.1 volt.

It is possible to eliminate this error in

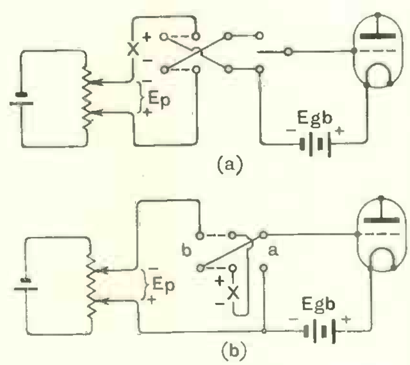


Fig. 5.

two ways. In Fig. 5(a), the unknown E.M.F. and the balancing potentiometer are shown connected to the grid circuit through a reversing switch (6). The balancing E.M.F's E_p and E_p' are found for both positions of the switch. The grid potential E_g is the same in each case, and hence

$$E_g = X - E_p - i_g R_x - E_{gb}$$
$$= -(X - E_p') - i_g R_x - E_{gb}$$

where E_{gb} is the grid bias, thus

$$X = \frac{E_p + E_p'}{2}$$

the mean of the two readings. Alternatively (7), the switching may be arranged as in Fig. 5 (b). The anode circuit balance is made with the switch at (*a*), whence

$$E_g = -X - i_g R_x - E_{gb}.$$

On switching to (*b*) and balancing with *P*,

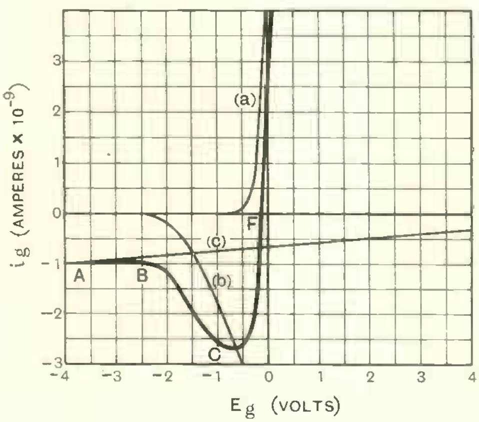


Fig. 6.

we have

$$E_g = (X - E_p) - i_g R_x - E_{gb}$$

and therefore

$$X = \frac{E_p}{2}$$

These methods of eliminating the *iR* error due to grid current do not reduce the current actually flowing through the cell under measurement: if it is an easily polarised cell, it may be necessary to reduce the current to a value many times smaller than 10^{-9} ampere. To show how this may be done, it will be necessary briefly to consider the causes of grid current and its dependence on grid potential.

In general, grid current is the algebraic sum of

(*a*) Electron flow from filament to grid,

(*b*) Positive ion flow from filament to grid,

(*c*) Insulation leakage between grid and anode and filament. Fig. 6 shows the general forms (*a, b, c*) of the relations of these three currents to the grid potential with respect to the filament (8). The thick curve indicates the sum of the three effects and shows the actual grid current over a range of grid potential. Rough magnitudes for ordinary hard valves are given.

The circuits using ordinary valves so far discussed operate at a grid potential near the point *A*, and hence are subject to negative grid current of the order of 10^{-9} ampere.

It is clear that if we can adjust the grid potential to the point *F*, then the external grid current is actually zero, not merely very small. If the circuit of Fig. 3 is modified (9, 10, 11) so that a further potentiometer *P'* (Fig. 7) is included in place of the grid bias battery, it is a simple matter to find the point *F*. With the switch *S open*, *i.e.*, with the grid "floating," the usual anode circuit balance is obtained. The external grid current must be zero, hence the grid potential is precisely that given by *F*. *S* is now closed at (*a*), and *P'* is adjusted until anode circuit balance is again obtained —*i.e.*, the grid is again at the floating potential, and the current through the now closed external grid circuit is zero. On switching *S* to (*b*) and balancing with *P*, the unknown E.M.F. is obtained as before. Clearly, owing to the form of the grid characteristic at the point *F*, the success of the method depends on a close adjustment of the grid potential to *F*, but this is quite readily obtained, and the grid current flowing through *X* is thereby reduced to $<10^{-12}$ ampere (11).

Still more satisfactory is the method of Harrison (12) and others (13, 14) which utilises an "electrometer" valve. This type of valve is designed to have the lowest possible grid current. Electron flow from filament to grid is prevented by placing the grid *outside* the anode; positive ion current is minimised by operating at a very low anode potential, below the ionisation potential of any residual gas in the bulb; and insulation of the grid is made as nearly perfect as possible by bringing the grid support out through the top of the bulb. Valves of this type* operating at the point *A* (Fig. 6) may have a grid current as low as $10^{-14} - 10^{-15}$ ampere. However, the mutual conductance is, as would be expected, very low, and a very sensitive galvanometer is necessary in the

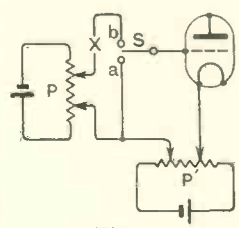


Fig. 7.

* Electrometer valves are manufactured by Philips, G.E.C. (British) and Westinghouse Lamp Co. G.E.C. (American) make the FP54 Pliotron (*see* reference 24), a tetrode with grid current $< 10^{-15}$ ampere.

anode circuit if a high degree of accuracy is to be maintained (15).

5. Extreme Sensitivity.

In measurements where the flow of a current of the order of 10^{-9} ampere through the unknown E.M.F. is permissible, much greater sensitivity than is possible with either the floating grid or electrometer valve methods may be obtained (7, 8). Apart from the sensitivity factor due to the galvanometer, valve sensitivity S may be defined as the change in anode current i_a per unit change in the balancing potential E_p in the grid circuit. Thus if E_g is the grid potential and i_g is the grid current,

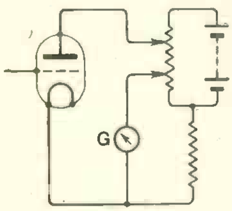


Fig. 8.

$$S = \frac{\partial i_a}{\partial E_p} = \frac{\partial i_a}{\partial E_g} \cdot \frac{\partial E_g}{\partial i_g} \cdot \frac{\partial i_g}{\partial E_p}$$

If X is the unknown E.M.F., E_{gb} the grid bias, and R_x the resistance of the external grid circuit,

$$E_g = X - E_p - i_g R_x - E_{gb}$$

$$\therefore \quad \frac{\partial E_g}{\partial i_g} = -\frac{\partial E_p}{\partial i_g} - R_x$$

and the expression for sensitivity becomes

$$S = \frac{\partial i_a}{\partial E_g} \cdot \frac{\frac{\partial E_g}{\partial i_g}}{\frac{\partial E_g}{\partial i_g} + R_x} \quad (S \text{ is taken as } + ve)$$

$$= g \cdot \frac{1}{1 + R_x \cdot \frac{\partial i_g}{\partial E_g}}$$

where g is the mutual conductance and $\frac{\partial i_g}{\partial E_g}$ is the slope of the grid current characteristic at the operating grid potential E_g (see Fig. 6). At the floating grid potential, point F, $\frac{\partial i_g}{\partial E_g}$ is large and positive, and the sensitivity is consequently poor. But between B and C, $\frac{\partial i_g}{\partial E_g}$ is small *and negative*, so that if R_x is large enough the sensitivity can be made very great. Morton (7) has obtained a sensitivity as great as 38 ma./volt when R_x is about 700 megohms without loss of stability, by operating between B and C — the "critical" potential.

6. Compensating Circuits.

All the systems so far described (save the null ballistic) suffer more or less from zero drift. This may be of no special importance in null instruments provided it is not inconveniently large, but if consecutive readings are to be taken rapidly elimination of zero drift is desirable, and if automatic recording is required it is essential.

The most important cause of zero drift is the decrease with time of the E.M.F. given by the anode battery. Since in the ordinary way the E.M.F. which supplies the balancing current in the anode circuit will be practically constant, frequent readjustment of the balancing rheostats is necessary. Bienfait (16) therefore supplied the balancing E.M.F. from a battery which varied with time in a similar manner to the anode battery, reducing the drift to 1.5 mv. apparent change in X per hour. Razek and Mulder (17) suggest that the main anode current and the balancing current be taken from the same potential divider (Fig. 8) and others (18) have devised similar arrangements. For perfect compensation in this way, it can be shown (17) that the valve must be operated at an anode potential such that it is acting as a purely ohmic resistance, with which condition it is often difficult or impossible to comply.

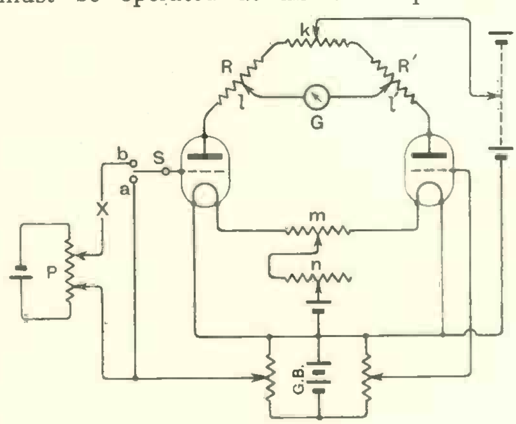


Fig. 9.

The two-valve bridge circuit first suggested by Wold (19) and Bretano (20) for current measurement and developed by many others (6, 21, 22, 23) for potential measurement is much more satisfactory. The essentials are shown in Fig. 9. The valves should have as nearly similar characteristics as possible; the circuit may in fact be regarded as one in which the balancing current through the galvanometer is supplied by the second "dummy" valve. Compensation for both anode and filament

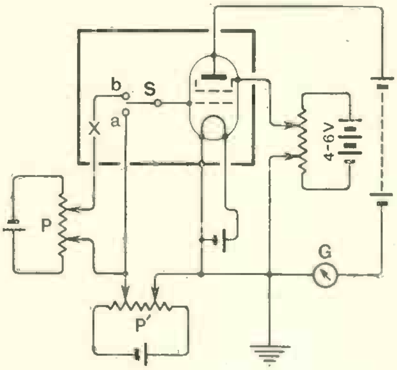


Fig. 10.

battery changes is obtained in the following manner:

S is closed at (*a*). Slider *k* is adjusted so that *R* and *R′* are equal (c. 10,000ω), and *m* is set so that the filament currents of the valves are about the same. If the valves are well matched, a slight adjustment of the grid bias applied to one of them will make their anode currents equal and no current will flow through *G*. A variation of filament current of both valves, effected by moving *n*, will now in general give a galvanometer deflection. By usual processes of trial and error, adjustments of grid bias and *m* are found such that the deflection remains zero when *n* is moved through a small range corresponding to the likely fluctuation of the filament battery with time, for which compensation is thus achieved. Anode battery compensation is then obtained by similarly finding a setting of *k*, *l*, and *l′* for which the deflection remains zero for small changes in anode battery E.M.F. This will have slightly upset the filament compensation, which may be repeated. Full details of the process, which is not in reality very complicated, will be found in the paper of Razek and Mulder (22). The extremely small zero drift which remains is due to the "ageing" of the valves, and is quite negligible if they are a well-matched pair initially.

It will be seen that any of the previous modifications can be applied to the bridge circuit, according to circumstances: for instance, it can be operated at the floating grid potential (23) or at the critical grid potential for extreme sensitivity (22).

7. Tetrode Circuits.

Tetrodes may be used in most of the foregoing circuits with advantage, as they have a very low control-grid current and are very stable (24). Fig. 10 shows the floating grid tetrode circuit of Dubois (25), in which the grid current is as low as 5×10^{-15} ampere. The very low anode current (a few microamperes) passes directly through the galvanometer, which is set at a convenient arbitrary "zero" by adjustment of the screen-grid potential. This arrangement will measure to within 0.0001 volt.

8. Automatic Recording.

A string galvanometer may be used in conjunction with any of the above circuits for recording rapidly varying potentials over a time scale of seconds (26). Where long-period recording is required, the use of a compensating circuit is essential if zero drift errors are to be avoided; Bannister (27) has successfully employed the usual type of recording potentiometer in a two-valve bridge circuit.

9. Technique.

No comprehensive treatment of practical technique can be attempted here, nor indeed is it necessary, as valve potentiometers and electrometers are in general very straightforward in operation provided certain simple precautions are taken. The following points may, however, be briefly noted.

Valves should be chosen mainly on their grid characteristics, with reference to Fig. 6 and the circuit it is desired to use. Oxide-coated filaments tend to "age" less than other types, and are preferable on that account for compensating systems. Ageing is also minimised by working at low filament and anode voltages; this sacrifices mutual conductance, but this is of minor importance where a reasonably sensitive galvanometer can be used.

There should be high insulation between the valve elements ; the grid in particular should be subject to as little leakage as possible. It is advisable to remove the bakelite cap (some manufacturers supply uncapped valves), and the valve may be with advantage mounted in a vessel containing a drying agent. Insulation must, of course, be carefully attended to throughout the instrument. The author has found paraffin wax to be more suitable than ebonite as it is much less hygroscopic : in the case of those circuits which take less than 10^{-13} ampere from the E.M.F. under measurement, and which may be termed " electrostatic," it is usually necessary to use amber, quartz or sulphur for insulating the grid connections.

It is important that the grid switch S be of good design : in circuits not operating at the floating grid potential, contact at (*b*) should be made immediately *before* contact is broken at (*a*) and *vice versa*, otherwise the momentary rise of the grid towards the floating potential disturbs the stability of the instrument. A convenient form of paraffin-

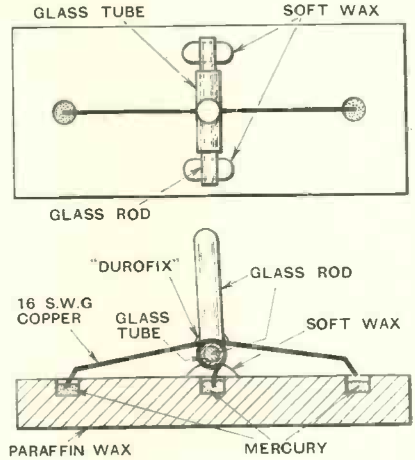


Fig. 11.—*S.P.D.T. wax/mercury switch.*

Circuit.	Fig.	Ref.	Current taken from E.M.F. being Measured (amperes).	Limit of Useful Accuracy (volts).	Maximum Possible Resistance of Cell being Measured (megohms).	Valve Sensitivity (S) (mA./volt).	Remarks and Uses.
Simple	1	2	10^{-6}—10^{-9}	±0.006	0.01	0.1—1.0	Direct-reading (Electro-titration).
Simple, with amplifier.	2	3	10^{-6}—10^{-9}	±0.002	0.01	4.0	Do. do.
Balanced.....	3	4	10^{-8}—10^{-9}	±0.0005	0.1	0.1—1.0	Very rapid reading.
Critical grid (corr. for grid current).	5(*b*)	7	10^{-8}—10^{-9}	±0.0001	1,000	Up to 38.0	For high res. cells, very sensitive.
Ballistic	4	5	10^{-14}—10^{-16}	±0.00001	1,000	—	Rather slow reading.
Electrometer valve.	—	12, 13, 14, 15.	10^{-14}—10^{-16}	±0.00005	10,000	0.02—0.03	General purposes.
Floating grid .	7	8, 9, 10, 11, 23.	10^{-11}—10^{-13}	±0.0001	500	0.03—0.8	Do. do.
Tetrode	10	6, 21, 23, 24, 25.	10^{-10}—10^{-15}	±0.0001	10,000	0.02—0.1	Do. do.
Two-valve bridge.	9	6, 19, 20, 21, 22, 23, 27.	10^{-8}—10^{-15}	±0.0001	10,000	0.02—0.5	Very stable ; long-period recording.

block/mercury switch with a rapid action is shown in Fig. 11; Nottingham (8) has described a switch of the highest insulation embodying gold contacts embedded in sulphur.

It is often necessary with the "electrostatic" instruments to adopt usual methods of screening from stray electrostatic and electromagnetic effects, as for instance in the circuit of Fig. 10. If for one reason or another the grid lead to the E.M.F. being measured is long, it is best to pass it through an earthed metal tube, to prevent it acting as an aerial. Whether or not the electrometer is earthed will depend upon local conditions; the author has found earthing a disadvantage when the instrument is operated near an electric motor, owing to "surge" effects.

In conclusion, it may be said that valve electrometers are more robust, more sensitive, and easier to handle than electrometers of the quadrant or capillary types, and are to be preferred to the latter except in cases where currents as low as 10^{-16} ampere are to be avoided (the quadrant electrometer leakage current may approach 10^{-19} ampere if all possible precautions are taken). A table is attached showing the characteristics of the most important circuits in summarised form: it is hoped that this will indicate the appropriate instrument for use in any given problem.

In one or other of the above forms, the valve electrometer can be used for many varied potential measurements. Electrolytic and thermoelectric P.D.s, whether or not associated with high resistances, may be measured directly. Very small direct currents, such as ionisation currents, photoelectric currents, and thermionic currents can be measured by passing them through a known high resistance and measuring the P.D. across it. Grid characteristics of valves are conveniently determined in this way. Recently, minute currents of the order of 2×10^{-19} ampere (*i.e.*, one electron per second) have been measured (28) by means of the FP54 valve developed by Metcalf and others of G.E.C. (American). High resistances, from 0.5 to 100,000 megohms, can be measured by usual electrometer methods. The extension of the valve principle to A.C. measurements, and hence to the determination of inductance and capacity, will be dealt with in a subsequent article.

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23. Stadie, O'Brien, and Laug, *J. Biol. Chem.*, 1931, 91, 243.
24. Metcalf and Thompson, *Phys. Rev.*, 1930, 36, 1489.
25. Dubois, *J. Biol. Chem.*, 1930, 88, 729.
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Books Received.

The Principles of Electromagnetism.

By G. B. Moullin.

A text-book for advanced students comprising the elements of magnetism, the second law of electrodynamics. Iron in a magnetic field. Equations and special problems. Pp. 279+viii, with 152 diagrams and illustrations. Published by the Oxford University Press, London. Price 17s. 6d.

Einfuhrung in die Schwingungslehre.

By Dr. H. Barkhausen.

Introduction to the study of oscillations by analogy between electrical and mechanical vibrations. Pp. 128 with 118 diagrams. Published by S. Hirzel, Leipsig. Price RM.5.

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.

Harmonic Content in Amplifiers.

To the Editor, The Wireless Engineer.

SIR,—In specifying the harmonic content of an amplifier it has been the practice of many people in this country to relate the amplitude of the harmonic, or harmonics, to that of the fundamental, the amplitude being specified in current or voltage.

I have found that in a number of instances fairly recently it has been the practice to specify the power content of the harmonics in relation to the power of the fundamental. It is, to say the least of it, confusing if some manufacturers are going to specify harmonic content on a power basis and others on an amplitude basis.

I feel it desirable, therefore, to ask you to give publicity to the matter, and to suggest that the subject should be discussed by, or before, some competent and authoritative body, and if possible a recommendation made as to which form the specification of harmonic content of an amplifier should take.

It has been the practice for some time to regard a 5 per cent. harmonic content worked out on an amplitude basis as something tolerable commercially having regard to the limitations of present-day apparatus. I have, however, recently seen reference to an amplifier in which the performance as regards harmonic content was referred to thus: "The total power in harmonics does not exceed 5 per cent. of the power at the fundamental frequency." This sounds quite a reasonable performance until it is realised that a 5 per cent. harmonic on a power basis is a 22½ per cent. harmonic on an amplitude basis which, in my opinion, is far from a good commercial performance.

If however, the harmonic content is specified in decibels below the fundamental, there can be no argument.

H. L. KIRKE.

Sound Distribution from a Horn.

To the Editor, The Wireless Engineer.

SIR,—In treating the sound distribution from a long logarithmic horn, the mouth is sometimes replaced by a rigid circular disc vibrating in an infinite rigid plane. Under this condition the horn flares out into a large wall. It is of practical interest to determine the pressure and particle velocity at the mouth to satisfy the rigid disc condition. Rayleigh gave a formula for the *total pressure* on a rigid disc, but the pressure at *any* point cannot be ascertained from his analysis. Accordingly, I have solved this problem for rigid and for flexible discs. The pressure at any point consists of two components (1) p_a the acoustic or load component in phase with the velocity, (2) p_i the inertia or wattless component in quadrature with the velocity. The total pressure is the modulus $\sqrt{p_a^2 + p_i^2} = p$.

In treating a rigid disc whose axial velocity is constant at all radii, the pressure at any point on the disc*:

$$p = p_a + ip_i, \text{ and}$$

$$p = \rho c\dot{A}\left\{\frac{z^2}{2!}f_2 - \frac{z^4}{4!}f_4 + \frac{z^6}{6!}f_6 \ldots \text{etc.} + i\left(zf_1 - \frac{z^3}{3!}f_3 + \frac{z^5}{5!}f_5 \ldots\right)\right\} \quad \ldots (1)$$

where $z = ka$, a = radius of disc, $k = \omega/c$, $\omega = 2\pi f$,
c = velocity of sound, ρ = density of air,
$\dot{A} = \omega X \operatorname{Cos} \omega t$ = axial velocity,
$b = x/a$, x = radius of point in question.

$$F(\alpha, \beta, \gamma, b^2) = 1 + \frac{\alpha\beta}{\gamma}b^2 + \frac{\alpha(\alpha+1)\beta(\beta+1)}{2!\gamma(\gamma+1)}b^4 + \ldots$$

(the hypergeometric function).

$$f_2 = 1$$
$$f_4 = 1 + 2b^2$$
$$f_6 = 1 + 6b^2 + 3b^4$$
$$f_8 = 1 + 12b^2 + 18b^4 + 4b^6$$
$$f_{10} = 1 + 18b^2 + 66b^4 + 36b^6 + b^8$$

$$f_1 = F(-\tfrac{1}{2}, \tfrac{1}{2}, 1, b^2)$$
$$f_3 = F(-3/2, \tfrac{1}{2}, 1, b^2) + 3/2\, b^2F(-\tfrac{1}{2}, \tfrac{1}{2}, 2, b^2)$$
$$f_5 = F(-5/2, \tfrac{1}{2}, 1, b^2) + 5b^2F(-3/2, \tfrac{1}{2}, 2, b^2) + \frac{15}{8}b^4F(-\tfrac{1}{2}, \tfrac{1}{2}, 3, b^2)$$
$$f_7 = F(-7/2, \tfrac{1}{2}, 1, b^2) + \frac{21}{2}b^2F(-5/2, \tfrac{1}{2}, 2, b^2) + \frac{105}{8}b^4F(-3/2, \tfrac{1}{2}, 3, b^2) + \frac{35}{16}b^6F(-\tfrac{1}{2}, \tfrac{1}{2}, 4, b^2)$$
$$f_9 = F(-9/2, \tfrac{1}{2}, 1, b^2) + 18b^2F(-7/2, \tfrac{1}{2}, 2, b^2) + \frac{189}{4}b^4F(-5/2, \tfrac{1}{2}, 3, b^2) + \frac{105}{4}b^6F(-3/2, \tfrac{1}{2}, 4, b^2) + \frac{315}{128}b^8F(-\tfrac{1}{2}, \tfrac{1}{2}, 5, b^2)$$

Integrating p in (1) over the surface of the disc Rayleigh's formula is reproduced, but by a different method. Using expression (1) the pressure over the disc for various values of ka† can be obtained. Some data are portrayed pictorially in Fig. 1. When $ka < 0.5$ the acoustic pressure is constant over the disc, but the inertia pressure falls off towards the edge. Obviously the total pressure $\sqrt{p_a^2 + p_i^2}$ must also vary over the disc. The edgewards decay increases with ka. To preserve constant pressure, *i.e.*, $\sqrt{p_a^2 + p_i^2}$ = constant at

* *Phil. Mag. Supplement* 14, 1012, Nov., 1932. The general expression for f_n is given in this paper.

† Additional terms are required for $ka > 2.0$.

all radii, the velocity of the disc (flexible !) would have to increase with the radius ultimately becoming infinite at the edge. If we imagine something of this nature to obtain when $ka > 0.5$, the focusing exceeds that for a rigid disc. The radiation characteristic in the former case is $\frac{\text{Sin}\,(z\,\text{Sin}\,\phi)}{z\,\text{Sin}\,\phi}$ and in the latter $\frac{J_1(z\,\text{Sin}\,\phi)}{z\,\text{Sin}\,\phi}$, where ϕ is the angle with the polar axis of symmetry.

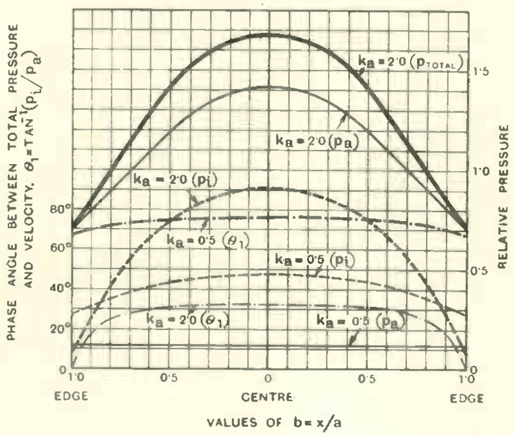

Fig. 1.

Applying the above results to a horn, if the rigid disc substitution is accurate, the air particle velocity v—as measured by a Rayleigh disc—should be constant over the mouth ; whilst the total pressure—as measured by a condenser microphone—should decrease towards the edge. Also the phase angle between p and v should be in accordance with the values calculated from (1). If the velocity increases with the radius, and the *total* pressure tends to constancy, the rigid disc substitution will be in error. Now that the formula is available, it would be of general interest if someone with the requisite apparatus made comparison between theory and practice.

London, Sept., 1932. N. W. McLACHLAN.

The Thermionic Valve.

I.E.E. Wireless Section Chairman's Address.

THE opening meeting of the I.E.E. Wireless Section was held on 2nd November, when Mr. L. B. Turner, M.A., M.I.E.E., delivered his inaugural address as Section Chairman. The chair for the meeting was taken by the President, Prof. E. W. Marchant.

The new Chairman said that he had taken as his subject " The Thermionic Valve," and proposed to give a wide general review of the subject. Although the valve was now concerned in a great many applications, its origin was in wireless. A slide showing a " family-tree " traced the development of the valve from the 'eighties, in work of Hittorf and Edison, through the Fleming diode of 1904, the De Forest audion, etc., to modern types of valve, not ignoring examples of modern soft-vacuum tubes which are also assuming commercial importance.

Passing to the practical versatility of the valve in relation to its circuital uses, the lecturer showed fundamental circuits which were rapidly developed with the advent of the original (French) bright-emitter R valve, *e.g.*, as an anode-bend rectifier, as a grid circuit rectifier, as a coupled-circuit oscillator, as a distortionless (low frequency) amplifier and as a dynatron.

Turning then to the principles of the valve as first exemplified in the diode, the lecturer discussed the characteristics of this thermionic device in relation to the characteristics of an ohmic resistance, drawing attention to its saturation properties and to the use of these as a constant-current device. The high-power rectifying diode and the high-voltage X-ray tube were also described and illustrated as examples of development arising out of the original diode.

The control of the anode current by the third electrode naturally followed, when the lecturer proceeded to describe the development of the modern receiving valve. Curves were given illustrating the comparative characteristics and efficiencies of modern oxide-coated (battery) valves in relation to the original R valve, these showing a gain of 10 decibels. The indirectly heated-cathode valve was next reviewed, reference being made to the new problems of electrode dispositions and construction arising out of the greater heating involved with this type. Next the electrometer valve was considered, the lecturer discussing the typical features of this type of triode and the precautions necessary in its design, construction and operation. Still continuing with the triode the lecturer dealt with large-sized transmitting valves, including the largest (*i.e.*, 100 kw.) sealed-off water-cooled-anode valve and the G.P.O. type of demountable 500 kw. valve.

Consideration of the effect of anode-grid capacity then led to discussion of neutrodyning methods in triodes of all sizes, including a transmitting " heptode " in which two push-pull valves are effectively contained in one envelope with neutralising electrodes. The development of the screened-grid valve next followed, with a discussion of the factors which cause this valve to have its known characteristics of high amplification factor and high internal impedance. The gain due to the screening grid was estimated at 9 db. Discussion of secondary emission led to the dynatron application of the s.g. valve utilising the negative-resistance characteristic. A practical value for this voltage had been found to be one-third to one-fifth that of the anode potential. The lecturer then discussed limiting conditions of electron speed, leading to the application of the magnetron principle for the development of a short-wave oscillator, illustrating a system capable of generating considerable power down to the one metre wavelength.

The latter part of the lecture was devoted to the limiting factors of valve amplifications.

A cordial vote of thanks to the lecturer was accorded on the motion of the President.

Abstracts and References.

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PROPAGATION OF WAVES.

CAUSES OF IONISATION IN THE UPPER ATMOSPHERE.—I. Ranzi. (*Nature*, 8th Oct., 1932, Vol. 130, p. 545.)

Since May, 1931, the writer has taken measurements of the virtual reflection height of radio waves of length between 40 and 140 m, and also determined the short wave limit for vertical reflection in the ionosphere. A summary of some of his principal results is as follows :—

" In the E region, by day, the maximum electronic density does not exceed 6×10^5 (electrons per cc) in summer and 3.7×10^5 in winter. In the F region, at sunset, the maximum electronic density is 9×10^5 in summer and 6×10^5 in winter." Remarkable increases in the maximum electronic density in E region occur after sunset when barometrical depressions occur at the place of observation or to the north of it. The coefficient of ionic recombination for F region is sometimes found to be of the order of 1 or 2×10^{-10} : but at other times there are rapid increases and decreases of the maximum electronic density, by no means connected with those of E region. " Corresponding with perturbations in the earth's magnetic field, the virtual reflection height in the F region is increasing ; no perceptible variation occurs in the E region." During the solar eclipse of 11th Oct., 1931, not visible in Italy, the writer observed a perceptible diminution of electronic density in the E region and in the F region. This can be explained by Dauvillier's recent theory (Abstracts, 1931, p. 609 : *see* also 1932, pp. 218, 337—two, and 633) of the arrival of electrons from the sun. " Chapman's theory (concerning the arrival of swiftly moving particles—1931 Abstracts, p. 607) does not appear to interpret easily the night increases of ionic density and the magnetic correlations regarding the F region alone."

ATMOSPHERIC CONDITIONS AND THE KENNELLY-HEAVISIDE LAYER.—R. C. Colwell (*Nature*, 22nd Oct., 1932, Vol. 130, pp. 627–628.)

The writer's observations upon the signal strength of a 309-metre wave from KDKA, Pittsburg, observed at Morgantown, West Virginia, are in complete agreement with those of Ranzi (1932 Abstracts, p. 632, and above) regarding the correlation between atmospheric conditions, especially to the north of the observing station, and ionisation in the E layer. Weather prognostications based on these observations were 85 to 90% correct for periods during the years 1927–1930.

ON THE ABSORPTION OF THE DEBYE-FALKENHAGEN RELAXATION FORCE IN A NEUTRAL, PARTIALLY IONISED GAS—PLASMA, KENNELLY-HEAVISIDE LAYER.—K. F. Niessen. (*Physik. Zeitschr.*, 1st Oct., 1932, Vol. 33, No. 19, pp. 705–718.)

Author's summary :—This paper investigates the influence of the Debye-Hückel-Falkenhagen relaxation force on the absorption of electromagnetic waves in a plasma.

This is assumed to be gas composed of one kind of molecule with relatively few positively charged molecular ions and the requisite number of free electrons for the total charge to be zero (in agreement with Langmuir's definition of a plasma). The positive ions are assumed to be singly charged, so the density of electrons is equal to that of the ions. The molecules are assumed non-polar, so that the other kind of relaxation force, also discovered by Debye and due to molecular rotation, does not occur. The relaxation here considered always gives rise to absorption and may also exert an apparent binding action on the free electrons.

The conditions are given for which the relaxation attenuation may be neglected in comparison with collision attenuation for any frequency and for waves only considered as passing through the medium. If these are not fulfilled, formulae are given for the dielectric constant and conductivity of the plasma. The relaxation binding can only occur if the plasma satisfies a given inequality, and a calculation is given for the resonance then possible in the plasma (which is, of course, of quite a different type from that calculated by Langmuir).

In the Kennelly-Heaviside layer (the ionised atmospheric layer, known through the part it plays in the propagation of radio waves and assumed to be a plasma) it appears that the attenuating effect of the relaxation force may be neglected in comparison with collisional friction, while the relaxation resonance mentioned here is impossible.

LONG WAVE TRANSMISSION, TREATED BY PHASE INTEGRAL METHODS.—T. L. Eckersley. (*Proc. Roy. Soc.*, July, 1932, Vol. 137, No. A 831, pp. 158–173.)

The writer applies his " phase integral " method (Abstracts, 1931, p. 548, and 1932, p. 514) to the consideration of problems of long wave propagation. The method can be used when the reflection coefficient of the layer as a function of the angle of incidence is known. He finds that, when the height of the layer is small compared with the radius of the earth and when $\cos \phi_1$ is not too small (ϕ_1 = angle of incidence of wave on layer), the formulae derived by considering the case of two parallel planes are adequate to deal with the case of a spherical earth and layer, if $\sin \theta_0$ in them is replaced by $\frac{2}{3} \sin \theta_0$ ($\theta_0 = 90° - \phi_1$ for grazing incidence) and this is the procedure adopted throughout the paper. For small gradients it is found that the direction of polarisation need not be taken into account. [The effect of the earth's magnetic field is not considered.]

Some examples of reflection coefficients are then worked out, to illustrate the behaviour of long waves in various circumstances. (*a*) In the case of a sharply defined layer, the horizontally polarised wave is found to be very much less attenuated than the vertically polarised one.

Curves are given showing ground reflection for vertically and horizontally polarised waves at various angles of incidence. (*b*) When the electronic concentration varies as the square of the height z, directly as z, or as e^{-z/z_0}, the transmission characteristics are summarised as follows: "(1) $\bar{a}$ [the attenuation constant] is some inverse function of the gradient of the electronic concentration . . . (2) $\bar{a}$ is in every case inversely proportional to the height of the layer above the earth . . . (3) The attenuation in every case varies inversely as some power of λ . . . (4) High angle transmissions are normally much more attenuated than gliding angle waves . . . (5) The attenuation decreases with increasing ionic concentration, other quantities remaining fixed . . . (6) The attenuation increases with increasing collision frequency. . . ."

Experimental evidence on the characteristics of long-wave daylight transmission is exhibited in the form of a curve and the theory is used to explain the results. The depth of penetration into E layer for the wave tangential to the earth's surface is shown as a function of the wavelength.

Direct-Ray Broadcast Transmission [and the Prediction of Field Strengths at Distances up to 2 000 Kilometres for Wavelengths from 60 to 2 000 Metres].—T. L. Eckersley. (*Proc. Inst. Rad. Eng.*, Oct., 1932, Vol. 20, pp. 1555–1579.)

The main part of the paper deals with daylight transmission, and the reflected ray recently found even at mid-day at great distances (700–1 000 km) is neglected in the curves, while in the theoretical calculations undisturbed direct-ray transmission is assumed. "The reflected ray is not amenable to calculation, and our knowledge is empirical." Some results on the reflected ray problem, and the interpretation of them, are given at the end of the paper, in a section on "Night Transmission"; among other results, for a wave-range of 200 to 600 metres, "the variabilities and uncertainties due to fading appear to swamp any real changes due to wavelength. . . . Contrary to expectation, there also appears to be little variation on account of the direction of the station relative to the magnetic meridian." This, as well as the observation of a fairly pronounced maximum at 600 km, seems to agree with recent U.I.R. published results.

The main part of the paper, on direct-ray daylight transmission, deals both with the Sommerfeld formula and with the Watson diffraction formula in a form (derived by the writer by a phase integral method—1932 Abstracts, p. 514) such that the correction due to the earth's resistivity can easily be incorporated. The intensity of the surface wave is computed from the results of Sommerfeld's analysis; the (unlabelled) Figs. 11–14 give these curves, on the assumption that K may be neglected in comparison with $2\sigma\lambda c$. The modifications to the normal Sommerfeld curves, obtained by Rolf (1930 Abstracts, pp. 29–30 and 388) by taking into account the "earth phase angle" ($\tan \phi = K/2\sigma\lambda c$), and the consequent prediction of "blind spots," are discussed; Fig. 4 shows curves by which the given Sommerfeld curves for $\sigma = 10^{-13}$ can be used for other values of σ (provided the phase angle is small) by replacing the actual wavelength by an "equivalent" wavelength. Such replacement can only be carried out within the range of validity of the Sommerfeld formula; this can be judged roughly from Fig. 5, which gives extended Sommerfeld curves superposed on the modified Watson diffraction curves (valid for the greater distances), the two classes of curves crossing one another. Thus by means of these various sets of curves it should be possible to obtain the direct-ray field strengths of stations in the wavelength range 60–2 000 m up to distances of 2 000 km, or alternatively to distances where the field intensity has dropped to less than one microvolt/metre for 1 kw radiated. Finally the effect of hills and obstacles is considered.

Studies in Radio Transmission [Short Wave Echo, Field Strength and Facsimile Measurements].—T. L. Eckersley. (*Journ. I.E.E.*, Sept., 1932, Vol. 71, No. 429, pp. 405–454: Discussion, pp. 454–459.)

The full paper, summaries of which (one in *The Wireless Engineer*) were referred to in 1932 Abstracts, pp. 454 and 632. In the final, theoretical section the writer sums up: "The model of the Kennelly-Heaviside layer, disclosed by interference, facsimile, and signal measurements, has been found adequate to explain the main features of daylight transmission over the whole gamut of wavelengths from 9 m to 25 km. Many details of the picture have yet to be filled in, and night transmission has been treated in rather a summary way. The phase-integral method of attacking the problem has been used throughout. . . . The absence of reflection of waves in the broadcast band is attributed, not to magneto-optical effects, which are so often invoked, but to the natural increase of the E-layer attenuation associated with the small penetration of waves into the layer on this band. Reasons are given for supposing that magneto-optical effects are only of major importance at night, and perhaps on extremely long waves in the day time. . . ." In the discussion, Hollingworth maintains that "when it comes to deciding whether a given ray will or will not be returned, and from which layer, the inclusion of the effect of the earth's magnetic field is essential," and illustrates his point by a curve. Eckersley argues that the low-angle rays and higher frequencies involved in his own tests render the magneto-ionic effects unimportant: "this illustrates one of the advantages of the facsimile method" over those using normal incidence. His reply also deals, among other points raised, with Builder's suggestion of an alternative to the "ionic cloud" explanation of scattering, namely that scattering is due to multiple splitting of echoes, which may lead to blurred signals lasting as long as 3 milliseconds.

Polarisation of Echoes from the Heaviside Layer [Sense of Polarisation of Split-Echo Rays].—T. L. Eckersley. (*Nature*, 10th Sept., 1932, Vol. 130, pp. 398–399.)

A letter describing, and deducing certain conclusions from, an investigation of the state of polarisation of split echoes on a 60 m wavelength, using pulses and a cathode-ray oscillograph (*cf. Wireless World*, 8th July, 1932, p. 17, and Ratcliffe and White, 1932 Abstracts, p. 276). In a letter in the issue of 24th Sept., p. 472, Appleton and Ratcliffe point out how some of the writer's conclusions are in disagreement with the established magneto-ionic theory.

WIRELESS STUDIES OF THE IONOSPHERE [INCLUDING A SECTION ON THE MAGNETO-IONIC THEORY AND AN EXTENSION OF THE LORENTZ DISPERSION THEORY].—E. V. Appleton. (*Journ. I.E.E.*, Oct., 1932, Vol. 71, No. 430, pp. 642–650.)

The I.E.E. paper of 25th May. (1) Introductory and historical. (2) The direct proof of the existence of the Kennelly-Heaviside layer. (3) Methods of measuring the equivalent height of the atmospheric reflecting layer. (4) Results of equivalent height measurements [and the evidence for the existence of E and F regions]. (5) The nature of down-coming waves [and the causes of fading: influence of earth's magnetic field, simultaneous reflection from different portions of a layer of non-uniform stratification].

(6) The magneto-ionic theory of electric wave propagation [including an extension of the dispersion theory given by Lorentz, to the general case of any direction of propagation: approximate formulae derived from the resulting equations, and useful in practical work, are given in an appendix. The equations show that there are propagated, in general, two waves of different phase-velocity, polarisation, and absorption: the "ordinary" ray whose characteristics are not relatively very much influenced by the magnetic field, and the "extra-ordinary" ray exhibiting the phenomenon of quasi-resonance with the characteristic gyroscopic frequency conditioned by the earth's magnetic field. The ordinary ray is, in general, less absorbed than the extra-ordinary ray: the polarisations of the magnetic forces in the two waves are similar ellipses whose major axes are at right angles. For a direction of propagation making an acute angle with the positive direction of the magnetic field, the polarisation of the ordinary wave is left-handed and that of the extra-ordinary wave right-handed. The conditions for which the refractive index for each ray becomes zero are given, together with two examples]. (7) The nature of the ionisation [the carriers in the F region are almost certainly of electronic mass: in the E region conclusions are not so definite, but the presence of at least some electrons is certainly indicated]. (8) The nature of the ionising agencies. The paper ends with a bibliography of 31 items and the appendix already referred to.

PRESENT KNOWLEDGE OF THE UPPER ATMOSPHERE.—E. V. Appleton. (*Wireless Engineer*, Sept., 1932, Vol. 9, No. 108, p. 513.)

Short summary of the I.E.E. paper read on 25th May. Among various points, the lecturer suggested that it would be interesting to send out a wave circularly polarised and check if there were less absorption and a better signal than from a wave linearly polarised: the summer-to-winter ratio of ionisation, and the ratio of the F layer ionisation to that of the E layer, were dealt with (*cf.* 1932 Abstracts, p. 575). The paper ended with a discussion of the agencies causing the ionisation, and the phenomena which might be produced by a solar eclipse. *See* also above.

THEORY OF THE PROPAGATION OF LOW-FREQUENCY WAVES [CHANGE FROM METALLIC TO DIELECTRIC REFLECTION, ETC.].—E. Yokoyama and S. Namba. (*Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, pp. 131–155.)

Abbreviated translation of the paper dealt with in 1932 Abstracts, pp. 454–455.

FADING AND NIGHT DISTORTION [OBSERVATIONS ON COLOMBO STATION].—(*World Radio*, 30th Sept., 1932, Vol. 15, No. 375, pp. 704 and 703.)

Continuation of the correspondence referred to in 1932 Abstracts, p. 632. Among the points noted in reception from Colombo over 68 miles of hilly country are the following:—distortion is usually worse during sunset, fading usually after dark: the more "glorious" the sunset the more pronounced are both effects: they are also "more pronounced during unsettled weather, and not so bad during wet and cloudy weather as during fine and clear weather": they apparently bear an inverse ratio to the intensity of atmospherics: fading, when prolonged and bad, is usually accompanied by "surges" of great volume completely overloading the set: another receiver four miles away, equidistant from Colombo within a fraction of a mile, observed very similar fading duration periods and intervals but by no means coincident times.

RADIO OBSERVATIONS DURING THE TOTAL SOLAR ECLIPSE OF AUG. 31ST [AND THE NATURE OF THE IONISING AGENCY].—(*Nature*, 10th Sept., 1932, Vol. 130, pp. 385–388.)

This paper is a preliminary summary and general survey of the observational data obtained during the solar eclipse of Aug. 31st, 1932. The conclusion is reached that, "in the light of all available evidence, weighted according to situation, the significance of ultra-violet light as a principal ionising agent for the ionosphere as a whole is established; the possible significance of neutral corpuscles is not established, but is not wholly excluded; it remains to be tested under more favourable conditions and in the light of our rapidly growing knowledge of the climatology of the ionosphere."

NEW RADIO FIELD STATIONS; MEASUREMENTS DURING ECLIPSE.—Bureau of Standards. (*Bur. of Stds. Tech. News Bull.*, Sept., 1932, No. 185, pp. 81–82.)

"Field intensity recorders showed no change in radio broadcast transmission during the eclipse. Ionisation of the lower (100-km) region of the Kennelly-Heaviside layer decreased considerably as the eclipse progressed, but returned to normal after the eclipse. Changes were also noted in the region above 225 km, but complete results are not yet available."

IONISATION DURING LUNAR ECLIPSES.—(*Electrician*, 23rd Sept., 1932, Vol. 109, p. 366.)

Short note. Improvements in the received strength of distant broadcasting stations (especially Madrid and Moscow) were noticed during the almost total lunar eclipse on 14th Sept., suggesting that the radiation of the full moon exerts an appreciable ionisation effect on the Kennelly-Heaviside layer.

EFFECTS OF THE AURORA BOREALIS [ON 40-METRE BAND RECEPTION IN PENNSYLVANIA].—P. Skitzki. (*QST*, Aug., 1932, Vol. 16, p. 76.)

CONSIDERATIONS FOR THE EXPLANATION OF WORLD SPACE ECHOES, THE AURORA AND MAGNETIC DISTURBANCES. PART I.—H. Dostal: Störmer. (*Ann. der Physik*, 1932, Series 5, Vol. 14, No. 8, pp. 971–984.)

The writer shows that the electronic space charges of Störmer's aurora theory are insufficiently dense to be the cause of the long-delay radio echoes which have been observed on wavelengths of the order of 30 m. He works out, from the standpoint of geometrical optics, a surface which would give echoes of the observed retardations, and finds that it must have a thickness of at least 10 m and an electron density of at least 10^6 electrons per cc, with an equal number of positive ions to give zero total charge. A current must flow in it with very great velocity, so that it must be highly charged at one end at least. A second paper is to discuss a dynamical possibility for the existence of such a surface and its emission from the sun's surface.

AN ELECTRON ORBIT IN THE MAGNETIC EQUATORIAL PLANE OF THE EARTH.—W. F. G. Swann. (*Journ. Franklin Inst.*, Oct., 1932, Vol. 214, No. 4, pp. 465–471.)

The writer works out mathematically a possible electron orbit, in the magnetic equatorial plane of the earth, which comes from a very large distance and curves round to touch the earth on the side away from the electron source. He draws attention to the conclusion that, "in considering celestial bodies as the origin of electron rays, one must pay attention to the radiation coming from bodies on the side of the earth remote from that on which we are stationed at the instant."

SOME APPLICATIONS OF THE RECIPROCITY THEOREM IN RADIO TELEGRAPHY.—D. Graffi. (*Nuovo Cimento*, Aug.–Sept.–Oct., 1932, Vol. 9, pp. 251–258.)

In the course of this paper the writer remarks: "One arrives thus at the conclusion, glimpsed by others but perhaps not clearly expressed, that the earth's magnetic field may affect propagation in such a way as to alter the directive properties of the horizontal aerial."

RADIO-TELEPHONE SERVICE BETWEEN FRANCE AND CORSICA ON ULTRA-SHORT WAVES.—Picault. (*See* abstract under "Stations, Design and Operation.")

THE PROPAGATION OF ULTRA-SHORT WAVES THROUGH OIL AND WATER.—S. Uda and N. Takao. (Summary in *Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, Supp. pp. 1–2.)

The wavelength in air of the waves used was 45 cm. A linear resonator immersed in transformer oil acted as wave director or reflector, just as in air, according to whether its length was shorter or longer than a half wavelength measured in oil. Propagation through oil was subject to comparatively little attenuation; through water the attenuation was naturally very great, but its determination was very difficult. When Lecher wires suspended in distilled water were made to carry the oscillations, the electric dissociation caused the evolution of gases.

THE NON-UNIFORM TRANSMISSION LINE: CORRECTIONS.—A. T. Starr. (*Proc. Inst. Rad. Eng.*, Oct., 1932, Vol. 20, pp. 1553–1554.)

Corrections to the paper dealt with in 1932 Abstracts, p. 576.

ON THE BEARING OF THE NATURAL INFRA-RED OSCILLATIONS OF MATERIALS ON THEIR DIELECTRIC LOSSES.—M. Czerny and W. Schottky. (*Zeitschr. f. Physik*, 1932, Vol. 78, No. 3/4, pp. 220–229.)

Authors' summary:—The paper draws attention to the fact that, in a solid dielectric, the same cause which gives rise to absorption in natural infra-red oscillations can also effect dielectric losses in the region of short Hertzian waves. For rock-salt a dispersion formula already exists which makes it possible to calculate the absorption in the region of short Hertzian waves. The phase angle [due to loss in a condenser] is calculated from the optical absorption constants. The rock-salt example shows that, for very short electric waves, dielectric losses of noticeable size may in fact be expected to arise from this cause.

OPTICAL PROPERTIES OF SOLID AND LIQUID MEDIA SUBMITTED TO SUPERSONIC ELASTIC VIBRATIONS.—R. Lucas and P. Biquard. (*Journ. de Phys. et le Rad.*, Oct., 1932, Vol. 3, pp. 464–477.) *See* also 1932 Abstracts, p. 576.

THE BRIGHT AND DARK FRINGES ON THE EDGES OF THE PENUMBRA THROWN BY AN OPAQUE BODY ILLUMINATED BY A LARGE SOURCE OF LIGHT.—F. Wolfers: Demetrovic. (*Comptes Rendus*, 17th Oct., 1932, Vol. 195, pp. 653–655.)

OPTICAL DISPERSION: QUANTUM THEORY OF DISPERSION.—S. A. Korff and G. Breit: G. Breit. (*Reviews of Mod. Physics*, July, 1932, Vol. 4, No. 3, pp. 471–503: 503–576.)

A FIELD INTENSITY METER [USING A MODIFIED SUPERHETERODYNE CIRCUIT].—Brown and Koehler.

(*See* under "Measurements and Standards.")

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY.

RECORDS OF ATMOSPHERICS [PIC DU MIDI, NOV. 1931 TO AUG. 1932: LUGEON'S "VERTICAL SOUNDING" OF THE ATMOSPHERE].—F. Link: Lugeon. (*Comptes Rendus*, 10th Oct., 1932, Vol. 195, pp. 619–621.)

Using a receiver tuned to 2 000 m and the Richard anemocinemograph equipment recording the frequency of the atmospherics as a function of the hour (1931 Abstracts, p. 206—Dowry). Three maxima of frequency were found, corresponding approximately to the following angles of depression of the sun below the horizon: 5° 8, 11° 0 and 15° 6. These are calculated to correspond to sunrise at heights of 35, 115 and 235 km respectively. "The first maximum corresponds to the maximum ozone concentration, the second to the Heaviside layer, and the third to the reflecting layer found by the echo method."

On the Relation between Atmospherics and Meteorological Elements observed at Okinawa.—T. Yanagimoto. (Summary in *Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, Supp. pp. 2–3.)

The atmospherics maximum (June) was one month earlier than at Tokyo, the minimum (Feb. or March) one month later. This agrees with the behaviour of meteorological elements, especially temperature. Among other observations, it was found that atmospherics due to typhoons were weaker in summer and stronger in spring and autumn.

Sources of Atmospherics observed between England and Australia, using the Cathode-Ray Direction Finder.—Munro and Huxley.

(*See* abstract under " Directional Wireless.")

Physics in Meteorology.—G. C. Simpson. (*Nature*, 5th Nov., 1932, Vol. 130, pp. 708–709: *Engineer*, 4th Nov., 1932, Vol. 154, p. 447.)

A brief account of a lecture at the Institute of Physics, giving a general description of the application of physical methods to the solution of meteorological problems. Among other points, recent experiments at Kew indicate that the ionisation of the lower atmosphere is not uniform, but that the ions occur in " parcels "—a fact which might have an important bearing on the theory of the ionisation of the atmosphere.

Some Considerations on the Hydrodynamical Interpretation of Sunspot Periodicity.—D. Riabouchinsky. (*Comptes Rendus*, 3rd Oct., 1932, Vol. 195, pp. 574–576.)

Ionisation Charts of the Upper Atmosphere [from Chapman's Theory].—G. Millington. (*Proc. Phys. Soc.*, 1st Sept., 1932, Vol. 44, Part 5, No. 245, pp. 580–593.)

Author's abstract:—In this paper Prof. Chapman's theory of the ionisation of the upper atmosphere by solar radiation has been applied to construct a set of charts giving contour lines of equal ionic density over the surface of the earth. A simple approximate method of solving the fundamental differential equation of the theory by a rapid arithmetical process is described. Charts are drawn for winter, equinox and summer conditions for the values 0.5 and 1 of the parameter σ_0 and the value 150 of the parameter R. A brief comparison of these charts with existing empirical charts is given with a short discussion of its practical and theoretical significance.

The Outer Atmosphere of the Earth [A Survey].—E. O. Hulburt. (*Trans. of the Royal Canadian Institute*, July, 1932, Vol. 18, No. 40, pp. 237–249.)

On the Ionic Spectrum of the Atmosphere [Summarising Report].—K. Kähler. (*Naturwiss.*, 21st October, 1932, Vol. 20, No. 43, pp. 783–786.)

The Space Charge in Relation to the Chemical Components of the Atmosphere.—R. Stoppel. (*Zeitschr. f. Physik*, 1932, Vol. 78, No. 11/12, pp. 849–853.)

Ionisation of the Atmosphere and its Biological Effects.—L. R. Koller. (*Journ. Franklin Inst.*, Nov., 1932, Vol. 214, No. 5, pp. 543–568.)

The Ultra-Violet Transmission Coefficient of the Earth's Atmosphere.—R. S. Rockwood and R. A. Sawyer. (*Journ. Opt. Soc. Am.*, Oct., 1932, Vol. 22, pp. 513–524.)

See 1932 Abstracts, p. 578.

The Electric Field of Overhead Thunderclouds.—S. K. Banerji. (*Phil. Trans. Roy. Soc.*, 1932, Vol. 231, No. A 694, pp. 1–27.)

This paper describes a continuation on more elaborate lines of the investigation of the changes in the electric field at the earth's surface produced by thunderstorms during their passage over the Colaba Observatory, Bombay (1931 Abstracts, pp. 33–34). " The results given in the first paper that a thundercloud of unitary type has in general a charge of negative electricity in its front, a charge of positive electricity in the centre, and a charge of negative electricity in the rear, are confirmed by these further observations. In thunderclouds of double type this sequence of changes is repeated, as if two thunderclouds of unitary type had passed over in succession. It is shown in the paper that the changes in the electric field produced on account of the different parts of the cloud coming overhead, the sign of the charges brought down by rain, and the sudden changes in the field produced by lightning discharges, all find a natural explanation on the basis of the 'breaking-drop' theory. Fluctuations in the field which occur during rainfall are explained as being due to removal of charge by raindrops, and increased concentration owing to increased vertical current, and this is confirmed by the actual sign of the charge brought down by raindrops. The 'sudden changes' satisfy collectively Wilson's law. An average thundercloud transfers to the ground by rainfall 6×10^3 coulombs of positive electricity and 7×10^3 coulombs of negative electricity; the excess negative electricity probably plays an important part in the replenishment of the earth's charge."

The Polarity of Thunderclouds.—E. C. Halliday. (*Proc. Roy. Soc.*, Oct., 1932, Vol. 138, No. A 834, pp. 205–229.)

A full account of the investigation dealt with in 1932 Abstracts, p. 32.

A Census of Summer Thunderstorms.—(*Nature*, 15th Oct., 1932, Vol. 130, pp. 587–588.)

Note on the annual report of the Thunderstorm Census Organisation, Langley Terrace, Huddersfield.

Lightning Research. American and Continental Observations—Influence of Radio-Activity in the Soil—Explanation of " Dowsing " [Summary of Papers at the International Electrical Congress].—Peek, Fortescue, Dauzère, Bogoïavlensky and Chatelain, Rudenberg, and others: Lehmann. (*Electrician*, 4th Nov., 1932, Vol. 109, pp. 577–578.)

BALL LIGHTNING.—W. N. Jones. (*Nature*, 8th Oct., 1932, Vol. 130, p. 545.)

This letter describes an appearance of ball lightning in thunderstorms over the Ligurian hills to the east of Rapallo, observed from Portofino.

THE INFLUENCE OF HUMIDITY ON THE BREAKDOWN VOLTAGE IN AIR.—C. Dei. (*Nuovo Cimento*, May, 1932, Vol. 9, pp. 150–155.)

ON THE INFLUENCE OF A SUPERPOSED MAGNETIC FIELD ON THE DIELECTRIC BEHAVIOUR OF SOME SOLID, LIQUID AND GASEOUS BODIES. —R. Schmid. (*Ann. der Physik*, 1932, Series 5, Vol. 14, No. 7, pp. 809–830.)

The only case in which the presence of a magnetic field was found to have any influence on dielectric behaviour was that of spark discharge in air at atmospheric pressure. The spark delay was found to be increased in a transverse and diminished in a longitudinal field. The effect depends on the material and constitution of the cathode surface: it can be recognised with certainty only when the strength of the magnetic field is above 2 000 gauss. The changes observed may run parallel to the behaviour of photoelectric effects at atmospheric pressure.

AN IMPROVEMENT TO THE KYLDONOGRAPH.—F. Hartje. (*E.T.Z.*, 29th Sept., 1932, Vol. 53, No. 39, pp. 939–940.)

A NEW WIDE-ANGLE LENS [APPLICABLE TO PHOTOGRAPHY OF LIGHTNING FLASHES, AURORA, ETC.].—H. Schulz. (*Zeitschr. f. tech Phys.*, No. 10, Vol. 13, 1932, pp. 487–491.)

A CONSIDERATION ON THE EMISSION OF THE AURORAL GREEN LIGHT IN THE NIGHT SKY [DISCUSSION OF THE REACTIONS BETWEEN OXYGEN AND NITROGEN ATOMS].—M. Kimura. (Summary in *Physik. Ber.*, 1st Sept., 1932, Vol. 13, No. 17, p. 1641.)

DENSITY OF ELECTRONIC SPACE CHARGES OF STÖRMER'S AURORA THEORY INSUFFICIENT TO CAUSE LONG-DELAY ECHOES.—Dostal: Störmer.

(*See* abstract under " Propagation of Waves.")

EVIDENCE OF A PENETRATING RADIATION FROM THUNDERSTORMS.—B. F. J. Schonland and J. P. T. Viljoen. (*Nature*, 10th Sept., 1932, Vol. 130, p. 399.)

The writers have recently carried out experiments which suggest that a penetrating radiation is emitted by charged thunderclouds. " One pen of an electric chronograph was activated by a Geiger-Müller counter, another pen by a chronometer marking half-seconds, and a third by the atmospherics received from lightning flashes on a two-valve amplifier. The records have been examined to see whether the kicks of the counter and the flashes showed any significant time relations. . . . The results indicate that a thunderstorm emits some form of penetrating radiation at the moment of occurrence of a lightning flash, that this is emitted upwards and not downwards, and is received at distant points by some action such as that of the earth's magnetic field upon electrified particles." There is evidence that the thunderclouds which produce such radiation can also do so *before* they are discharged by lightning. The evidence suggests that the effective storms lay to the east of the meridian through the station. " Observations on overhead thunderstorms provided further evidence of the screening effect on the ordinary fine-weather penetrating radiation " already reported by Schonland (1931 Abstracts, p. 146).

ON THE COSMIC RADIATION [THEORY OF ORIGIN COVERING BOTH HARD AND SOFT COMPONENTS].—É. Sevin. (*Comptes Rendus*, 24th Oct., 1932, Vol. 195, pp. 698–701.)

Millikan and Cameron attribute the production of the cosmic rays to the formation of certain elements; Jeans considers them the result of the destruction of matter. The former base their calculations on the softer rays, the latter on the harder. The present writer, on his theory that the general evolution of the universe is characterised by a progressive decrease of potential energy, accounts for both classes of ray, his calculated wavelengths agreeing very closely with those of the other writers.

SPECTRUM OF COSMIC RADIATION.—A. St. Skapski. (*Nature*, 24th Sept., 1932, Vol. 130, pp. 472–473.)

This letter points out " a curious regularity which seems to occur in the energy values of the constituents of cosmic radiation."

MEASUREMENT OF COSMIC RADIATION IN THE STRATOSPHERE.—E. Regener. (*Naturwiss.*, 16th Sept., 1932, Vol. 20, No. 38, pp. 695–699.)

This paper describes the balloons used to carry self-registering apparatus to heights of the order of 30 km and also the apparatus itself. The results obtained are summarised; the intensity of the radiation increases more slowly after pressures of 150 mm Hg (heights of 12 km) are reached, and extrapolation to zero pressure gives an end value of 275 ion pairs per cc per sec. There is no sign of the presence of gamma radiation from known radioactive bodies in appreciable intensity.

RECENT RESEARCHES ON COSMIC RAYS.—Piccard: Regener. (*Nature*, 15th Oct., 1932, Vol. 130, pp. 570–571.)

This note gives a short account of the results obtained by Piccard in his balloon ascent in August, 1932, and summarises the methods which are now being used to investigate the nature of cosmic radiation. Piccard's observations on change of intensity with height agree with those of Regener (1932 Abstracts, p. 634, and above); he also finds that the radiation at great heights is uniform in all directions.

STUDY OF THE COSMIC RADIATION AT GREAT ALTITUDES.—A. Piccard and M. Cosyns. (*Comptes Rendus*, 10th Oct., 1932, Vol. 195, pp. 604–606.)

Some results of the ascent in August, 1932. Between 15 and 60 cm Hg pressure, the ionisation values lie on the exponential curve $I = 775e^{-0.0855p}$, where p is in cms of Hg. Near the ground the values are above those of the curve, owing to the radioactivity of the earth and the emanation from the lower atmosphere; at pressures below 15 cm Hg the values are below those of the curve. These results agree very well with those of Kolhörster and of Regener; they disagree with those of Millikan. A 4 cm screen of paraffin had no visible effect; one of lead between 4 and 5 cm in thickness gave a 20–35% diminution. Geiger tubes gave the same number of discharges per minute, within 1%, in horizontal and vertical positions. "The interpretation of all these facts together is not easy. The usual hypotheses are insufficient. Other researches will show whether an intrinsic radioactivity of the stratosphere may be thought of."

Origin of the Cosmic Rays.—Piccard. (*Electrician'* 14th Oct., 1932, Vol. 109, p. 468.)

Paragraph on the author's tentative suggestion that cosmic rays are formed in the stratosphere and not in outer space. This hypothesis would explain why the radiation is independent of the earth's direction in space and is not, therefore, a definite function of sidereal or solar time.

On Measurements of Fluctuation in Cosmic Radiation.—W. Messerschmidt. (*Zeitschr. f. Physik*, 1932, Vol. 78, No. 9/10, pp. 668–689.)

Observations of a total duration of 20 126 registration hours lead to the conclusion that all fluctuations of cosmic radiation at sea-level can be explained as due to meteorological influences, and thus the intensity of the primary cosmic radiation may be regarded as constant. The fluctuations caused by the ionisation process and related questions are also discussed.

Variation of Cosmic Radiation with Geographical Latitude and Terrestrial Magnetism.—J. Clay and H. P. Berlage. (*Naturwiss.*, 9th Sept., 1932, Vol. 20, No. 37, pp. 687–688.)

Comparison of the intensity of cosmic radiation at Amsterdam with the values obtained on a voyage from Amsterdam to Batavia leads to the conclusion that the simplest explanation of the variations observed is given by the effect of the changes of the earth's magnetic field rather than changes in latitude; the cosmic radiation as measured in the apparatus used must therefore consist of charged corpuscles.

The Variation with Pressure of Ionisation by Cosmic Rays.—B. Gross. (*Zeitschr. f. Physik*, 1932, Vol. 78, No. 3/4, pp. 271–278.)

The writer deduces an equation for the variation of ionisation current at high pressure which gives satisfactory agreement with experimental results.

Professor A. H. Compton's Studies of Cosmic Rays.—Compton. (*Science*, 7th Oct., 1932, Vol. 76, No. 1971, pp. 325–326.)

Summary of the survey in the western hemisphere. Chief results are (1) a gradual increase in cosmic ray intensity from equator towards poles, and (2) increase in intensity with altitude. Both these results are held as arguments against the pure-wave theory.

Counting Cosmic Rays.—Johnson and Street. (*Science*, 23rd Sept., 1932, Vol. 76, Supplement p. 9: photograph in *Sci. News Letter*, 24th Sept., 1932, p. 193.)

Using "an electrical telescope that automatically counts the cosmic rays," these workers are studying the effects of the earth's field on the directional distribution of the rays. They are working on the summit of Mount Washington, 6 288 ft high. So far, a slightly greater intensity of the rays in the magnetic meridian seems to have been found.

The Direction of Cosmic Rays.—Johnson and Street. (*Science*, 30th Sept., 1932, Vol. 76, No. 1970, Supp. p. 6.)

Experiments at the Bartol Research Foundation and on the summit of Mount Washington indicate that cosmic radiation is more intense from the magnetic north and south than from east and west. At the former site, the first measurements indicate a difference of 5 to 10%, which is just outside the probable error of measurement. The experiments are still in progress.

Cosmic Rays Bombard Earth with 40 000 Million Volts [New Estimate].—Johnson. (*Sci. News Letter*, 1st Oct., 1932, Vol. 22, p. 207.)

Concerning the Production of Groups of Secondaries by the Cosmic Radiation.—J. C. Street and T. H. Johnson. (*Phys. Review*, 1st Oct., 1932, Series 2, Vol. 42, No. 1, pp. 142–144.)

From the results of experiments with different arrangements of counters and lead blocks the writers conclude that the primary cosmic ray is itself an ionising ray (which may itself have been produced by a non-ionising gamma-ray or neutron).

The Biological Effect of Cosmic Rays.—Lakhovsky: Rivera.—(*Lincei, Atti d. R. Ac. d., Rendic.*, 6th March, 1932, pp. 403–405.)

PROPERTIES OF CIRCUITS.

Real Power Accommodation and Apparent Power Accommodation [for the Transmission of Maximum Power from Source to Load].—J. Fischer. (*Hochf:tech. u. Elek:akus.*, Oct., 1932, Vol. 40, No. 4, pp. 122–124.)

The writer points out that a full investigation of the accommodation conditions shows that these are different for apparent, reactive, and real power; only those for real power have hitherto been taken into account, whereas the apparent power accommodation is frequently the most important, since true matching free from reflection is only given in this way. His investigation covers all three types, expressions being found for each, together with values for the power transmitted under the optimum conditions of accommodation.

Transformer Coupling Circuits for High-Frequency Amplifiers.—A. J. Christopher. (*Bell S. Tech. Journ.*, Oct., 1932, Vol. 11, No. 4, pp. 608–621.)

Author's summary:—This article deals with the use of transformer type of coupling circuits in high-frequency amplifiers to transmit efficiently voltages or currents between certain limiting frequencies while attenuating those above and below the limiting frequencies. The similarity of these coupling circuits to band-pass filters is shown, and the conditions to be satisfied in order that they may act as such are covered. Means of obtaining uniformly high amplification over relatively wide frequency bands are explained. Typical conditions under which these coupling circuits have been employed and factors affecting their performance are discussed.

A FOURIER ANALYSIS OF RADIO-FREQUENCY POWER AMPLIFIER WAVE FORMS.—Hallman. (*See* under "Transmission.")

CROSSTALK AS A REFLECTION PHENOMENON.—K. Ohashi. (*E.N.T.*, Sept., 1932, Vol. 9, pp. 346–354.)

Dissatisfied with existing theories of crosstalk, the writer has worked out a theory of his own, involving the quantity "complex reflection," according to which the phenomenon of crosstalk is merely one example of a number of effects easily explained and dealt with in terms of the theory.

A DYNAMIC CHARACTERISTIC OF THERMIONIC VACUUM TUBE WITH NEGATIVE RESISTANCE [AND THE CONDITIONS FOR THE OCCURRENCE OF THE "BLOCKING" PHENOMENON].—Y. Fukuta. (Summary in *Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, Supp. p. 4.)

THE MAGNETIC FIELD OF A SOLENOID OSCILLATING AT RADIO FREQUENCIES.—O. Stuhlman, Jr., and S. Githens, Jr. (*Rev. Scient. Instr.*, Oct., 1932, Vol. 3, pp. 561–571.)

The question here experimentally investigated was "whether the line-of-force diagram and relative distribution of intensity in a loosely wound solenoid when operated at radio frequencies is the same as when actuated with direct current, and whether variations in frequency or type of oscillator used produce any differences." It was found that a single-valve tuned-plate tuned-grid oscillator circuit (in which the plate supply directly increases the flow of r.f. current in one direction only) gives a distorted field, the distortion being variable in amount and of a "shearing" nature, more pronounced at the plate end than at the filament end of the solenoid. A symmetrical push-pull circuit gives a symmetrical field similar to a d.c. field: to obtain a uniformly parallel field, the middle third or quarter of a solenoid at least 4 times as long as its diameter is recommended.

The magnetic field strength distribution along the axis of a solenoid is also dissymmetrical for the first type of oscillator, the dissymmetry increasing with the power but unchanging with frequency within the range employed—1 500 to 6 000 c/s. For the push-pull oscillator it conforms (at least as a first approximation) to the d.c. field, independently of power and of frequency. The paper ends with an investigation of the field strength distribution across the diameter of a solenoid, using push-pull excitation.

RESISTANCE IN BAND PASS FILTERS.—G. H. Buffery. (*Wireless Engineer*, Sept., 1932, Vol. 9, No. 108, pp. 504–511.)

"Any estimation of the performance of a band pass filter which leaves out of account the influence of the resistance of the circuit is likely to be extremely misleading [Abstracts, 1931, p. 383—G.W.O.H.; *also* 1932, pp. 521–522—Drouin]. Further, the position is complicated by the fact that, in the perfectly general case, no definite allowance can be made for the effective resistance introduced into the primary member by the aerial re-radiation, etc., nor into the secondary member by the load impedance of the amplifier. Within certain limits, however, it is possible to assign values to these quantities, based upon specific measurements in definite cases, and assuming that such values hold approximately for the case under consideration. Thus in what follows the resistance in each filter member is assumed to be known at all frequencies."

THEORY AND APPLICATION OF SYMMETRICAL MULTIPOLE CONNECTIONS.—H. G. Baerwald. (*E.N.T.*, Sept., 1932, Vol. 9, pp. 357–360.)

NOTE ON NETWORK THEORY [GENERAL EXPRESSIONS FOR PASSIVE "TRANSDUCERS" OR QUADRIPOLES CONNECTED IN VARIOUS WAYS TO FORM A RESULTANT PASSIVE TRANSDUCER].—J. G. Brainerd. (*Proc. Inst. Rad. Eng.*, Oct., 1932, Vol. 20, pp. 1660–1664.)

EQUIVALENT CIRCUITS [AND THEIR METHODS OF USE].—F. M. Starr. (*Transactions of the American I.E.E.*, June, 1932, Vol. 51, pp. 287–298.)

GEOMETRICAL CIRCUITS OF ELECTRICAL NETWORKS.—R. M. Foster. (*Ibid.*, pp. 309–317.)

NOTE ON BARTLETT'S BISECTION THEOREM FOR 4-TERMINAL ELECTRICAL NETWORKS.—O. Brune. (*Phil. Mag.*, Nov., 1932, Vol. 14, No. 93, pp. 806–811.)

THE SIGNIFICANCE OF THE SIGN OF A MUTUAL INDUCTANCE.—R. R. Nimmo and H. D. Poole. (*Proc. Camb. Phil. Soc.*, Oct., 1932, Vol. 28, No. 4, pp. 531–537.)

COUPLING AND COUPLING COEFFICIENTS.—G.W.O.H. (*Wireless Engineer*, Sept., 1932, Vol. 9, No. 108, pp. 485–486.)

Editorial on the unsatisfactory nature of the usual definitions, leading to a method of treatment ("the coupling between two circuits may be defined as the relation between the possible rate of transfer of energy and the stored energy of the circuits") which is applicable in all cases.

THE EQUIVALENT CIRCUIT OF A SYSTEM OF TWO INDUCTIVELY COUPLED CIRCUITS.—C. Rimini. (*Nuovo Cimento*, Aug.–Sept.–Oct., 1932, Vol. 9, pp. 240–250.)

REPLACEMENT OF A MECHANICAL VIBRATING SYSTEM BY AN EQUIVALENT ELECTRICAL CIRCUIT.—F. J. Domerque. (*Zeitschr. f. Fernmeldetech.*, No. 2, Vol. 13, 1932, pp. 30–31.)

TRANSMISSION.

SECRET [TELEGRAPHIC AND TELEPHONIC] COMMUNICATION BY PHASE MODULATION METHOD.—T. Kujirai and T. Sakamoto. (*Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, pp. 175–186.)

English version of the paper dealt with in Abstracts, 1932, p. 458. For other methods see Kujirai and Koga, 1930, p. 354; Chireix, 1932, p. 405; Bell Laboratories, 1930, p. 99; and Matsuyuki, below.

A Bridge Type Speech Inverter [for Secret Radio-telephony].—T. Matsuyuki. (*Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, pp. 187–193.)

A device for speech inversion developed by the Japanese Department of Communications. One arm of a resistance bridge contains two triodes with the plate of one connected to the filament of the other, and *vice versa*. *See* also below.

A System for the Inversion of Frequency Distribution [for Secrecy and Other Purposes].—Y. Niwa and T. Hayashi. (*Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, pp. 195–210.)

A four-valve system, successfully used in Japan, in which the input voltage whose frequency arrangement is to be inverted, and a carrier voltage of frequency a little above the band of the input voltage, are combined. The four sets of voltages thus obtained are impressed upon the grids of the four valves. These valves have almost the same characteristics, and are so connected that the final output consists only of the lower and upper sidebands of the input waves modulated by the carrier. If the carrier frequency is suitably chosen, the upper band is naturally attenuated by the amplifier or other transmitting paths; in other cases a low-pass filter can be used. A final section deals with various applications: a very reliable secrecy system is given by a combination of the inversion method with phase modulation, time retardation, or some other principle. The advantages of the inversion system for communication lines of high attenuation, such as submarine cables, or for lines suffering from severe induction, are described, together with other uses.

The Mechanism of the Production of Oscillations [General Mathematical Treatment].—Ph. le Corbeiller. (*Ann. des P.T.T.*, Aug., 1932, Vol. 21, pp. 697–731.)

A Method of Obtaining Very Low Frequency Alternating Currents by means of a Series-Wound D.C. Dynamo [combined with a Separately-Excited Dynamo acting as a Condenser].—E. Hueter. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 13, 1932, pp. 470–472.)

A substitute for Moeller's valve method (1932 Abstracts, p. 163.)

On the Spontaneous Generation of Oscillation in Low Pressure Discharges.—S. K. Mitra and Premtosh Syam. (*Phil. Mag.*, Oct., 1932, Series 7, Vol. 14, No. 92, pp. 616–631.)

This paper describes an investigation into the nature of the oscillations generated in a discharge in air at low pressure with a condenser connected across the discharge-tube and a high resistance in series with the h.t. source. The range of frequency investigated was the audio range 100 to 1 000 c/s. The observations generally confirmed those made by Gill (1930 Abstracts, p. 97) in the supersonic range of frequency.

The rôle of the external resistance in the maintenance of interruptions is discussed. A critical value of this resistance is found both theoretically and experimentally below which no oscillations will occur.

Wave-forms of pulsating current, obtained with a cathode-ray oscillograph, confirm in a general way the charge and discharge theory of Righi. Falling-plate photographs of the discharge show that " the duration of the discharge is very small compared with the period during which the tube is extinguished," thus showing that the discharge is almost instantaneous.

The Generation of Hertzian Waves [including Ultra-Short Waves] by means of Diodes.—J. Sahánek. (*Physik. Zeitschr.*, 15th Sept., 1932, Vol. 33, No. 18, pp. 693–703.)

From the author's summary:—The author has reached the following conclusions by analysis of methods hitherto used to produce Hertzian waves. Every arrangement of two or more electrodes in a more or less highly evacuated space can be made to produce Hertzian waves, when the following conditions are satisfied: an electron current crosses from one electrode to the second and is such that its periodic intensity component lies in the plane of the first electrode and varies synchronously with the periodic part of the e.m.f. connected to the two electrodes. The time of electron transit between the two electrodes must be of the order of magnitude of the period of the waves produced. Several oscillation regions can then be found for every constant voltage between the electrodes or for every velocity of emission of electrons from the first electrode.

Two new discharge paths of this nature are given in the paper. In the first, the anode consists of two parts which are at the same potential relative to the cathode. Both parts surround the glowing filament. The effect of a magnetic field in either direction relative to the electrodes gives rise to a current as described above. The simplest discharge path is a diode in which the anode is placed so that the greatest part of the potential drop occurs near the anode. [The writer goes on to describe experiments which gave rise to waves of length less than a metre and supported his hypothesis.]

On the Production of Undamped Oscillations of [Ultra-Short] Wavelengths of the Order of a Decimeter in a Reaction Circuit. Part I.—W. Kroebel. (*Ann. der Physik*, 1932, Series 5, Vol. 14, No. 1, pp. 80–102.)

Author's summary:—" The production of centimetre waves in the Barkhausen-Kurz circuit is first discussed, and, starting from this, the question is investigated as to whether and under what conditions the production of waves as short as those given by this circuit is possible in the ordinary reaction circuit, that is, where the anode has a high positive voltage relative to the grid and cathode. It is found and proved experimentally that such waves may in fact be produced in the reaction circuit [with a specially designed valve in which filament and grid are not 180° out of phase with one another]. So far, waves down to 31 cm have been produced with relatively large oscillatory energy, but this does not represent the theoretical limit; it is only the result of preliminary experiments. A theory is given which explains the experimental results in every detail. The oscillatory mechanism for centimetre waves is explained; further questions are raised, particularly as regards intensity, and will form the subject of a later paper." For previous papers by the same writer *see* 1931 Abstracts, p. 497.

OSCILLATORS FOR VERY HIGH FREQUENCIES AND RADIO-COMMUNICATION ON ULTRA-SHORT WAVES. [A SURVEY.]—C. Gutton. (*Rev. Gén. d'Élec.*, 17th Sept., 1932, Vol. 32, No. 11, pp. 333–339.)

THE GENERATION OF "CENTIMETRE" [ULTRA-SHORT] WAVES.—F. W. Chapman. (*Wireless Engineer*, Sept., 1932, Vol. 9, No. 108, pp. 500–503.)

A description of the methods used at King's College, London, to generate wavelengths down to about 40 cms.

ELECTRON [ULTRA-SHORT-WAVE] OSCILLATIONS.—A. Rostagni. (*Nature*, 1st Oct., 1932, Vol. 130, pp. 509–510.)

The writer has made a series of observations on ultra-short-wave oscillations in three-electrode valves with positive grid with a Lecher wire system attached to the grid and anode terminals. Oscillations of maximum strength were found for definite pairs of values of the grid potential V_g and the emission current i_e as a movable condenser joining the wires was varied. From these and the constructional details of the valve, using the writer's theory (1932 Abstracts, pp. 223, 282 and 341) the total number N of electrons between grid and anode can be calculated, and curves are given which show that experimental data follow closely the theoretical relation $\lambda\sqrt{N} = \text{const.}K$. The values of K found for different valves agree reasonably well with the theoretical valve $3.35 \times 10^6 v^{1/2}$, where v is the volume between the grid and anode of the valves.

A SYSTEM OF DOUBLE MODULATION FOR DUPLEX RADIO COMMUNICATION ON MICRO-WAVES.—Carrara. (*See* under "Stations, Design and Operation.")

CRYSTAL CONTROL OF ULTRA-SHORT-WAVE TRANSMITTERS. — Anon.: Straubel. (*Zeitschr. V.D.I.*, 3rd Sept., 1932, Vol. 76, No. 36, pp. 873–874.)

Including an outline of the Telefunken 7-stage 15 kw transmitter (quartz-controlled: 1932 Abstracts, p. 404) and of Straubel's work (*ibid.*, p. 355). In the issue of 24th September (p. 948) Straubel makes a correction regarding the temperature coefficient of tourmalin oscillators, and mentions that at 21 metres they give about twice the control energy given by quartz.

ELECTRON-COUPLED OSCILLATORS FOR THE SMALL TRANSMITTER [GIVING STEADY-FREQUENCY NOTE CHARACTERISTIC OF CRYSTAL CONTROL, WITH THE POSSIBILITY OF CHANGING THE FREQUENCY].—G. Grammer. (*QST*, Oct., 1932, Vol. 16, pp. 13–17 and 88.) *See* also Bull, *ibid.*, pp. 35–36.

THE STABILISATION OF HIGH FREQUENCY GENERATORS [SURVEY, FOR INTERNATIONAL ELECTRICITY CONFERENCE].—F. Kiebitz. (*T.F.T.*, Sept., 1932, Vol. 21, pp. 235–239.)

STUDY ON THE FREQUENCY VARIATION OF VALVE GENERATORS.—V. FURTHER COMPARISON OF FREQUENCY-VARIATION CHARACTERISTICS OF HARTLEY AND COLPITTS OSCILLATORS, AND A NEW METHOD OF STABILISATION USING LOW EXCITATION.—S. Ishikawa. (Summary in *Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, Supp. p. 5.)

Further development of the work dealt with in 1931 Abstracts, p. 149.

A FOURIER ANALYSIS OF RADIO-FREQUENCY POWER AMPLIFIER WAVE FORMS [CLASS B AND C R.F. AMPLIFIERS].—L. B. Hallman, Jr. (*Proc. Inst. Rad. Eng.*, Oct., 1932, Vol. 20, pp. 1640–1659.)

Author's summary:—A theoretical treatment of class B and C radio-frequency amplifier wave forms by means of the Fourier series is presented. Assuming constant plate tuned circuit impedance, general expressions for the Fourier coefficients for any value of grid bias from cut-off to the position for class A operation are derived. The variation in plate circuit efficiency as the bias is moved from the position for class A operation to cut-off is considered. Ideal wave forms with which class C operation would be obtained are analysed. The extent to which the ideal forms may be approached in actual operation is considered and a wave form which may be approximated in practice is analysed. The efficiency of the several wave forms is discussed.

POWER RATIOS IN HIGH POWER RADIO TRANSMITTERS [VALUES FOR ALL STAGES REPRESENTED ON SINGLE LOGARITHMIC DIAGRAM: DETERMINATION OF EFFICIENCIES].—U. Steudel. (*E.T.Z.*, 22nd Sept., 1932, Vol. 53, No. 38, pp. 905–907.)

MAXIMUM EFFICIENCY FROM THE TYPE 52 VALVE: 800 WATTS IN AERIAL WITH 1 KILOWATT INPUT.—C. D. Perrine. (*QST*, Sept., 1932, Vol. 16, pp. 17–20.)

Based on the attainment of three points—high plate voltage (4 500 v), high excitation and high L/C ratio.

A LOW-POWER BROADCAST TRANSMITTER [100 WATTS OUTPUT BASIC UNIT, EXTENSIBLE UP TO 1 000 WATTS BY ADDING AMPLIFIER UNIT].—A. W. Kishpaugh. (*Bell Lab. Record*, Oct., 1932, Vol. 11, No. 2, pp. 37–42.)

MAKING PRACTICAL USE OF GRID-BIAS MODULATION: APPLYING IT TO AMATEUR 'PHONE TRANSMITTERS.—R. A. Isberg. (*QST*, Aug., 1932, Vol. 16, pp. 37–40.)

RECEPTION.

AMPLIFIERS FOR BANDS OF FREQUENCIES (FOR FREQUENCY - CHANGING RECEIVERS). — Drouin. (*L'Onde Élec.*, June, 1932, Vol. 11, No. 126, pp. 33–64.)

Continuation of the paper dealt with in September Abstracts, pp. 521–522. Chapter IV deals with amplifying functions of the 3rd degree $\left(A = \dfrac{ux^2 + 1}{sx^2 + 1}\right)$ corresponding to a single anti-resonant (rejector) circuit: such circuits cannot furnish anything like uniform amplification over the modulation band, but they have to be studied because they include the classic "tuned amplifier" which serves as a basis of comparison. Chapter V deals with functions of the 5th degree $\left(A = \frac{rx^4 + ux^2 + 1}{vx^4 + sx^2 + 1}\right)$ consisting of two symmetrical anti-resonant circuits and including amplifiers with "negative" distortion and those with "positive" distortion, according to whether $u - s$ is negative or positive. The former are in general inferior to the latter, giving less selectivity for a given allowable distortion (Fig. 26), and also *adding* their distortion to the inevitably negative distortion of the tuning system; but they are valuable, in the construction of amplifiers with non-identical stages, on account of their great selectivity in the immediate neighbourhood of the band. Another fact emerging from the analysis, important for such mixed-stage amplifiers, is that whatever may be the sign of the distortion the selectivity is considerably increased if a non-zero amplification at a large distance from the band is tolerated.

Chapter VI deals with amplifying functions of the 7th degree. Since those of the 5th degree give excellent results, the use of these more complex amplifiers, with their more delicate adjustments, is only justifiable if their effects are definitely better. Examination of such amplifiers, with positive distortion and zero amplification at infinity, shows that for a distortion of 10 % they may give a maximum selectivity of 6.5 as against 4.36 for the 5th degree amplifiers; while for the same distortion but a decreased band breadth a value of 29.4 is attainable. The paper is continued in the July number, pp. 65–96, where Chapter VII deals with a general study of compensation. The final part is in the August number, pp. 97–124, where Chapter X gives two practical examples—a compensated superheterodyne receiver covering 200–2 000 m, with 2 stages of i.f. amplification; and an i.f. amplifier, of 3 stages, of high amplification, intended for the amplification of short waves for a public radiotelephone service, the corresponding superheterodyne having the range 10–100 m.

THE RADIO RECEIVER CHARACTERISTICS RELATED TO THE SIDE-BAND COEFFICIENT OF THE RESONANCE CIRCUIT.—S. Takamura. (*Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, pp. 97–129.)

English version of the paper dealt with in 1932 Abstracts, p. 344. The "side-band coefficient" of a circuit is the ratio α of the impedance of the circuit for the carrier frequency to that for the side frequency, and the modulated current can be expressed by $I_{\text{mod. eff.}} = I_{\text{carr. eff.}} \sqrt{1 + \frac{K^2}{4}(\alpha'^2 + \alpha''^2)}$, where K is the degree of modulation and α' and α'' are the lower and upper side-band coefficients. The coefficient varies considerably near the resonance point when the ratio of the modulation frequency to the carrier frequency is comparatively large, *e.g.*, >0.001; the smaller the decrement of the circuit, the greater the variation. Generally the coefficient at the resonance point <1.

The combined side-band coefficient (made up from those of the various circuits, in position) must be introduced into the equation of the receiver output. Single, double and triple humps may appear in the resonance curves measured by the receiver output voltage, according to receiver conditions, even if the resonance curves for the carrier voltage applied to the detector has only a single hump. This phenomenon is explained by the combined side-band coefficient. The resonance curve of the carrier voltage represents directly the fidelity or the side-band coefficient at the resonance point of the circuit. The fidelity of the receiver is better at detuned points than at the resonance point, and the sharper the resonance the greater is the change of fidelity with detuning.

"SYNCHRONOUS" RECEPTION.—H. de Bellescize. (*L'Onde Élec.*, June, 1932, Vol. 11, No. 126, pp. 225–240.)

Continuation of the paper dealt with in 1932 Abstracts, p. 521. Chapter II considers the principles and possibilities of "synchronous" reception, and Chapter III discusses the realisation of such a receiver, Fig. 9 giving a circuit by which the local oscillations are automatically maintained at a constant phase difference with regard to the incoming carrier, the actual procedure for setting up synchronism (with the two currents in quadrature) being described on p. 237, and the automatic maintenance of this condition on pp. 238–239. The final section deals with possible occurrences destroying the synchronism (*e.g.*, a slow variation of the frequency of the transmitting station, combined with a "fade") and the precautions to be taken against them. Two different cases require consideration, one where the receiver has to be simple and economical, the other where the maximum effectiveness is required. The rest of the paper is to be found in the July and August numbers, pp. 241–256 and 257–272.

THE DETECTION OF MICROWAVES [ULTRA-SHORT WAVES OF FREQUENCY ABOUT 10^9 C/S].—N. Carrara. (*Proc. Inst. Rad. Eng.*, Oct., 1932, Vol. 20, pp. 1615–1625.)

See 1932 Abstracts, p. 461.

THE DETECTOR.—W. B. Lewis. (*Wireless Engineer*, Sept., 1932, Vol. 9, No. 108, pp. 487–499.)

A method is developed by which the performance of certain simple detector circuits employing straight-line rectifiers can be estimated graphically, and various conclusions are drawn from selected examples. Thus "the efficiency of the detector for the modulation frequencies is somewhat less [than that for a steady maintained input], being reduced by a factor which may be compared with the transmission efficiency of a single stage resistance-capacity filter," whose time constant is roughly the geometric mean of the time constants of the detector circuit when the rectifier is conducting and non-conducting—or rather less for a push-pull detector.

SCREEN-GRID VOLTAGE AND DETECTOR SENSITIVITY.—J. C. Flippin. (*QST*, Oct., 1932, Vol. 16, p. 37.)

SYSTEMATIC STUDY OF SHORT-WAVE TRIODE AMPLIFYING CIRCUITS BY "NEUTRALISATION" [PARTICULARLY THE BRIDGE METHOD].—Y. Haraguchi. (Summary in *Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, Supp. pp. 4–5.)

VISUAL TEST DEVICES [GIVING R.F. FREQUENCY RESPONSE CURVE OF RECEIVER OR COMPONENTS, FOR PRODUCTION TESTING: ROTATING SWEEP CONDENSER AND MIRROR, MIRROR GALVANOMETER, ETC.].—O. H. Schuck. (*Proc. Inst. Rad. Eng.*, Oct., 1932, Vol. 20, pp. 1580–1598.)

In order to make the determination of the resonance point more accurate, the first derivative of the resonance curve may be obtained at will by switching in a resistance-capacity-coupled stage as described at the top of p. 1585.

AN INTERMEDIATE-FREQUENCY AND AUDIO UNIT FOR THE SINGLE-SIGNAL SUPERHET: MORE ABOUT ADJUSTMENT AND PERFORMANCE.—J. J. Lamb. (*QST*, Sept., 1932, Vol. 16, pp. 9–16.)

A continuation of the work dealt with in 1932 Abstracts, p. 583. An editorial note states that extended experiment with this receiver leads to the conviction that it is "at least the basis of the ultimate high frequency receiver of this era."

A HIGH-OUTPUT AMPLIFIER [ATTACHMENT] FOR THE BATTERY RECEIVER: IMPROVED PERFORMANCE FROM BATTERY SETS—AN APPLICATION FOR THE NEW CLASS B AUDIO TUBE.—C. B. de Soto. (*QST*, Aug., 1932, Vol. 16, pp. 29–33.)

RECEIVERS AT THE BERLIN RADIO SHOW.—E. Schwandt. (*Radio, B., F. f. Alle*, Sept., 1932, pp. 390–393.)

DESIGN OF D.C. SETS: PROBLEMS PECULIAR TO DIRECT CURRENT SUPPLY.—W. T. Cocking. (*Wireless World*, 18th November, 1932, Vol. 31, pp. 450–451.)

WIRELESS WORLD BATTERY BABY SUPERHET.—W. T. Cocking. (*Wireless World*, 7th October, 1932, Vol. 31, pp. 334–337.)

A battery-operated version of the receiver referred to in 1932 Abstracts, p. 639.

THE DI-SUPER-6 [SUPERHETERODYNE] RECEIVER WITH DOUBLE FREQUENCY CHANGE [AVOIDING "DOUBLE IMAGE" TROUBLE WITHOUT DEFECTS OF USUAL METHODS].—De Giorgi. (*Alta Frequenza*, June, 1932, Vol. 1, No. 2, pp. 308–310.)

THE DIODE QUALITY FOUR [FOUR-VALVE BATTERY-OPERATED RECEIVER WITH DIODE RECTIFIER].—H. F. Smith. (*Wireless World*, 30th Sept., 1932, Vol. 31, pp. 308–311.)

SHORT WAVE TWO [WITH SCREEN-GRID VALVE AS REGENERATIVE DETECTOR].—H. B. Dent. (*Wireless World*, 4th Nov., 1932, Vol. 31, pp. 414–417.)

FLEXIBLE BAND PASS UNIT.—H. B. Dent. (*Wireless World*, 14th Oct., 1932, Vol. 31, pp. 358–360.)

A tuning unit which can be added to any existing receiver not already employing the band-pass principle.

WHISTLE SUPPRESSOR [A SIMPLE TUNED FILTER FOR ELIMINATING HETERODYNE INTERFERENCE].—W. T. Cocking. (*Wireless World*, 28th Oct., 1932, Vol. 31, pp. 396–397.)

WIRELESS IN THE MODERN HOTEL [WALDORF ASTORIA].—A. Dinsdale. (*Wireless World*, 21st Oct., 1932, Vol. 31, pp. 379–380.)

COPPER-OXIDE RECTIFIER USED FOR RADIO DETECTION AND AUTOMATIC VOLUME CONTROL.—L. O. Grondahl and W. P. Place. (*Proc. Inst. Rad. Eng.*, Oct., 1932, Vol. 20, pp. 1599–1614.)

Authors' summary:—A new type of radio detector has been developed which depends for its action on the rectifying properties of the boundary between copper and cuprous oxide formed on the copper at a higher temperature. In order to make the copper-oxide rectifier useful up to broadcast frequencies, it was necessary to use small discs and a high current density. The high current density was obtained in part by connecting an inductance in parallel with the rectifier and tuning it with the rectifier capacity.

The circuits developed possess unique advantages in that harmonic distortion is practically eliminated, a stage of audio-frequency amplification is eliminated, and automatic volume control of variable μ tubes as well as other tubes is achieved without the necessity of using an auxiliary tube for volume control. A new form of automatic volume control made possible by the use of a single rectifier element as an asymmetrical resistance is described and discussed.

RECEIVER SCALES AT THE BERLIN RADIO SHOW, IN PARTICULAR THE AEG "OPTICAL STATION INDICATOR."—(*Radio, B., F. f. Alle*, Oct., 1932, pp. 426–430.)

THE TUNING CURVES OF ELECTRICAL DISTANT CONTROL DEVICES FOR RADIO RECEIVERS.—Schadow. (*See* abstract under "Subsidiary Apparatus.")

THE NEW TUNING COILS ["FERROCART" IRON CORES].—A. L. M. Sowerby: Vogt. (*Wireless World*, 30th Sept. and 14th Oct., 1932, Vol. 31, pp. 312–314 and 368–369.)

Investigations on the coils referred to in 1932 Abstracts, p. 640. In addition to smaller size, a much more constant dynamic resistance is an advantage over an equivalent air-cored coil.

ELECTRICAL INTERFERENCE [ADDITIONAL CAUSES, INCLUDING STATIC CHARGE ON MOTOR FRAME DUE TO BELT SLIPPAGE].—(*QST*, Sept., 1932, Vol. 16, p. 45.)

INTERFERENCE WITH WIRELESS RECEPTION ARISING FROM THE OPERATION OF ELECTRICAL PLANT.—A. S. Angwin. (*Institution P.O. Elec. Engineers*, Paper No. 137, 1932, 36 pp.)

THE CONSTRUCTION OF CHOKING COILS FOR PREVENTING RADIO INTERFERENCE [*e.g.* FROM MERCURY VAPOUR RECTIFIERS].—E. T. Glas. (*Teknisk Tidskrift*, 5th Nov., 1932, Vol. 62, pp. 168–172.)

CUTTING OUT THE CRACKLE: WHAT THE LISTENER CAN DO TO MINIMISE INTERFERENCE.—A. B. Calkin. (*Wireless World*, 21st Oct., 1932, Vol. 31, pp. 374–376.)

AERIALS AND AERIAL SYSTEMS.

THE EFFECTIVE COMBATING OF SHORT RANGE FADING IN BROADCASTING, BY SPECIAL TRANSMITTING AERIAL SYSTEMS [FOR SPACE-WAVE SUPPRESSION].—H. Harbich and W. Hahneman. (*E.N.T.*, Oct., 1932, Vol. 9, pp. 361–376.)

A paper on the "series" aerial system (or in its broadcasting form, the "polygon" or "ring" system) dealt with in 1932 Abstracts, pp. 166–167 and 526, and also the "high" aerial system, consisting either of an elevated dipole, as erected experimentally at the Lorenz station at Eberswalde, or of two dipoles one above the other, as under test at the Leipzig station. The possibility of improving still further the anti-fading results obtained by each system (as shown by fading records compared with results from a simple earthed vertical aerial), by combining the two systems, is discussed on pp. 367–368. Such a combination should give practically no radiation between 45° and 90°.

RADIATION CHARACTERISTICS OF BEAM ANTENNAS [AND THE DISPERSION OF THE BEAM BY THE HEAVISIDE LAYER]: ERRATA.—Minohara, Tani and Ito. (*Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, inset.)

Corrections to five equations in the paper dealt with in 1932 Abstracts, p. 527.

ASYMPTOTIC DIPOLE EXPANSIONS FOR SMALL HORIZONTAL ANGLES.—F. H. Murray. (*Proc. Camb. Phil. Soc.*, Oct., 1932, Vol. 28, No. 4, pp. 433–441.)

Author's summary:—The wave function V for a vertical dipole above the earth's surface has been expanded by a method differing somewhat from that of Sommerfeld, expansions being obtained for large and for small numerical distances respectively. On the earth's surface E_z, H_x, H_y can be expanded in ordinary asymptotic series, the explicit expansions for small numerical distances being given . . . Sommerfeld's approximation $k_2 - s = k_2 - k_1$ [Sommerfeld's notation] has been avoided, and if the constant $a\,[= (s^2 - k_1^2)^{\frac{1}{2}}]$ is small the variation of the method of expansion of Wise [1930 Abstracts, p. 46] should improve the convergence of the series for points not on the earth's surface.

THE GENERALISED THEORY OF THE ELECTROMAGNETIC FIELD OF A DIPOLE AND OF RADIATION FROM THE LATTER.—B. L. Rosing. (*Westnik Elektrot.*, No. 11/12, 1931, Sec. I, pp. 410–417.)

Of the two solutions obtained by Lorentz for the differential equations of an electromagnetic field, ϕ_1 with $(t - r/c)$ is used as the basis of classical electrodynamics, while ϕ_2 with $(t + r/c)$ does not agree with experiment. But Poincaré has attacked the use of ϕ_1, and the writer adopts a third solution $\phi_3 (= a_1\phi_1 + a_2\phi_2$, where $a_1 + a_2 = 1)$, and applies his results to the field of a dipole. The existence of stationary waves in an ideal resistance-less dipole is thus shown.

ON THE CALCULATION OF THE [SHORT-WAVE] FRAME ANTENNA WITH UNIFORMLY DISTRIBUTED ELECTROMOTIVE FORCE.—I. Iwakata. (Summary in *Rep. of Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, Supp. p. 4.)

The writer has previously dealt with the straight-wire short-wave aerial (1932 Abstracts, p. 462) and now considers the more complex question of the frame aerial, dividing the latter into two parts, the vertical and the horizontal, and obtaining the resultant voltage by the use of the superposition theory.

SHORT-WAVE AERIALS [FOR BROADCAST RECEPTION: INCLUDING FRAME AERIALS].—W. F. Floyd. (*World Radio*, 23rd and 30th Sept., and 7th Oct., 1932, Vol. 15, pp. 650–651, 707–708, and 762.)

TRANSMISSION-LINE FEED FOR SHORT-WAVE ANTENNAS (INCLUDING THE GROUNDED ANTENNA].—T. McLean. (*QST*, Oct., 1932, Vol. 16, pp. 25–29 and 88, 90.)

GROUNDS [THE USE OF GROUND RODS: SMALL EFFECT OF INCREASING DIAMETER: MINIMUM SPACING FOR SEVERAL RODS: TRENCH METHOD OF SOIL TREATMENT, USING CHEMICALS].—(*QST*, Aug., 1932, Vol. 16, pp. 50–51.)

(*See* also Everitt, *ibid.*, October issue, p. 39.)

NOTES AND RECOLLECTIONS ON THE ERECTING OF THE TOWERS OF THE WIRELESS STATION OF CROIX D'HINS [NEAR BORDEAUX: METAL TRIPODS 250 METRES HIGH, AND THEIR FOUNDATIONS].—J. B. Pomey. (*Ann. des P.T.T.*, Sept., 1932, Vol. 21, pp. 791–795.)

MEASUREMENTS OF WIND PRESSURE ON OVERHEAD WIRES.—R. H. Sherlock. (Extract in *E.T.Z.*, 29th Sept., 1932, Vol. 53, No. 39, pp. 941–942.)

VIBRATION IN ELECTRICAL CONDUCTORS [AND THE ADVANTAGE OF A TRIANGULAR CROSS SECTION].—A. E. Davison, J. A. Ingles and V. M. Martinoff. (*Elec. Engineering*, Nov., 1932, Vol. 51, pp. 795–798.)

VALVES AND THERMIONICS.

RADIATION-COOLED POWER TUBES FOR RADIO TRANSMITTERS [WITH PEAK OUTPUT CAPACITIES 500, 1 500, and 2 000 WATTS].—H. E. Mendenhall. (*Bell Lab. Record*, Oct., 1932, Vol. 11, No. 2, pp. 30–36.)

The molybdenum plates may be run as high as 1 000° C, a cherry red heat. They are roughened by carborundum blasting, are of extra large size, and are provided with radiating fins. Molybdenum is also used for the grids; secondary emission and its variation "have been decreased by spraying the grid with a thin coating of carbon. In the manufacture of the new tubes, however, a special treatment for the grid has been employed. . . ." The filament has a core of tungsten containing about 1% of thorium dioxide: it is covered by a thin layer of tungsten carbide over which lies a monatomic layer of metallic thorium. Compression springs of tungsten are employed to take up filament expansion. The valve types are 270 A, 251 A and 279 A, in ascending order of power.

ON SHORT WAVE TRANSMITTING VALVES [AND THE SUPERIORITY OF THE LOW-VOLTAGE HIGH-EMISSION TYPE].—Y. Haraguchi. (Summary in *Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, Supp. p. 4.)

THE FLASH-ARC [" ROCKY POINT EFFECT "] IN HIGH-POWER VALVES.—B. S. Gossling. (*Journ. I.E.E.*, Sept., 1932, Vol. 71, No. 492, pp. 460–483 : Discussion, pp. 483–487.)

The full paper, a *Wireless Engineer* summary of which was referred to in 1932 Abstracts, p. 528.

A NEW TYPE OF VALVE DIAGRAM [SHOWING " DURCHGRIFF," MUTUAL CONDUCTANCE AND INTERNAL RESISTANCE, AND ALSO " GÜTE " —PRODUCT OF MUTUAL CONDUCTANCE AND AMPLIFICATION FACTOR].—F. W. Gundlach. (*E.N.T.*, Sept., 1932, Vol. 9, pp. 354–356.)

Unlike the " valve triangles " of Meyer and of Klingelhöffer and Walther (Abstracts, 1931, p. 42 ; 1932, p. 227) the writer's diagram includes also the Barkhausen " figure of merit," product of amplification factor and mutual conductance. Every point on the diagram belongs simultaneously to two logarithmic co-ordinate systems mutually displaced by 45°. At no part of the diagram are the points unduly congested, and the use of only rectangular co-ordinates makes its reading particularly simple and convenient. *See* also Zilitinkevitch, 1932 Abstracts, p. 341.

SOME FACTS ABOUT THE RECENTLY-ANNOUNCED TUBES [TYPES 41–44, 52, 55 and 85 (DUPLEX-DIODE TRIODES), 83 (MERCURY-VAPOUR RECTIFIER), 89, WUNDERLICH AND TRIPLE-TWIN].—(*QST*, Sept., 1932, Vol. 16, pp. 30–32.)

TUBE TYPES TABULATED [INCLUDING SECTIONS FOR SPECIAL TYPES AND FOR WESTERN ELECTRIC TRANSMITTING TUBES].—(*Ibid.*, pp. 36, 38 and 39.)

ANTI-MICROPHONIC VALVES [" RIGID UNIT " CONSTRUCTION].—Mullard Wireless Service Company. (*Journ. Scient. Instr.*, Oct., 1932, Vol. 9, pp. 325–327.)

THE OUTPUT POWER OF THE FINAL VALVE IN AN AMPLIFIER, AND ITS PRACTICAL SIGNIFICANCE.—Leithäuser.

(*See* under " Acoustics and Audio-frequencies.")

OXIDE CATHODES [A SURVEY].—A. Gehrts. (*Naturwiss.*, 30th Sept., 1932, Vol. 20, No. 40, pp. 732–738.)

This paper gives a general survey of the present state of our knowledge of oxide cathodes. Its scope is shown by the paragraph headings, which are as follows : (1) Barium (alkaline earth metal) as electron source in the surface of oxide cathodes (Wehnelt cathodes). (2) Activation (formation) of oxide cathodes by electrolysis. (3) Current conductivity of unformed oxide cathodes. (4) Electron conductivity of activated oxide cathodes. (5) Reactions of alkaline earth oxides with one another and with the core material. (6) Activation (formation) of oxide cathodes without electrolysis.

THE THERMIONIC AND PHOTOELECTRIC WORK FUNCTIONS OF MOLYBDENUM.—L. A. Du Bridge and W. W. Roehr. (*Phys. Review*, 1st Oct., 1932, Series 2, Vol. 42, No. 1, pp. 52–57.)

ON MICROPYROMETRY.—G. Lewin. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 13, 1932, pp. 497–498.)

Continuation of the work referred to in 1932 Abstracts, p. 642.

TESTING THE ELASTICITY OF VACUUM TUBE FILAMENTS.—C. H. Marshall. (*Bell Lab. Record*, Oct., 1932, Vol. 11, No. 2, pp. 48–52.)

ELECTRIC CURRENTS FROM HOT CATHODES IN GASES AND VAPOURS AT ATMOSPHERIC PRESSURE.—M. Ruhnke. (*Ann. der Physik*, 1932, Series 5, Vol. 14, No. 8, pp. 881–904.)

THE EMISSION OF POSITIVE IONS FROM HOT TUNGSTEN.—P. B. Moon. (*Proc. Camb. Phil. Soc.*, Oct., 1932, Vol. 28, No. 4, pp. 490–496.)

Author's summary :—Measurements have been made of the positive ion currents emitted by tungsten at temperatures between 3 000°K and 3 200°K. The results are in general accordance with the values calculated on the basis of the Saha equation from the rate of evaporation of neutral atoms, the electron work-function and the ionisation potential of tungsten. The " work-function " associated with the ionic evaporation appears to lie between 10 and 11 electron-volts.

THE EMISSION FROM GLOWING PLATINUM IN GASES, IN PARTICULAR IN IODINE VAPOUR AND CHLORINE.—E. Müller. (*Ann. der Physik*, 1932, Series 5, Vol. 14, No. 7, pp. 831–855.)

DIRECTIONAL WIRELESS.

SHIPBOARD OBSERVATIONS WITH A CATHODE-RAY DIRECTION FINDER BETWEEN ENGLAND AND AUSTRALIA.—G. H. Munro and L. G. H. Huxley. (*Journ. I.E.E.*, Sept., 1932, Vol. 71, No. 429, pp. 488–496.)

Authors' summary :—The paper describes the installation of a cathode-ray direction-finder on board a ship and observations on long-wave stations and atmospherics during a voyage from Port Said to Brisbane.

Directional observations of long-wave wireless stations at distances of from 1 000 to 5 000 miles showed little evidence of errors in bearings, and the bearings obtained were compared with the calculated ones to find the quadrantal error due to the ship.

Systematic daily observations of atmospherics on 30 000 metres gave intersections suggesting tropical thunderstorm areas, particularly one in Central Africa, as the main sources during most of the voyage, but round the coast of Australia the predominant sources were in the northern interior of that Continent. The directions of these sources in Australia are shown to correspond to areas of low barometric pressure accompanied by thunderstorms in those regions,

A NOTE ON THE THEORY OF NIGHT ERRORS IN ADCOCK DIRECTION-FINDING SYSTEMS.—J. F. Coales. (*Journ. I.E.E.*, Sept., 1932, Vol. 71, No. 429, pp. 497–506.)

Author's summary :—The paper deals with the theory of night errors (*i.e.* those errors which cannot be estimated owing to their variation from minute to minute and their dependence on factors not easily determined) in wireless direction-finding systems, and has arisen out of experimental work carried out at H.M. Signal School, Portsmouth. Expressions are derived for the errors which may be obtained as a result of the presence of both ground and atmospheric waves. The fixed Adcock system is shown to be less liable to error than loop systems, but there are substantial zones in which, for certain conditions of the atmospheric or indirect ray from a transmitter, the fixed Adcock system is subject to blurred minima and to errors of bearing. These zones increase with increase of spacing between the aerials, and the maximum error occurs when the intensities of the ground and atmospheric waves are approximately equal. The rotating Adcock system, however, is shown to be free from blurred minima and errors due to night effect.

AN INVERTER-LAMP FOR THE CONVERSION OF 60-CYCLE POWER INTO 1 000-CYCLE MODULATED LIGHT [WITH PARTICULAR APPLICATION TO MODULATED LIGHT BEACONS AND TUNED PHOTOELECTRIC CELL RECEIVERS FOR AIRCRAFT DIRECTION IN FOG].—W. F. Westendorp. (*Physics*, Oct., 1932, Vol. 3, pp. 193–202.)

Cf. 1932 Abstracts, p. 169.

ACOUSTICS AND AUDIO-FREQUENCIES.

THE ELECTRODYNAMIC DIAPHRAGM DRIVE [FOR MOVING-COIL LOUD SPEAKERS: THE OPTIMUM MASS FOR THE MOVING COIL].—H. Benecke. (*E.N.T.*, Oct., 1932, Vol. 9, pp. 382–387.)

The common assumption that the best relation between the moving-coil mass and the diaphragm mass is equality is derived from the usual expression for the electro-mechanical efficiency. The fact that this relation is not the best in actual practice is due to this expression for efficiency having no true application to the practical working of a loud speaker: the really important ratio is that of the radiated energy to the *apparent* power.

The writer derives an expression for this ratio, the apparent efficiency (equation 5); from this he obtains a second expression (equation 14) for the same quantity, involving a constant a depending on the air gap. The maximum value of this efficiency is seen to be given, at a first approximation, by equation 19, and at a second approximation by equation 20. From the latter it is clear that *the optimum moving-coil mass increases only slightly more rapidly than the cube root of the diaphragm mass.* No marked deviation from this calculated (and experimentally confirmed) optimum value is found for medium frequencies, but it shows itself at the borders of the zone of reproduction. If the ratio of the apparent efficiency at high frequencies to that at low frequencies is called the "tendency," the definition being so chosen that unity represents uniform reproduction throughout the scale, then the tendency is inversely proportional to the moving-coil mass.

THE AXIAL SOUND-PRESSURE DUE TO DIAPHRAGMS WITH NODAL LINES.—N. W. McLachlan. (*Proc. Phys. Soc.*, 1st Sept., 1932, Vol. 44, Part 5, No. 245, pp. 540–545.)

Author's abstract :—A formula is found for the axial sound-pressure due to a disc having a nodal circle and vibrating in an infinite rigid plane. Beyond a certain axial distance, when the nodal circle occurs at $r = a/\sqrt{2}$, the pressure vanishes owing to interference caused by the inner and outer portions of the disc vibrating in opposite phase. The case of n nodal circles of arbitrary radii is treated by an approximate method. A rigid disc is imagined to be severed around each nodal circle whilst contiguous annuli vibrate with equal amplitudes in opposite phases. Finally, the pressure on the axis of a conical shell having nodal circles is treated as in the previous case. When the semi-apical angle of the cone is $\frac{1}{2}\pi$ and there are no nodal circles, the formula reduces to that for a rigid disc.

THE ACCESSION TO INERTIA OF FLEXIBLE DISCS VIBRATING IN A FLUID.—N. W. McLachlan. (*Proc. Phys. Soc.*, 1st Sept., 1932, Vol. 44, Part 5, No. 245, pp. 546–555.)

Author's abstract :—In this paper formulae are obtained for the velocity-potential at the surface of a free-edge disc vibrating with nodal lines in a fluid. These formulae are used to ascertain the accession to inertia due to the fluid when the disc is set in an infinite rigid plane. The equivalent mass and the mass coefficient of the disc vibrating *in vacuo* are found also. By means of these results, the influence of the fluid on the frequency of vibration with (a) one nodal circle, (b) one nodal diameter, (c) stationary centre, is evaluated. In air the alteration in frequency is almost negligible, whereas in water the frequency is reduced to a small fraction of its value *in vacuo*.

THE DISTRIBUTION OF SOUND RADIATION FROM A SPHERE VIBRATING IN VARIOUS WAYS: WITH APPLICATIONS TO LOUD SPEAKER DIAPHRAGMS.—N. W. McLachlan. (*Phil. Mag.*, Nov., 1932, Vol. 14, No. 93, pp. 747–758.)

Author's abstract :—"By aid of Legendre functions, formulae are deduced for the acoustic pressure at a great distance from a sphere vibrating in various ways. Polar diagrams are given showing the distribution of radiation for (a) sphere vibrating axially, (b) hemisphere vibrating axially, (c) two hemispheres vibrating axially in opposition, (d) sphere with two nodal circles. The results are applied to hornless loud speakers."

Thus (a) gives an approximate conception of the radiation from a loud speaker diaphragm vibrating as a whole without a baffle, or at low frequencies with a small baffle. The results of (b) can be applied, with the necessary limitations, to a diaphragm vibrating in a small absorbent cabinet; (c) can be compared roughly with a double loud speaker where two diaphragms, moving axially in opposition, are employed, as in patents taken out by the writer. Finally, (d) gives a broad idea of the radiation distribution to be expected from a free-edged conical diaphragm vibrating at low frequencies with nodal diameters in a large baffle.

THE ACOUSTIC AND INERTIA PRESSURE AT ANY POINT ON A VIBRATING CIRCULAR DISC.—N. W. McLachlan. (*Phil. Mag.*, Nov., 1932, Supp. Number, Vol. 14, No. 94, pp. 1012–1025.)

Author's abstract :—A formula is obtained for the acoustic pressure at *any* point on a rigid circular disc vibrating in an infinite plane. The analysis is extended to flexible discs whose dynamic deformation curve is taken to be of the form $w = A\left(1 - p_1 \cdot \frac{r^2}{a^2}\right)$, where p_1 is a variable parameter. It is shown that the acoustic and inertia components, into which the pressure can be resolved, vary from the centre to the edge. The expressions derived for the pressure in the cases considered involve Bessel, Struve, and hypergeometric functions. The results obtained are discussed with reference to the distribution of sound from the mouth of a long loud speaker horn. By integrating the product of pressure and velocity over the surface of the disc, the radiated power can be evaluated. As an example, the case of a free-edge disc vibrating with free centre and one nodal circle is treated.

SOUND INTENSITIES : VOLUME LEVEL AND THE LOUD SPEAKER.—N. W. McLachlan. (*Wireless World*, 4th Nov., 1932, Vol. 31, pp. 419–420.)

Leading from the article dealt with in 1932 Abstracts, p. 590. The "masking effect" of the lower tones on the higher is dealt with : it is largely responsible for the poor performance given by loud speakers which have a prominent bass resonance.

LOUDNESS AND INTENSITY RELATIONS.—L. B. Ham and J. S. Parkinson. (Summary in *Sci. Abstracts, Sec. A*, Oct., 1932, Vol. 35, No. 418, p. 958.)

See also 1932 Abstracts, p. 288.

FURTHER INVESTIGATIONS INTO THE ACOUSTIC-ELECTRICAL TRANSFORMATION IN LOUD SPEAKERS [DIFFERENCE IN ELECTRICAL BEHAVIOUR, AT RESONANCE POINTS, OF MAGNETIC AND ELECTRO-DYNAMIC TYPES : "IRON LOSSES" AND "ARMATURE REACTION"].—H. Zickendraht and W. Lehmann. (*Helvet. Phys. Acta, Fasc.* 4, Vol. 5, 1932, pp. 312–314.)

ELECTRO-ACOUSTIC INVESTIGATIONS ON LOUD SPEAKERS.—H. Zickendraht and W. Lehmann. (Short summary in *Physik. Ber.*, 1st Sept., 1932, Vol. 13, No. 17, p. 1631.)

THE PRINCIPLE AND ADVANTAGES OF THE "FREE SWINGING" LOUD SPEAKER MOVEMENT.—(*Radio, B., F. f. Alle*, Sept., 1932, pp. 411–412.)

A NEW MOVING-COIL LOUD SPEAKER WITH CONE REPLACED BY FLAT PLEATED DIAPHRAGM, AVOIDING AIR COLUMN RESONANCE EFFECTS, ETC.—(*Radio, B., F. f. Alle*, Sept., 1932, p. 426.)

SOME ACOUSTIC AND TELEPHONE MEASUREMENTS [BRITISH POST OFFICE : INCLUDING LOUD SPEAKER TESTS].—H. R. Harbottle. (*Journ. I.E.E.*, Oct., 1932, Vol. 71, No. 430, pp. 605–631 : Discussion, pp. 632–641.)

The full paper, summaries of which (one in *The Wireless Engineer*) were referred to in 1932 Abstracts, pp. 413 and 589.

MODERN THEORY AND NEW EXPERIMENTS ON THE ACOUSTIC HORN.—A. Bernini. (*Nuovo Cimento*, April, 1932, Vol. 9, No. 4, pp. 85–101.)

Leading to various conclusions, one being that the superiority of the exponential shape over the conical is not always confirmed.

A NEW HIGH EFFICIENCY LOUD SPEAKER OF THE DIRECTIONAL BAFFLE TYPE [CONE LOUD SPEAKER BUILT INTO AN EXPONENTIAL HORN : THEORY AND PREDICTED FREQUENCY CHARACTERISTIC, EFFICIENCY, ETC.].—H. F. Olson. (*Journ. Acous. Soc. Am.*, No. 4, Vol. 2, 1931, pp. 485–498.)

THEORY OF THE HORN-TYPE LOUD SPEAKER.—C. R. Hanna. (*Journ. Acous. Soc. Am.*, No. 2, Vol. 2, 1931, pp. 150–156.)

Including curves for the reflection at the end of the horn and for the radiation resistance of various types of horn.

THE THEORY OF HORNS [AND SOME EXPERIMENTAL INVESTIGATIONS OF THE VALIDITY OF ITS ASSUMPTIONS AND APPROXIMATIONS].—W. M. Hall. (*Journ. Acous. Soc. Am.*, April, 1932, Vol. 3, pp. 552–561.)

THE PRODUCTION OF HOMOGENEOUS MAGNETIC FIELDS.—Bühl and Coeterier.

(*See* under "Subsidiary Apparatus and Materials.")

THE VIBRATION FORMS OF CONE DIAPHRAGMS [CHLADNI FIGURES OBTAINED BY PREVENTING THE POWDER FROM SLIDING BY ROTATING THE CONE ABOUT ITS AXIS].—H. Benecke : Telefunken Company. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 13, 1932, pp. 481–483.)

THEORY OF VIBRATING MEMBRANES AND PLATES.—R. C. Colwell and J. K. Stewart. (Summary in *Sci. Abstracts, Sec. A*, Oct., 1932, Vol. 35, No. 418, p. 959.)

See also 1931 Abstracts, p. 620.

HIGHER VIBRATIONS OF CHLADNI PLATES.—R. C. Colwell. (*Nature*, 5th Nov., 1932, Vol. 130, p. 701.)

The writer has obtained symmetrical vibration figures upon brass plates 1/32″ and 1/64″ thick, using a valve oscillator (Abstracts, 1931, p. 620 ; *see* also 1932, pp. 414 – two, 533, and 645 – two).

ELECTRO-ACOUSTIC LISSAJOUS FIGURES.—Z. Carrière. (*Journ. de Phys. et le Rad.*, Aug., 1932, Vol. 3, No. 8, pp. 255–272.)

THE "TOPOLY" [TOBIS-POLYPHON] PROCESS FOR MAKING SOUND FILMS IN SEVERAL LANGUAGES.—A. Neuburger. (*Fernsehen u. Tonfilm*, Oct., 1932, Vol. 3, No. 4, pp. 240–243.)

THE SELENOPHON SOUND-ON-STRIP GRAMOPHONES.—H. Rosen : Selenophon Company. (*Fernsehen u. Tonfilm*, Oct., 1932, Vol. 3, No. 4, pp. 245–246.)

Cf. 1930 Abstracts, p. 512—Petsch.

A NEW SYSTEM OF SOUND RECORDING [VERTICAL CUT].—H. C. Harrison. (*Bell Lab. Record*, July, 1932, Vol. 10, No. 11, pp. 389–393.)

GRAMOPHONE TRACKING [A GEOMETRICAL NOTE].—F. Record. (*Journ. Scient. Instr.*, Sept., 1932, Vol. 9, pp. 286–289.)

HOME RECORDING OF GRAMOPHONE RECORDS.—E. Nesper. (*Radio, B., F. f. Alle*, Sept. and Oct., 1932, pp. 417–424 and 460–468.)

SOUND RECORDING FOR THE AMATEUR.—N. P. Slade. (*Wireless World*, 21st October, 1932, Vol. 31, pp. 377–378.)

A discussion of the four principal methods of sound-recording in general use, namely disc, cylinder, magnetised steel tape and film, leads to the conclusion that the film method is the one which holds out the most promise for the future.

ELECTRONIC MUSIC [SYSTEM OF ELECTRO-MAGNETS AND TOOTHED PHONIC WHEELS].—I. Eremeef. (*Scient. American*, Nov., 1932, pp. 308–309.)

ELECTRICAL MUSICAL INSTRUMENTS AT THE BERLIN RADIO EXHIBITION : EDITORIAL.—(*Radio, B., F. f. Alle*, Sept., 1932, pp. 387–388.)

THE RIBBON MICROPHONE [THEORY].—H. F. Olson. (*Journ. Acous. Soc. Am.*, No. 1, Part 1, Vol. 3, 1931, pp. 56–68.)

OBSERVATIONS ON FILMED AND FILTERED VOWELS.—E. W. Scripture. (*Nature*, 20th Aug., 1932, Vol. 130, pp. 275–276.)

From film curves of German vowels obtained by the use of a recording wire in a magnetic field slantwise across a slit, the writer concludes that " the character of a sound as a vowel does not depend on the presence of any special frequencies . . . the vowel character depends on the general shape of the vibration profile and any frequencies of any kind may be present provided they give the same general form of profile."

OBSERVATIONS ON FILMED AND FILTERED VOWELS.—W. E. Benton : R. A. S. Paget. (*Nature*, 24th Sept., 1932, Vol. 130, p. 475.)

Benton draws attention to the agreement between Paget's conclusion that " the ear judges a vowel by the form of the compound wave : the ratio of the amplitudes is possibly quite as important as the ratio of frequencies, and a resonator is only successful in imitating a vowel when both ratios can be reproduced " and Scripture's hypothesis (1932 Abstracts, p. 590) that " the vowel character depends on the general shape of the vibration profile." Paget's letter directs attention to " the effect of the changes of attitude or ' expression ' of the larynx and adjoining parts which accompany vowel formation." *See* also above.

OSCILLOGRAPHIC INVESTIGATIONS ON THE INSULATION, AGAINST SOUND TRANSMISSION ALONG SOLID BODIES, PROVIDED BY VARIOUS BUILDING CONSTRUCTIONS.—H. Kreüger and J. H. Sager. (*Zeitschr. V.D.I.*, 1st Oct., 1932, Vol. 76, No. 40, pp. 964–967.)

INTERFERENCE ELIMINATION [IN REVERBERATION TIME MEASUREMENTS] WITH THE WARBLE TONE.—W. L. Barrow. (Summary in *Sci. Abstracts, Sec. A*, Oct., 1932, Vol. 35, No. 418, p. 959.)

EFFECT OF POSITION ON THE ABSORPTION OF MATERIALS FOR THE CASE OF A CUBICAL ROOM [AND THE NEED OF CAUTION IN APPLYING THE USUAL FORMULAE FOR ABSORPTION COEFFICIENT AND DECAY FACTOR].—C. A. Andree. (Summary in *Sci. Abstracts, Sec. A*, Oct., 1932, Vol. 35, No. 418, pp. 958–959.)

THE EFFECT OF HUMIDITY UPON THE ABSORPTION OF SOUND IN A ROOM, AND A DETERMINATION OF THE COEFFICIENTS OF ABSORPTION OF SOUND IN AIR.—V. O. Knudsen. (*Journ. Acous. Soc. Am.*, No. 1, Part 1, Vol. 3, 1931, pp. 126–138.)

Cf. Chrisler and Miller, 1932 Abstracts, p. 647.

ABSORPTION OF SOUND BY POROUS MATERIALS.—V. Kühl and E. Meyer. (*Nature*, 15th Oct., 1932, Vol. 130, pp. 580–581.)

This letter gives a preliminary account of measurements on the ratio of absorption to angle of incidence of sound for various materials at various frequencies, and on the dependence of absorption upon frequency. The angle theory of Rayleigh and Paris and a frequency theory proposed by the writers receive qualitative confirmation.

MEASUREMENTS OF SOUND INSULATING PROPERTIES AT SUPERSONIC FREQUENCIES.—N. N. Malov and S. N. Rschevkin. (*Hochf : tech. u. Elek : akus.*, Oct., 1932, Vol. 40, No. 4, pp. 134–136.)

Measurements of a number of materials, at a frequency of 573 kc/s, show that the insulating power of a homogeneous plate of given dimensions is a function only of the weight of the plate. The vibrations were produced by a quartz oscillator in oil, the measurements being made by the sound-pressure deflection of a light suspended vane.

SUPERSONIC DISPERSION AND ABSORPTION IN CO_2.—W. H. Pielemeier. (*Phys. Review*, 15th Sept., 1932, Series 2, Vol. 41, No. 6, pp. 833–837.)

A PHOTOELECTRIC-MECHANICAL METHOD FOR THE HARMONIC ANALYSIS OF PERIODIC FUNCTIONS.—G. Dietsch and W. Fricke. (*E.N.T.*, Sept., 1932, Vol. 9, pp. 341–345.)

The curve to be analysed is cut out of black paper and fixed round a glass cylinder which is illuminated by a tube-shaped lamp inside it and is rotated by a small motor steadied by a heavy flywheel. A screen close to the cylinder is provided with an adjustable slit, whose image is focused on to a photocell ; the photoelectric current fluctuations, corresponding to the silhouette of the curve, are amplified and taken to a mechanical resonant system whose tuning is so sharp that a 5 c/s mistuning reduces the deflection of the steel reed to zero. This deflection can be measured either optically (by the broadening of an image thrown on to a scale) or electrically (rectifier and meter). The black paper curve must be so dimensioned that the cylinder circumference corresponds to a whole number of periods: this is accomplished, if the curve is an oscillogram, by adjusting the recording paper speed suitably: otherwise, by enlarging the given curve to a suitable size. The advantages of this new analyser are particularly noticeable in the case of curves with numerous peaks and hollows, and curves whose periodic elements have statistical fluctuations superposed on them so that they present "concealed frequencies." Results of a sample test, taking about 3 minutes, are given: calculated and measured values agree admirably, from the 1st to the 11th harmonic.

A NEW ELECTRICAL METHOD OF FREQUENCY ANALYSIS AND ITS APPLICATION TO [THE DETECTION AND MEASUREMENT OF] FREQUENCY MODULATION.—W. L. Barrow. (*Proc. Inst. Rad. Eng.*, Oct., 1932, Vol. 20, pp. 1626–1639.)

An oscillographic method with a very high resolving power, allowing component voltages of only 2 c/s frequency difference to be clearly resolved. *See* 1932 Abstracts, p. 229. The method is based on the appearance of certain figures, typical of definite frequency ratios, appearing in an oscillogram of the superposition of a constant frequency and a "search" voltage.

SOME MEASUREMENTS ON THE RAYLEIGH DISC [MAGNESIUM, PAPER AND MICA ABOUT EQUALLY SUITABLE: SENSITIVITY INCREASED BY RECTANGULAR SHAPE: IN INHOMOGENEOUS FIELDS, ONLY CORRECT ON AXES OF SYMMETRY].—P. Kotowski. (*E.N.T.*, Oct., 1932, Vol. 9, pp. 404–406).

DETERMINATION OF WORKING CHARACTERISTICS AT DIFFERENT FREQUENCIES, BY THE USE OF A PHOTOELECTRIC SYREN.—W. Schäffer and G. Lubszynsky. (*Ann. des P.T.T.*, Oct., 1932, Vol. 21, pp. 905–913.)

French version of the paper dealt with in 1931 Abstracts, p. 563.

A LOW-FREQUENCY OSCILLATOR [DELIVERING 23 MILLIAMPERES INTO A 600 OHM LOAD AT FREQUENCIES BETWEEN 10 and 800 CYCLES/SEC.].—J. M. Hudack. (*Bell Lab. Record*, July, 1932, Vol. 10, No. 11, pp. 378–380.)

PAPERS ON THE GENERATION OF AUDIO AND VERY LOW FREQUENCIES.—Mitra and Syam: Hueter.

(*See* under "Transmission.")

A THERMIONIC VOLTMETER WITH LOGARITHMIC CALIBRATION CURVE [PARTICULARLY FOR ELECTRO-ACOUSTIC RECORDING EQUIPMENTS].—Rommel.

(*See* under "Measurements and Standards.")

THE OUTPUT POWER OF THE FINAL VALVE IN AN AMPLIFIER, AND ITS PRACTICAL SIGNIFICANCE.—G. Leithäuser. (*E.T.Z.*, 29th Sept., 1932, Vol. 53, No. 39, pp. 937–939.)

The power of an amplifier is sometimes specified by the anode dissipation, which is simply a characteristic of the type of output valve. Another and better method of specification is to give the maximum a.c. output (for an ohmic resistance load). Radt's work (*E.N.T.*, 1926) on the calculation of this is discussed, and a summary of Bartels' treatment (Abstracts, 1929, p. 388: *see* also p. 446) is given; the work of Forstmann (particularly on the importance of increasing the external resistance and using small anode currents, to improve the output: 1930, p. 390) and of Hanna, Sutherlin and Upp (1928, p. 344) is referred to.

The above leads up to the writer's suggestion that the best procedure of all is to give the value of the *undistorted* a.c. output; instead of the grid potential being increased from zero to the point of zero anode current, regardless of the bends in the characteristic, he would consider only the undistorted zone: the limit of this is considered to be reached when the amplification has fallen by 3%. This is an empirical value which the writer considers satisfactory, for reasons which he gives. Two methods of measuring this undistorted a.c. output are described. Even for large theatres the values 20 to 40 watts are sufficient, and greater powers are undesirable owing to the non-linear working of the human ear.

REAL POWER ACCOMMODATION AND APPARENT POWER ACCOMMODATION [FOR THE TRANSMISSION OF MAXIMUM POWER FROM SOURCE TO LOAD].—Fischer.

(*See* under "Properties of Circuits.")

MEASUREMENT OF THE POWER OUTPUT OF LOW FREQUENCY FINAL STAGE AMPLIFIERS.—V. Babits. (*Zeitschr. f. Physik*, 1932, Vol. 78, No. 1/2, pp. 133–137.)

A method depending on the measurement of the separate factors on which the output depends. Some practical results are given.

QUANTITATIVE INVESTIGATION OF THE ACOUSTIC "PULL-IN" [MITNAHME] EFFECT.—S. Chaikin. (*E.N.T.*, Oct., 1932, Vol. 9, pp. 376–382.)

The apparatus used in these researches consisted of two identical electro-magnetic systems back to back, one a microphone and the other a telephone, their armatures being mounted on a common spindle carried at each end on a flat steel spring. One end of the spindle carried a paper diaphragm. The microphone was also coupled to the telephone by a 3- or 4-stage l.f. amplifier, so that vibrations were maintained whose amplitude could be adjusted by a shunt to the telephone windings; the actual linear displacement of the spindle-end of the vibrating system was measured by means of a microscope with micrometer eye-piece. This arrangement was also used to determine the elastic coefficient, by measuring the displacement produced by a known static force on the end of the spindle.

The external force required to produce the "pull-in" effect was obtained from the sound field of a calibrated loud speaker acting on the outer surface of the diaphragm of the vibrating system. The experimental results show that the breadth of the "pull-in" zone is proportional to the external force. This agrees with theory, which gives the relation $\Delta\nu/\nu = a/A$ (equation 4, $\Delta\nu$ being the zone breadth, ν the natural frequency of the system, a and A the amplitudes of the external force and of the elastic force involved in the vibrations). Table 1 shows that the values of the acoustic field of the loud speaker (*i.e.*, the "external force") calculated from the experiments by means of equation 4 agree very well with those calculated from the loud speaker calibration. The small but systematic discrepancy is largely due to error in observing the limits of the zone; this was done by listening to beat notes, and the human ear is bad at detecting very slow beats.

The Frequency Analysis of Aircraft Noises [using the Exploring Note Method and the Rectifier Bridge Analyser].—F. Eisner, H. Rehm and H. Schuchmann. (*E.N.T.*, Sept., 1932, Vol. 9, pp. 323–333.)

The paper begins with a discussion of the complex aircraft noises and their effects, and of various frequency analysing methods applicable to their study, a large number of literature references being given. From Part III onwards it deals with the particular method chosen and developed for this D.V.L. investigation, and with the results obtained with various types of aeroplane motors on the test bed, and with various aeroplanes on the ground and in flight.

A band microphone (Hartmann, 1931 Abstracts, p. 561) converts the sounds into potential variations which are magnified by a resistance-capacity amplifier. The exploring note is generated by a beat-note generator and is varied by clockwork between 0 and 10 000 c/s. The dry-plate rectifier bridge described by Walter (1932 Abstracts, pp. 593 and 651) is used as analyser, in combination with a band-pass filter and rectifier, a d.c. amplifier, and a loop oscillograph. It is pointed out that this analyser has the great advantage (in addition to its simplicity) over the usual analysers that if the exploring voltage is sufficiently high the analyser output is *not* dependent on its value, so that the beat-note generator potential need not be kept accurately constant. The resolving power of the equipment, as used, is 100 c/s.

A number of oscillograms are given. Figs. 7 and 8 (test bed records) show that the motor noises have strong components as high as 5 000 c/s and over, but these seem to be chiefly due to the action of the brake propeller used to take up the power of the motor. The other records would indicate that the true frequency spectrum lies chiefly between 100 and 1 000 c/s, but it is pointed out (p. 332) that the region below 100 c/s requires further investigation and that the absence of frequencies above 1 000 c/s cannot be assumed from these particular tests.

A New Acoustic Analyser—Determination of the Sound Spectra produced by Aircraft in Flight [Microphone, Amplifier, and Tuned Bifilar Quadrant Electrometer].—L. P. Delsasso. (*Journ. Acous. Soc. Am.*, No. 1, Part 1, Vol. 3, 1931, pp. 167–178.)

The Barkhausen Effect as Noise Standard.—H. Nukiyama and T. Saito. (*Journ. I.E.E.*, Japan, Vol. 52, 1932, pp. 461–462.)

Noise Measurements on Motor Vehicles.—E. Meyer and W. Willms. (*Zeitschr. V.D.I.*, 8th Oct., 1932, Vol. 76, No. 41, pp. 983–987.)

Practical Methods of Combating Noise in Industrial Works [General Account].—F. M. Osswald. (*Naturwiss.*, 14th Oct., 1932, Vol. 20, No. 42, pp. 767–770.)

A Study of Noises, and of the Acoustic Insulation of Materials and Buildings.—J. F. Cellerier. (*Rev. Gén. de l'Élec.*, 29th Oct., 1932, Vol. 32, No. 17, pp. 559–567.)

The Significance of Noise Measurements.—K. H. Pratt. (*Elec. Engineering*, Oct., 1932, Vol. 51, pp. 705–708.)

Acoustic Sounding Equipments [particularly the "Echometer" Direct Indicating Equipment and the "Elektrolot" with Electrical Detonation at Sea Bottom].—(*Zeitschr. V.D.I.*, 27th Aug., 1932, Vol. 76, No. 35, pp. 847–849.)

On the Possibility of Determining the Slope of the Sea Bottom by means of a Single Acoustic Sounding.—P. Marti. (*Comptes Rendus*, 12th Sept., 1932, Vol. 195, pp. 528–530.)

A New Method of Sound-Pulse Photography [Foley Sound-Shadow Method modified to use Induction Coil in place of Electrostatic Machine].—S. Kalyanaraman. (*Journ. Scient. Instr.*, Sept., 1932, Vol. 9, pp. 284–285.)

A Simple Resonance Receiver for Short Sound Waves.—H. Kröncke. (*Physik. Zeitschr.*, 1st Oct., 1932, Vol. 33, No. 19, pp. 733–734.)

World-Wide Telephony—Its Problems and Future.—B. Gherardi and F. B. Jewett. (*Bell S. Tech. Journ.*, Oct., 1932, Vol. 11, No. 4, pp. 485–519.)

Long Distance Telephone Circuits in Cable.—A. B. Clark and H. S. Osborne. (*Bell S. Tech. Journ.*, Oct., 1932, Vol. 11, No. 4, pp. 520–545.)

PHOTOTELEGRAPHY AND TELEVISION.

Television Developments: Great Britain–Germany–United States.—(*World Radio*, 23rd Sept., 1932, Vol. 15, pp. 646–647.)

Demonstration of Marconi Television [at British Association Meeting].—(*Engineer*, 9th Sept., 1932, Vol. 144, p. 264.)

Sight and Sound on One Wave.—A. P. Peck: Columbia Broadcasting Company. (*Television*, Sept., 1932, Vol. 5, No. 55, pp. 240–242.)

On the system referred to in 1932 Abstracts, p. 591.

Television at the Berlin Radio Exhibition, 1932: Television from the Witzleben Ultra-Short-Wave Transmitter.—G. Kette: F. Kirschstein. (*Fernsehen u. Tonfilm*, Oct., 1932, Vol. 3, No. 4, pp. 193–205: 205–210.)

The Special German P.O. Section for Television at the 9th Great German Radio Exhibition.—G. Kette. (*T.F.T.*, Oct., 1932, Vol. 21, pp. 275–281.)

The Practical Realisation of Thun's "Line Control" [Variable Spot Speed Principle] with the Application of Newly Developed Methods.—M. von Ardenne: Thun. (*Fernsehen u. Tonfilm*, Oct., 1932, Vol. 3, No. 4, pp. 210–221.)

"On the foundation of the methods and view-points communicated in this paper, there should be no serious difficulty in the technical realisation of a cathode-ray television transmitter with 'line-control' and 30 000 elements. So far as all tests, results and calculations indicate, this path offers a promising prospect of arriving soon at a satisfactorily realistic and also commercially practical television."

Among the various points mentioned, it is found that even for a picture rich in contrasts, with a mean line frequency of 2 000–3 000 c/s, the longest scanning time per line is less than 1/800 sec. Therefore for the line trip voltages the band required is only from 800 c/s to the maximum (200 000 c/s, for sharp contrast transitions in the dark parts of the picture). This leaves the frequencies below 800 c/s available for the transmission of the modulated picture trip signals. The 25–200 000 c/s band can be dealt with at the receiver by the use of the latest aperiodic r.f. amplifiers for ultra-short waves (1932 Abstracts, p. 637), or of short-wave superheterodyne apparatus with aperiodic i.f. amplification.

THE CONSTRUCTION AND WORKING OF A CATHODE-RAY OSCILLOGRAPH [WITH SPECIAL CATHODE GIVING RAY OF SECONDARY ELECTRONS BY IMPACT OF POSITIVE IONS].—H. Peters. (*Fernsehen u. Tonfilm*, Oct., 1932, Vol. 3, No. 4, pp. 234–240.)

Presenting, over the ordinary cathode-ray tube, the advantages that intensity control produces no appreciable effect on the ray velocity, and that the life is longer. The working voltage required is somewhat higher. The special cathode is a combination of an outer perforated disc and a central rod (Fig. 2), the latter being of a more electro-positive metal.

ASPECTS OF THE TRANSMISSION AND RECEPTION OF STILL PICTURES.—C. J. F. Tweed. (*Journ. I.E.E.*, Sept., 1932, Vol. 71, No. 429, pp. 536–537: abstract only.)

HIGH FREQUENCY AMPLIFICATION IN TELEVISION [ADVANTAGES AND DIFFICULTIES IN R.F. AMPLIFICATION, AS OPPOSED TO A.F. AMPLIFICATION, OF THE PHOTOELECTRIC CURRENTS]. G. Krawinkel and K. Ziebig. (*Fernsehen u. Tonfilm*, Oct., 1932, Vol. 3, No. 4, pp. 221–227.)

CHARACTERISTICS OF CERTAIN CAESIUM-OXIDE PHOTOELECTRIC CELLS.—J. C. Peters, Jr., and E. B. Woodford. (*Physics*, Oct., 1932, Vol. 3, No. 4, pp. 172–178.)

COMPARATIVE CHARACTERISTICS OF THE COPPER OXIDE AND "PHOTRONIC" CELLS: THE WESTON PHOTRONIC CELL IN OPTICAL MEASUREMENTS: A NEW PHOTO-CELL PHOTOMETER [USING TWO PHOTRONIC CELLS]. —C. H. Bartlett: G. A. Shook and B. J. Scrivener: P. R. Gleason. (*Rev. Scient. Instr.*, Oct., 1932, Vol. 3, pp. 543–552; 553–555: 556–560.)

THE SELENIUM PHOTO-ELEMENT AND ITS APPLICATIONS.—E. Schwandt. (Summary in *Physik. Ber.*, 15th Sept., 1932, Vol. 13, No. 18, p. 1684.)

See also the next summary on the same page.

THE CRYSTAL PHOTOELECTRIC EFFECT IN TRANSPARENT ZINC SULPHIDE.—H. Dember. (*Naturwiss.*, 7th Oct., 1932, Vol. 20, No. 41, p. 758.)

PHOTO-CONDUCTIVITY [SURVEY, WITH BIBLIOGRAPHY OF 189 ITEMS UP TO 1932].—F. C. Nix. (*Reviews of Mod. Physics*, Oct., 1932, Vol. 4, No. 4, pp. 723–766.)

THE THEORY OF THE BECQUEREL EFFECT [AND THE DISTINCTION BETWEEN IT AND THE HALLWACHS EFFECT AND PHOTO-CONDUCTIVITY].—E. Baur. (Summary in *Sci. Abstracts, Sec. A*, Sept., 1932, Vol. 35, No. 417, pp. 880–881.)

PHOTOELECTRIC AND THERMIONIC EMISSION FROM COMPOSITE SURFACES.—W. B. Nottingham. (*Phys. Review*, 15th Sept., 1932, Series 2, Vol. 41, No. 6, pp. 793–812.)

From the author's summary:—A study of the thermionic emission, with a new thyratron circuit for heating tungsten and thoriated tungsten filaments, reveals that many [inconsistent] points can be explained if we take into consideration the complex form of the potential barrier produced by an atom layer of electro-positive metal when deposited on an electro-negative base. . . . Since the width and perhaps the height of the barrier seem to depend upon the temperature, it becomes clear that the Richardson-Dushman equation is applicable only as an empirical representation of the data obtained with composite surfaces as emitters. This surface model explains very naturally the fact that the electrons emitted from a composite [surface] have an apparently Maxwellian distribution of velocities corresponding to a temperature 50% higher than that of the filament as reported by Koller and Rothe. It also gives a qualitative explanation of the observed dependence of the photoelectric long wavelength limit on the applied potential for thin films of sodium on nickel, using very low fields.

THE NATURE OF THE SPONTANEOUS CURRENTS OCCURRING ON ILLUMINATION OF VARIOUS DETECTOR SUBSTANCES.—F. Waibel. (*Zeitschr. f. Physik*, 1932, Vol. 78, No. 7/8, pp. 423–429.)

Author's summary:—The physical nature of the effects occurring on illumination of narrowly bounded detector contacts of a series of semiconductors is investigated; the effects are shown to be purely thermal in nature. Barrier-layer photoelectric effects play a minor part even in the case of known barrier-layer materials such as cuprous oxide and selenium, when point contacts are illuminated. Lead sulphide and a number of other semi-conductors of good conductivity show no barrier-layer effects even when the electrodes are surfaces.

ON THE WORK-FUNCTIONS OF ELECTRONS EMITTED FROM METALS [THEORETICAL INVESTIGATION]. —I. Tamm and D. Blochinzev. (*Zeitschr. f. Physik*, 1932, Vol. 77, No. 11/12, pp. 774–777.)

THE THERMIONIC AND PHOTOELECTRIC WORK FUNCTIONS OF MOLYBDENUM.—L. A. Du Bridge and W. W. Roehr. (*Phys. Review*, 1st Oct., 1932, Series 2, Vol. 42, No. 1, pp. 52–57.)

On the Conditions Necessary for the Occurrence of an Independent Photoelectric Voltage.—H. Teichmann. (*Zeitschr. f. Physik*, 1932, Vol. 78, No. 1/2, pp. 21–25.)

Author's summary :—It is shown that the occurrence of an independent photoelectric voltage is connected with the presence of a difference in the distribution of the permissible electron conditions in the media in contact which produce the photoelectric effect.

The Electron Emission from Metals under the Action of X-Rays.—H. Küstner. (*Ann. der Physik*, Oct., 1932, Series 5, Vol. 14, No. 8, pp. 857–880.)

New High Intensity Light Sources for Television Receivers [especially the "Linear" Lamp for Mirror Helix, with Modulated D.C. to Internal Electrodes and R.F. Control to External Ring Electrodes].—Scholz : Leithäuser. (*Radio, B., F. f. Alle*, Sept., 1932, pp. 404–406.)

Television Reception with Mirror Helix and Mercury-Argon Lamp fed with High Frequency Current.—W. Scholz. (*Fernsehen u. Tonfilm*, Oct., 1932, Vol. 3, No. 4, pp. 227–230.)

Recent researches at the Heinrich-Hertz Institute.

The Importance of the High Frequency Gas Discharge for Television.—L. Rohde (*Fernsehen u. Tonfilm*, Oct., 1932, Vol. 3, No. 4, pp. 230–234.)

Collisions of the First and Second Kind in the Positive Column of a Caesium Discharge.—F. L. Mohler. (*Bur. of Stds. Journ. of Res.*, Oct., 1932, Vol. 9, No. 4, pp. 493–508.)

A Method of Measuring the Maximum Intensity of Light from the Photoflash Lamps or from Other Sources of Short Duration.—W. E. Forsythe and M. A. Easley. (*Rev. Scient. Instr.*, Sept., 1932, Vol. 3, pp. 488–492.)

MEASUREMENTS AND STANDARDS.

A Method of Damping Measurement for Oscillatory Circuits [using a Quartz-Controlled Signal Generator].—V. Petržílka and W. Fehr. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 13, 1932, pp. 472–475.)

Of the two usual methods based on resonance curves, one (depending on the breadth of the curve at half resonance height) gives results which vary with the current amplitude, while the other (depending on the variation with frequency) is complicated by the reaction of the circuit under measurement on the self-excited signal-generator circuit. Both these effects are shown in Pauli's theoretical treatment of these methods.

The method here described is free from both defects : the use of a quartz-controlled signal generator allows the damping measurement to be carried out with accuracy unaffected by current amplitude, de-tuning, or the degree of coupling between the two circuits. The half-resonance-height curve-breadth method is used. For a theoretical treatment of the circuit relations *cf.* 1932 Abstracts, p. 636.

A Field Intensity Meter [using a Modified Superheterodyne Circuit].—G. H. Brown and G. Koehler. (*Review Scient. Instr.*, Aug., 1932, Vol. 3, pp. 403–415.)

Authors' abstract :—The fundamentals of field intensity measurements are summarised. The general methods of using a receiving set and a source of voltage for calibrating are outlined. The methods are then extended in application to a radio receiver which utilises a modified superheterodyne circuit. The resultant beat note is of low frequency and may be greatly amplified by means of audio-frequency stages of amplification. This gives the receiver not only extreme sensitivity but also great selectivity.

In other methods of measurement, the apparent field strength depends on the amount of modulation of the incoming wave. In the method here described, the beat note with the carrier wave is so great, compared to any contribution of the side-bands, that the meter readings do not change by any noticeable amount when a transmitting station ceases to modulate and transmit only the carrier wave. The beat note with the carrier wave is so great that it is possible to make measurements on stations whose fields are so weak that they cannot be detected on an ordinary receiver.

The attenuator is of the capacity type with a range of voltage from less than 1 microvolt to 3×10^6 microvolts. Detailed descriptions of the receiver and attenuator are given, as well as the methods of calibrating the apparatus.

A Simple Method of Measuring Harmonics in High-Frequency Circuits [using an Ordinary Wavemeter].—M. Osnos. (*Hochf: tech. u. Elek:akus.*, Oct., 1932, Vol. 40, No. 4, pp. 121–122.)

The wavemeter is coupled to the oscillating circuit in such a way that when the former is tuned to the harmonic λ_n under measurement, its indicator gives a conveniently large maximum deflection a_n with a steep descent to zero on either side. Then, without altering the coupling, the wavemeter is adjusted nearer and nearer to the fundamental λ_1 till the same deflection a_n is again obtained. Under these conditions the writer shows that the harmonic strength i_n is related to the fundamental strength i_1 by the equation

$$\frac{i_n}{i_1} = \frac{r_n}{n\rho_1\left(\frac{\lambda_1^2}{\lambda_v^2} - 1\right)},$$

where r_n is the ohmic resistance of the wavemeter circuit for the wavelength λ_n, $\rho_1 = \frac{1}{\omega_1 C_1}$, and λ_v is the wavelength at which the second deflection a_n is obtained. A special artifice is necessary if the deflection produced by the harmonic is extremely small compared with that produced by the fundamental, so that the coupling condition specified at the beginning of this abstract cannot be obtained.

High-Frequency Measuring Apparatus and Signal Generators.—Siemens and Halske Company. (*T.F.T.*, Oct., 1932, Vol. 21, pp. 281–282.)

R.F. Frequency Response Curves of Tuned Circuit, Tuned Transformer, Amplifier or Complete Receiver, Rapidly Obtained by Visual Method.—Schuck. (*See* abstract under " Reception.")

Simplifying the Practical Use of the Starr Impedance Measuring Set.—J. Steffensen : Starr. (*Wireless Engineer*, Sept., 1932, Vol. 9, No. 108, pp. 512–513.)

A note on the paper dealt with in 1932 Abstracts, pp. 534 and 594.

The Bearing of the Earth's Internal Magnetic Permeability upon the Self and Mutual Inductance of Coils Wound on its Surface.—W. F. G. Swann. (*Journ. Franklin Inst.*, Oct., 1932, Vol. 214, No. 4, pp. 481–486). Abstract only.

Measurement of the Mutual Impedance of Circuits with Earth Return [with Separations of 5 to 800 Metres and Frequencies from 200 to 3 000 Cycles/Second : including Values found for Earth Resistivity].—J. Collard. (*Journ. I.E.E.*, Oct., 1932, Vol. 71, No. 430, pp. 674–682.)

The Measurement of Mutual Inductance by the Compensation Method.—W. Geyer. (*Archiv f. tech. Mess.*, March, 1932, Vol. 1, T 32.)

Difficulties and sources of error in the simplest method, and the elaborations necessary to remove them.

A Simplified Precision Formula for the Inductance of a Helix with Corrections for the Lead-In Wires.—Chester Snow. (*Bur. of Stds. Journ. of Res.*, Sept., 1932, Vol. 9, No. 3, pp. 419–426.)

A modification, for simplicity of computing without loss of precision, of a former Bureau of Standards formula for a single-layer helix wound with ordinary round wire. Certain correction terms have been evaluated and are replaced by approximation formulae.

The Calculation of Air-Cored Single-Layer Coils [Formula for Least Length of Wire].—R. Edler. (*Zeitschr. f. Fernmeldetech.*, No. 9, Vol. 13, 1932, pp. 136–140.)

Triode Instruments for the Measurement of Capacity, with Proportional Scales and Direct Reading.—F. Vecchiacchi. (*Alta Frequenza*, June, 1932, Vol. 1, No. 2, pp. 202–220.)

Describing several circuits successfully used at the Royal Electrical Naval Institute at Leghorn. They include one in which the only triode acts both as generator and as rectifier.

Exact and Absolute Measurement of Small Capacities.—J. Clay. (*Zeitschr. f. Physik*, 1932, Vol. 78, No. 314, pp. 250–256.)

Author's summary :—A condenser is described with which it is possible to measure small capacities absolutely with a degree of accuracy of 1 : 13 000. Its accuracy is compared with a Wulf condenser calibrated by the P.T.R. Using an improvement of a method formerly described [1931 Abstracts, p. 264) it is now possible to measure exactly the capacity of an electrometer with an internal, insulated system, without the necessity of considering the probe electrode.

Interference [Heterodyne] Wavemeter with Large Wave Range [6—3 600 Metres] for Laboratory Use.—L. Rohde and H. Schwarz. (*Hochf:tech u. Elek:akus.*, Oct., 1932, Vol. 40, No. 4, pp. 117–120.)

This transportable instrument, in which all the components are mounted on the front panel, is a combination of two wavemeter circuits, one for coarse and the other for precision measurements. The wave to be measured is first tuned in on the one circuit (wave range 6—3 600 m, with six interchangeable coils) and read off with an accuracy within $\pm$ 0.5%. The precision circuit, whose wave range is only one octave (*e.g.*, 42 to 84 m), is then brought into action, and the wavelength of the coarse circuit, already tuned to zero beat with the wave under measurement, is thus measured within 0.01%. This is done by using either the fundamentals of both circuits or the fundamental of one and a harmonic of the other, according to the length of the wave in question : thanks to the high frequency of the precision circuit, the adjustment to zero beat can be made with the desired accuracy by listening on telephones.

The two wavemeter circuits are only coupled by a common current source, and this coupling is so weak that amplification is necessary to make the interference note clearly audible ; the " pull-in " effect (when both circuits are tuned to 42 m) is less than 1 c/s. While the precision wavemeter circuit is designed essentially for constancy of action in its one function (preliminary tests showed that the oscillating circuit lies preferably in the grid circuit), the coarse wavemeter circuit is provided with various switching arrangements to enable it to be used in several ways : thus as a signal generator it will give 0.3 watt output over its whole range. A quartz crystal can be switched in for checking the calibration.

A New Method of Absolute Measurement of Frequency [Photographing Phase Shift at Each Second Signal of Chronometer : Accuracy of 0.4 $\times$ 10^{-6} obtainable within 1 Minute].—H. Kono. (Short summary in *Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, Supp. p. 6.)

Frequency Requirements and the Control of Frequency for Synchronous Motor Operation of Astronomical Telescopes [including Discussion of Manual and Automatic Control on a Power Station].—G. W. Moffitt. (*Rev. Scient. Instr.*, Sept., 1932, Vol. 3, pp. 499–510.)

A New Apparatus for Determining the Relationship between Wavelengths of Light and the Fundamental Standards of Length.—J. E. Sears, Jr., and H. Barrell. (*Phil. Trans. Roy. Soc. London*, Vol. 231, 1932, No. A 697, pp. 75–145.)

THE TEMPERATURE VARIATIONS OF THE FREQUENCY OF PIEZOELECTRIC OSCILLATIONS OF QUARTZ.—R. E. Gibbs and V. N. Thatte. (*Phil. Mag.*, Oct., 1932, Series 7, Vol. 14, No. 92, pp. 682–694.)

Authors' summary:—The temperature coefficients of the frequency of piezoelectric vibrations of quartz have been measured over a range of several hundred degrees for two types of vibrations, *viz.*, (a) longitudinal vibrations along the X-axis for an "X-cut," (b) shear vibrations about the Z-axis for a "Y-cut." In both cases a simple hyperbolic relation has been found to connect the temperature coefficient with the temperature. The constant temperature axis to which the curve is asymptotic appears to be either the $(\alpha - \beta)$ transition temperature, or a value differing only slightly from it.

A comparison, based on very simple assumptions, is made between the temperature variations of elasticity and of the square of the frequency of vibration of the crystal.

THE FREQUENCY VARIATION DUE TO HEAT GENERATED BY THE VIBRATION OF A QUARTZ PLATE: SOME CHARACTERISTICS OF A Y-CUT QUARTZ PLATE.—K. Hatakeyama. (Summaries in *Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, Supp. p. 6.)

A SIMPLE METHOD OF DETERMINING THE FIRST PIEZO-MODULUS OF QUARTZ FROM MEASUREMENTS OF A QUARTZ RESONATOR.—A. Székely. (*Zeitschr. f. Physik.*, 1932, Vol. 78, No. 7/8, pp. 560–566.)

Author's summary:—A variation of the capacity and conductivity of the condenser occurs in a quartz resonator at oscillations whose frequency is near the natural frequency of the quartz block. The amount of these variations can be determined by simply measuring the resonance curve of the resonator; the first piezo-modulus and the damping of the quartz block may thence be measured.

EXPERIMENTAL DETERMINATION OF THE FIRST PIEZO-MODULUS OF QUARTZ.—B. Nussbaumer. (*Zeitschr. f. Physik*, 1932, Vol. 78, No. 11/12, pp. 781–790.)

Author's summary:—A method given by Székely [*see* preceding abstract] has been used to determine the piezoelectric modulus d_{11} of quartz with a quartz resonator. Measurements on a quartz rod with twinning formations of different structure gave a marked decrease in the value of d_{11}. Measurements on a faultless quartz rod gave a value $d_{11} = 6.84 \times 10^{-8}$ Ces/Dyne [charge in e.s.u. per dyne] for homogeneous quartz.

THICKNESS VIBRATION OF PIEZOELECTRIC OSCILLATING CRYSTAL.—I. Koga. (*Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, pp. 157–173; *Physics*, Aug., 1932, Vol. 3, No. 2, pp. 70–80.)

The natural vibration proportional only to the *thickness* of the crystal is shown to be due to the standing wave produced by the interference of plane waves incident on and reflected from the major plane boundary surfaces of the plate. There are three normal modes for this thickness vibration; a representative formula is obtained giving the corresponding frequencies at a first approximation. These three normal modes may or may not be sustained piezoelectrically, according to the orientation of the major surfaces. The fundamental frequency and mode of thickness vibration of quartz (for various cuts) and tourmalin (Z-cut) are given in a table. Other points are discussed.

MAGNETOSTRICTION OF A CIRCULARLY MAGNETISED BAR AND ITS APPLICATIONS.—S. Mori. (Summary in *Sci. Abstracts, Sec. A*, Oct., 1932, Vol. 35, No. 418, p. 981.)

Such a bar can be used for the measurement of mechanical forces which vary rapidly, or for an indicator of transverse or torsional vibrations, *e.g.*, the torsional vibrations of a rotating shaft.

A SPEAKING CLOCK [FOR USE ON TELEPHONE NETWORK].—P. Nimier. (*Rev. Gén. de l'Élec.*, 10th Sept., 1932, Vol. 32, No. 10, pp. 315–317.)

Cf. M. Lange, on the Belin system, *ibid.*, 1st October, 1932, pp. 421–425.

FURTHER DEVELOPMENT OF THE ROTARY VOLTMETER.—P. Kirkpatrick. (*Review Scient. Instr.*, Aug., 1932, Vol. 3, pp. 430–438.)

See 1932 Abstracts, p. 293.

NOTE ON THE CORRECTION OF FREQUENCY ERROR IN MOVING IRON VOLTMETERS.—R. O. Carter. (*Journ. Scient. Instr.*, Oct., 1932, Vol. 9, pp. 322–324.)

A THERMIONIC VOLTMETER WITH LOGARITHMIC CALIBRATION CURVE [PARTICULARLY FOR ACOUSTIC MEASUREMENTS].—F. E. Rommel. (*Hochf:tech. u. Elek:akus.*, Oct., 1932, Vol. 40, No. 4, pp. 124–127.)

Various optically recording equipments have been designed for electro-acoustic measurements, but they all have the disadvantage of giving linearly divided ordinates. The writer makes use of the recently developed "exponential" (variable-mu) valve to obtain the convenient logarithmically divided ordinates. An additional advantage is the protection of the oscillograph loop against excessive currents.

A VIBRATION GALVANOMETER WITH DEFLECTION RANGE INDEPENDENT OF FREQUENCY.—W. Meissner and U. Adelsberger. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 13, 1932, pp. 475–477.)

An improved form of the instrument referred to in 1930 Abstracts, pp. 405–406.

DESIGN OF A MOVING-MAGNET GALVANOMETER RENDERED ASTATIC BY A NEW METHOD [GIVING A STABLE ZERO].—L. Meylan. (*Helvet. Phys. Acta*, Fasc. 4, Vol. 5, 1932, pp. 276–295.)

A NULL INSTRUMENT FOR A.C. WITH THE SENSITIVITY OF A D.C. INSTRUMENT.—H. König. (*Ibid.*, pp. 302–306.)

Consisting of a d.c. galvanometer and a mechanical (polarised reed) rectifier excited by a simple "kipp" circuit at a frequency slightly differing from that of the a.c. under measurement.

DISCUSSION ON "THE GROWTH OF ELECTRICAL MEASUREMENT FROM ITS COMMENCEMENT."—Knowles. (*Journ. I.E.E.*, Sept., 1932, Vol. 71, No. 429, pp. 525–531.)

Discussions on the Chairman's Address to the Meter and Instrument Section referred to in 1932 Abstracts, p. 105.

THE THOMPSON BRIDGE FOR DIRECT CURRENT [GENERAL EQUATIONS, IMPORTANT VARIANTS, AND COMMERCIAL TYPES].—J. Krönert. (*Archiv f. tech. Mess.*, April, 1932, Vol. 1, T 60.)

BRIDGE METHODS FOR MEASUREMENTS AT RADIO FREQUENCIES [USING A BROADCAST RECEIVER AS NULL INDICATOR].—C. T. Burke. (*General Radio Experimenter*, July, 1932, Vol. 7, pp. 1–6.)

A NEW A.C. MEASURING SET BASED ON THE PRINCIPLE OF THE POTENTIOMETER [USING A VACUUM THERMO-JUNCTION CARRYING A CURRENT KEPT CONSTANT BY A POTENTIOMETER DEVICE].—M. Tanaka and M. Sakai. (Abstract in *Rev. Scient. Instr.*, Oct., 1932, Vol. 3, p. 645.)

THE MEASUREMENT OF IONISATION CURRENTS BY MEANS OF AN A.C. BRIDGE AND VALVE AMPLIFIER.—J. Ewles. (*Proc. Leeds Philosophical Soc.*, Jan., 1932, Vol. 2, pp. 267–270.)

DISCUSSION ON "THE CAMPBELL-SHACKELTON SHIELDED RATIO BOX."—Behr and Williams. (*Proc. Inst. Rad. Eng.*, Sept., 1932, Vol. 20, pp. 1535–1536.)

Discussion on the paper dealt with in 1932 Abstracts, p. 594.

A NEW SYSTEM OF UNITS IN ELECTROMAGNETISM.—J. E. Verschaffelt. (*Journ. de Phys. et le Rad.*, June, 1932, Vol. 3, pp. 225–228.)

MEASUREMENT OF THE POWER OUTPUT OF L.F. FINAL STAGE AMPLIFIERS.—Babits.

(*See* under "Acoustics and Audio-frequencies.")

THE B.A. STANDARDS OF RESISTANCE, 1865–1932—R. T. Glazebrook and L. Hartshorn. (*Phil. Mag.*, Oct., 1932, Series 7, Vol. 14, No. 92, pp. 666–681.)

SUBSIDIARY APPARATUS AND MATERIALS.

THE SENSITIVITY OF THE BRAUN [CATHODE-RAY] TUBE WITH GAS CONCENTRATION, AT VARIOUS FREQUENCIES [0 TO 1 MEGACYCLE/SEC.].—W. Heimann. (*Hochf:tech. u. Elek:akus.*, Oct., 1932, Vol. 40, No. 4, pp. 127–128.)

The experiments covered 7 kinds of gas. The very marked variation of sensitivity with frequency appeared to be less dependent on the gas than on the electrode system: this point is being investigated further. The large change in sensitivity on exceeding a frequency of 5×10^4 c/s is analogous to the change in spot sharpness; this suggests that the two phenomena have a common cause—inversion in the space charge. The experiments indicated that hydrogen, which is commonly considered particularly good for high-frequency oscillography as regards spot sharpness, is much more unsuitable than would be expected from its position on the sensitivity diagram.

THE TECHNIQUE OF THE HIGH-SPEED CATHODE-RAY OSCILLOGRAPH.—F. P. Burch and R. V. Whelpton. (*Journ. I.E.E.*, Aug., 1932, Vol. 71, No. 428, pp. 380–388: Discussion, *ibid.*, November, pp. 832–834.)

The plant described is primarily for work with a 1-million volt impulse generator. A "kipp" relay (Gábor) actuating a low-voltage trap having been found unsatisfactory with the beam of appreciable angular divergence, the use of a spark relay and high-voltage trap was adopted; the trap has two stages, the plates being cross-connected (by resistances from whose mid-points the external connections are taken—thus preventing the plate-pairs from oscillating "against each other") to give zero deflection for a small voltage. In the long section on time-sweeping circuits the importance of symmetrical electrification of the sweep-plates, to avoid impairment of the focus by the sweep deflection, is discussed and illustrated. Other sections deal with potential dividers, screening, and the performance of the equipment.

A CATHODE-RAY OSCILLOGRAPH FOR INTERNAL RECORDING AND RAPID CHANGING OF FILM WITHOUT BREAKING THE VACUUM.—W. Holzer and M. Knoll. (*Zeitschr. f. Instrumentenkunde*, June, 1932, Vol. 52, pp. 274–281.)

Using the double barometer tube device (*cf.* Hochhäusler, 1929 Abstracts, p. 520).

WAVE-FORM STUDIES WITH THE CATHODE-RAY OSCILLOGRAPH [WITH DESCRIPTION OF GENERAL RADIO TUBE AND CONTROLLED LINEAR SWEEP CIRCUIT].—H. H. Scott. (*General Radio Experimenter*, June, 1932, Vol. 7, pp. 1–6.)

THE CATHODE-RAY OSCILLOGRAPH.—M. Knoll. (*Archiv f. tech. Mess.*, April, 1932, Vol. 1, T 59.)

THE ELECTRON MICROSCOPE.—M. Knoll and E. Ruska. (*Zeitschr. f. Physik*, 1932, Vol. 78, No. 5/6, pp. 318–339.)

Authors' summary:—The most important systems giving electron-optical images, and their suitability for magnified reproduction of objects which emit electrons, are discussed. The general conditions for faultless images and definition, and the limit of resolving power, are given. A magnetic electron microscope with cold cathode for rapid electrons and the construction of magnetic lenses are described, and several microphotograms are reproduced. The method of investigating the electron microscope and suitable systems for an ion microscope are discussed.

SOME EXPERIMENTS ON THE ELECTROSTATIC CONCENTRATION OF CATHODE RAYS.—H. Graupner. (*Archiv f. Elektrot.*, 7th Oct., 1932, Vol. 26, No. 10, pp. 725–730.)

THE GEOMETRY OF THE ACCELERATING FIELD AS IT AFFECTS THE ELECTRON BEAM WITH GAS CONCENTRATION.—E. Brüche. (*Zeitschr. f. Physik*, 1932, Vol. 78, No. 1/2, pp. 26–42.)

FLEXIBLE ELECTRON BEAMS.—E. Brüche. (*Zeitschr. f. Physik*, 1932, Vol. 78, No. 3/4, pp. 177–195.)

Author's summary:—Electron beams may, under certain circumstances, be conducted through long, narrow metal tubes. If the tube is bent, the electron beam "bends" with it and issues therefrom with no change in intensity. A very much simplified discussion of the phenomenon on the lines of electron optics is attempted. The degree to which the tube can be bent without interruption of the electron beam enables the concentrating potential of the beam in the tube to be estimated at a multiple of the potential of a normal gas-concentrated beam.

THE POSSIBILITY OF INTRODUCING VERY HIGH POTENTIALS INTO DISCHARGE TUBES [2 130 kV, BY LONG SUB-DIVIDED PATH WITH MAGNETIC FIELDS AT THE BENDS].—M. Sitnikov. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 13, 1932, pp. 460–464.)

COMPARISON OF ELECTRONIC AND OPTICAL BLACKENING WITH THE CATHODE RAY OSCILLOGRAPH.—K. Buss and A. Pernick. (*Archiv f. Elektrot.*, 7th Oct., 1932, Vol. 26, No. 10, pp. 723–724.)

THE PHOTOGRAPHIC ACTION OF ELECTRONS [AND THE EFFECT ON THE "THRESHOLD" OF THE SENSITISING PROCESS OF OILING THE SURFACE OF THE FILM].—R. Whiddington and J. E. Taylor. (Summary in *Sci. Abstracts, Sec. A*, Oct., 1932, Vol. 35, No. 418, pp. 931–932.)

THE PHOTOGRAPHIC EMULSION; VARIABLES IN SENSITISATION BY DYES.—B. H. Carroll and D. Hubbard. (*Bur. of Stds. Journ. of Res.*, Oct., 1932, Vol. 9, No. 4, pp. 529–545.)

THE INTENSIFICATION OF PHOTOGRAPHIC RECORDS BY SUBSEQUENT EXPOSURE TO WEAK LIGHT BEFORE DEVELOPMENT.—W. Hartree and A. V. HILL. (*Journ. Scient. Instr.*, Oct., 1932, Vol. 9, pp. 329–330.)

THE SENSITIZATION OF ORDINARY PHOTOGRAPHIC PLATES TO WAVE LENGTHS BELOW 2 500 Å: A SIMPLIFIED METHOD OF PREPARING SCHUMANN PLATES.—A. J. Allen and R. G. Franklin: J. J. Hopfield and E. T. S. Appleyard. (*Journ. Opt. Soc. Am.*, Sept., 1932, Vol. 22, pp. 469–476: 488–495.)

A NEW TYPE OF VACUUM OR CIRCULATING PUMP [SLANTING HELICAL TUBE ROTATING ABOUT AXIS OF HELIX, LOWER PART FILLED WITH PUMPING LIQUID].—E. L. Harrington. (*Rev. Scient. Instr.*, Sept., 1932, Vol. 3, pp. 476–481.)

HIGH-SPEED HIGH-VACUUM DIFFUSION PUMPS.—I. Estermann and H. T. Byck. (*Ibid.*, pp. 482–487.)

A RECENT CONTRIBUTION TO THE DESIGN OF ELECTRIC FILTER NETWORKS [CAUER'S METHOD IN SIMPLIFIED FORM OF SUFFICIENT ACCURACY FOR MOST CASES].—E. A. Guillemin: Cauer. (*Journ. Math. and Phys., Massach. Inst. Tech.*, June, 1932, Vol. 11, pp. 150–211.)

For Cauer's own paper *see* 1932 Abstracts, p. 537.

THE SIGNIFICANCE OF INTERNAL TENSIONS IN THE THEORY OF MAGNETISATION CURVES.—F. Preisach. (*E.N.T.*, Sept., 1932, Vol. 9, pp. 334–340.)

HYPERNIK—ITS USES AND LIMITATIONS.—E. C. Wentz. (*Electric Journ.*, May, 1932, Vol. 29, pp. 227–229.)

PHYSICAL PROPERTIES OF IRON-NICKEL ALLOYS [ESPECIALLY PERMINVAR].—O. Dahl. (*Zeitschr. f. Metallkunde*, May, 1932, Vol. 24, pp. 107–111.)

PHYSICAL PROPERTIES AND STRUCTURE OF THE BINARY SYSTEM IRON-COBALT.—A. Kussmann, B. Scharnow and A. Schulze. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 13, 1932, pp. 449–460.)

CALCULATION OF IRON-CORED COILS SIMULTANEOUSLY TRAVERSED BY A.C. AND D.C.—C. Matteini. (*R. Accad. Navale Livorno*, Pub. No. 62, Vol. 10, 1931, 9 pp.)

THE PRODUCTION OF HOMOGENEOUS MAGNETIC FIELDS.—A. Bühl and F. Coeterier. (*Physik. Zeitschr.*, 15th Oct., 1932, Vol. 33, No. 20, pp. 773–774.)

The writers attain homogeneity of field by the use of a relatively short cylindrical coil and one or two coaxial auxiliary coils of suitable dimensions. Convenient formulae for the dimensions of the auxiliary coils are given.

A NOVEL THERMOMETER [FOR CRYSTAL HEATER OVENS: METALLIC EXPANSION VARIES CARBON BUTTON MICROPHONE PRESSURE].—R. P. Gutterman. (*QST*, Sept., 1932, Vol. 16, p. 45.)

MODIFICATIONS IN THE HAUGHTON-HANSON [HOT AND COLD BULB] THERMOSTAT.—J. L. Haughton. (*Journ. Scient. Instr.*, Oct., 1932, Vol. 9, pp. 310–315.)

A PRECISION APERIODIC THERMOSTAT [TO AVOID RAPID LOCAL TEMPERATURE FLUCTUATIONS OFTEN UNDETECTED BY THERMOMETER].—O. H. A. and F. O. Schmitt. (*Rev. Scient. Instr.*, Sept., 1932, Vol. 3, pp. 467–473.)

NEW CRYSTAL OVEN [SMALL: HEAT-INSULATED CHAMBER REPLACED BY HEAVY COPPER PLATE AND SMALL CRYSTAL COMPARTMENT].—(*QST*, Aug., 1932, Vol. 16, p. 46.)

PHOTRONIC CELL FOR TEMPERATURE CONTROL [OF A CRYSTAL OVEN].—(*Ibid.*, pp. 49–50.)

TESTS ON INSULATORS FOR CARRIER CURRENT LINES.—M. Boella. (*Alta Frequenza*, June, 1932, Vol. 1, No. 2, pp. 221–237.)

The tests employed a resonance method. Metallising the head of the bell-shaped insulator halved the conductance under rain, and the use of a guard ring just below the insulator, and connected to the line, effected a further reduction in losses of about 50 %.

A NEW INSULATING MATERIAL: PERMALI [FROM WOOD AND SYNTHETIC RESINS].—H. Steinmann. (*Rev. Gén. de l'Élec.*, 5th Nov., 1932, Vol. 32, No. 18, pp. 591–597.)

LOSSES IN COMMERCIAL INSULATING MATERIALS [AND A COMPARISON BETWEEN THE MAXWELL-WAGNER AND DEBYE THEORIES].—E. Kirch. (*E.T.Z.*, 29th Sept., 6th and 20th Oct., 1932, Vol. 53, Nos., 39, 40 and 42, pp. 931–932, 958–961, 1007–1010, and 1021–1022.)

ON THE BEARING OF THE NATURAL INFRA-RED OSCILLATIONS OF MATERIALS ON THEIR DIELECTRIC LOSSES.—Czerny and Schottky. (*See* under " Propagation of Waves.")

BARRIER LAYER INVESTIGATIONS ON CARBORUNDUM CRYSTALS.—B. Claus. (*Ann. der Physik*, 1932, Series 5, Vol. 14, No. 6, pp. 644–654.)

From the author's summary :—The current-voltage characteristics of a carborundum detector show voltage threshold values, at which a spontaneous increase of current takes place. These threshold values are explained by the presence of a quartz barrier layer, which breaks down at the voltages referred to. . . . The thickness of the barrier layer is calculated to be about 10^{-5} cm and contour diagrams are drawn for it. [The effect of etching the surface is investigated.] . . . The rectifying action at a carborundum surface is explained as due to two causes : (1) the barrier layer and (2) processes inside the crystal shown by the occurrence of luminous phenomena. The two effects act in opposite directions and this gives an explanation for the reversal in direction of the rectifying action which is frequently observed.

SELENIUM OR SELENIDE RECTIFIER ?—W. S. Gripenberg. (*Physik. Zeitschr.*, 15th Oct., 1932, Vol. 33, No. 20, p. 778.)

The writer considers that certain experimental facts show that the rectifying layer in the iron-selenium-lead rectifier does not consist of selenium itself but of iron selenide.

ON THE OPTICAL TRANSPARENCY OF CUPROUS OXIDE IN CONNECTION WITH THE ELECTRICAL CONDUCTIVITY.—G. Mönch. (*Zeitschr. f. Physik*, 1932, Vol. 78, No. 11/12, pp. 728–733.)

COPPER-OXIDE RECTIFIER USED FOR RADIO DETECTION AND AUTOMATIC VOLUME CONTROL.—Grondahl and Place. (*See* under " Reception.")

GASFILLED RELAYS. PART II.—PRACTICAL APPLICATIONS.—S. K. Lewer and C. R. Dunham. (*G.E.C. Journal*, Aug., 1932, Vol. 3, No. 3, pp. 119–132.)

THE THYRATRON RELAXATION OSCILLATOR AND SOME OF ITS APPLICATIONS.—H. J. Reich. (*Rev. Scient. Instr.*, Oct., 1932, Vol. 3, pp. 580–585.)

" If certain types of thyratrons are connected to a d.c. source through sufficient load resistance, and a condenser of proper size is connected between anode and cathode, it is found that oscillations are set up in the anode circuit when current is allowed to pass. The action seems to be similar to that which takes place in the familiar neon-tube oscillator circuit, but differs from it in that the current supplied to the neon-tube circuit by the source of power is normally of the order of a few microamperes, whereas the thyratron circuit can be made to oscillate even when rated current passes through the load resistance." The FG-67 can be made to oscillate up to 20 000 c/s, with a $\frac{1}{4}$ μF condenser, " and it seems likely that with proper circuit design radio-frequency oscillations might be produced. When oscillating at a low frequency the circuit appears to be very sensitive to r.f. radiation, and current may be cut off by means of a short-wave oscillator (two 210 tubes in push-pull) at a distance of 15 to 20 ft." The sensitivity might perhaps be greatly increased by the use of a tuned receiving circuit. A magnetic field passing across the thyratron will also break off the oscillations.

The last part of the paper deals with various applications of the circuit, particularly to obtaining complete grid control of d.c., and good wave-form when the circuit is used as an inverter.

THE TUNING CURVES OF ELECTRICAL DISTANT CONTROL ELEMENTS [ELECTROMAGNETICALLY OR -DYNAMICALLY CONTROLLED TUNING DEVICES].—R. Schadow. (*Hochf:tech. u. Elek: akus.*, Oct., 1932, Vol. 40, No. 4, pp. 129–134.)

The tuning curve shape of such a device is made up of the capacity curve of the condenser controlled, the movement curve of the control system, and the variation curve of the regulating action. These are dealt with separately and in detail. The types of device included are those in which the movement is produced by a " moving-coil meter " action, by an electrodynamic system with field coil and moving coil, or by a purely electromagnetic system. Methods depending on motor or step-by-step relays are neglected. The variable tuning element is either a variometer or a condenser, the latter being of the balanced rotor type or of the compression type : the compression condenser seems to afford the most satisfactory solution of the problem, combined with the electrodynamic system.

SPIRAL SPRINGS [NEW THEORY, NEW METHODS OF ATTACHMENT, ETC.].—J. A. van den Broek. (*Zeitschr. V.D.I.*, 24th Sept., 1932, Vol. 76, No. 39, p. 930.)

Long summary of a paper read before the American Society of Mechanical Engineers.

A PHOTOELECTRIC-MECHANICAL HARMONIC ANALYSER.—Dietsch and Fricke. (*See* abstract under " Acoustics and Audio-frequencies.")

VARIABLE INDUCTORS FOR BRIDGE MEASUREMENTS [10 : 1 RATIO, 0.005 to 500 MILLIHENRIES].—C. T. Burke. (*General Radio Experimenter*, June, 1932, Vol. 7, pp. 7–8.)

A STUDY OF THE PROBABLE ERROR OF SLIDE RULES.—D. L. MacAdam. (*Rev. Scient. Instr.*, Oct., 1932, Vol. 3, pp. 620–625.)

AN AUTOMATIC [PHOTOELECTRIC] TIME-RECORDER.—L. A. Richards and L. A. Wood. (*Rev. Scient. Instr.*, Oct., 1932, Vol. 3, pp. 616–619.)

STATIONS, DESIGN AND OPERATION.

SOME EXPERIMENTS ON COMMON FREQUENCY BROADCASTING.—Y. Takata and M. Kinase. (*Rep. of Rad. Res. and Works in Japan*, Sept., 1932, Vol. 2, No. 2, pp. 75–96.)

In these tests a quartz oscillator was used at each station, and receiving conditions both for common and for different programmes, at night and in the daytime, were investigated. In one set of tests four stations were used, each with 500 w output. Among the numerous results obtained, it was found that the distortion of speech for a common programme was roughly proportional to the ratio of field strengths; theoretically it can be estimated as $2E_2/E_1$. For different programmes the distortion decreased a little, the theoretical estimate being E_1/E_2. Gillett (1932 Abstracts, p. 111) found that when several stations broadcast a common programme simultaneously, fading was compensated and better results obtained at night than by single broadcasting; the writers, however, found that the results generally became worse with an increase of stations—owing, perhaps, to frequency deviation.

THE RADIO-TELEPHONE SERVICE BY ULTRA-SHORT WAVES BETWEEN THE CONTINENT AND CORSICA [ON WAVELENGTHS OF 7.60 AND 8.20 METRES].—E. Picault. (*Rev. Gén. de l'Élec.*, 29th Oct., 1932, Vol. 32, No. 17, pp. 569–572.)

The angle of diffraction formed by the effective rays is 40 hundredths of a degree, the heights of the two sites being only 200 and 500 metres instead of the 300 and 1 500–1 800 metres originally anticipated as necessary. The wavelengths had to be increased from 5–6 m to their present values. Communication is very satisfactory, occasional periods of fading being insufficient to trouble it.

A SYSTEM OF DOUBLE MODULATION FOR DUPLEX RADIO COMMUNICATION [TELEPHONY OR TELEGRAPHY] ON MICRO-WAVES [ULTRA-SHORT WAVES BELOW 1 METRE].—N. Carrara. (*Alta Frequenza*, June, 1932, Vol. 1, No. 2, pp. 189–201.)

The microphone current is made to modulate the oscillating current of a normal telegraphy transmitter (*e.g.* 3 000 m wavelength) and this modulated wave used to modulate the micro-wave (*cf.* von Ardenne, 1932 Abstracts, p. 582, and back references). A reverse process is used at the receiver. The method allows a duplex service to be carried on, using one common reflector for transmission and reception, as well as a common source of supply. Microphonic troubles in the receiving triodes are also eliminated. For previous work of the writer on these micro-waves, *see* 1932 Abstracts, pp. 222 and 461.

THE COMPLETION OF THE GERMAN BROADCASTING NETWORK: THE NEW HIGH POWER STATIONS LANGENBERG AND BRESLAU.—A. Semm. (*T.F.T.*, Aug., 1932, Vol. 21, pp. 225–232.)

A TELEPHONE SYSTEM FOR HARBOUR CRAFT: FISHING INDUSTRY ADOPTS MARINE TELEPHONY.—W. K. St. Clair: F. B. Woodworth. (*Bell Lab. Record*, Nov., 1932, Vol. 11, No. 3, pp. 62–65: 77–79.)

GENERAL PHYSICAL ARTICLES.

THEORY OF ELECTRIC CHARGE.—A. Eddington. (*Proc. Roy. Soc.*, Oct., 1932, Vol. 138, No. A 834, pp. 17–41.)

From the author's summary:—This paper contains an improved development of the author's theory of the fine-structure constant $hc/2\pi e^2$ [1930 Abstracts, p. 115]. It is believed that the value 137 is here obtained by pure deduction, employing only hypotheses already accepted as fundamental in wave mechanics.

ON AN ANALOGY BETWEEN THE DIRAC ELECTRON AND THE ELECTROMAGNETIC WAVE.—L. de Broglie. (*Comptes Rendus*, 19th Sept., 1932, Vol. 195, pp. 536–537.)

REMARKS ON THE MAGNETIC MOMENT AND THE MOMENT OF ROTATION OF THE ELECTRON.—L. de Broglie. (*Comptes Rendus*, 3rd Oct., 1932, Vol. 195, pp. 577–578.)

ON ATOMS OF ACTION, ELECTRICITY AND LIGHT.—Ambrose Fleming. (*Phil. Mag.*, Oct., 1932, Series 7, Vol. 14, No. 92, pp. 591–599.)

THE FUNDAMENTAL PARTICLES.—R. M. Langer. (*Science*, 30th September, 1932, Vol. 76, No. 1970, pp. 294–295: *Sci. News Letter*, 8th Oct., 1932, p. 223.)

A new theory based on Dirac's hypothesis of fundamental magnetic poles, and on the experiments of Millikan and Anderson which indicated the probable existence of a *positive* electron. Taking the electron and the Dirac magnetic pole as the fundamental particles, the writer pictures the neutron as built up of a positive and a negative pole (their combination giving a simple explanation of the origin of the cosmic rays), the proton as a combination of a neutron and a positive electron, and the photon either as a positive and a negative electron so close (about 10^{-13} cm) that the potential energy almost compensates the rest mass, or as a combination of an ordinary and a negative-energy electron, the mass term vanishing and the system moving with the velocity of light.

PROBLEMS OF ELECTRICAL IMAGES IN DIELECTRICS. I.—J. J. Weigle. (*Helvet. Phys. Acta*, Fasc. 4, Vol. 5, 1932, pp. 262–275.)

Calculation of the "image force" (which plays a certain part in thermoelectric and photoelectric phenomena) due (1) to a discontinuity in the dielectric, (2) to a dielectric sphere, and (3) to a finite layer. Finally, the force on a charge in a non-homogeneous dielectric is calculated.

GENERALISATIONS OF MAXWELL'S THEORY.—I. E. Viney. (*Phil. Mag.*, Nov., 1932, Supp. No., Vol. 14, No. 94, pp. 961–976.)

The writer's generalisations of Maxwell's theory and criticisms of those made by other writers have led her to the conclusion that such generalisations "still seem to be fruitless unless we are prepared to admit the possibility of a new field entity akin to, but distinct from, electric charge."

THE HYDRODYNAMIC THEORY OF ELECTRO-MAGNETISM.—F. Prunier. (*Rev. Gén. de l'Élec.*, 5th Nov., 1932, Vol. 32, No. 18, p. 587.)

Further development of the work referred to in 1931 Abstracts, p. 340.

PHYSICS AND THE METHOD OF COINCIDENCES.—W. Bender. (*Journ. Franklin Inst.*, Oct., 1932, Vol. 214, No. 4, pp. 443–463.)

THE PROBLEMS OF PERTURBATIONS AND SELF-CONSISTENT FIELDS.—L. Brillouin. (*Journ. de Phys. et le Rad.*, Sept., 1932, Vol. 3, pp. 373–389.)

THE PASSAGE OF PHOTONIC RAYS THROUGH ATOMS [AND THE ETHER AS A CORPUSCULAR STRUCTURE WHOSE CORPUSCLES ARE ATOMS OF ZERO ATOMIC NUMBER WITH NUCLEI FORMED OF A PROTON AND AN ELECTRON].—V. Posejpal. (*Ibid.*, pp. 390–407.)

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

ELECTRON DIFFUSION, ELECTRON ATTACHMENT, AND THE AGEING OF NEGATIVE IONS IN COMMERCIAL NITROGEN AT ATMOSPHERIC PRESSURE.—J. Zeleny. (*Journ. Franklin Inst.*, Nov., 1932, Vol. 214, No. 5, pp. 513–532.)

LANGMUIR'S PLASMA.—R. Seeliger. (*Naturwiss.*, 23rd Sept., 1932, Vol. 20, No. 39, pp. 711–715.)

A general account of our present knowledge of the properties of a plasma.

ON THE COLD CATHODE VACUUM ARC.—F. H. Newman. (*Phil. Mag.*, Nov., 1932, Vol. 14, No. 93, pp. 788–794.)

The author's experiments show " that the starting and maintenance of these cold cathode arcs is due primarily to the presence of spots of impurities on the cathodic metal. . . . There is no question of thermionic emission."

ARC, SPARK AND GLOW: A NOTE ON NOMENCLATURE.—J. Thomson. (*Phil. Mag.*, April, 1932, Vol. 13, pp. 824–834.)

NEW INVESTIGATIONS OF THE ELECTROLYTIC VALVE ACTION. V. THE PROPERTIES OF THE SPARKS.—A. Güntherschulze and H. Betz. (*Zeitschr. f. Physik*, 1932, Vol. 78, No. 3/4, pp. 196–210.)

Continuation of the work referred to in 1932 Abstracts, p. 419.

MISCELLANEOUS.

ON THE THEORY OF ERRORS AND LEAST SQUARES.—H. Jeffreys. (*Proc. Roy. Soc.*, Oct., 1932, Vol. 138, No. A 834, pp. 48–55.)

Author's summary :—" It is shown that where we have no previous knowledge of the probable degree of precision of a set of observations, the correct procedure is to assume that the probability of a value of h in the range dh is proportional to dh/h. The result is applied to the theory of least squares, with definite results. It is found that where the number of observations is small, the probability of error is more widely distributed than is given by the usual formula. In the extreme case of two observations and one unknown, the probable error of the mean is equal to the standard deviation." For other papers on the subject *see* 1932 Abstracts, pp. 300 and 479 (Brennen, Birge).

THE DISTRIBUTION OF SECOND ORDER MOMENT STATISTICS IN A NORMAL SYSTEM.—J. Wishart and M. S. Bartlett. (*Proc. Camb. Phil. Soc.*, Oct., 1932, Vol. 28, No. 4, pp. 455–459.)

THE THEORY OF FUNCTIONS AND ITS APPLICATION IN ENGINEERING.—Rothe, Ollendorff and Pohlhausen. (Book review in *E.N.T.*, Sept., 1932, Vol. 9, p. 333.)

THE POTENTIAL VALUE IN INDUSTRY OF DISCOVERIES WHICH ARE OF COMPARATIVELY SMALL SCIENTIFIC IMPORTANCE.—H. Moore. (*Journ. Scient. Instr.*, Sept., 1932, Vol. 9, pp. 273–276.)

INTERNATIONAL ELECTRICITY CONGRESS, PARIS, 1932: SUMMARIES OF PAPERS IN SECTIONS I AND II.—(*Rev. Gén. de L'Élec.*, 10th, 17th and 24th Sept., 1st and 8th Oct., 1932, Vol. 32, pp. 291–296, 323–332, 363–376, 403–407, and 443–455.)

THE TECHNICAL PROBLEMS OF RADIO-TELEPHONY, AT THE U.I.R. MEETING AT MONTREUX, JUNE, 1932.—M. Adam. (*Rev. Gén. de l'Élec.*, 5th Nov., 1932, Vol. 32, No. 18, pp. 588–590.)

THE 9TH GERMAN RADIO EXHIBITION, 1932.—(*Radio, B., F. f. Alle*, Sept., 1932, pp. 390–403: Editorial, pp. 386–390.) *See* also *T.F.T.*, Sept., 1932, Vol. 21, pp. 251–255, *Zeitschr. f. Fernmeldetech.*, No. 9, Vol. 13, 1932, pp. 143–144, and *Hochf:tech. u. Elek: akus.*, Oct., 1932, Vol. 40, pp. 137–139.

THE TRANSPARENCY OF CLOUDS AND FOGS TO VISIBLE AND INFRA-RED RADIATIONS.—C. Müller, H. Theissing and H. Kiessig. (*Zeitschr. V.D.I.*, 24th Sept., 1932, Vol. 76, No. 39, pp. 925–929.)

MAGNETOSTRICTION OF A CIRCULARLY MAGNETISED BAR AND ITS APPLICATIONS (*e.g.*, TO INVESTIGATE THE TORSIONAL VIBRATIONS OF A ROTATING SHAFT].—Mori. (*See* under " Measurements and Standards.")

MEASURING THE VIBRATIONS OF MACHINE PARTS [BY METHOD OF TUNED REEDS] TO REDUCE NOISE AND SPEED-UP PRODUCTION.—F. A. Firestone, F. M. Durbin and E. J. Abbott. (*Mechanical Engineering*, April, 1932, Vol. 54, pp. 271–274.)

THE TECHNIQUE OF VIBRATION MEASUREMENT [ACCELERATION METERS, VIBROMETERS, PHASOMETERS, TORSIOMETERS, ETC. A SURVEY WITH BIBLIOGRAPHY OF 73 ITEMS].—E. Lehr. (*Zeitschr. V.D.I.*, 29th Oct., 1932, Vol. 76, No. 44, pp. 1065–1073.)

THE STROBOPHONOMETER [MICROPHONE, AMPLIFIER AND ROTATING CONTACT EQUIPMENT FOR STUDYING THE KNOCK IN INTERNAL COMBUSTION ENGINES].—R. Stansfield and R. E. H. Carpenter. (Summary in *Sci. Abstracts, Sec. B*, Oct., 1932, Vol. 35, No. 418, p. 582.)

MECHANICAL VIBRATION RESEARCH.—J. P. Den Hartog. (*Ibid.*, pp. 582–583.)

A NON-ELECTRIC ULTRA-MICROMETRIC DEVICE FOR MEASURING LENGTH- OR PRESSURE-CHANGES, DEPENDING ON MERCURY COLUMNS OF LARGE AND SMALL CROSS-SECTIONS.—R. Mohr. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 13, 1932, pp. 477–479.)

LIGHTNING RESEARCH [AND WATER DIVINING TESTS].—Rudenberg: Lehmann. (*See* abstract under " Atmospherics and Atmospheric Electricity.") *See* also Abstracts, 1931, p. 494 (Bogoïavlensky), and 1932, p. 577.

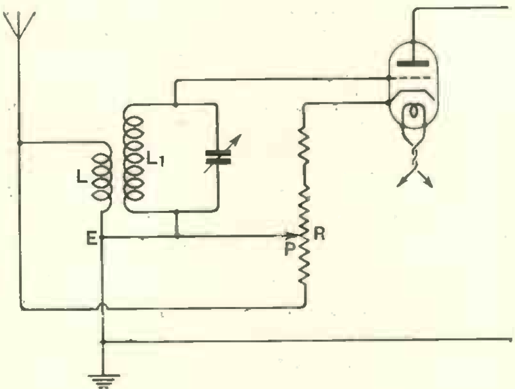
Some Recent Patents.

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.

VOLUME CONTROL.

Application date, 27th May, 1931. *No.* 376901.

A single resistance R is arranged to provide a volume control depending in part upon the aerial input and in part upon the effective grid bias.



No. 376901.

The portion of the resistance R below the adjustable tapping P is in shunt with the aerial input coil L, whilst the portion above lies between the grid coil L_1, which is earthed at E, and the cathode of the valve. Accordingly an upward movement of the contact point P serves to reduce the grid bias, and by increasing the shunt resistance across the aerial coil L simultaneously helps to strengthen the signal input.

Patent issued to E. K. Cole, Ltd., and A. W. Martin.

COOLING HIGH-FREQUENCY APPARATUS.

Convention date (Germany), 14th January, 1931. *No.* 376187.

In cooling systems for apparatus carrying high-frequency currents, the voltage drop along the water pipe-line is at first rapid and then becomes asymptotic, so that high-frequency losses are not appreciably reduced by further increasing the length of the pipe-line. According to the invention the pipe-line is provided with a series of conducting bands or sleeves, which are spaced equally along its length and each connected to a condenser. The condensers are then joined in series to form a capacity potentiometer, thus ensuring a uniform voltage fall. In an alternative arrangement, the same object is achieved by coiling a conductive winding around the outside of the pipe-line, the top of the winding being connected to the high-potential point, and the bottom being earthed.

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

SIGNALLING TO AIRCRAFT.

Convention date (France), 9th April, 1930. *No.* 375887.

The landing-field at an aerodrome is wired with concentric cables which are fed from a common source of alternating current in such a way that the spreading fields of force are in opposition inside the landing area whilst their effects are added together outside this area. In addition a second field of force is produced having a limited vertical spread. The combination allows the pilot of an aeroplane to ascertain during foggy weather, or at night (a) when he is in the neighbourhood of the aerodrome, and when he passes the boundaries of the landing field, (b) the direction of the centre of the landing field, and (c) his height above ground. Signalling frequencies are superposed on the cable leader-gear to enable the aerodrome staff to communicate any necessary instructions to the pilot whilst preparing to land.

Patent issued to Société Industrielle des Procédés W. A. Loth.

SHORT-WAVE AERIALS.

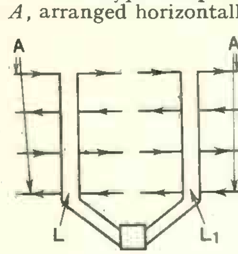
Convention date (Germany), 30th December, 1930. *No.* 377074.

An aerial for the transmission or reception of wavelengths of the order of centimetres consists of a plate or sheet of metal several wavelengths long and at least one wavelength in width. The excitation of the aerial occurs in the form of standing waves, and energy is fed to or collected from points one half-wave apart and situated symmetrically about the centre line of the metal sheet.

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

Convention date (Austrian), 6th March, 1931. *No.* 378642.

A short-wave aerial of the beam type comprises a series of dipole radiators A, arranged horizontally and at a comparatively low height. They are connected to common feed-lines L, L_1 and spaced half a wavelength apart, so that whilst each coaxial pair oscillates cophasially as shown by the arrows, there is a phase-difference of 180° between adjacent pairs along the line of maximum emission. The radiation resistance of a system comprising four by four oscillators is stated to be more than double that of an equal number of oscillators all energised in phase.



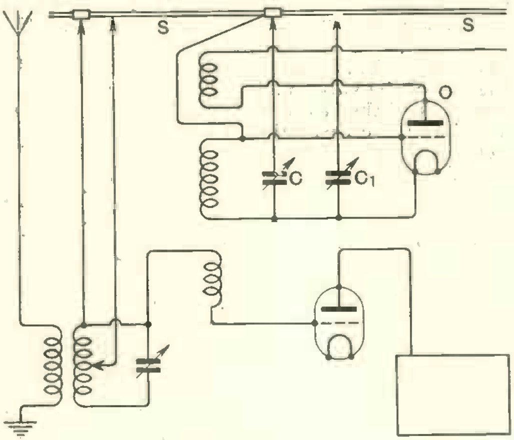
No. 378642.

Patent issued to Radio-Austria A-G.

WAVE-BAND SWITCHING.

Convention date (Germany), 7th July, 1930. No. 375563.

The difficulty of ganging the tuning-controls of a superhet receiver over two different wave-bands



No. 375563.

is overcome by providing a change-over switch, which simultaneously alters one of the tuning-impedances of the local-oscillator circuit, thereby preserving a constant beat or intermediate frequency over the double wave-range. When the change-over switch *S* is in the long-wave position shown, the condenser *C* tunes the circuit of the local oscillator *O* ; but when the switch is moved to the left, or short-wave position, the tuning-condenser *C* is thrown out of circuit and is replaced by the condenser C_1.

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

PHOTO-ELECTRIC CELLS.

Convention date (Germany), 25th November, 1930. No. 373066.

In photo-electric cells of the cuprous-oxide type it is usual to superimpose a network electrode on the protoxide layer in order to increase the efficiency of the cell. This, in turn, however gives rise to a lack of uniformity in current-emission, owing to the fact that the network electrode screens a portion of the photo-sensitive material from the incident light. According to the invention the surface of the protoxide is entirely exposed, and the "take-off" electrode is in the form of a marginal ring of gold or platinum a few millimetres in annular width and 20 millimetres in internal diameter.

Patent issued to B. Lange.

DRY-CONTACT RECTIFIERS.

Convention date (France), 30th December, 1930. No. 373849.

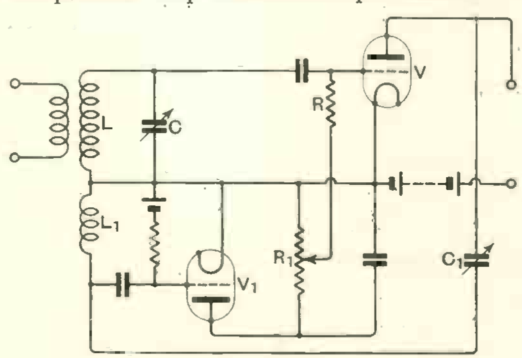
A rectifying combination consists of silicon in contact with bromide or iodide of copper. Each of the two substances may either be agglomerated under pressure with a binding-material, or powdered and mixed with a resin varnish. It is stated that an effective surface contact of two square centimetres will furnish a rectified current of from 0.5 to 0.7 amp. at from 10-12 volts. Pressures up to 35 volts may be applied. The rectifying action is independent of temperature change over a wide range. To stabilise the action it is desirable to add a small percentage of manganese dioxide or a similar polariser to the copper compound.

Patent issued to R. Audebert.

REACTION CONTROL.

Application date, 1st April, 1931. No. 375826.

In a receiver of the highly selective type, wherein a back-coupled valve is utilised to maintain the circuits on the verge of self-oscillation, the system is stabilised by an auxiliary valve which serves automatically to check excessive reaction. Signal energy is applied to the tuned grid circuit *L*, *C* of a detector valve *V*, the plate circuit of which is back-coupled to the input through a variable condenser C_1 and coil L_1. An auxiliary "control" valve V_1 is shunted across the coil L_1. The plate circuit of the valve V_1 comprises a potentiometer resistance R_1 with an adjustable tapping to the grid leak *K* of the detector valve *V*. When the back-feed current through the coil L_1 exceeds a predetermined limit, the potential drop across the output resistance *R*



No. 375826.

alters the effective bias on the grid of the valve *V*, and acts automatically to cut down the output.

Patent issued to J. Robinson.

VALVE-HOLDERS.

Application date, 24th March, 1931. No. 375332.

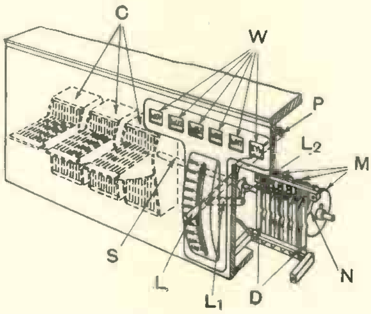
A valve-holder of the five-socket type is rendered sufficiently flexible to accommodate slight differences in the standard setting of the pins on the valve-base, by making one or more deep incisions in the insulating material, preferably between the socket-holes. This provides sufficient "give" to allow the valve pins to enter easily, even if the latter are slightly out of "centre," and, in addition, increases the resistance of the leakage path between plate-grid and screen-grid pins across the surface of the holder.

Patent issued to C. R. Cook.

"AUTOMATIC" TUNING.

Convention date (U.S.A.), 10th April, 1930.
No. 376345.

The control shaft *S* of a number of ganged condensers *C* is rotated by means of a lever *L* pivoted at *P* and connected to a bell-crank lever L_1, L_2. The lever is arrested at certain definite points on the tuning scale, corresponding to pre-selected broadcast transmissions, by means of a corresponding number of discs *M*, keyed to the control shaft *S* and provided with peripheral notches *N* which co-operate with a row of detents *D*. As any given setting is reached, the name of the corresponding transmitting station is shown in an illuminated panel-window *W*.



No. 376345.

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

SHORT-WAVE GENERATORS.

Application date, 30th April, 1931. No. 377967.

In a short-wave oscillator of the type in which the grid is given a high positive potential and the anode a slightly negative potential, relatively to the filament, the anode potential is derived solely from the voltage drop across a variable resistance inserted between the anode and filament. The ordinary H.T. supply is connected either between grid and filament or between grid and anode. The frequency of the generated oscillations may be varied by adjusting the value of the shunt resistance.

Patent issued to W. B. MacKenzie, J. C. W. Drabble, and R. A. Yeo.

Convention date (U.S.A.), 27th June, 1930.
No. 379395.

The time taken for the electrons to pass from the cathode to the anode inside the valve sets a limit to the production of very high frequency oscillations in the normal way. To overcome this difficulty the anode of the valve is made as a half-wave radiator, on which a stationary-wave system is set up by the direct impact of the electron stream, the necessary phase-difference along the length of the anode being ensured by means of a superposed magnetic field, which deflects the electrons into alternate paths longer than the shortest distance normally followed.

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

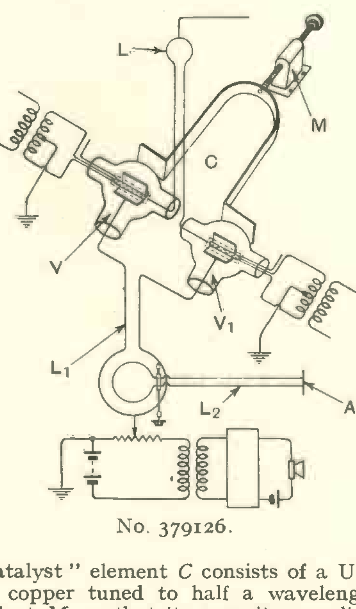
Application date, 16th April, 1931. No. 379306.

In a valve used to generate oscillations of the order 5 to 20 metres there is a tendency to the production of an "electrodeless" discharge, which is to be distinguished from flashover between the electrodes. This tendency, which increases with the size of the valve, and is a function of the mean free path of the electrons, is reduced by providing a series of glass partitions extending inwards and radially from the glass surface of the bulb. The partitions restrict the free movement of the electrons and so lessen the risk of ionization due to collision.

Patent issued to Marconi's Wireless Telegraph Co., Ltd., and E. W. B. Gill.

Convention date (U.S.A.), 4th October, 1930.
No. 379126.

In short-wave oscillators of the Barkhausen-Kurz type, a frequency limit is set by the inter-electrode capacity, which, according to the invention, is removed by the application of a "catalyst" element consisting of a low-loss circuit tuned to half the working wavelength. As shown, two generators, *V*, V_1 are arranged in push-pull, the grid voltages being applied at the mid-point of a loop conductor, whilst the anodes are connected through a similar loop L_1 which is coupled through a transmission line L_2 to a half-wave radiator *A*.



No. 379126.

The "catalyst" element *C* consists of a U-shaped strip of copper tuned to half a wavelength and mounted at *M*, so that its capacity coupling with the valve electrodes can be finely adjusted, this being a critical factor in the starting and maintenance of the high-frequency oscillations.

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

RADIO BEACONS.

Application date, 26*th May*, 1931. *No*. 375958.

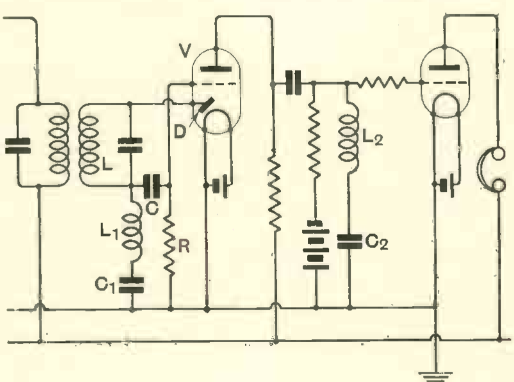
Relates to marine signals of the kind in which a fog-horn or similar acoustic warning-signal is combined with a radio transmitter which is made to " count " by means of an associated gramophone record, the time interval between successive " counts " being fixed so that at the moment a ship's navigating officer receives the acoustic signal direct he also hears through a headphone a number which tells him his actual distance from the beacon station in nautical miles. According to the present invention the gramophone turntable and a device for raising and lowering the pick-up arm to start the " counting " are both positively geared to the motor which controls the periodic emission of the acoustic signal.

Patent issued to Evershed and Vignoles, Ltd., and J. C. Needham.

SUPERHETERODYNE RECEIVERS.

Convention date (*Germany*), 22*nd June*, 1931. *No*. 377639.

The output from the last stage of the intermediate-frequency amplifier is coupled to a valve V which combines the function of a diode rectifier with that of the first stage of L.F. amplification. One end of the input coil L is connected to an electrode D forming the plate of the diode rectifier. The other end of the coil is connected to earth through a tuned circuit L_1, C_1, which bypasses the intermediate frequency oscillations. The rectified oscillations are fed through a condenser C and biasing-resistance R to the control grid of the valve V, which now acts as a low-frequency amplifier.



No. 377639.

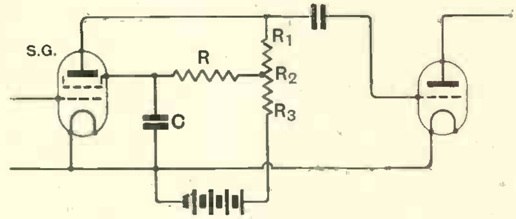
It is found that the second harmonic of the intermediate-frequency oscillations is liable to appear in the output of the valve V, and a tuned acceptor circuit L_2, C_2 is accordingly inserted across the input of the next L.F. stage to act as a bypass. The arrangement is primarily designed to avoid the use of grid-leak rectification for the second detector, where owing to the relatively-low frequency of the modulated current the grid condenser cannot be made sufficiently large to give perfect quality.

Patent issued to N. V. Philips Gloeilampenfabrieken.

SCREENED GRID AMPLIFIERS.

Convention date (*Germany*), 28*th May*, 1931. *No*. 377635.

The biasing voltage for the screening grid SG is applied from the H.T. source through a resistance R and a resistance R_2 R_3, the latter forming part of the total anode impedance. The arrangement ensures that the direct current passing through the valve is maintained substantially constant, because any variation is compensated by a change in the S.G. bias owing to the corresponding voltage drop across the resistance R_2 R_3. The A.C. impedance and therefore the amplification of the valve is, however, higher than in the case of the ordinary arrangement—in which R and R_1 R_2 R_3 are all in series—because only the part R_2 R_3 of the total anode resistance is now shunted by the resistance R and the series bypass condenser C. Moreover the resistances R and R_1 R_3 may be made larger than in the ordinary arrangement, this again tending to improve the effective amplification.



No. 377635.

Patent issued to N. V. Philips Gloeilampen-Fabrieken.

TUNING CONTROLS.

Convention date (*U.S.A.*), 19*th August*, 1930. *No*. 374695.

It is helpful in tuning a highly-sensitive receiver, such as a superhet, to have some positive indication to show when the circuits are accurately in resonance with the incoming carrier. At the same time it is desirable to prevent " static " and other background " noise " from being reproduced at full strength in the loud-speaker when searching for a given station. To secure both results, a cut-out relay for the loud-speaker is arranged in the plate circuit of the last intermediate-frequency amplifier, and the effective grid-bias on certain of the HF valves is varied by a regulating valve, so that the speech-coil of the loud speaker is automatically short-circuited in the absence of a carrier of predetermined strength. As soon, however, as a carrier-wave is received and is tuned in to proper strength, the short-circuit is removed from the loud speaker and simultaneously a signal lamp is lit to indicate that the circuits are in resonance.

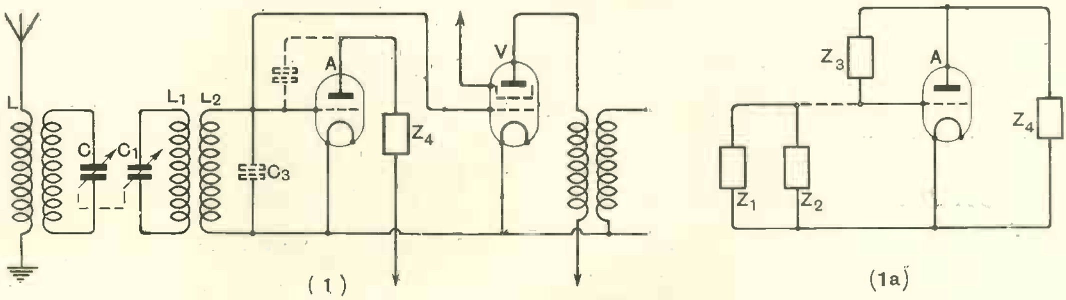
Patent issued to Marconi's Wireless Telegraph Co., Ltd.

SELF-TUNED AMPLIFIERS.

Convention date (U.S.A.), 11th October, 1930.
No. 378256.

The high-frequency stages of a receiver are so arranged that provided a pre-selection circuit, such as L, C, L_1, C_1, preferably having a band-pass characteristic, is adjusted to any point over a wide tuning range (say between 200–600 metres) the subsequent H.F. stages, such as the screen-grid amplifier V, automatically set themselves into resonance with the selected frequency. This effect is secured by shunting an auxiliary valve A across the secondary winding L_2, and inserting an impedance Z_4 of calculated value in the plate circuit such that, as the frequency of the applied signal varies within the given limits, the apparent total capacity C_3 across the secondary L_2 alters to such a value as to tune the circuit L_2, C_3 into resonance. The equivalent network is shown in Fig. 1A where the impedance Z_1 includes the input capacity of the amplifier V, the reflected capacity of the preceding stages, and the grid-filament capacity of the auxiliary valve A. The impedance Z_2 is the input impedance due to the grid-plate capacity Z_3 of the valve A, and the impedance Z_4 is that of the network inserted in the plate circuit of the valve A.

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



No. 378256.

SUPER-REGENERATIVE CIRCUITS.

Convention date (Germany), 13th September, 1930.
No. 375620.

The "quenching" frequency of a super-regenerative receiver having tuned input and output circuits is obtained by periodically varying the capacity value of a condenser. In one arrangement a tuning condenser, forming part of the output circuit of the amplifier, is located close to the moving diaphragm of a condenser microphone, which is energised at the desired quenching-frequency by a separate source of oscillations. The movement of the condenser-microphone diaphragm periodically alters the electrostatic field of the tuning-condenser, and so imposes a tuning variation which serves to "quench" the valve oscillator. A piezo-electric crystal may replace the tuned input circuit.

Patent issued to Siemens and Halske Akt.

VARIABLE CONDENSERS.

Application date, 19th November, 1931. No. 376158.

A small variable condenser, suitable for use in the aerial circuit to control either volume or selectivity, consists of two tubular members or electrodes one sliding within the other. The adjacent surfaces are covered with metal foil or metallized paper, with an intermediate wrapping of insulating material to form the dielectric. The surface of the inner electrode is tapered off in a spiral outline, thus giving a smaller "minimum" capacity than is possible if both surfaces were made truly cylindrical. By modifying the Operal outline, the rate of increase of capacity with axial movement can be made to follow any desired law, whilst by shaping both electrodes instead of one a differential action is obtained.

Patent issued to R. W. Bebrunner and British Pix Co., Ltd.

LOUD SPEAKERS.

Convention date (France), 14th August, 1930.
No. 375598.

Two or more conical diaphragms are mounted concentrically about the same moving coil. The diaphragms are of different sizes, to cover different parts of the audible range, and are set one inside the other, the outer periphery in each case being flexibly connected to the adjacent cone. A conical suspension plate, with intermediate bridge-pieces, holds the double diaphragm in position. The compound speaker has an acoustic range equivalent to that of two separate speakers.

Patent issued to Société Française Radio-Electrique.

Application date, 27th November, 1931. No. 378286.

An equivalent effect to the use of large baffle-plates is secured by mounting the speaker diaphragm in an open-ended box, any tendency to resonance being eliminated by packing the inside with slag-wool. The packing is held in position by a wire-mesh covered with muslin, and is arranged so as to form a flared surface extending outwards in a logarithmic curve. The top and bottom of the casing may be removed, so that only the two sides are operative. A similar flared casing may be arranged to extend in front of the diaphragm.

Patent issued to H. L. Kirke and A. B. Howe.

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