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Editorial.

The Valve Triangle.

THE three characteristic constants by which the suitability of a valve for any purpose is judged are (i) its mutual conductance $g_m = \partial I_a/\partial V_g$, the anode voltage being maintained constant, (ii) its amplification factor $\mu = \partial V_a/\partial V_g$, the anode current being maintained constant, and the signs of the voltage variations being neglected, and (iii) its differential resistance $r_a = \partial V_a/\partial I_a$, the grid voltage being maintained constant.

It will be seen that the product

$$g_m \times r_a \times \frac{1}{\mu} = \frac{\partial I_a}{\partial V_g} \times \frac{\partial V_a}{\partial I_a} \times \frac{\partial V_g}{\partial V_a} = 1$$

This is true if I and V are expressed in amperes and volts. If g_m is expressed in milliamperes per volt, the product will still be unity if r_a is expressed in 1,000 ohm units, *i.e.*, in kilo-ohms, a very suitable unit for the resistances concerned.

Now in the 18th century Ceva showed that if lines are drawn from the corners of *any* triangle through *any* point in the triangle to cut the opposite sides, the sides are divided into two parts a and b, c and d, e and f—the lettering running continuously around the triangle—such that

$$\frac{a}{b} \times \frac{c}{d} \times \frac{e}{f} = 1$$

Hence, if in any triangle the ratio a/b is made to represent to some suitable scale the value of the mutual conductance g_m of a valve, and the ratio e/f its differential resistance r_a, then the third side will necessarily

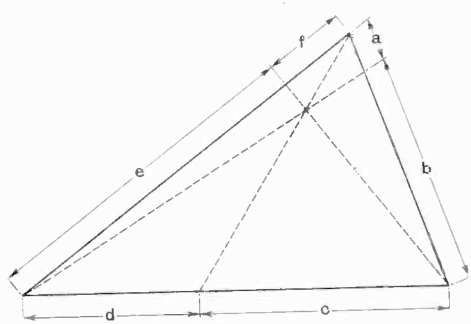


Fig. 1.

be divided into two parts c and d such that the ratio c/d represents $1/\mu$, and consequently the reciprocal ratio d/c represents the amplification factor μ.

Any given valve will have a characteristic point in the triangle, and the position of this point will enable one to read off its characteristic properties on the three sides if these are provided with suitable scales. Any new valve that appears on the market can be registered by a single dot made on the triangle at the appropriate point; a large-scale triangle mounted and hanging on the wall would be very convenient for the purpose.

To enable one to modify the scales and avoid having the most important part of any scale crowded together at one end, we can make use of the fact that

$$pg_m \times q\frac{1}{\mu} \times \frac{r_a}{pq} = 1$$

where p and q are any numbers whatever.

It is found convenient to make $p = 1.25$ and $q = 20$ so that $pq = 25$. If then r_a for a certain valve is 100,000 ohms, *i.e.*, 100 kilo-ohms, instead of the resistance side of the triangle being divided into two parts in the ratio of 100 to 1, which would give a point uncomfortably near one corner, it is divided in the ratio of 100/25, *i.e.*, 4 to 1 as will be seen in Fig. 2. Similarly, if $\mu = 100$

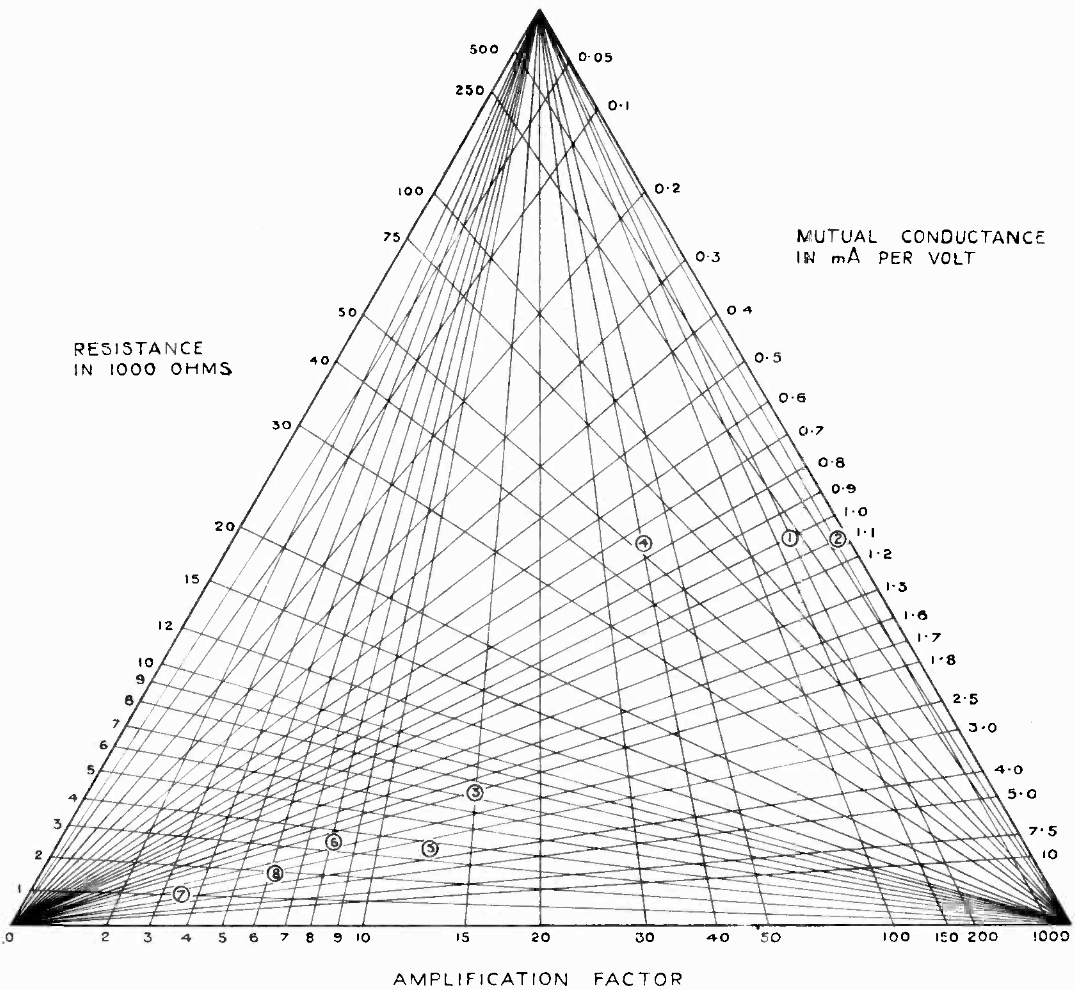


Fig. 2.

the point is not crowded into a corner, as it would be if the side were divided in the ratio of 100 to 1, but by making the ratio 100/20, the point is moved out where it can be easily read.

The characteristic points of eight different types of valves have been marked on the triangle in Fig. 2. They are as follows :—(1) PM16; (2) S4V indirectly heated; (3) PM4DX; (4) PM5B; (5) PM2A; (6) PM6; (7) DO/60 and (8) the directly heated output valve AC064.

G. W. O. H.

For further details of the valve triangle, see articles by Erich Meyer in *Telefunken Zeitung*, April, 1930, and by Max Wallenta in *Elektrotechnik und Maschinenbau* (Vienna), 18th Jan., 1931.

Errata.

We regret that an error occurred in Fig. 2 on page 234 of the May number. The two coils in Fig. 2 (*b*) which replace the coil L_c of Fig. 2 (*a*) should, of course, each have an inductance of $2L_c$ and not, as shown, of $L_c/2$. In the middle of the right-hand column $L_c/2$ should read $2L_c$ and the formula for f_2 and the three following lines should read as follows :—

$$“ f_2 = \frac{1}{2\pi\sqrt{C(L_1 + 2L_c)}}$$

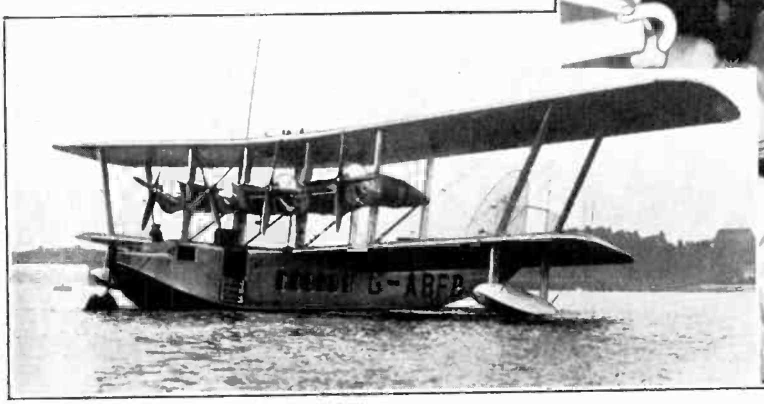
The two frequencies are thus the same as in Fig. 1 if we put $L = L_1 + L_c$ and $M = L_c$, from which

$$k = \frac{M}{L} = \frac{L_c}{L_1 + L_c}. ”$$

In the last formula on page 236 the addition sign was omitted between the two terms in the bracket.

Radio on Modern Aircraft.

THE three new "Kent" type flying boats for the Trans-Mediterranean service of Imperial Airways, Ltd., are equipped with the Marconi type A.D.18A aircraft transmitter which has an independent drive to ensure constancy of wavelength. The right-hand photograph shows the wireless compartment, while below can be seen one of the completed aircraft. Power for the transmitter is supplied by a wind-driven generator operating in the slip stream of the propellers, but to enable the set to be worked when the boat is at rest the generator can be driven by the gas starter engine.



High Frequency Feeders.*

Some Investigations into Design and Measurement.

By H. O. Roosenstein (*Telefunken Laboratories, Berlin*).

I. Introduction.

IN modern Short Wave stations the transmitting energy is led to the aerial system through feeders. The design and construction of these conductors present several problems, for the solution of which it is necessary to know exactly their damping and characteristic impedance. In the following paper methods are given for measuring these quantities, together with a procedure for proportioning them in such a way as to avoid loss by reflection.

II. Damping Measurements.

In a completely loss-free conductor, closed at the end in a manner free from loss, the waves reflected at the end have exactly the same amplitudes as the incoming waves. At those points on the conductor where the phases of the two sets of waves are opposed there is therefore complete extinction; *i.e.*, the amplitude at the nodes is a true zero.

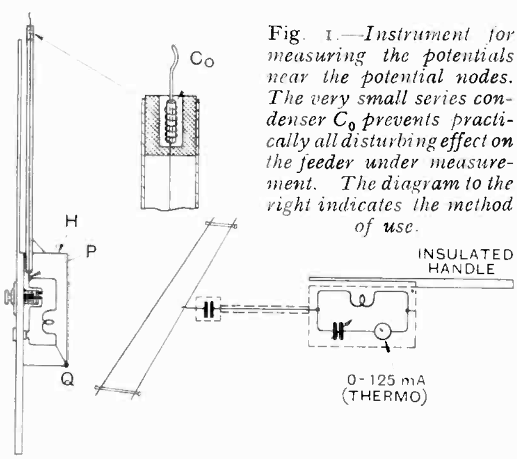


Fig. 1.—*Instrument for measuring the potentials near the potential nodes. The very small series condenser C_0 prevents practically all disturbing effect on the feeder under measurement. The diagram to the right indicates the method of use.*

This is not the case when a conductor possessing damping, closed at the end in a loss-free manner, has stationary waves set up in it; here the incoming waves have their greatest amplitude at the input end of the conductor, while the amplitude of the reflected waves is greatest at the closed end. At the latter point, where both waves have approximately equal amplitudes, the amplitude at the nodes nearly reaches the zero value occurring in the loss-free conductor. Farther and farther from the closed end, the residual amplitudes left at the nodes become greater and greater.

It follows from the above that the "sharpness" of a node is a measure of the damping of the portion of the conductor beyond the node. To define this "sharpness" we introduce the term "node-width," *i.e.*, the distance between the two points, one on either side of a node, where the amplitude is $\sqrt{2}$ times that at the node itself. The writer has shown† from the telegraph equations that between the damping b of a conductor, closed in a loss-free way at its end, and its node-width k the following relation holds:—

$$k/\lambda = b/\pi \quad \quad (1)$$

This relation forms the foundation for the measurements of damping now to be described.

For measuring the node-width at the potential nodes, an instrument is necessary which can be applied to the conductor without appreciably altering the potential distribution. Such an instrument is shown in Fig. 1.

As may be seen, connection to one wire of the feeder is made by means of a small hook which is connected through a very small condenser C_0 to the circuit of the instrument. This hook forms the only exposed point of the circuit, the rest of which is enclosed in a miniature Faraday cage formed by the metal armouring H. Inside this screen there is an oscillatory circuit which is set into oscillation by the currents reaching it through C_0. The amplitude of oscillations is read from a thermal milliammeter with a scale maximum of 150 mA. The side of the oscillatory circuit not connected to C_0 is joined to the metal

* MS. received by the Editor Sept., 1930.

† *Zeitschr. f. Hochf. Tech.*, Vol. 36, 1930, pp. 81–85 and 121–133.

casing, which by reason of its large expanse acts as an earth.*

The theory of the instrument indicates that it must always be kept at right angles to the conductor under investigation. But actual practice showed that almost identical readings were obtained with the instrument in considerably different positions; the screening is so effective that only the potentials at the end of the hook are measured, the rest of the instrument being quite insensitive to the electric fields due to the conductor.

With this instrument a large number of measurements were made on various feeders. One example is here given, in which it was tried to separate out the various causes of loss.

The feeder shown in Fig. 2 was constructed; the length was 51.94 metres, the spacing of the wires was 16.5 cms., and the average height above ground was 1.5 metres. The corrugated insulators were so arranged that they came at the potential nodes, and the feeder was short-circuited at its free end by a bridge (Fig. 3). By these precautions the losses in the insulators were first reduced to zero.

* *See also* Ref. (†) on previous page.

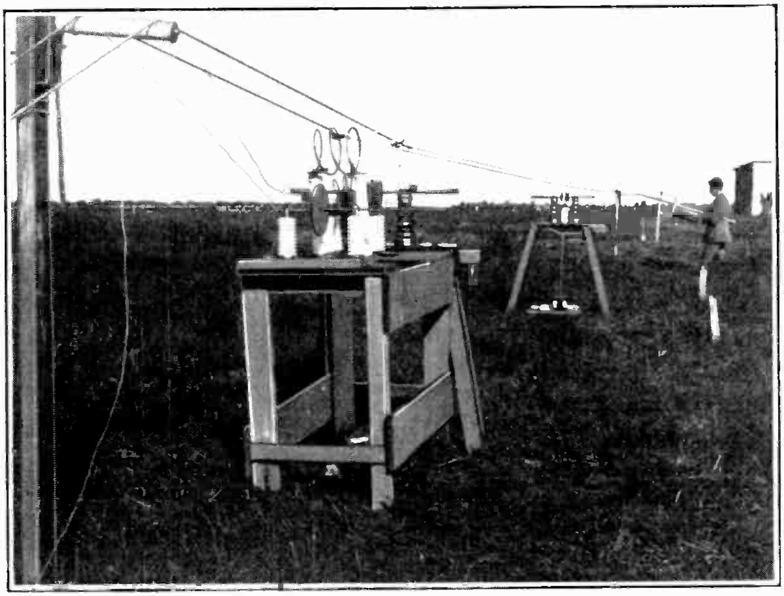


Fig. 2.—*Feeders at the Nauen wireless station.*

To determine, by way of the node-width, the damping of the feeder the potential distribution in the neighbourhood of a potential node had to be measured by the instrument just described. A number of test-notches, at 2.5 cm. intervals, were therefore filed in the wire in the neighbourhood of the seventh potential node (counting from the free end) for the hook of the instrument to rest in. The potentials measured at these points are plotted in Fig. 3. The first set of measurements were taken on the uncleaned wire, which had been much exposed to the weather (curves 1*a* and 1*b*). They give, according to formula (1), as the mean result for the two wires, a damping of 2.0% for the free end of the feeder. Next, the feeder wires were carefully sandpapered and curves 2*a* and 2*b* were taken. No decrease in damping by the removal of the oxidised layer was found ($b = 2\%$). In order to measure the damping introduced by the insulators, corrugated insulators were fastened at every potential antinode. The slight decrease in damping which was then noted (curves 3*a* and 3*b*; $b = 1.9\%$) must be attributed to an error in measurement. The displacement of the node from its original position is a measure of the capacity of the insulators.

Finally, the insulators at the potential antinodes were wetted by having water poured over them. The resulting potential curves are marked 4*a* and 4*b*. They indicate a greatly increased insulator capacity and a marked increase in damping ($b = 3.3\%$).

These results, confirmed several times, show that damp insulators constitute a serious source of loss in feeders, which should be avoided as much as possible. They also indicate that the damping of 2% found in the feeder is due to ohmic losses in the copper, induction losses in the ground, and radiation losses.

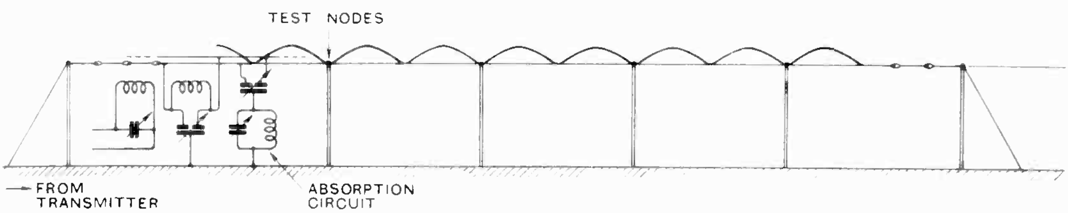
III. Characteristic Impedances.

For the losses in a feeder to be reduced to a minimum the reflected wave—which represents a flow of energy in the wrong direction, and whose losses also add themselves to the other losses—must be of zero value. As can easily be calculated from the telegraph equations, this is the case if the feeder is closed at the free end by an ohmic resistance equal to the characteristic impedance. In order to satisfy this condition the characteristic impedance must be known and matched against the output load. For certain types of feeder the characteristic impedance W can readily be found by formulae. For instance, for a feeder made up of two cylindrical wires stretched parallel to each other at a distance d, each wire having a radius r, the approximate formula is :—

$$W = 120 \log_e d/r \text{ ohm} \quad .. \quad (2)$$

For a feeder composed of two concentric cylinders of radius r_e and r_i respectively, the formula is :—

$$W = 60 \log_e r_e/r_i \text{ ohm} \quad .. \quad (3)$$



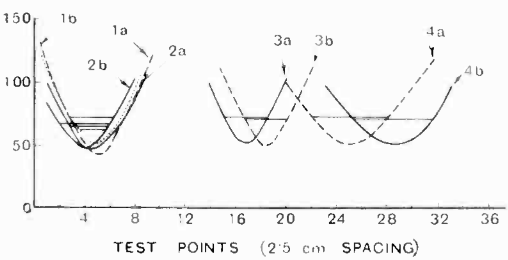


Fig. 3.—*Damping measurements.* $\lambda = 14.84$ *m.; length of wires, to test nodes,* 51.94 *m.; spacing of wires,* 16.5 *cm.; curve* 1, *wires oxidised by exposure; curve* 2, *wires cleaned; curve* 3, *insulators at voltage loops, dry; curve* 4, *insulators at voltage loops, wet.* a = *north wire;* b = *south wire.*

In order to calculate the characteristic impedances of other types of feeder systems, and to check the above formulae for use with very high frequencies, the following procedure has been worked out.

IV. Measurement of the Characteristic Impedances at Very High Frequencies.

A loss-free feeder whose self-inductance and capacity per unit length are denoted by L_0 and C_0 respectively, behaves between its input terminals as a reactance given by

$$X = -\sqrt{\frac{L_0}{C_0}} \cot \omega \sqrt{C_0 L_0} \; *$$

This formula can be re-written

$$X = -W \cot \frac{2\pi l}{\lambda},$$

where W is the characteristic impedance and l the length of the feeder. This formula indicates that a free-ended piece of feeder of length $\lambda/8$ has a reactance $X_{\lambda/8} = -W$ between its terminals, and can therefore be replaced by a capacity of size C_1 which satisfies the equation

$$W = \frac{1}{\omega C_1} \quad .. \quad .. \quad (4)$$

By means of this formula the measurement of the characteristic impedance can be brought down to an ordinary capacity measurement.

Example. A feeder composed of two 1.5 mm. wires spaced 100 mm. was insulated at its free end and excited with a 26.7 m. wave by being coupled to a transmitter (*see* Fig. 4).

* *Electrical Engineers Data Books,* Vol. 3 (E. Benn, Ltd.), 2nd Impression, p. 83.

The capacity K was so adjusted that the feeder was in resonance. A length at the free end, equal to $\lambda/8$ (*i.e.*, 3.34 m.), was then cut off and the ends again insulated. The system, now reaching to AB, was again brought into resonance by a new condenser C at the free end; the value of this for resonance was found to be $C_1 = 25$ cm. From formula (4) the characteristic impedance was therefore $W = 527$ ohms, while the theoretical formula would give a value of 500 ohms. Considering the presence of insulators and of other sources of error, the agreement can be considered as very good.

V. The Matching of Aerials and Feeders.

A normal value for the radiation resistance of a dipole aerial is about 70 ohms. A twin-wire feeder, on the other hand, has a characteristic impedance of about 500 ohms, and a linking stage is therefore needed between aerial and feeder to transform the effective resistance of the aerial up to 500 ohms (*see* III).

For this purpose the well-known high-frequency transformer is especially suitable. It consists of two windings, which at these high frequencies must be tuned to the wave in use, while the coupling between them must be so chosen as to give the required transformation ratio. Such high-frequency transformers have been investigated thoroughly by W. Moser.*

Another method of obtaining optimum matching consists in the application of the "transformation-feeders" worked out by the writer. Such a "transformation-feeder," in general, consists of a piece of feeder of length $\lambda/4$, which is introduced between the load circuit and the lines supplying it. To such a short feeder-element the telegraph equations for loss-free lines can be applied :—

$$\bar{V}_a = \bar{V} \cos \frac{2\pi l}{\lambda} + j \bar{J} W \sin \frac{2\pi l}{\lambda}$$

$$\bar{J}_a = \bar{J} \cos \frac{2\pi l}{\lambda} + j \bar{V}/W \sin \frac{2\pi l}{\lambda} \quad .. \quad (5)$$

Here $\bar{V}$ and $\bar{J}$ are the vector amplitudes of potential and current at the end, while $\bar{V}_a$ and $\bar{J}_a$ are the same quantities at the input end of the lines. l is the length of the lines and λ the impressed wavelength. For the length employed, $l = \lambda/4$, the equations (5) become

$$\bar{V}_a = j \bar{J} W$$

$$\bar{J}_a = j \bar{V}/W \quad .. \quad .. \quad (6)$$

If the feeder is loaded at the free end with an ohmic resistance R_v, so that $\bar{V} = \bar{J}R_v$, then it will behave between its input ter-

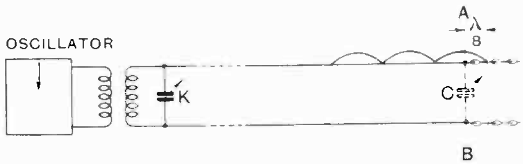


Fig. 4.—*Characteristic impedance measurements.*

minals as if it were an ohmic resistance, R_a, with the value

$$R_a = \bar{V}_a/\bar{J}_a = W^2/R_v \quad .. \quad (7)$$

In the case assumed above, the radiation resistance of a dipole aerial ($R_v = 70$ ohms) required transforming up to the value $R_a = 500$ ohms in order that the waves advancing along the feeder (characteristic impedance 500 ohms) supplying the aerial should not be reflected. By formula (7) this requirement is fulfilled if the characteristic impedance of the feeder-element inserted has the value $W = \sqrt{70 \times 500} = 183$ ohms. A feeder-element of this impedance can be constructed by connecting several wires in parallel.

Finally, a third method of matching is by means of a type of transformation-feeder described by Rüdenberg,† the characteristic impedance of which changes slowly along the length of the feeder. It can be shown that no marked reflection can take place in such a feeder. In the direction of increasing characteristic impedance the potentials increase with the square root of the impedance at each point, while the current amplitudes decrease in the same proportion; in the other direction the reverse action takes place. The action is very similar to that of a loud-speaker horn.

Such an arrangement has the advantage, over those previously mentioned, that its transformation ratio is independent of frequency; on the other hand, the construction is less simple and the length of the feeder is often too great in practice.

* *E.N.T.*, Vol. 5, 1928, No. 11, p. 423.

† *El. und Maschinenbau*, 1913, p. 412.

Frequency Measurements of High Accuracy.*

By J. J. Vormer and C. van Geel.

(Radio-Laboratory of the Dutch State Telegraphs, The Hague, Holland.)

FOR some years the Radio-Laboratory of the Dutch State Telegraphs has made use of apparatus for frequency measurements which gives a high degree of precision. Such a system is of great value to a Telegraph Department:

First, for the calibration of frequency-meters;

Second, for the measurement of the frequency of transmitting stations, so that if any interference occurs it is possible to determine which transmitter is not working at its correct frequency.

With the arrangement described, tests have been made over a long period. During this period the apparatus has been improved several times. A description of its present form follows:

The standard frequency is obtained from an oscillator which is controlled by a quartz crystal. This crystal, which has been calibrated by the National Physical Laboratory at Teddington, has a frequency of 288,496 (λ about 1000 m.).

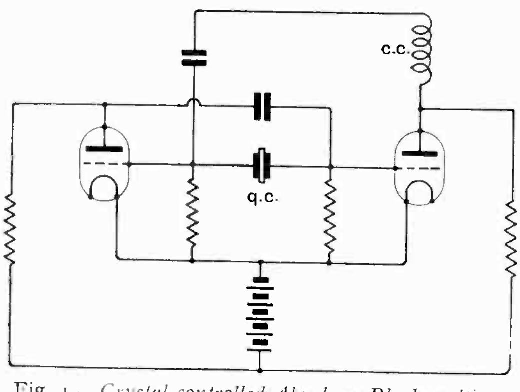


Fig. 1.—*Crystal-controlled Abraham-Bloch multivibrator. q.c.=quartz crystal. c.c.=coupling coil.*

This calibration, however, is of very limited importance as the frequency of the standard oscillator depends not only on the crystal itself, but also, in a slight degree, on the crystal mounting and on the constants of the circuit. From this it follows that if a crystal-controlled oscillator has to be used as a standard, it is an absolute necessity to calibrate the frequency of the whole complex. In most cases this frequency is a function of temperature. For accurate measurements these variations with temperature must be taken into account.

The piezo oscillator used as a standard in the apparatus of the Radio-Laboratory is a multivibrator of Abraham and Bloch (Fig. 1). Its frequency is 288,464 cycles (roughly 300,000 cycles).

During the first tests a tetrode multivibrator was used, as described in *Radio Nieuws*, June, 1926, by Roosenstein (who also indicated the method of using it for wave measurements and for absolute frequency measurements as described below †). This type of multivibrator has the advantage of producing many strong harmonics (the 300th can be used). On the other hand, it has the disadvantage that its frequency depends very much on the filament and high-tension. This causes not only a difficulty in adjusting the oscillator to a desired frequency, but it has, moreover, the disadvantage that the frequency is not absolutely fixed. More frequencies of the multivibrator and crystal are possible, and big errors in the measurements can be the result of it. The frequency of an Abraham-Bloch multivibrator is less dependent on filament and high-tension, so that if the necessary precautions are taken a constant adjustment can be easily obtained.

Besides, it is not necessary to use a multivibrator for the first oscillator. The only condition to fulfil is that the crystal oscillator gives a frequency which is independent of small variations in high- and low-tension.

The harmonics of this first oscillator, however, are too weak to serve for measurements. Moreover, the frequency is too high for immediate comparison. For that reason the following device is applied (see Fig. 2).

* MS. received by the Editor, Dec., 1929.

† Theoretical description in *Tijdschrift Nederlandsch Radiogenootschap*, 1927, papers of v.d. Pol and Roosenstein.

The standard oscillator is followed by a high-frequency amplifier. The amplified fundamental frequency coming from this amplifier serves to stabilise a tetrode-multivibrator. Consequently, this multivibrator is not an independent oscillator, but a synchronised oscillating amplifier with many and strong harmonics.

The basic frequency of this multivibrator is $\frac{f}{n_1}$, in which formula $f =$ fundamental frequency of the standard oscillator, while n_1 can have values from 1 to 10 or more. Generally in this multivibrator $n_1 = 2$ is taken. Then the distances between every two harmonics are always 150,000 cycles. For measurements between 10 and 100 meters this is close enough to assure a good accuracy.

Now the only difficulty consists in the determination of the order of a certain harmonic. For that purpose the arrangement has been enlarged by the addition of still another multivibrator with the fundamental frequency of $2f$ (600,000 cycles), this multivibrator being controlled by the 4th harmonic from the multivibrator mentioned above. The harmonics of this "counting multivibrator" coincide with the 4th, 8th, 12th harmonic, etc., of the 150,000 cycle multivibrator. As both multivibrators are coupled to the short-wave receiver, the result is that the 4th, 8th, 12th are received stronger than the other harmonics. In this way the counting of the harmonics is very much facilitated, as the order of those strong ones, which are 600,000 cycles apart, can be easily determined by means of any ordinary wavemeter.

For long-wave measurements, however, this disposition cannot be used. In that case it is necessary to make the distance between two harmonics much smaller, which can be obtained as follows. The 150,000 cycle multivibrator is set to a fixed frequency, stabilised by the standard oscillator. In this case we choose $n_1 = 5$, then the frequency of this multivibrator will be 60,000 cycles. This frequency is once more amplified in a high-frequency amplifier, and stabilises in turn a tetrode multivibrator. The arrangement is shown in Fig. 3. The basic frequency of this multivibrator, which is $\frac{f}{n_2}$, is a very low one. If we choose $n_2 = 100$, the 20th harmonic of this multivibrator is controlled by the input frequency $\left(\frac{n_2}{n_1} = 20\right)$ so that its fundamental frequency is 3000. At this adjustment a stable working is still obtained.

If we listen with a normal oscillating receiver to the succeeding harmonics of this multivibrator we hear always two harmonics at the same time, the difference between them being only 3000 cycles per second. By turning the tuning condenser the beat note with the harmonic on the other side of the frequency on which the receiver is tuned becomes lower. By further turning of the

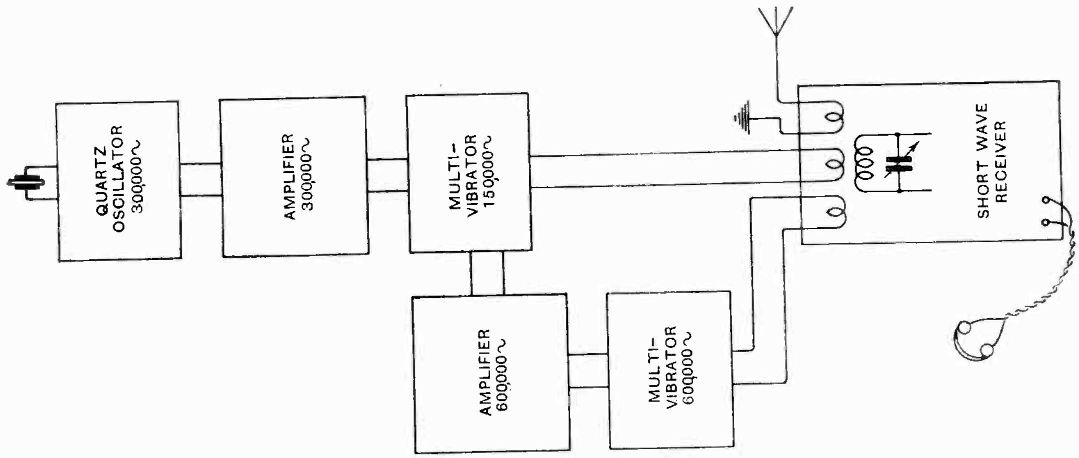


Fig. 2.—*Arrangement for short-wave measurements.*

tuning condenser all the harmonics of the 3000 cycle multivibrator are heard one after the other. If we now couple the receiver also with the 60,000 cycle multivibrator, we get the impression that every

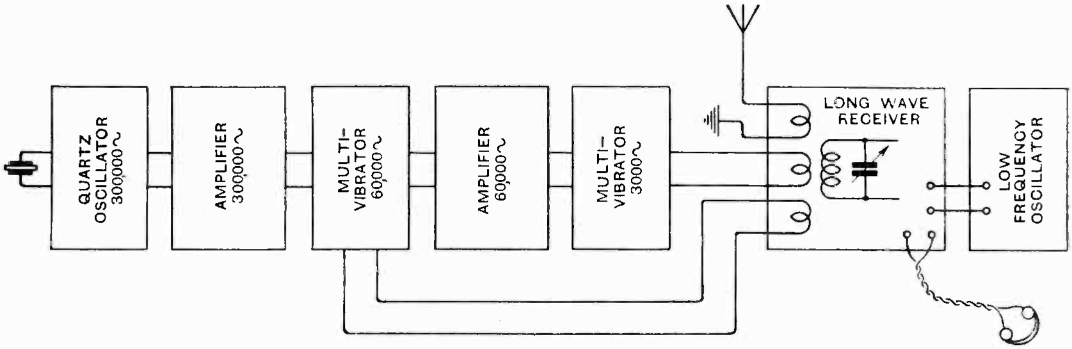


Fig. 3.—*Arrangement for long-wave measurements.*

20th harmonic of the 3000 cycle multivibrator is extra strong. On that tuning the receiver gets power from both multivibrators as before, the counting of the harmonics takes less time and the chance of making a mistake is reduced. This proceeding is illustrated by Fig. 4.

In practice, we make a difference between the measuring of wavelengths from 10 to 100 metres and wavelengths above 100 metres.

Short-Wave Measurements.

In this case the arrangement is as shown in Fig. 2.

The signal to be measured is received in an oscillating short-wave receiver, which at the same time can be coupled to the multivibrators. The tuning condenser of this receiver has a special slow motion and a scale which can be read with great accuracy.

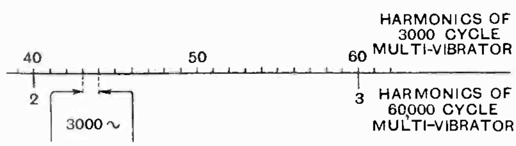


Fig. 4.

From the scale divisions we take the following readings:

First, the point where the signal produces "zero beat" with the oscillating receiver;

Second, the two points where the beat notes produced by interference between the receiver and the nearest harmonics of the second multivibrator are zero.

As we know the order of the harmonics used we can calculate the frequency of the transmitting station by interpolation, as shown in Fig. 5. The frequency of the receiver is supposed to change proportionally to the scale readings.

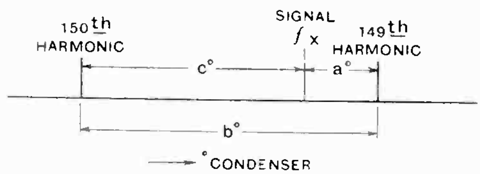


Fig. 5.—$f_x = \left(149 + \frac{a}{b}\right) \times 150{,}000 \sim$

$$f_x = \left(150 - \frac{c}{b}\right) \times 150{,}000 \sim$$

This method of measurement contains an inaccuracy. If we approach the tuning of the transmitting station the beat note in the telephone becomes lower and lower. As the low-frequency amplifier of the short-wave receiver does not amplify the lowest frequencies it is not possible to determine the point of zero beat correctly. For short-wave measurements this is no trouble whatever. Fifty cycles, more or less, makes only a little difference on frequencies in the order of 10^7 cycles. But for long-wave measurements (frequencies of the order of 10^5 cycles or less) this inaccuracy becomes important.

Long-Wave Measurements.

For these long-wave measurements another method is followed, as shown in Fig. 3.

A transmitting station is assumed to be working on a frequency between the 50th and 51st harmonic. We now will try to tune the receiver to that frequency where the beat note between the oscillating receiver and the 50th harmonic of the multivibrator is zero. In approaching this tuning a moment arrives at which the note in the telephones fades. It is quite possible that in this position the receiver is yet 60 cycles removed from the true zero beat. For the reason mentioned above we do not hear this tone of 60 cycles. However, we hear two other tones, *viz.*, beat notes produced by interference between the receiver and the 51st and 49th harmonics of the multivibrator. In the present case these beat notes are respectively 2940 and 3060 cycles, and these are frequencies which are very well amplified by the low-frequency amplifier. If we come nearer to the exact frequency of the 50th harmonic, these beat notes approach each to the value of 3000 cycles. At a certain moment heterodyne interference between those tones appears and by means of this phenomenon the receiver can be tuned to the 50th harmonic with an accuracy of 1 cycle or less.

In the same way the receiver can be set just between two harmonics. If this is done we hear a tone of 1500 cycles, being the difference between the receiver tuning and the adjacent harmonics on both sides. If we now couple the receiver with the aerial we hear the station in a certain tone. The frequency of this tone, that is the frequency difference between receiver and station, can be measured by means of a calibrated low-frequency oscillator. This comparison, too, takes place with the aid of heterodyne interference. As the order of the harmonics of the multivibrator is known, and as we have measured the frequency difference (a) respectively, (b) between the station and two harmonics, the transmitter frequency can be calculated (see Fig. 6).

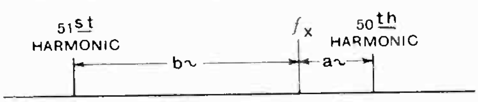


Fig. 6.—$f_x = 50 \times 3000 + a \sim$
$f_x = 51 \times 3000 - b \sim$

For exact measurement it is necessary to make a temperature correction. For the fundamental frequency of the apparatus of the Radio Laboratory this correction amounts to about − 2 cycles per degree C.

The disposition is continuously checked with standard signals, as transmitted by the National Physical Laboratory at Teddington.

The following table gives data of a test on October 2, 1928 :

Frequency according to Teddington.	Measured by R.L. Arrangement.	Difference in Cycles.	% Difference
960,000	960,025	+ 25	0.026
840,000	840,015	+ 15	0.018
700,000	700,018	+ 18	0.026
580,000	580,008	+ 8	0.014
500,000	jammed by	ship traffic.	

It is interesting to see how much the measurements in different countries differ notwithstanding all precautions. In order to compare frequency standards in October, 1928, an international test was arranged. Different services measured the frequency of the American short-wave station WKM at the same moment and the results were as follows :—

17 October, 1928.	14.30 GMT. k.p.	19.00 GMT. k.p.
Radio Lab. D.S.T. the Hague	18,862.7	18,865.0
Teddington	18,861.8	18,861.7
Marconi	18,862.0	18,865.0
Riverhead	18,862.8	18,861.7
Bellvue	18,862.2	18,863.1
Reichspost, Berlin . .	18,858.0	18,858.0
Transradio, Berlin . .	18,882.0	18,882.0
G.E. Schenectady . .	18,869.0	18,867.2
R. C. A. Marshall . .	18,885.0	18,876.0

The accuracy of the measurements depends :

1° on the calibration of the crystal and multivibrator. (The way in which this standard frequency is determined will be described below.)

2° on the calibration of the audio-oscillator for long-wave measurements.

3° on the accuracy by which for short-wave measurements the tuning condenser can be read off.

With the arrangement described above an accuracy in the order of 1 : 100,000 can be obtained.

Absolute Frequency Measurements.

In order to enable the accurate calibration of quartz crystals as well as the recheck of the standard crystal oscillator the following arrangement has been devised with which an absolute frequency measurement can be executed, this means that the measured frequency is really found by counting the number of cycles in a certain time. The same arrangement can be used for the calibration of the low-frequency oscillator mentioned above. The arrangement is shown in Fig. 7.

For this purpose the fundamental frequency of $\frac{f}{100} = 3000$ cycles from the multivibrator is divided once more by 10 by using another multivibrator with a fundamental frequency of $f^1 = \frac{f}{1000}$ cycles, so that its 10th harmonic is controlled by the input frequency.

The alternating potential of 300 cycles, obtained in this way, is, after amplification in an ordinary audio-frequency amplifier, superimposed on a direct tension of 100 volts, and then applied to a neon tube. As this neon tube glows at a voltage of 125, an alternating tension with maximum amplitude of 25 volts is sufficient to make

disc is moved a number of light-spots or dashes are to be seen near each other. (Fig. 8).

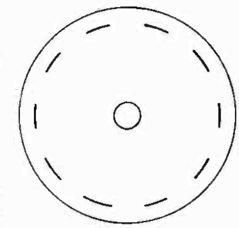


Fig. 8.

Now it is possible to choose such a speed of the disc that the frequency f^1 of the alternating tension divided by the number of revolutions per second n gives a whole number, *e.g.*, $\frac{f^1}{n} = 10$. In that case the tube will glow up 10 times in each rotation, so that 10 light dashes are visible on the disc. If the speed of rotation remains constant the light dashes of each turn will be on the same place and the image of 10 light dashes as shown in Fig. 8 will stand still.

The whole frequency measurement now comes to :

First, regulating the speed of the disc on such a constant number of revolutions per second that the 10 light dashes stand continuously still ;

Second, counting the number of rotations

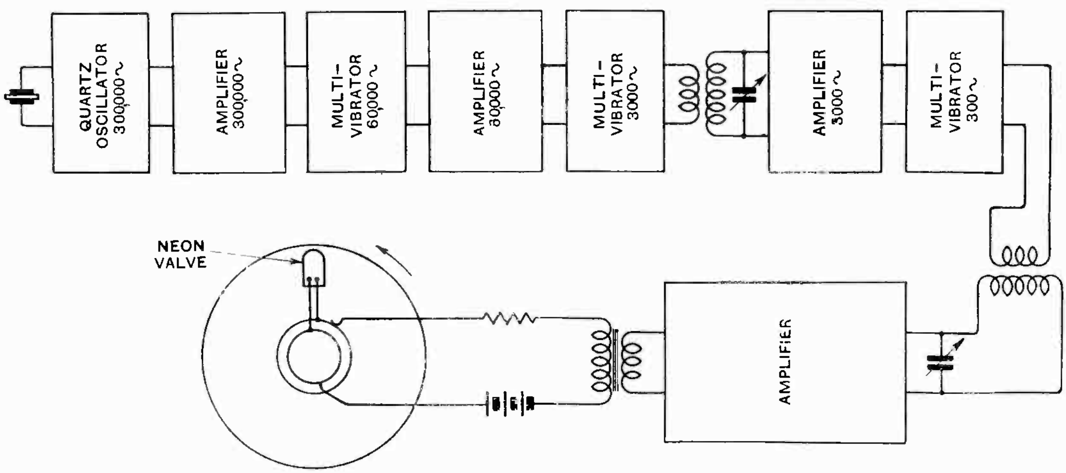


Fig. 7.—*Arrangement for absolute frequency measurements.*

the tube glow at the moment of highest potential. Thus the neon tube glows up once in every cycle.

This neon tube is placed on a circular disc rotated by an electromotor the speed of which can be accurately regulated. If the

of the disc during the time of measurement

The disc, made of massive copper, is rotating between the poles of an electromagnet. According to the movement of the disc in the magnetic field, Foucault currents will flow, which cause a counteracting influence. The direct current, going through the coils of the electromagnet, can be regulated by means of a variable resistance. The speed of rotation is kept constant by increasing or reducing this resistance as required. A small increase of the speed is immediately visible from a slow movement of the light dashes in the direction of rotation of the disc, because in that case the dashes of one rotation do not fall exactly upon the equivalent dashes of the preceding revolution but a little further on. In the same way a slow movement of the light dashes in the opposite direction shows that the speed of the disc is diminishing.

To obtain an accurate determination of the number of rotations, the shaft of the disc has been provided with a pair of rings and brushes, by means of which after every revolution a dot is registered on a multiple chronograph. A worm gear 1 : 20, in combination with a second pair of contacts, serves for the separate recording of every twenty revolutions. Moreover, on the same tape of paper the seconds and minutes from a Brillié clock are registered. (This clock is checked with an astronomical time signal at intervals). A part of the tape is represented in Fig. 9.

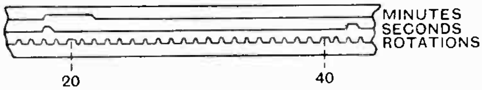
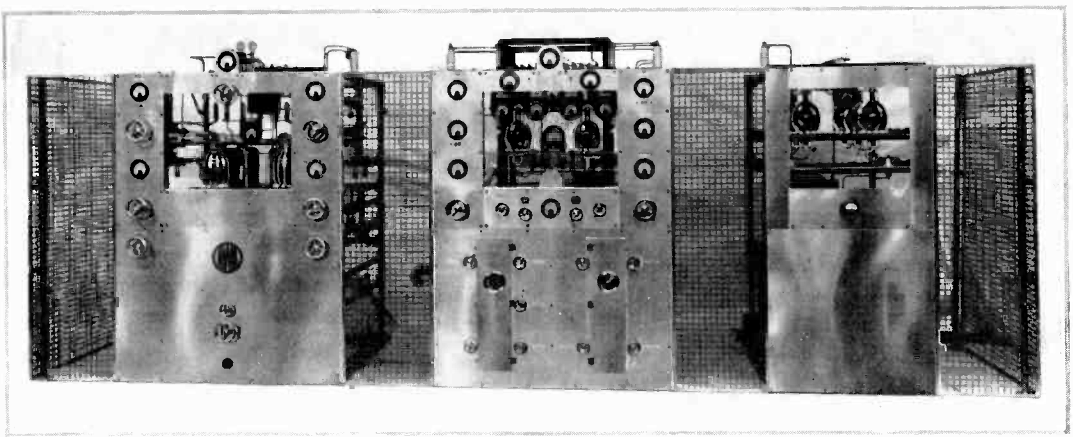


Fig. 9.

In this way the number of cycles and the duration of the measurement can be fixed with a very high degree of precision, which depends only on the length of time over which the measurement is continued. The frequency of the alternating voltage is found by multiplying the number of revolutions per second of the disc by 10 ; this frequency multiplied by 10 × 20 × 5 gives the exact frequency of the quartz oscillator.

AN AUSTRALIAN SHORT-WAVE TRANSMITTER.



THE recent opening of the new works of Amalgamated Wireless (Australasia), Ltd., at Ashfield, near Sydney, marks a fresh stage in the development of an enterprise which has steadily progressed since the Company began manufacturing radio apparatus of all kinds over sixteen years ago. " A.W.A. " has designed and erected the principal stations in the Commonwealth, New Guinea and the neighbouring islands in the Pacific, besides many of the installations on Australian coasting vessels.

The photograph shows a 3-kilowatt (1 kW. aerial) short-wave transmitter which has been supplied to the New Zealand Posts and Telegraphs Department and installed at Tinakori Hills for service between New Zealand and Australia.

The Moving Coil Loud Speaker.*

By H. M. Clarke, B.Sc.

IN a previous article† on the moving coil loud speaker the author suggested that the electrical constants of the coil, namely, the resistance and reactance, are different when the coil is moving from when it is stationary, this difference being in the purely electrical constants and occurring in addition to changes due to air loading, diaphragm absorption and suspension losses.

If a coil placed near to a piece of iron were vibrated axially to and from the iron, and at the same time its resistance and reactance were measured in a bridge by a current synchronising with the vibrating force, the values might not be the same at all amplitudes and at all time phases between the vibrating force and the bridge current. The dissymmetry of conformation of the magnetic field indicates that the constants of the path of secondary currents induced in the iron might be different from those when the coil is stationary, and that they might be different for different conditions of movement, *i.e.*, amplitude and time phase.

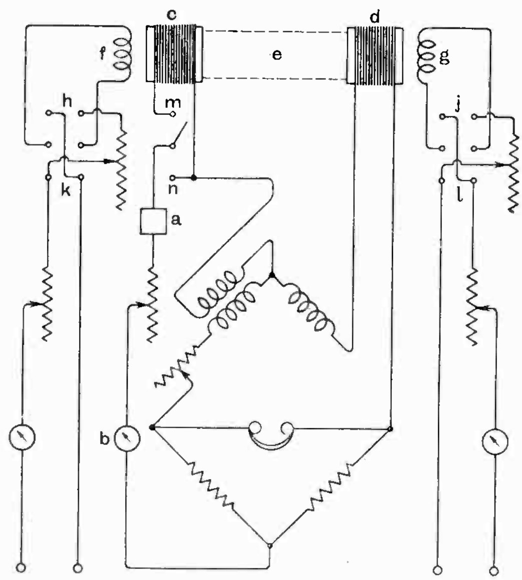


Fig. 1.—*Bridge tests.* a, *source* ; b, *milliammeter* ; c, *driving coil* ; d, *driven coil* ; f, *driving coil magnet field* ; g, *driven coil magnet field* ; h, j, *zero fields positions of switches* ; k, l, *full field strength positions of switches* ; m, *driver carrying current* ; n, *driver out of circuit* ; e, *fibre tube.*

The changes in electrical constants caused by movement of the moving coil of a loud speaker would no doubt be small, but so also is the change produced by the dynamic loading due to air, diaphragm and suspension.

If no allowance is made for a possible change in the electrical constants, the dynamic impedance attributed to the moving system and measured by difference of input resistance and reactance of the system when in motion, from those of the system at rest, may be considerably in error.

With a view to observing the possible existence of such changes, the author has carried out the experiments described below.

Two coils were coupled at the ends of a stiff fibre tube, each coil being located in the air-gap of its own homopolar magnet. One, the test coil, could thus be driven by the other. No diaphragm was attached, so as to make as simple a vibrating system as possible and to avoid frequent resonances.

The field currents of the magnets were adjusted so that when the test coil was carrying a current equal to half that of the driving coil, the forces of the two coils were equal.

The test coil was included in a mutual inductometer bridge and the driving coil was in series with the main lead between the source and the bridge (see Fig. 1). The bridge was arranged for unity ratio and the main current throughout the tests was 21.4 milliamperes r.m.s. The various a.c. and d.c. currents were flowing for several hours before readings were taken, bridge balances being made periodically until no changes due to temperature were observable.

Fig. 1 is a simplified diagram and omits confusing switching arrangements for reversing various parts and for converting the circuit to a different method of testing shown in Fig. 2 and to be described later.

*MS. received by the Editor, February, 1931.
†*E.W. & W.E.*, September, 1930.

The constants of the coil were obtained under the following conditions: (i) when stationary, with the switches in *h*, *j*, *n* positions; (ii) when driven by *c*, switches in *k*, *j*, *m* positions; (iii) when self-driven, switches in *h*, *l*, *n* positions, *h* and *j* being zero d.c. fields positions.

The results are shown in the Table below, lines (2) and (3) for the stationary test; lines (4) and (5), driven by *c*; lines (10) and (11), self-driven. The usually accepted figures for dynamic impedance, namely (10)—(2), and (11)—(3) are shown in lines (14) and (15).

The test coil when separately driven was moving under the same force and against the same mechanical resistance as when self-driven, and therefore moved in the same way both as regards amplitude and phase.

In consequence, the values of resistance and reactance given in lines (4) and (5), when compared with lines (2) and (3) show the

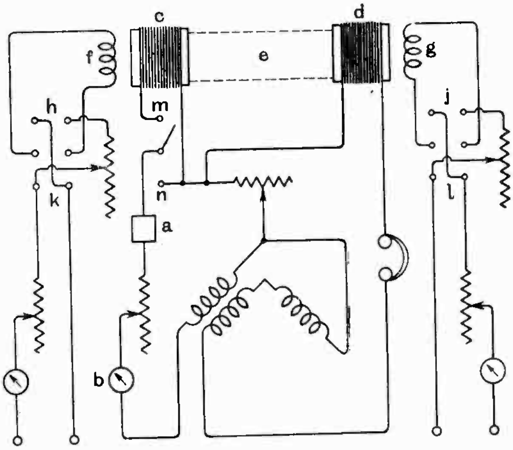


Fig. 2.—*Potentiometer tests.*

There is, however, a correction to be made to the figures obtained for the coil when driven by *c*.

RESISTANCES IN OHMS. INDUCTANCES IN MICROHENRYS.

(1)	Frequency		1,536	1,760	1,880	1,960	2,048	2,180	2,330	2,750
(2)	R_1	No motion.	518.1	525.3	529.2	532.05	535.55	538.7	543.3	551.5
(3)	L_1		13,630	13,290	13,166	13,034	12,890	12,740	12,564	12,070
(4)	R	Driven.	529.1	537.4	541.0	543.3	546.4	550.6	554.5	564.7
(5)	L		13,870	13,530	13,280	13,200	13,030	12,860	12,670	12,150
(6)	R	Double Potentiometer. No motion.	8.8	9.12	9.24	9.34	9.4	9.42	9.44	9.6
(7)	L		232	191	174	156	134	120	103	74
(8)	(4)—(6)	R_1 and L_1 corrected for motion.	520.3	528.3	531.76	533.96	537.0	541.18	545.06	555.1
(9)	(5)—(7)		13,638	13,339	13,106	13,044	896	740	12,567	12,076
(10)	R_3	Self Driven.	519.0	529.7	534.7	543.3	552.5	546.55	545.65	553.4
(11)	L_3		13,990	13,966	13,834	13,808	12,400	12,280	12,184	12,000
(12)	(10)—(8)	Motional impedance corrected for motional change in R_1 and L_1.	−1.3	1.42	2.94	9.34	15.5	5.37	0.59	−1.7
(13)	(11)—(9)		352	627	728	764	− 496	− 460	− 383	− 76
(14)	$R_3—R_1$	Usually taken for motional impedance.	0.9	4.4	5.5	11.25	16.95	7.85	2.35	1.9
(15)	$L_3—L_1$		360	676	668	774	− 450	− 460	− 380	− 70
(16)	R	Double Potentiometer with motion.	8.3	6.4	2.96	−3.6	−12.00	0.56	7.52	8.74
(17)	L		−320	−590	−660	−780	694	632	494	192
(18)	(16)—(6)	Resistance and self-induction used for velocity calculation.	−0.5	−2.72	−6.28	−12.94	−21.4	−8.86	−1.92	−0.86
(19)	(17)—(7)		−552	−781	−834	−936	560	512	391	118
(20)	Centimetres/second		0.693	1.176	1.52	2.25	2.94	1.47	0.545	0.288

Lines (2) and (3). Coil stationary. Bridge measurements.
(4) and (5). Coil driven. Bridge measurements.
(6) and (7). Coil driven. Potentiometer measurements of strays.
(10) and (11). Coil self driven. Bridge measurements.
(12) and (13). Motional impedance corrected for motional change in R_1 and L_1.
(14) and (15). Motional impedance not corrected for motional change in R_1 and L_1.
(16) and (17). Coil driven in known field. Potentiometer measurements.
(18) and (19). (16) and (17) corrected for strays.
(20). Derived from (18) and (19).

change due to movement; they may, moreover, be subtracted from lines (10) and (11) to give motional impedance.

Under these conditions, there are stray d.c. and a.c. fields from the driving and polar systems, inducing e.m.f.s in the test coil which are detected by the bridge and are included in lines (4) and (5).

These stray effects may be measured by the potentiometer method shown in Fig. 2, the switches being as before in the *k*, *j*, *m* positions. In this way balance is obtained with zero current in the test coil, and the readings obtained are a measure of the e.m.f.s induced by strays. The values are, however, associated with the full current of 21.4 mA.s and have therefore to be doubled to compare with those taken in the bridge with half that current.

These double values are shown in lines (6) and (7) of the Table. Lines (8) and (9) show the values of resistance and self induction for the test coil corrected for motion. These are the figures which the author suggests should be subtracted from (10) and (11) to give output impedance as shown in lines (12) and (13), which should be compared with (14) and (15) to see the effect of the suggested correction.

Over the range of frequencies examined there is a resonance between 1960 and 2048, and it will be seen that the motional resistance is affected to the extent that the values are lower and the resonant peak more pronounced.

The self induction is only slightly affected. Probably the reverse is the case for frequencies well removed from resonance.

The author hesitates to claim that the limited test proves the existence of the suggested difference. The observed changes are small and may well be within the zone of natural variations of the system. He is unfortunately unable at present to verify the suggestion by exhaustive tests and consequently can only put forward the idea and the method of testing.

A further interesting application of the potentiometer method is for measuring velocity and amplitude and their phase relation to the driving current. If the switches be arranged *k*, *l*, *m*, in Fig. 2, balance is obtained with the test coil *d* being driven by *c* in a field of known strength.

The e.m.f. so generated, when corrected for strays, is a measure of the velocity. Lines (16) and (17) are the doubled uncorrected and (18) and (19) the doubled corrected readings.

Let B = Flux density in gausses in field of coil d.

l = Length of wire in centimetres of coil d.

v = Velocity in centimetres/second of coil d.

$R = \frac{1}{2} \times$ Reading of line (18).

$L = \frac{1}{2} \times$ Reading of line (19).

$I_{r.m.s.}$ = Driving current in mA.s. r.m.s.;

then $V_{max.} = \dfrac{\sqrt{2}\, I_{r.m.s.} \sqrt{R^2 + \omega^2 L^2} \times 10^5}{Bl}$ and

the time phase angle θ of "lead" of the velocity is given by $\tan\theta = \dfrac{\omega L}{R}$.

Line (20) shows the value of $V_{max.}$ for the particular case when $I_{r.m.s.} = 21.4$ and $Bl = 5.82 \times 10^6$. The time phase of the velocity relative to the driving force being given by lines (18) and (19), which are comparable with lines (12) and (13) but of opposite sign, one set being generated e.m.f. and the other back e.m.f.

The conclusions may be summarised in this way :—

The following frequency characteristics of the moving coil telephone may be obtained by the bridge and potentiometer methods.

1. Iron loss {Line (2)—A.C. Resistance measured in air}.
2. Changes of working a.c. resistance and reactance due to motion {as shown in lines (6) and (7)}.
3. Corrected "no mechanical load" resistance and reactance {lines (8) and (9)}.
4. Mechanical load {(12) and (13)}.
5. Air loading for rigid diaphragm {line (20) and phase angle θ}.
6. Mechanical losses for rigid diaphragm {4—5 above}.

In conclusion it may be remarked that possibly a combination of tests by Chladni figures and the velocity at the centre by potentiometer (or perhaps an extension of the potentiometer method to other points on the diaphragm) might lead to a method of integrating the output and losses for the non-rigid diaphragm.

The Distortionless Amplification of Electrical Transients.*

By C. W. Oatley, M.Sc.

PART II.

Introduction.

IN the previous part of this article an analysis was given of the distortion which may arise when a transient E.M.F. passes through a resistance-capacity or transformer coupled audio-frequency amplifier. In order to simplify the analysis these amplifiers were represented by "ideal" circuits, the frequency characteristics of which approximated closely to those of practical amplifiers at the low frequency end, but which, unlike those of practical amplifiers, showed no cut-off at the high frequency end. We shall next consider the distortion which would be introduced by an amplifier, the frequency characteristic of which approximates to that of a practical amplifier at the high frequency end, but which exhibits no cut-off at the low frequency end.

In connection with the distortion due to high frequency cut-off we shall consider only resistance coupled amplifiers, partly because we have already seen that these are better suited to the amplification of transients than are transformer coupled amplifiers and partly because the circuit equations for the latter are considerably more complicated than for the former.

Solution for Resistance Coupled Amplifier.

The circuit with which we are dealing is shown in Fig. 10 (*a*), where C_1 is the anode-filament capacity of the valve and C_3 is any capacity due to the output circuit of the amplifier. Since we suppose that the amplifier has no low frequency cut-off, both the coupling capacity C_2 and the resistance r may be assumed to be infinitely large. Then the circuit may be represented as in Fig. 10 (*b*) where capacity C is the sum of C_1 and C_3 in parallel. Then we may write,

$$\rho i_1 + R(i_1 - i_2) = E \quad .. \quad (13)$$

$$R(i_2 - i_1) + \frac{1}{C}\int i_2 \, . \, dt = 0 \quad .. \quad (14)$$

From (13) $\quad i_1 = \dfrac{E + Ri_2}{\rho + R}$

Differentiating (14) with respect to t and substituting for i_1 and $\dfrac{di_1}{dt}$,

$$\frac{di_2}{dt}\left(R - \frac{R^2}{\rho + R}\right) + \frac{i_2}{C} = \frac{R}{\rho + R} \cdot \frac{dE}{dt}$$

Put $\dfrac{\rho + R}{\rho RC} = \kappa$, then

$$\frac{di_2}{dt} + \kappa i_2 = \frac{1}{\rho}\frac{dE}{dt} \quad .. \quad (15)$$

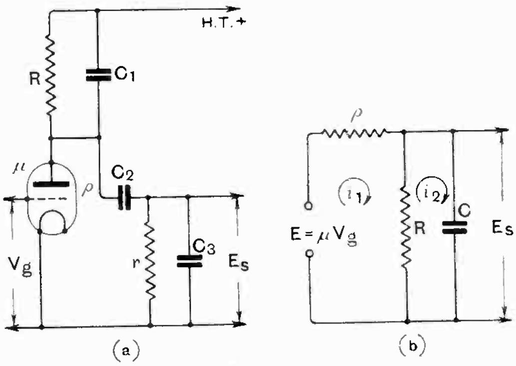


Fig. 10.

Whence $\quad i_2\epsilon^{\kappa t} = \dfrac{1}{\rho}\int \epsilon^{\kappa t} \, . \, \dfrac{dE}{dt} \, . \, dt$

$$= \frac{1}{\rho}[E\epsilon^{\kappa t} - \kappa \int E\epsilon^{\kappa t} \, . \, dt]$$

$$\therefore \quad i_2 = \frac{1}{\rho}[E - \kappa\epsilon^{-\kappa t}\int E\epsilon^{\kappa t} \, . \, dt] \quad (16)$$

Then if E_s is the output E.M.F., we have

* MS. received by the Editor November, 1930.

from (13)

$$E_s = R(i_1 - i_2) = E - \rho i_1$$
$$= E - \frac{\rho}{\rho + R}(E + Ri_2)$$
$$= E - \frac{\rho E}{\rho + R} - \frac{R}{\rho + R}[E - \kappa\epsilon^{-\kappa t}\int E\epsilon^{\kappa t} . dt]$$
$$= \frac{\kappa R}{\rho + R}\epsilon^{-\kappa t}\int E\epsilon^{\kappa t} . dt$$
$$= \frac{1}{\rho C}\epsilon^{-\kappa t}\int E\epsilon^{\kappa t} dt \quad \ldots \quad \ldots \quad \ldots \quad (17)$$

This may also be written in the form

$$E_s = \frac{R}{\rho + R}\left[E - \epsilon^{-\kappa t}\int\frac{dE}{dt}\epsilon^{\kappa t} . dt\right] \quad \ldots \quad (18)$$

Then, since $RE/(\rho + R)$ is the output E.M.F. which would be obtained from a perfect amplifier, the term $\epsilon^{-\kappa t}\int\frac{dE}{dt} . \epsilon^{\kappa t} . dt$ in (18) is a measure of the distortion at any instant and the form of this term shows clearly that the magnitude of the distortion is closely bound up with the value of $\frac{dE}{dt}$.

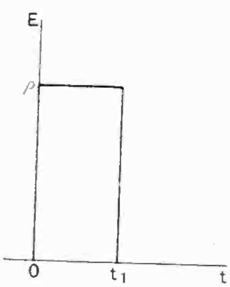


Fig. 11.

Let us assume, as before, that

$$E = p_0 + p_1 t + p_2 t^2 + \ldots + p_n t^n + \ldots \quad (19)$$

and consider the general term $p_n t^n$. Then from the analysis leading up to equation (6) of the previous article we may write

$$\kappa\epsilon^{-\kappa t} p_n \int_0^t t^n \epsilon^{\kappa t}$$
$$= p_n \left[\left\{t^n - \frac{n}{\kappa}t^{n-1} + \ldots (-1)^{n-1} . \frac{n(n-1) \ldots 3 . 2}{\kappa^{n-1}} t\right\}_0^t + (-1)^n \frac{n!}{\kappa^n}(1 - \epsilon^{-\kappa t})\right]$$
$$\ldots \quad \ldots \quad (20)$$

Assuming that the input E.M.F. is zero for all negative values of t and is represented by (19) for all positive values of t and remembering that $\frac{1}{\rho C} = \frac{\kappa R}{R + \rho}$, substitution of (20) in (17) leads to the formula

$$E_s = \frac{R}{\rho + R}\Big[p_0(1 - \epsilon^{-\kappa t}) + p_1 t \left\{1 - \frac{1}{\kappa t}(1 - \epsilon^{-\kappa t})\right\} \ldots + p_n t^n \left\{1 - \frac{n}{\kappa t} + \frac{n(n-1)}{\kappa^2 t^2} \ldots + (-1)^n \frac{n!}{\kappa^n t^n}(1 - \epsilon^{-\kappa t})\right\} \ldots\Big] \quad (21)$$

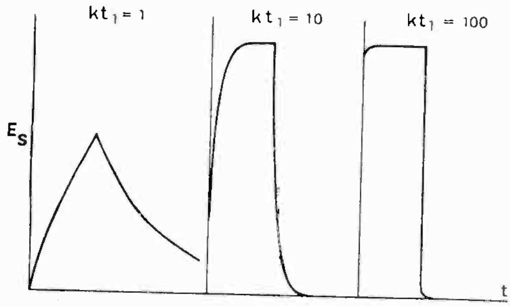


Fig. 12.

Comparing this with (19) we see that the distortion tends to diminish as t increases and will be negligible for any term of the series provided κt be large compared with n. Whether the total distortion at any instant is large or small will depend also on the relative importance of the various terms of the series. Remembering that $\kappa = \frac{R + \rho}{R\rho C}$ if we put $C = 100\mu\mu f = 10^{-10}$ farad, $\rho = 10^4$ ohms and $R \gg \rho$ then $\kappa = 10^6$. If we further assume that the input transient can be represented sufficiently well by ten terms of the series, then, for negligible distortion, κt must be large compared with 10; *i.e.*, t must be greater than about 10^{-3} second.

It is interesting to compare the output from an amplifier with high frequency cut-off, given by equation (17) which may be written

$$E_s = H\kappa\epsilon^{-\kappa t}\int E\epsilon^{\kappa t}dt$$

with that from an amplifier having low frequency cut-off, and which the former article showed could be written in the form

$$E_s = J[E - A\epsilon^{-At}\int E\epsilon^{At}dt]$$

where H and J are the voltage amplifications which would be obtained if the respective cut-offs were absent and K and A are circuit constants which govern the distortion. It thus appears that the types of distortion produced in the two cases are complementary so that by taking an amplifier of each kind, such that $H = J$ and $K = A$, applying the same transient E.M.F. simultaneously to the input of each and connecting the output E.M.F.'s in series, the distortion due to one would exactly balance that due to the other and the total output E.M.F. would be a faithful reproduction of the input.

Solution of the Equation for Particular Forms of Transient E.M.F.

Consider first the transient illustrated in Fig. 11 where

$$E = 0 \text{ for } t < 0$$

$$E = p = \text{constant for } 0 < t < t_1$$

$$E = 0 \text{ for } t > t_1$$

Then for $0 < t < t_1$

$$E_s = \frac{Rp}{R + \rho} \kappa \epsilon^{-\kappa t} \int_0^t \epsilon^{\kappa t} \, . \, dt$$

$$= \frac{Rp}{R + \rho} (1 - \epsilon^{-\kappa t})$$

For $t > t_1$

$$E_s = \frac{Rp}{R + \rho} \epsilon^{-\kappa t} \left[\epsilon^{\kappa t} \right]_0^{t_1}$$

$$= \frac{Rp}{R + \rho} [\epsilon^{-\kappa(t - t_1)} - \epsilon^{-\kappa t}]$$

The form of E_s is shown in Fig. 12 for values of κt_1 equal to 1, 10 and 100 respectively.

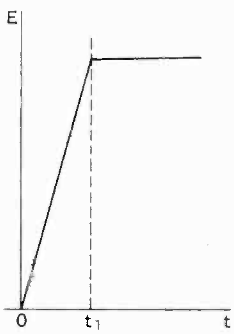


Fig. 13.

As a second example we consider the transient shown in Fig. 13, for which $E = 0$ for t negative, $E = pt$ for $0 < t < t_1$. The value of E_s for $0 < t < t_1$, may be obtained directly from the general solution given in equation (21). Thus

$$E_s = \frac{R}{R + \rho} pt \left[1 - \frac{1}{\kappa t} (1 - \epsilon^{-\kappa t}) \right]$$

For $t > t_1$, since $\frac{dE}{dt} = 0$ we have from equation (18)

$$E_s = \frac{R}{\rho + R} \left\{ pt_1 - \epsilon^{-\kappa t} \left[\frac{p}{\kappa} \epsilon^{\kappa t} \right]_0^{t_1} \right\}$$

$$= \frac{Rpt_1}{R + \rho} \left\{ 1 - \frac{1}{\kappa t_1} \epsilon^{-\kappa(t - t_1)} + \frac{1}{\kappa t_1} \epsilon^{-\kappa t} \right\}$$

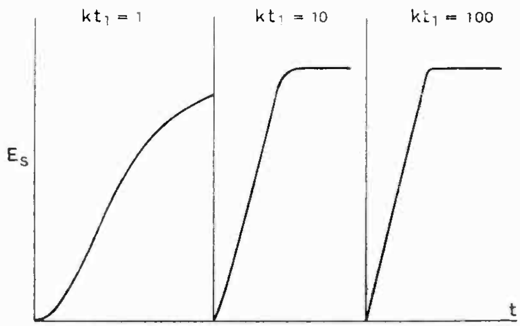


Fig. 14.

This result is shown graphically in Fig. 14 for three values of κt_1.

Conclusion.

Of all the methods which may be used to determine the distortion which a given amplifier will produce in a given transient, the one given above is probably the most direct. Another method, and one which gives a somewhat better picture of the physical principles involved, lies in the representation of a transient by means of a Fourier Integral. This method is not of much practical value for purposes of calculation since it leads to considerable mathematical complexity, and for that reason it will not be further considered here. It does, however, show clearly the theoretical connection between the distortion produced in a transient and the frequency characteristic of the amplifier, and incidentally it provides justification for treating independently the distortion produced by the low-frequency and high-frequency cut-offs respectively.

Technical Problems in Connection with Television.

(I.E.E. Wireless Section Discussion.)

THE closing meeting of the session of the I.E.E. Wireless Section was held on 6th May, and took the form of a discussion on the technical problems of television.

The discussion was opened by MR. C. O. BROWNE, B.Sc., who said that there were two difficult problems to be faced in connection with television. The first was the wide band of frequencies required to be sent out by the transmitter. The second was that of obtaining sufficient illumination at the receiver to permit a number of people to view the image simultaneously. The problem of synchronisation was much less difficult; he thought that attention to electrical and mechanical design could overcome all the difficulties in that connection.

The speaker then outlined the nature of picture structure on a basis of black-and-white reproduction as in newspaper pictures. The detail of the picture varied with the number of points or picture elements. To obtain a picture comparable with an average newspaper picture, 15,000 picture points were necessary. Slides were shown of pictures based on 1,800 points and on 15,000 points; even the latter was crude compared with cinema pictures.

A picture of this detail, transmitted at the rate of 12½ pictures per second, called for a frequency band of 93,750 cycles per second, or roughly 100 kc.s. Vacuum-type photo-electric cells offered no difficulty up to 50 kc.s, but the amplifier to work with it was a matter of greater difficulty. Amplifiers with effective flat response from 20 to 50,000 c.s had been made, and it was hoped that it might be possible to extend this to 100 kc.s without phase distortion. After the amplifier, it was not easy to provide a channel capable of handling this wide band of frequencies. The radio channel seemed the most hopeful, and the speaker suggested an ultra-short wave of the 5-metre order, unless it was possible to effect a compromise by the use of a number of channels.

The second major difficulty—that of illumination at the receiver—was due to the necessity of treating each picture-point individually, giving it both position and magnitude on the receiver screen. This necessitated illuminating only a very small fraction of the screen at any instant. The projected picture should preferably be of a size comparable with that of the home cinema, *e.g.*, 3ft. by 2ft. Possible solutions might be found in (*a*) the "crater" type of neon lamp, (*b*) the Kerr cell, (*c*) the modulated arc, the latter appearing the most favourable for strong illumination.

Other methods of effecting progress in television lay in the cathode-ray tube, to be visible to a limited number of people at once, or by a multi-channel system for projection to large numbers (after the manner of the demonstration at the Exhibition of the Physical Society last January). The cathode-ray system is essentially limited to a single channel and is therefore confronted with the difficulty of the frequency-band necessary. Pictures up to 6 inches square had been effected by this method, and the persistence or after-glow in certain fluorescent materials smoothed the "jumpy" effect.

The speaker regarded the multi-channel system as being a possible compromise, rendering it practicable to procure good television within a reasonable time. Although admittedly cumbersome, it represented a stepping-stone in the right direction.

MR. H. M. DOWSETT, who continued the discussion, agreed with the need for a wide frequency-band. Considering the frequency-bands now in use, he pointed out that in the present B.B.C. transmissions 2,100 points were used in scanning, representing a frequency-band of 13 kc.s. Only 9 kc.s, however, were sent out from the aerial, and in one receiver on the market the performance fell off at 1 kc. Work on strict lines was necessary for the development of television. What frequencies could be sacrificed without loss of detail? One American worker used a band of 300 kc.s in scanning, but claimed to put only 7 kc.s on the channel. As regards the size of picture, the Marconi Co. had a picture of 6ft. by 3ft., using a special Kerr cell.

Further work on television was bound to be a tedious matter. He thought the cathode-ray oscillograph method was too complicated and that the technique of these tubes had yet to go a long way.

MR. BRIDGEWATER thought the results from the present B.B.C. transmissions were better than the last speaker suggested. As regards calculation of the frequency-band, due to the presence of harmonics, more frequencies were necessary than simple calculation indicated. Although retinal persistence helped the reception of pictures, it was also true that only a small part of the retina was used at any instant. Mr. Baird had suggested concentrating on that part where it was most necessary. Movement of the subject also detracted from detail. These facts tended to lead to over-estimation of the frequency band required.

MR. LEWIN, referring to the multi-channel system, said that the two main difficulties of this method were alignment of the sections and differences or variations of gain in the amplifiers of the different sections. One large American concern had abandoned the method on account of these troubles. As regards band-width, frequency-compression methods were available.

MR. PORTER thought Mr. Browne had exaggerated the situation. Development must be towards projection, and he thought it would go on multi-channel lines, but the number of channels must be minimised.

MR. OWEN HARRIES considered the suggestion of 5 metres very valuable. Short range was no disadvantage and such a wave would give ample band-width and little interference. He briefly outlined the Farnsworth system, stating that it consisted effectively of suppressing frequencies common to all tones and restoring them at the receiver. He was of opinion that the cathode-ray oscillograph was the best method, and spoke also of the limited scope of the eye and the possibility of concentrating on the centre of greatest interest.

MR. WALLIS also referred to this point, and agreed with the need of emphasising part of the picture. He showed reproductions giving comparison of detail with picture-elements corresponding to band-widths of 124, 46 and 9 kc.s respectively.

MR. A. J. GILL criticised the assumption of the frequency-band necessary on a basis of transmitting picture-elements corresponding to "square" dots of Morse transmission. This involved a strong third harmonic, and would therefore call for a band three times as wide as that suggested.

MR. C. O. BROWNE briefly replied to some of the points raised by other speakers, and the meeting terminated with a vote of thanks moved by the Chairman (Mr. C. E. Rickard, O.B.E.) to those who had participated in the discussion.

It was announced that Lt.-Col. A. S. Angwin had been nominated as Chairman of the Section for next session.

Book Reviews.

The Theory and Practice of Radio-Frequency Measurements.

By E. B. Moullin.

A handbook for the laboratory and a text book for advanced students. Pp. xii + 487 with 284 figures. Griffin, 34s.

The first edition of this well-known work appeared in 1926; this second edition has been practically re-written and almost doubled in size. The book is much wider in scope than the title indicates, for considerable space is devoted to the theory not only of the methods of measurement but of the phenomena to be measured. The first three chapters occupying 126 pages are devoted entirely to laying foundations, the first to the electromagnetic field, the second to circuit formulae and the third to the valve generator. Actual measurements are first considered in the fourth chapter, and successive chapters are devoted to potential difference and current, frequency, resistance, capacity, inductance, antenna characteristics, field intensity and miscellaneous quantities. Every section is dealt with in the thorough but practical manner which characterises all the author's work, the descriptions and criticisms being those of the practical experimenter. Great advances have been made in radio measurements in the last few years and Mr. Moullin has himself been responsible for several of the new methods and instruments; so far as we can see, nothing of importance has been omitted and it may be safely assumed that this book represents accurately the present state of development of the subject. The references to original publications appear to be very complete. There is a slight slip in equation (4) on p. 49 where L_1 should be L. On page 125 we read that van der Pol has *lately* obtained the conditions for the maintenance of the oscillations of the multivibrateur—why not multivibrator? Now 1926 is really long-long ago in the radio world, whereas the word "lately" suggests last week. The book is written in a pleasant colloquial style that gives it an added personal touch. We feel that the whole English-speaking radio world is deeply indebted to the author for this comprehensive work.

G. W. O. H.

Cours élémentaire de Télégraphie et Téléphonie sans Fil.

By F. Bedeau with a preface by Général Ferrié. viii + 424 pp., 330 figures. Librairie Vuibert. Paris, 60 frs.

This volume is based on the course of lectures given at the Ecole d'Electricite et de Mécanique to students of radio-engineering. An English reader is apt to be misled by the word "elementary" as applied to a French text-book. On page 26 of the book under review, for instance, we find the formula

$$\text{div } XYZ = -\left(\frac{\delta^2 V}{\delta x^2} + \frac{\delta^2 V}{\delta y^2} + \frac{\delta^2 V}{\delta z^2}\right) = -\triangle V,$$

which, in the opinion of the average English reader, would disqualify the book as an elementary text book. The author evidently anticipated this criticism, for in the introduction he says that, although on a casual perusal the book may appear to bristle with mathematics, it really does nothing of the sort, the mathematical appearance being due to the setting out of the steps in more detail than is usual, in order to maintain the interest and save the time of the reader. The book is intended for those who already have some scientific and mathematical knowledge and wish to acquire a sound knowledge of the principles underlying the modern developments of radio-telegraphy and telephony. There is an admirable air of thoroughness about the whole book and numerous references are given to original publications. The whole range of modern wireless is covered, aerials, valves and their circuits, electromagnetic waves, piezo-oscillators, lines and filters, instruments and measurements. Numerical data are given and examples worked out wherever possible. It is a book that we can thoroughly recommend.

G. W. O. H.

Correspondence.

Letters of interest to experimenters are always welcome. In publishing such communications the Editors do not necessarily endorse any technical or general statements which they may contain.

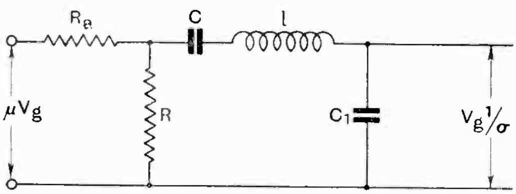
The Resistance Capacity Coupled Transformer.

To the Editor, E.W. & W.E.

SIR,—It is with interest that I have read the article by Messrs. Aughtie & Cope in the April issue of *E.W. & W.E.*

The authors seemed to have confined their attention chiefly to the low-frequency end of the audio-frequency range, and I am wondering whether they have made any investigation at the higher frequencies.

At high frequencies the transformer may be represented by the following circuit :—



Where R and C are the coupling resistance and capacity, l is the leakage inductance and C_1 the effective capacity of the transformer, it will be seen that the coupling resistance is exactly similar to a damping resistance in the ordinary series connection.

It may be of interest to mention that the reduction in size of transformers made possible by the use of high permeability alloys is a great advantage, apart from a saving of space, inasmuch as the leakage inductance is a function of the winding volume, and thus an iron circuit of small cross section and large permeability enables a transformer to be produced having a high ratio of main inductance to leakage with a consequent improvement of the characteristic, and this ratio is, of course, increased by removing the polarising current.

A. D. HODGSON.

Carrier Waves and Side Bands.

To the Editor, E.W. & W.E.

SIR,—I was interested to read the letter from Professor Fortescue in the May issue of your journal, especially the last paragraph in which he states " The carrier wave and side band theory rests upon logical deduction supported by experiment, the latter support proving that the premises upon which the logical argument is based are correct and complete for all the conditions contemplated."

Has he considered the case of a choke-controlled transmitter in which the carrier frequency is held constant by means of a quartz crystal ? According to a number of contributors to your journal, if the carrier frequency is a million cycles per second and the modulation frequency a thousand cycles per second, then three frequencies are transmitted, *viz.*, one million, one million plus one thousand, and one million minus one thousand.

The crystal, however, holds the carrier frequency constant, but Prof. Fortescue and several other investigators insist that this frequency varies by as much as ± 10 kilocycles per second.

Which of the following statements is correct ?

(*a*) The crystal-controlled transmitter radiates more than one frequency (depending on the modulation).

(*b*) The frequency is maintained at one value only.

If (*b*) is correct then the so-called " Side Band Theory " is a myth.

Admittedly the addition of two sine waves of frequencies n_1 and n_2 can be resolved into a Fourier Series, but does this represent the practical condition ? The carrier and modulation frequencies are not added in the mathematical sense, but the amplitude of the carrier varies in accordance with the modulation. The carrier is then no longer a pure sine wave.

It is certainly debatable whether the side bands are a physical reality. The reduced response of a number of receivers to the higher audio frequencies may be more closely related to the attenuation of the circuits than is at present appreciated.

It is interesting to consider the limiting case in which the modulation and carrier frequencies are equal.

H. W. BAXTER.

Amplitude of Driven Loud Speaker Cones.

To the Editor, E.W. & W.E.

SIR,—There are several points in Dr. M. J. O. Strutt's paper in your May issue to which I should like to refer. In section VI he says : " That ordinary driven paper cones have circular nodes already at 500 cycles seems to be somewhat unexpected, as most constructors of loud speakers assume that cones are nodeless up to much higher frequencies."

In my book " Wireless Loud Speakers," written in 1925, and published in March, 1927, on pp. 55, 56 and elsewhere, I anticipated circular nodes. In the *W.W.*, July 10th, 17th, 1929, I described experiments on a cone showing radial and circular nodes. The latter commenced about 300 cycles. The acoustic short circuit effect is also treated in these publications. Consequently, I think we are not quite so black as our friend paints us.

In section I we are told that no trustworthy observations of non-linear effects in loud speakers are known. Mr. G. A. V. Sowter and myself conducted tests on this subject in the summer of 1928, but were unable to obtain publication. Some of these, however, appeared in *Phil. Mag.*, January, 1931, but this was after Dr. Strutt's paper came to *E.W. & W.E.* Overlapping which occurs in loud speaker work should be regarded as the confirmatory evidence of independent workers, and is extremely useful.

Our experience with paper cones indicates that measurements of linearity should be made at six or more radii. Measurements of Young's modulus for paper show variation (1) with direction in which strip is cut, (2) in the sample of paper of a given class. Moreover, a paper cone might be linear over a certain portion, but non-linear over another. In our method of test the input to the L.S. was varied and the output from a microphone of known linearity measured. This method gives a *practical* result very quickly, and the whole diaphragm structure (cone, surround, drive) is tested simultaneously. The output wave form is checked by an oscillograph, an harmonic analyser, or otherwise. Measurements should be made at a number of frequencies from 30 cycles upwards.

Owing to the heterogeneity of paper and asymmetry due to the seam, we find that the nodal lines are not truly circular. In fact, they are quite irregular and not necessarily continuous. The second symmetrical mode usually predominates (2000 to 3000 cycles for a 9-inch cone 90° angle), and comes out clearly on impulse records of the form given in *Phil. Mag.*, January, 1931, *W.W.*, April, August, 1929, and May, 1931.

Irregularities are evinced in Fig. 5 of Dr. Strutt's paper. Although Fig. 5B indicates three nodal circles, I doubt if they were complete. With a homogeneous symmetric sheet the nodal figure is more likely to be two circles. Owing to these irregularities, amplitude curves for a number of radii are essential.

In section VI it is stated that radial modes should have no effect on the emission of sound, provided the wavelength is many times the radius of the diaphragm. This, however, is not the case in practice, as a glance at Fig. 4, *W.W.*, May 6th, 1931, will show. Here we have a number of large peaks indicating considerably enhanced output at radial modes. This is due partly to the vibrating segments being of unequal area owing to the seam and to heterogeneity of the paper. At the same time, it must be realised that if the amplitude of vibration of an isotropic symmetrical cone is large, there will be an appreciable sound output due to radial modes unless the velocity of sound is infinite.

In section II

$$\eta = \frac{\int p.ds}{P.S.} = M_a/M = \frac{\text{Apparent mass}}{\text{True mass}}$$

is said to be the efficiency as a sound emitter. At any mode of a centrally driven disc $M_a = 0$ (*see* Warren, *Phil. Mag.*, May, 1930), and the sound output is a maximum, so that $\eta \neq 0$. Under this condition the power factor is unity and—apart from internal losses—the power (force × velocity) supplied by the driving agent is converted into sound. Since $M_a = 0$, the amplitude is abnormal. The above relationship only holds *in vacuo*, and is no criterion of acoustic performance in air. The same argument applies to a cone.

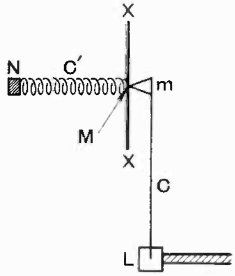
The first nodal circle of a certain disc 10 cm. radius occurs at 120.5 ∼. $\lambda = 300$ cm. and is large compared with the radius. $M_a = 0$ by measurement, but the motional resistance was 40 times the d.c. resistance of the coil, with a correspondingly large sound output and efficiency, *i.e.*, $\eta \neq 0$.

N. W. McLachlan.

Amplitude of Speaker Diaphragms.

To the Editor, E.W. & W.E.

Sir,—Dr. Strutt's paper on the Amplitude of Speaker Diaphragms in the May number of *E.W. & W.E.* raises a number of interesting issues of which space will only permit me to refer in detail to one. The use of Bragg's method of measuring the amplitude of vibration for other than a rigid body appears so daring that further details of the method by which it was successfully accomplished would be of value. The difficulties are at once apparent when one considers how lack of rigidity of the vibrating body affects the calibration of the measuring system. Dr. Strutt gives the expression for calculating the amplitude of vibration of a rigid body, but he does not point out how this expression is modified when the compliance of the structure is taken into account.



The mechanical structure approximates to that shown, XXc' representing the compliant diaphragm. When not vibrating, the position of L is adjusted so that there is just contact at M. Suppose N is then given a vibration $y = a \cos \omega t$. To maintain contact, L is moved to the left a distance A. In consequence of the compliance of the diaphragm, M also moves to the left by an amount we will call B. We will assume that the motion of M is then $x = b \cos \omega t$. The force P at the contact is then given by

$$P = c(A - B + b \cos \omega t) - m\omega^2 b \cos \omega t.$$

Contact being maintained, P can never be negative; the limiting condition is $P = 0$ when $\cos \omega t = 1$, giving

$$c(A - B) + b(c - m\omega^2) = 0.$$

Putting $c = m\omega_0^2$ we obtain

$$b = (A - B)\left\{\frac{\omega_0^2}{\omega^2 - \omega_0^2}\right\} \quad \ldots \quad (1)$$

whence $$P = m\omega_0^2(A - B)(1 - \cos \omega t) \quad \ldots \quad (2)$$

Again, for the diaphragm, we have

$$P = c'\{B + a \cos \omega t - b \cos \omega t\} \quad \ldots \quad (3)$$

whence $$m\omega_0^2 (A - B) = c'B \quad \ldots \quad (4)$$

and $$m\omega_0^2 (A - B) = c'(b - a) \ldots \quad (5)$$

giving $$B = b - a = \frac{c}{c + c'} A$$

and $$a = A\left\{\left(\frac{c'}{c + c'}\right)\left(\frac{\omega_0^2}{\omega^2 - \omega_0^2}\right) - \left(\frac{c}{c + c'}\right)\right\} \quad (6)$$

If $c' = \infty$ this gives $$a = A\left(\frac{\omega_0^2}{\omega^2 - \omega_0^2}\right) \quad \ldots \quad (7)$$

which is practically the same as Dr. Strutt's expression. It is clear, however, that c' must be large compared with c if (7) is to be sufficiently accurate. The difference between the expressions (6) and (7) arises chiefly in the second term of (6). If an accuracy of 10 per cent. is demanded it is clear that

$$\left(\frac{c'}{c + c'}\right)\frac{\omega_0^2}{\omega^2} > 10\left(\frac{c}{c + c'}\right)$$

or

$$c'\omega_0^2 > 10\, c\omega^2.$$

Suppose that the diaphragm is working at a frequency of about 800 cycles per second, say, $\omega = 5{,}000$ and that $\omega_0 = 20$. We then have $c' > 625{,}000\ c$!

Measurements made on a speaker diaphragm showed that to depress it by 1 mm. required weights between 20 and 50 gms. according to position (no measurements were made at the edge of the diaphragm) giving

$c' = 200{,}000$ to $500{,}000$ dynes per cm. approx. Hence c must be less than 0.32 to 0.8 or m less than 0.0008 to 0.002 gm.

The construction of such a piece of apparatus presents obvious difficulties. It would be of value to know how these difficulties were overcome. What were the dimensions of the clock springs which had such an enormous compliance ?

Equation (6) may be rewritten approximately

$$a = \frac{A\omega_0^2}{\omega^2}\left\{1 - \frac{m\omega^2}{c'}\right\} \quad .. \quad .. \quad (8)$$

For a given value of ω, the value of $A\omega_0^2$ is therefore practically independent of c, the stiffness of the spring used. Constancy of this expression for various springs is therefore no criterion of the accuracy of the method and does not indicate that springs of the stiffness used " do not measurably influence the motion of the cone."

A. G. Warren.

The " Stenode."

To the Editor, E.W. & W.E.

Sir,—Mr. Moullin's letter on the Reality of Side Bands in your May issue is of great interest to me as I have been advocating for some considerable time that interesting and important results are obtained by employing circuits of extreme selectivity for the reception of modulated waves. I have, on numerous occasions, demonstrated with the Stenode receiver that it is possible to receive high-grade telephony with very highly selective circuits (the frequency acceptance, for example, being determined by the response of a quartz crystal) and have shown that even when the carrier frequencies of two telephony stations differ by only 5,000 cycles per second perfect separation can be effected. In spite of this, however, there has been a certain amount of scepticism concerning my results, principally because it has been held that the side band theory definitely leads to the conclusion that, no matter what the selectivity of the receiver may be, it is impossible to separate telephonic stations, the side bands of which overlap.

In a paper read before the Radio Club of America, which was published in the *Radio News* for February, 1931, the fundamental Stenode formula was derived. I showed there that when waves whose modulation factor is m fall on a highly selective circuit whose logarithmic decrement is δ the modulation factor is diminished after passing through this circuit, becoming $m \cdot \frac{n}{p}\frac{\delta}{2\pi}$ where n and p are the high frequency and modulation frequency respectively.

I further pointed out that the side band theory as usually applied gives an incomplete account of wireless effects as it applies only to the waves before they have fallen on a receiver. It is my opinion that in order to determine the complete response of the receiver it is necessary to take into account, first the effect of the receiver on the waves, and in particular the damping factor, and secondly the action of the rectifier. In my view, false deductions were being made from the side band theory, since it had not been applied to a receiver as a whole.

Mr. Moullin's letter is thus of great importance, as he has taken these factors into account. In the first place, he has obtained the fundamental Stenode formula given above for the diminution of the modulation factor. Secondly, he has investigated the subsequent effect of the rectifier on modulated signals, and has obtained the remarkable result that, when two identical transmissions are only 5,000 cycles per second apart in frequency, and when a highly selective receiver is employed, whose logarithmic decrement is 0.1 per cent., the interference from the second transmission when one is tuned to the first is only one part in 62 at the output terminals of the rectifier, the notes being both 2,000 cycles per second.

Whilst I am of opinion that even better results will be obtained when other facts are considered, such as linear rectification, Mr. Moullin's work is of very great importance as it shows that there is great utility in the use of highly selective circuits, and that improvement in the progress of elimination of interference can be permanently obtained by increasing the selectivity of circuits as much as possible.

I am sure that your readers will be grateful to Mr. Moullin for having taken the trouble to perform these calculations which confirm that the results of the Stenode are obtained on strictly scientific lines.

J. Robinson.

British Radiostat Corporation Limited,
29, George Street, W.1.

Ultra-short Wave Communication.

To the Editor, E.W. & W.E.

Sir,—In my letter of the 11th February, 1931, (*E.W. & W.E.*, Vol. 8, p. 200), it was implied that the use of e.m. units instead of e.s. units for both V and e in the equation

$$t = s\sqrt{\frac{2}{V \cdot e/m}}$$

would lead to a wrong result.

This is evidently incorrect since, apart from more fundamental reasons, the ratio of the e.m.u. to the e.s.u. of p.d. is c and the corresponding ratio for the units of charge is $1/c$.

The error in the calculation criticised in my letter was the result of the use of two inconsistent systems of units.

E. C. S. Megaw.

Abstracts and References.

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PROPAGATION OF WAVES.

Les Gaz ionisés et la Loi de Coulomb (Ionised Gases and Coulomb's Law).—Th. V. Jonescu. (*Comptes Rendus*, 20th April, 1931, Vol. 192, pp. 928–930.)

Instead of the natural vibration frequency formula $\nu = \left(\frac{e^2 N}{\pi m}\right)^{\frac{1}{2}}$ obtained by the use of the Poisson equation, the writer obtains $\nu = \frac{2}{\pi}\left(\frac{e^2 N}{m}\right)^{\frac{1}{2}}$ by assuming that in the absence of the external field the electrons place themselves at the middle of the lines of union between two positive ions whose distances are equal to $r = N^{-\frac{1}{3}}$. The electrons can vibrate in the planes perpendicular to these lines of union, with a period which may be calculated from Coulomb's law.

The electrons, during their vibration under the influence of an external field, can modify the dielectric constant of the medium; only that component of the vibration which is in the direction of the external field determines this modification. Allowing for the fact that the line of union between two positive ions may make any angle with the field, calculation shows that the result is as if $\frac{2}{3}N$ electrons were vibrating in the direction of that field. "Gutton finds a natural period corresponding to $\lambda = 2.475$ m. for $N = 0.9 \times 10^8$ deduced from the variation of the dielectric constant. If one calculates, starting from this number, the wavelength corresponding to the resonance frequency by J. J. Thomson's formula, one obtains $\lambda = 3.53$ m., whereas by our formula $\lambda = 2.55$ m."

The writer applies his treatment to the Chenot results (May Abstracts, p. 261) and concludes:—"It is thus seen that the existence of a natural period of vibration for ionised gases gives us the possibility of calculating the velocity of propagation of an electric wave in these media." For previous papers by the same writer, *see* April Abstracts, p. 204.

Radio Frequency Properties of Ionised Air.—R. T. Lattey and W. G. Davies. (*Phil. Mag.*, April, 1931, Series 7, Vol. 11, No. 72, p. 997.)

A letter pointing out that in the work of Appleton and Childs under the above title (February Abstracts, p. 88) no account is taken of any effect which may be produced by the inductance of the leads to the test condenser. A formula is given for the apparent capacity of a condenser with a conducting dielectric between its plates and whose leads possess inductance (*cf.* Lattey and Gatty, 1929 Abstracts, p. 521) which suggests the possibility that the supposed lowering of capacity when the air in the condenser is ionised may be only apparent and the observations therefore not conclusive evidence for a dielectric constant less than unity.

Das Verhalten elektromagnetischer Wellen bei räumlich veränderlichen elektrischen Eigenschaften (The Behaviour of Electromagnetic Waves in the Presence of Spatially Varying Electrical Characteristics).—G. J. Elias. (*E.N.T.*, Jan., 1931, Vol. 8, pp. 4–22.)

Author's summary:—1.—The reflection of electromagnetic waves is studied in the case of the variation in one direction, according to the specified exponential laws, of (*A*) the dielectric constant, (*B*) the conductivity, and (*C*) the dielectric constant and the conductivity.

2.—In case (*A*) the waves are totally reflected.

3.—In case (*B*) the reflected amplitude is $e^{-\frac{\pi}{2} p \cos\phi}$ for large values of p, while for very small values of p there is total reflection [$p = \frac{2\omega}{ck}$, where ω and c have their usual meanings and k is the exponential constant giving the variation in the one direction of the dielectric constant and specific conductivity].

4.—In case (*C*) the reflected amplitude is $e^{-\frac{p}{\eta}\cos\phi}$ for large values of p and η [η = the constant in the expression for the dielectric constant], while for small values of p the reflection is total.

5.—The reflected amplitude varies according to whether the waves are polarised in the plane of incidence or perpendicularly to this plane.

See also 1930 Abstracts, p. 330.

Negative Attenuation of Wireless Waves at Broadcast Frequencies.—S. R. Kantebet. (*Nature*, 4th April, 1931, Vol. 127, p. 521.)

More concerning the work referred to in May Abstracts, p. 261. The letter describes "a type of negative attenuation effect observed on a 357.1 metre wave at a great circle distance of about 640 km. Field intensities of the Bombay Broadcasting Station were measured in the laboratories [at Bangalore] and gave an average ratio of more than 2.5 : 1 between the observed and calculated values. The ratio sometimes reached an abnormal figure of 7 : 1 in the early part of the year, dwindling down to about 2 : 1 about the middle of the year. These consistent abnormally high signal strengths are believed to be a clear case of negative attenuation at great distance from broadcasting stations."

The features of excessive fading with periods of very strong signals, general poor audibility with daytime transmission and abnormally strong signals during wintry months as compared with summertime reception, lead to the conclusion that the negative attenuation effect "is explained by the probability that the observed field strength is due entirely to the indirect ray, all propagation equations applicable to ground level transmission giving signal intensities which are too low."

The receiver is situated 3,000 feet above sea-level and a long mountain range about 10,000 feet high, covered with dense tropical forest, lies between it and the transmitter at sea-level.

MESSUNGEN IM STRAHLUNGSFELDE EINER ZWISCHEN ZWEI PARALLELEN, LEITENDEN FLÄCHEN ERREGTEN LINEARANTENNE (Measurements in the Field Radiated by a Linear Antenna Excited in the Space Between Two Parallel, Conducting Surfaces).—L. Bergmann and W. Doerfel. (*Physik. Zeitschr.*, 1st March, 1931, Vol. 32, No. 5, p. 222.)

A preliminary notice of experiments on the propagation of electromagnetic waves of length 33.1 cm. from a linear antenna excited in its fundamental mode of oscillation [direction not given] between two parallel metal surfaces size 4 × 4 metres [distance apart not given]. It was found that the field measured between the plates agreed well with the theoretical results of Weyrich (1928 Abstracts, p. 516; *see* also 1930 Abstracts, p. 101).

RADIATION MEASUREMENTS OF THE HIGH FREQUENCY COMMISSION OF THE WURTEMBERG ELECTRICAL UNION.—R. Thomson and A. Thierer. (*Funk-Bast.*, Jan., 1931, Vol. 2, pp. 1–4.)

Field strength measurements around the broadcasting stations of Klagenfurt, Linz, Stuttgart and Witzleben. Results are given as obtained, without "smoothing," so that local influences can be observed. One clear cause only emerges for excessive weakening: high ground, which forms a screen casting a shadow which sometimes extends many kilometres. On the other hand, urban districts do *not* necessarily (as has been stated) form marked absorption zones. In the case of Witzleben, for instance, situated at the western edge of Berlin, the radiation is much better to the east and north-east, over the town, than to the south and south-west, over open country. The writers explain this fact as an effect of the railway lines, power lines, etc.; although these *sometimes* cause reduced field strengths, in many cases they produce greatly increased strengths (10 times the normal, for example).

REZULTATY OPYTNYH RABOT S METROVYMI VOLNAMI (The Experimental Investigation of Ultra-Short Waves).—P. V. Shmakov. (*Westnik Elektrot., Leningrad*, September-October, 1930, Part 1, pp. 294–307.)

In Russian. A report on experiments carried out in 1929 in Moscow with a view to ascertaining the possibility of communication on ultra-short waves.

An account is given of how a special ultra-short wave radio transmitter was evolved employing one valve only in the oscillating circuit in place of two valves in push-pull. For operation on telephony a modulator valve was used whose anode-filament circuit acted as a grid leak for the oscillator. The transmitter was inductively coupled to a vertical dipole antenna. The maximum radiated power was of the order of 0.25 kw. and the lowest wavelength attained was 3.31 metres.

A special super-regenerative receiver was also developed for these tests. This receiver comprised a h.f. oscillator using two valves in push-pull, a 10,000 cycle quenching oscillator, and a l.f. amplifier which could be switched in when necessary. It was found that with this receiver no special precautions were required to stabilise the carrier frequency of the transmitter.

For the purpose of the experiments the transmitter was mounted on the roof of a building in Moscow, 46 metres high, and signals were observed from a number of points in and outside the city. The following results were obtained:

(1) The signals received in the streets of Moscow and suburbs, up to a distance of 13 km., were of loud speaker strength. Reception inside buildings, even in localities completely screened from the transmitter by intervening structures, was also quite satisfactory, though the signals were weaker on the lower floors and more particularly near the metal structures of the lift shafts. The wavelengths used for these experiments varied from 5.50 to 5.75 metres.

(2) Outside Moscow signals could be received up to a distance of 70 km. approx. As the horizon was only about 16 km. distant from the location of the transmitter and as the soil round Moscow is a poor dielectric, it would appear that the ultra-short waves were diffracted and propagated around the curvature of the earth. This view is supported by the fact that on steep slopes away from the transmitter reception was best with the receiving antenna nearly perpendicular to the slope. Furthermore, if the waves were propagated linearly, a reduction in the wavelength would improve reception, whereas experience showed that at a distance of 56 km., for example, reception on 8 metres was 50 times stronger than on 5.65 metres.

(3) Reception on crystal detectors was not satisfactory even with the receiver in the adjoining streets and in full view of the transmitter.

The following interesting phenomena requiring a further study were also observed:

(4) The position of the observer with regard to the receiving antenna affected the strength of the received signals.

(5) The crystal detector used for detecting the r.f. oscillations showed a reversal of polarity depending on the position of the grid tapping on the oscillating circuit of the transmitter.

(6) When two transmitters were operating on different wavelengths and a crystal detector was tuned to one of these, the other wave could also be received when the observer was in a certain position with regard to the vertical-dipole receiving antenna. The same effect was observed when the observer was moving in a vertical plane. The shorter wave was received with the observer near the upper branch of the antenna and the longer wave with the observer near the lower branch. It would appear possible for several observers to receive simultaneously several waves on the same receiver.

(7) With the short wave transmitter operating and the crystal or super-regenerative receiver tuned to this, and with certain adjustments in the oscillating circuit of the transmitter, very good quality reception of long wave broadcasting stations was obtained. This phenomenon did not take place when the short wave transmitter

was not operating, and was probably due to the short-wave carrier being modulated at the grid of the oscillator valve by radio-frequency pick-up from these stations. This indicates a possibility of relaying broadcast programmes without receiving apparatus at the relaying station.

The main conclusion reached is that ultra-short waves are quite suitable for establishing reliable inter-communication in a large city.

SOME DETAILS RELATING TO THE PROPAGATION OF VERY [ULTRA-] SHORT WAVES.—R. Jouaust. (*Proc. Inst. Rad. Eng.*, March, 1931, Vol. 19, pp. 479–488.)

See 1930 Abstracts, p. 268, where "at the close of day" should read "at the close of warm days." This effect of sunny days on the France-Corsica service [*see* also Beauvais, April Abstracts, p. 204] is explained as a result of changing refraction: "owing to the effect of the sun in the morning, the air heated more rapidly than the water, which has a high heat capacity. In the afternoon, on the other hand, as the sun sank to the horizon the air cooled more rapidly than the water, causing a reduction in the factor $2\ m/(m-1)$, as in Torel's observations," where the range of visibility of objects on the opposite side of Lake Leman was found to decrease whenever the water became hotter than the air. [But Beauvais (*loc. cit.*) says the progressive weakening occurs either *in the middle of the day* or in the afternoon, never after sunset.]

LONG RANGES WITH ULTRA-SHORT WAVES.—(*Rad., B., F. f. Alle,* April, 1931, p. 192.)

A somewhat sceptical announcement of reports in the Russian press concerning 7.12 and 19 cm. tests from Nishni-Novgorod: on 20 watts power, good reception is reported over thousands of kilometres.

TELEPHONY ON 18 CENTIMETRES [ENGLAND-FRANCE]. (*See* under "Stations, Design and Operation.")

POSSIBLE EFFECT OF MOON'S POSITION ON RADIO.—H. T. Stetson. (*Sci. News Letter*, 3rd January, 1931, p. 5.)

Stetson suggested to the American A.A.S. that the distance of the moon from the meridian was associated with the height of the Heaviside layer. He had found evidence of this during investigations on the effect of sun spots on transmission. *See* also under "Atmospherics and Atmospheric Electricity."

NOTE ON THE FIFTEEN-MONTH PERIOD IN SOLAR ACTIVITY, TERRESTRIAL MAGNETISM, AND RADIO RECEPTION.—Pickard. (*See* under "Atmospherics and Atmospheric Electricity.")

ON THE VARIABILITY OF THE QUIET-DAY DIURNAL MAGNETIC VARIATION. PART II.—S. Chapman and J. M. Stagg. (*Proc. Roy. Soc. A*, March, 1931, Vol. 130, No. 815, pp. 668–697.)

A sequel to the paper referred to in 1929 Abstracts, p. 266.

A METHOD OF WEATHER FORECASTING [BY SIGNAL INTENSITY].—Colwell. (*See* under "Miscellaneous.")

SUR LA DISTRIBUTION DE L'OZONE DANS L'ATMOSPHÈRE (The Distribution of Ozone in the Atmosphere).—D. Chalonge and E. Dubois. (*Comptes Rendus*, 30th March, 1931, Vol. 192, pp. 808–810.)

Observations at the Pic du Midi Observatory lead to the conclusion that the "ozone layer" is not such a well-defined layer as has been supposed, and that appreciable quantities of ozone exist at comparatively low heights.

DIFFUSION REGARDED AS A COMPENSATION FOR SMOOTHING.—L. F. Richardson and J. A. Gaunt. (*Mem. Roy. Met. Soc.*, No. 30, Vol. 3, pp. 171–175.)

VELOCITY OF SOUND WAVES IN THE ATMOSPHERE: THE TEMPERATURE OF THE STRATOSPHERE.—B. Gutenberg. (*Gerlands Beitr.*, No. 2, Vol. 27, pp. 217–225.)

The height at which the velocity of sound and the temperature begin to increase is not the same in all cases; sometimes, especially in winter, it may be not more than 20 km. The velocity in the stratosphere may easily be calculated by a method given.

ON THE DIRECT MEASUREMENT OF WAVELENGTH AND DAMPING OF ELECTROMAGNETIC WAVES IN ROCK.—A. A. Petrowsky. (*Westnik Elektrot., Leningrad,* No. 11/12, 1930, Part I, pp. 329–339.)

In Russian. Author's summary:—Investigations carried out by the author and his collaborators at the Verkh-Nedvinsky Mine (Ural, near Sverdlovsk) are described. A radio transmitter was located in a shaft 35 m. below ground, and the field intensity was measured overland. The curves obtained show the existence of the interference of two waves. The author suggests that one of these waves passes directly from the transmitter to the receiver through rock, while the other travels along the shaft and further overland. The wavelength in the rock was calculated by formula 20 [based on this supposition] and was found to be 12 m., compared with 60 m. in air.

A theory of the interference of damped waves, which is in accordance with the observations described, is given. A conception of an equivalent homogeneous medium having the same wavelength and damping factor as the actual one, at the same frequency, is introduced. Formulae are derived by which the resistivity and dielectric constant of the equivalent medium may be calculated.

THE VELOCITY OF LIGHT.—M. E. J. Gheury de Bray. (*Nature*, 4th April, 1931, Vol. 127, p. 522.)

A letter pointing out that new determinations of the velocity of light "invariably give values which are lower than the last one obtained, the observations distributing themselves so as to put in evidence an excellent linear law of variation."

It is also remarked that measurements of the velocity of light are performed in the earth's varying magnetic field, by which it is affected, yet no correction is applied for this. The relatively large error of the most recent determination (Karolus and Mittelstaedt, 1929 Abstracts, p. 221) prevents it from deciding the question, but "a redetermination of the 'constant' by Michelson would settle it once for all."

THE PROPAGATION OF ENERGY BY WAVES AND THE AMPLITUDE OF A LIGHT WAVE.—W. W. Sleator. (*Journ. Opt. Soc. Am.*, March, 1931, Vol. 21, pp. 187–204.)

OPTICS IN RADIO TRANSMISSION AND OTHER FRESH FIELDS.—F. Twyman. (*Trans. Opt. Soc.*, Vol. 31 [3], pp. 113–130.)

Interference, selective absorption and beam transmission in wireless are compared with interference, anomalous dispersion and radiation by the echelon grating in optics. The paper also discusses the diffraction of X-rays by crystals and the corpuscular nature of positive rays.

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY.

VARIATIONS DES PARASITES ATMOSPHÉRIQUES PENDANT L'ÉCLIPSE DE LUNE DU 2 AVRIL 1931 (Variations of Atmospherics during the Lunar Eclipse of 2nd April, 1931).—R. Bureau. (*Comptes Rendus*, 20th April, 1931, Vol. 192, pp. 975–977.)

"The records of atmospherics at St. Cyr and Mont Valérien have disclosed a very important anomaly in the development of the phenomenon on 2nd April, 1931, between 18^h and 14^h." Record curves from St. Cyr are given for atmospherics on (*a*) 25,000 m., (*b*) 6,000 m., moderately sensitive adjustment of relay, and (*c*) 6,000 m., very sensitive adjustment. The effect referred to is seen most clearly on (*b*), which shows a sudden marked decrease in the number of atmospherics setting in at 18^h on 2nd April and lasting till about 23^h, when the number increases sharply to reach the normal value at 24^h. Thus the phenomenon coincides with the total eclipse of the moon. The fact that curve (*c*) shows the effect only to a less extent and for a shorter time suggests that the producing cause exercises its effect particularly on strong atmospherics. Curve (*a*) shows no appreciable effect.

The writer considers that the explanation of the connection (if it exists) must lie in an influence of the eclipse on the propagation of waves from the atmospheric sources. In a final note he refutes the idea that the anomaly might be due to a momentary defect in the recorders. The 6,000 m. curve at Mont Valérien was similar to that at St. Cyr, and moreover the recorders were tested during the course of the anomaly.

RÉFRACTION ET PROPAGATION DES ATMOSPHÉRIQUES DANS LA TROPOSPHÈRE (Refraction and Propagation of Atmospherics in the Troposphere).—J. Lugeon. (*Assoc. franç. p. l'Av. des Sci.*, 53rd Session, pp. 305–308.)

The writer's observations on the direction, range, frequency per minute, intensity and wave-form of atmospherics lead him to distinguish three zones of different altitude for their sources :—(*a*) the troposphere, the source of the most intense atmospherics ; (*b*) the regions just above the troposphere, probably near the isothermal layer of Teisserenc de Bort ; and (*c*) the stratosphere, either in the inversion (ozone) layer or even beyond the Heaviside layer in the region of the polar aurorae. The classes of atmospheric (*b*) and (*c*) rarely reach the surface of the earth, partly because of their small energy and partly because of the absorptive screen formed by the lower layers of the troposphere.

The diurnal variation, frequency per minute and other properties often enable one to decide what type of atmospheric is being received. Practically all anomalies of diurnal variation can be attributed to bodies of air differently ionised, whose form in the troposphere is given by the isobaric surfaces. The most remarkable phenomenon is that which occurs at the passage from an anticyclonic to a cyclonic régime, or *vice versa*. In the anticyclone the isobaric surfaces are convex to the sky, propagation is bad, the air is electrically "polluted" (especially by large ions) and is favourable to the production of local atmospherics in the stratified layers of temperature-inversion. In the cyclone the air is much "purer," *i.e.*, less ionised ; propagation is good and the form of the isobaric surfaces, concave towards the sky, is unfavourable to the formation of local atmospherics but favourable to long-distance propagation.

If the surface of separation between such a combination of cyclonic and anticyclonic masses of air, which may be called a "surface of electromagnetic refraction," moves from W. to E. over Switzerland, an almost instantaneous disappearance of local night atmospherics is observed, together with an increase of distant atmospherics. This change of régime is not necessarily accompanied by a barometric change at *low* levels, and the phenomenon presents a real interest from the point of view of meteorological diagnosis. In the case of small anticyclones composed of *tropical* air, pure electrically, atmospherics are strengthened in another way—the receiver then finds itself, as it were, at the focus of a lens convex to the sky and converging on to the receiver the atmospherics arriving from above. Another important phenomenon is that of absorption by electromagnetic screens above the receiver, such as may be formed by cirrus, by dry fog, or by warm air from the tropics thrown on a heavy mass resting on the ground.

The writer sums up by enunciating that propagation is the more easy and regular the larger and more intense the cyclonic activity of the polar front. When all the layers of the troposphere are in rapid movement and the streams of air are parallel or on continuous spiral surfaces, no diffraction or refraction is possible over the whole cyclonic zone, which may have a radius of thousands of kilometres.

LES ATMOSPHÉRIQUES ET LES MASSES D'AIR (Atmospherics and Air Masses).—A. Viaut. (*Assoc. franç. p. l'Av. des Sci.*, 53rd Session, pp. 309–313.)

The general situation of 6th to 12th June, 1929, and its evolution: relation between the atmospherics registered at St. Cyr and the evolution of the air masses.

Sur un Cas particulier de Parasites écoutés sur petites Ondes (A Particular Case of Atmospherics heard on Short Waves).—E. Rougetet. (*Assoc. franç. p. l'Av. des Sci.*, 53rd Session, pp. 313–315.)

Record of an example of the connection between atmospherics and a cloud system accompanying a warm front.

Origin of Cosmic Radiation.—J. H. Jeans. (*Nature*, 18th April, 1931, Vol. 127, p. 594.)

Calculations of the absorption (per metre of water) for the radiation produced by the synthesis of iron and by the annihilation of 1, 2 and 4 protons and their accompanying electrons suggest that the most penetrating constituent so far observed in cosmic radiation may originate in the annihilation of an α particle and its two neutralising electrons (the components of a helium atom), while the next softer constituent may originate in the annihilation of a proton and its one neutralising electron (the components of a hydrogen atom). These two constituents are apparently far too hard to be produced by the synthesis of iron, suggested by Millikan as a possible origin of the hardest radiation of all (May Abstracts, p. 264).

Note on the Nature of Cosmic Rays. Answer to Professor Störmer's Remark. P. S. Epstein: C. Störmer. (*Proc. Nat. Ac. Sci.*, March, 1931, Vol. 17, pp. 160–161.)

A reply to the note dealt with in April Abstracts, p. 207. After referring to the comparative inaccessibility of Störmer's papers (*cf.* 1929 Abstracts, pp. 38, 623 and elsewhere) as a reason for his being unaware of the latter's work on that particular phase of the problem, he points out the interest attaching to the fact that Störmer's results, based on classical mechanics, appear to agree with his own conclusions based on the relativistic case: for the high velocities in question greatly different results might be expected. He proceeds to examine this point and shows how the agreement occurs. An erratum in his original paper (March Abstracts, p. 146) is corrected.

Residual Ionisation in Air at New High Pressures and its Relation to the Cosmic Penetrating Radiation.—J. W. Broxon. (*Phys. Review*, 15th Feb., 1931, Series 2, Vol. 37, No. 4, p. 468.)

Abstract only.

The Audibility and Lowermost Altitude of the Aurora Polaris.—R. Ruggles Gates. (*Nature*, 28th March, 1931, Vol. 127, p. 486.)

An account of an audible aurora of low altitude, observed on Slave River in the Canadian North-West on Aug. 10th, 1928. *Cf.* Chapman, May Abstracts, p. 264.

Observations of a Low Altitude Aurora and Simultaneous Phenomena.—A. Corlin. (*Nature*, 11th April, 1931, Vol. 127, pp. 553–554.)

An account of an aurora observed at Abisko in Northern Sweden on November 16, 1929, beneath a completely cloudy sky (*cf.* March Abstracts, p. 147). Data of simultaneous magnetic disturbance and atmospheric ionisation are also given.

Note on the Fifteen-Month Period in Solar Activity, Terrestrial Magnetism, and Radio Reception.—G. W. Pickard. (*Proc. Inst. Rad. Eng.*, March, 1931, Vol. 19, pp. 353–355.)

Author's summary:—"A marked 15-month period has been found in sun spots, terrestrial magnetism, and radio reception. Early in 1929 this cycle abruptly changed phase by about 60 deg., 210 deg., and 160 deg., respectively, for these elements, resulting in changed relations between solar activity and the two geophysical measures." The author ends by expressing his belief ("although it would be difficult to summarise briefly the reasons for it") that the present 1929–1930 15-month period in radio reception will continue without phase change for several years to come, and will therefore be useful in the prediction of reception levels.

Possible Origin of Sun Spots [Tidal Effect of Planets].—D. Alter. (*Sci. News Letter*, 3rd January, 1931, p. 5.)

Speaking before the American A.A.S., Alter suggested that the gravitational attraction of the planets produced tides on the sun and that the formation of sun spots was dependent on this. He had obtained close agreement between the calculated and observed number of spots. The chance of accidentally obtaining such a close correspondence was about one in thirty thousand. *See* also Stetson, below.

Sunspots and a Tidal Effect of the Planets.—H. T. Stetson. (*Sci. News Letter*, 3rd January, 1931, p. 5.)

Stetson has found a short 15-month cycle of sunspot variation, in addition to the 11-year cycle; this period corresponds closely with the recurrence of certain arrangements of Venus and Mercury, thus suggesting a possible tidal effect. *See* also Alter, above.

Earth Movements and Terrestrial Magnetic Variations.—R. Gunn. (*Terrestr. Mag.*, Sept., 1930, Vol. 35, pp. 151–156.)

Étude des Courants telluriques (A Study of Earth Currents).—D. Stenquist. (*Mém. pub. par la Direc. gén. des Tél. de Suède*, *Fasc.* 2.)

Su Inversioni del Campo elettrico terrestre a Cielo sereno e una loro possibili Spiegazione (On Inversions of the Earth's Electric Field under a Clear Sky, and Their Possible Explanation).—G. Aliverti and M. C. Montù. (*Nuovo Cim.*, Jan., 1931, Vol. 8, pp. 15–21.)

THE INFLUENCE OF RAIN ON THE ATMOSPHERIC-ELECTRIC FIELD.—A. V. R. Telang. (*Terrestr. Mag.*, Sept., 1930, Vol. 35, pp. 125–131.)

LA CONDUCTIBILITÉ ÉLECTRIQUE DE L'AIR À PARIS (The Electrical Conductivity of the Air at Paris).—F. Bayard-Duclaux. (*Comptes Rendus*, 30th March, 1931, Vol. 192, pp. 810–812.)

Comparing the values of conductivity here obtained with those found simultaneously at Val Joyeux, the ratio agrees very well with the ratio of the number of small ions at Paris and Val Joyeux respectively, measured by Maurain and Salles. Among other results, increase of humidity—which should favour the formation of large ions—gave decreased conductivity as expected.

STATISTICAL INQUIRY INTO FREQUENCY OF THUNDERSTORMS IN BRITISH ISLES.—(*Nature*, 11th April, 1931, Vol. 127, p. 566.)

A note drawing attention to an appeal for help by S. Morris Bower, of Langley Terrace, Oakes, Huddersfield, who wishes to extend a statistical inquiry into the frequency of thunderstorms in the British Isles in winter, which was originated by C. J. P. Cave in 1916 and was concluded in March, 1929, to a similar inquiry for the six months April to September. "What is required is a note of the place, date and time of occurrence of thunder, lightning, or hail, with the direction in which the lightning was seen. Additional details, such as the time of commencement of very heavy rain or hail, should such occur, and of the direction of movement of any well-developed storm, would be welcome."

A ROCKET TO FORECAST THE WEATHER [EXPLORATION OF THE UPPER ATMOSPHERE BY ROCKETS].—W. J. Humphreys. (*Discovery*, Feb., 1931, Vol. 12, pp. 56–59.)

An article on Humphreys' design of rocket and on its possibilities.

INSTRUMENTS FOR LIGHTNING MEASUREMENTS.—C. M. Foust. (*Gen. Elec. Review*, April, 1931, Vol. 34, pp. 235–246.)

Latest developments and applications of surge-voltage recorders: cathode-ray oscillographs: lightning-stroke recorders: surge indicators: lightning-severity meter.

FIELD TESTS ON THYRITE LIGHTNING ARRESTERS.—K. B. McEachron and E. J. Wade. (*Gen. Elec. Review*, April, 1931, Vol. 34, pp. 247–257.)

PROPERTIES OF CIRCUITS.

OSCILLATION IN TUNED RADIO-FREQUENCY AMPLIFIERS.—B. J. Thomson. (*Proc. Inst. Rad. Eng.*, March, 1931, Vol. 19, pp. 421–437.)

Author's summary:—"The wide use of screen-grid tubes renders an understanding of the conditions for stability of tuned radio-frequency amplifiers important. In this paper the relation between the feed-back capacity and the other circuit and tube parameters at the threshold of instability is computed for one, two, three, and four stages. The form of the relation is found to be $C_0 = \frac{Ag^2}{\omega g_m}$ where g is the conductance of the load circuit and plate resistance in parallel, assuming that all circuits are similar. The values of A are 2.0, 1.0, 0.764, and 0.667, respectively, for one, two, three, and four stages. It is found that the circuits are tuned so that the phase angle of each is approximately 45 deg. lagging, still including the plate resistance of the tube in the tuned circuit. An experimental verification of the conditions for stability of a one-stage amplifier is described. The experimental value checks the theoretical value within the accuracy of the measurements."

Among other workers in this field, Nelson has already extended his one stage analysis and set up a general expression for n stages (1929 Abstracts, p. 268); but the present writer remarks that "even ignoring the fundamental error mentioned above [neglect of the effect of feed-back on amplification] the latter expression is erroneous," and that other previous analyses only refer to one stage

O GENERACII MNOGOKASKADNYH REZONANSNYH USILITILEI (On Self-Oscillations in Multi-Stage Tuned Amplifiers).—V. I. Siforov. (*Westnik Elektrot., Leningrad*, No. 9/10, 1930, Part 1, pp. 310–315.)

In Russian. A theoretical discussion is presented with a view to determining the effect of the internal grid-anode capacity of the valves on the stable operation of a multi-stage tuned amplifier. Reference is made to investigations by other authors and in particular by Beatty and Nelson. It is pointed out, however, that in a multi-stage amplifier each stage is affected by each of the succeeding stages and that therefore the method of deduction by analogy, *i.e.*, from the n^{th} to the $(n+1)^{th}$ stage, is not admissible in these investigations.

Starting from the necessary condition for stable operation of a tuned amplifier followed by another stage, the author determines how this condition is modified if several further stages are added. For the limiting case, when $n \rightarrow \infty$, the following condition is derived:

$$\omega CSZ^2 \leqslant \tfrac{1}{4} \quad \dots \quad (1)$$

where ω = angular velocity of the wave; C = grid-anode capacity of the valve; S = mutual conductance of the valve; and Z = dynamic resistance of the tuned circuit.

When this condition is fulfilled for each stage, there will be no self-oscillation with any setting of the tuning condensers or with any number of stages. It is also shown that the dynamic resistance Z of the tuned circuit and the amplification of each stage are not increased by more than 100 per cent. by the addition of subsequent stages when equation (1) holds good for every stage.

PARASITIC REACTIVE COUPLINGS IN MULTI-STAGE AMPLIFIERS.—V. I. Siforov. (*Westnik Elektrot., Leningrad*, No. 11/12, 1930, Part I, pp. 339–344.)

In Russian. Author's summary:—The paper

deals with the parasitic reactive coupling acting in a resonance amplifier with n stages from the output to the input terminals. The conditions for self-excitation and the influence of the coupling are investigated by means of the method of Heaviside. The results are as follows :—1. If $n > 2$, the self-excitation takes place at any phase angle, when the value of the reactive coupling exceeds some upper critical value. 2. There is a lower critical value of coupling below which no self-excitation occurs, whatever values the phase angle and number of stages n may have. 3. When $n > 2$ and the value of the reactive coupling lies between the lower and upper limits, the probability of self-excitation increases with the increasing of the reactive coupling, and approaches unity. 4. The ratio of the upper to the lower values of critical coupling approaches unity, when n increases indefinitely ; hence in a multi-stage amplifier the probability of self-excitation depends only on the value of reactive coupling and practically does not depend upon its phase angle. Formulae for the dependence of the upper critical value of coupling upon n are derived. Curves of the probability of self-excitation as a function of parasitic coupling, for several values of n, are plotted.

RESONANT IMPEDANCE AND EFFECTIVE SERIES RESISTANCE OF HIGH-FREQUENCY PARALLEL RESONANT CIRCUITS.—H. Iinuma. (*Proc. Inst. Rad. Eng.*, March, 1931, Vol. 19, pp. 467–478.)

In a former paper (1930 Abstracts, pp. 404–405), the writer described his "dynatron oscillator" method of measuring r.f. resistance and resonant impedance, which was applied to frequencies of the broadcast range. In the present paper he gives results on frequencies from about 6 to 26 megacycles/sec. [*See* also Pauli, 1930 Abstracts, p. 166.] He finds that the additional dielectric loss, introduced into the resonant circuit by the use of a screen-grid valve as a dynatron, exercises only a slight influence on the measurements.

His results in the measurement of a parallel resonant circuit lead him to say :—" It can therefore be concluded that high-frequency amplifiers ought to be operated with as small a capacity as possible in the resonant circuits, otherwise the amplification will be lowered ; and that, since the dielectric loss in such a case decidedly limits the value of L/Cr, an improvement in amplification at high frequencies depends in rather greater measure upon the proper choice of materials as well as geometrical shapes of dielectric parts, than upon the design of coils."

He points out that the method is undoubtedly applicable also to ultra-high frequencies, provided that a lower numerical value of the negative resistance is available. Two or more valves in parallel would provide this, though some undesirable increase of valve capacity would be introduced. He suggests that a better way would be to apply a material of great emissivity to the surface of the plate.

The paper ends by discussing, as a further application of the method, the measurement of the amplification of high-frequency amplifiers, " which has scarcely been attained successfully by other methods using the measurement of radio-frequency currents or voltages."

ÉTUDE DE L'AMPLIFICATION D'UN ÉTAGE BASSE FRÉQUENCE À TRANSFORMATEUR EN FONCTION DE LA FRÉQUENCE ET DE L'AMPLITUDE (The Amplification of a Low-Frequency Transformer-coupled Stage as a Function of Frequency and Amplitude).—R. Watrin. (*L'Onde Élec.*, Feb., 1931. Vol. 10, pp. 80–96.)

Author's summary :—" (i) The equations are given for the amplification of such a stage, neglecting the plate-filament capacity of the valve associated with the transformer primary, the distributed capacity of the primary, and the capacity between windings. (ii) Geometrical solution : knowing the transformer constants, the curve $\frac{V_2}{V_1} = f(\omega)$ can be plotted. (iii) Example of application. (iv) Algebraic solution, showing that, on the assumptions made, the curve $\frac{V_2}{V_1} = f(\omega)$ has one maximum only, between the values $\omega_p = \sqrt{\frac{1}{L_2C_2}}$ and $\omega_s = \sqrt{\frac{1}{2\sigma L_2C_2}}$. (v) Special values of $f(\omega)$ and of ω_p and ω_s, in the case of low frequencies. (vi) The relative displacement of V_1 and V_2. (vii) Amplification as a function of the amplitude. (viii) Numerical application to a transformer coupling between two Métal-Mazda valves, types DW. 1508 and DW. 702." The February issue contains only the first instalment of the paper.

THE RESISTANCE CAPACITY COUPLED TRANSFORMER.—F. Aughtie and W. F. Cope. (*E.W. & W.E.*, April, 1931, Vol. 8, pp. 177–182.)

" The recent developments of intervalve transformers rendered possible by the use of alloys of high initial permeability, realisable only in the absence of a polarising field, and the use with transformers of normal construction of valves taking higher anode currents than hitherto, give increasing importance to those circuits in which the steady anode current is not passed through the primary of the transformer." The writers favour the circuit in which a resistance (*not* a choke) is connected in the anode circuit, the transformer primary being fed through a coupling condenser. They establish the theoretical foundation for this circuit and show that, compared with the standard series arrangement, the circuit lowers the cut-off frequency by roughly an octave ; taking into account the additional gain in this direction due to the increased transformer inductance following upon the removal of the polarising current, this reduction is in practice commonly increased to between one and two octaves. Moreover, the coupling efficiency/frequency curve more nearly approaches the ideal horizontal straight line.

They then show that these results are realisable in practice, illustrating by a series of curves, derived from the formulae, the effect of likely departures of the circuit constants from their nominal values; and conclude by laying down a design procedure for ensuring sufficient output voltage for the following stage. Owing to a change of phase displacement at a particular frequency, the arrangement is not recommended for a number of stages in cascade, though in most practical cases this critical frequency is too low for the effect to cause trouble.

THE TUNED TRANSFORMER COUPLING.—S. O. Pearson. (*Wireless World*, 1st April, 1931, Vol. 28, pp. 357–359.)

The theoretical calculation of stage gain.

ON REGENERATIVE RECEIVING.—U. B. Kobsarev. (*Westnik Elektrot., Leningrad*, No. 11/12, 1930, Part I, pp. 344–354.)

From the State Physico-Technical Laboratory; in Russian. A simple regenerative circuit is investigated on the basis of Van der Pol's theory, starting from the equation

$$\ddot{v} + \phi(v)\dot{v} + \omega_0^2 v = \omega_1 B \sin \omega_1 t$$

Two cases are considered:—(i) where the anode characteristic is non-linear and there is no grid current, and (ii) where it is linear and grid current is present. The conditions at the critical coupling for telegraphy and telephony reception on long and short waves are investigated, and the principal conclusions confirmed experimentally.

TRIODE HARMONIC AMPLIFIER.—Y. Fukuta. (*Journ. I.T.T.E., Japan*, Dec., 1930, p. 1212.)

In Japanese. Investigation of the output power of a harmonic amplifier in which a circuit tuned to the *n*th harmonic of the frequency of the grid excitation voltage is connected in the plate circuit as load impedance. At the end, convenient formulae are given for currents, output power and efficiency in the special case where $n = 2$.

THEORY AND DESIGN OF WAVE BAND FILTERS OF CONSTANT BREADTH OF RESONANCE.—G. Schweikert. (*Zeitschr. f. Fernmeldetech.*, 27th Sept., 28th Oct., and 30 Dec., 1930, pp. 135–144, 157–160, and 185–189.)

Continuation and end of the paper referred to in January Abstracts, p. 36.

DEFINITION OF SELECTIVITY: CORRESPONDENCE.—F. M. Colebrook: P. David. (*E.W. & W.E.*, April, 1931, Vol. 8, pp. 199–200.)

Referring to David's letter (May Abstracts, p. 266), Colebrook describes it as a very masterly and judicial summing up of the situation; with its principal conclusions he is in entire agreement; for coupled circuits and filter systems in general, where the solutions of $\delta Z/\delta\omega = 0$ are so close to each other in frequency that the component resonances of the system combine with each other and merge into a single peak, there seems to be no general practicable specification other than the full description implied in David's proposals. For all cases, however, where the various solutions are so far removed from each other that the resonance peaks are distinct and separate, his own generalised procedure [1930 Abstracts, p. 156] is applicable and very useful. This class would cover all cases involving a single tuned circuit only, associated in any manner with other, non-resonant, elements.

DETERMINATION OF FREQUENCY AND DAMPING OF RESONATING CIRCUITS.—J. Tykocinski-Tykociner. (*Phys. Review*, 15th Feb., 1931, Series 2, Vol. 37, No. 4, p. 461.)

Abstract only. "Periodic variations of constants of a coupled circuit produce periodic variations of plate and grid current. This property of oscillators was investigated and applied for the determination of frequency and damping of circuits whose location or other conditions do not allow the insertion of a variable condenser, variometer or resonance indicator. . . . The method was applied to closed circuits and antennae at frequencies from 100 to 100,000 kc/s."

"THE DESIGN OF TUNED CIRCUITS TO FULFIL PREDETERMINED CONDITIONS": CORRESPONDENCE.—S. Butterworth: A. L. M. Sowerby. (*E.W. & W.E.*, April, 1931, Vol. 8, p. 199.)

On the subject of the paper dealt with in March Abstracts, p. 148.

THE EFFICIENCY OF THE MIXED FILTER.—Cocking. (*See* under "Reception.")

AN ANALYSIS OF A PIEZO-ELECTRIC OSCILLATOR CIRCUIT.—Wheeler. (*See* under "Measurements and Standards.")

THE AMPLIFICATION OF SMALL DIRECT CURRENTS.—L. A. DuBridge. (*Phys. Review*, 15th Feb., 1931, Series 2, Vol. 37, No. 4, pp. 392–400.)

Author's abstract:—A new type of thermionic tube recently described by Metcalfe and Thompson [February Abstracts, 1931, p. 98; also Nottingham, 1930 Abstracts, p. 464] has made it possible for the first time to construct d.c. amplifying circuits with a current sensitivity exceeding that of any form of electrometer except the Hoffman; and with a ruggedness and dependability unattainable with any form of sensitive electrometer. The circuits are easily constructed and simple to operate. Three types of circuits have been tested out and are described. (1) A simple single-tube circuit with a Type R galvanometer has been found satisfactory for measurements of currents as small as 10^{-14} amp. (2) A two-tube bridge circuit gives greater stability and will easily measure currents of 10^{-16} amp. It has been found capable of detecting currents of 5×10^{-18} amp. (3) A two-stage circuit, using one of the new tubes and one of the *UX*-112A type, will amplify currents of 10^{-14} amp. to such a value that they may be read on a microammeter.

OSCILLOGRAPHIC COMPARISON OF THE CHARACTERISTICS OF ANODE AND GRID RECTIFICATION.—R. Okada. (*Thesis, University of Illinois*, 1930.)

Using the "saw-tooth" voltage wave method described by Reich (*see* under "Acoustics").

LINEAR DETECTION OF HETERODYNE SIGNALS.—Terman. (*See* under "Reception.")

STUDIES IN NON-LINEAR CIRCUITS.—C. G. Suits. (*Phys. Review*, 15th Feb., 1931, Series 2, Vol. 37, No. 4, p. 462.)

Abstract only.

ELECTRICAL DELAY CIRCUITS FOR RADIO TELEPHONY.—R. T. Holcomb. (*Bell Lab. Record*, Jan., 1931, Vol. 9, pp. 229–239.)

Dealing with the improved delay circuits used in the Transatlantic telephony circuits.

TRANSMISSION.

PIERRET'S CIRCUITS FOR ULTRA-SHORT WAVES (TRANSMISSION AND RECEPTION).—(*Rad., B., F. f. Alle*, April, 1931, pp. 181–183.)

Giving the various circuits described by Pierret and by Beauvais and referred to in numerous past abstracts. The super-regenerative receiver due to Esau is included.

ULTRA-SHORT WAVE COMMUNICATION [SCREENING THE GLASS BULB, ETC.]: CORRESPONDENCE.—E. C. S. Megaw: C. C. Whitehead. (*E.W. & W.E.*, April, 1931, Vol. 8, pp. 200–201.)

Referring to Whitehead's paper (Feb. Abstracts, p. 94), Megaw criticises a statement regarding the relation between the amplitude of the a.c. component of the anode current and the electron transit-time. He points out also that eddy current and dielectric loss in the valve (which will be considerable at frequencies of the order of 10^8 cycles/sec.) should have been included in the various causes of r.f. loss in the transmitter. Finally, regarding the effect of screening the bulb of the valve, he urges that this is more likely to be due to the presence of ionised gas than to the effects of electron inertia; Langmuir has shown that secondary emission can occur from a glass surface, even for voltages of a few hundred, and the shield would have the effect of stabilising the charges on the glass and reducing local heating which might well result in the liberation of gas.

DEMONSTRATION OF SIDEBANDS BY THE USE OF A QUARTZ-CONTROLLED R.F. AMPLIFIER.—Harnisch. (*See* under "Reception.")

MEASUREMENT OF POWER AND EFFICIENCY OF RADIO TRANSMITTING APPARATUS.—Pession & Gorio.—(*See* under "Measurements and Standards.")

RECEPTION.

THE STENODE RADIOSTAT.—(*Electrician*, 27th March, 1931, Vol. 106, p. 492.)

Describes the first commercial Stenode receiver, manufactured by Radio Instruments, Ltd. It is a mains-driven 7-valve transportable receiver, with 4 operating controls (frame rotation, frame tuning condenser, medium-long switch, and main tuning control, calibrated direct in wavelengths). "With regard to actual results, it may be accepted that there is good separation of the London Regional and Mühlacker stations, while on the long wavelengths selectivity is equally good. Volume is adequate in all cases, some 60 odd stations being within the compass of the receiver, while in spite of the sharpness of tuning there is no appreciable loss of clarity."

THE PERFORMANCE OF THE STENODE.—E. L. Gardiner. (*Wireless World*, 29th April, 1931, Vol. 28, pp. 449–451.)

Measurements on the performance of the Stenode Radiostat in the laboratories of the Crosley Radio Corporation, in America. R.f. resonance curves were taken by feeding into the receiver continuous waves of variable frequency, and as resonance was progressively departed from, the amplitude of the input was increased to give a constant reading. The results were combined in a mean curve showing the actual intermediate frequency voltage across the grid circuit of the second detector valve, plotted against the frequency difference from resonance. This curve shows zero response at 3,000 cycles from resonance and, considered in conjunction with the overall fidelity curve, demonstrates the high selectivity of the instrument. The latter curve shows that low notes are well reproduced, there being a rising slope at 60 cycles and the general level of reproduction being maintained with an upward trend to 2,000 cycles. Up to 3,000 cycles the response is still good.

EIN HOCHSELEKTIVER HOCHFREQUENZVERSTÄRKER UND DER EXPERIMENTELLE NACHWEIS DER SEITENBÄNDER BEI MODULATION (A Highly Selective [Quartz-controlled] High Frequency Amplifier and the Experimental Demonstration of the Sidebands in Modulation).—A. Harnisch. (*Physik. Zeitschr.*, 1st March, 1931, Vol. 32, No. 5, p. 223.)

A short account of a receiving amplifier with selectivity controlled by a quartz crystal. An emitter whose frequency is roughly equal to that of the quartz is loosely coupled to the receiver and on tuning the emitter the presence of sidebands in frequency- and phase-modulation is clearly demonstrated.

THE EFFICIENCY OF THE MIXED FILTER.—W. T. Cocking. (*Wireless World*, 1st April, 1931, Vol. 28, pp. 345–348.)

It is shown that the mixed band pass filter, *i.e.*, a combination of capacity and negative mutual inductance for the filter coupling [*see* Page, May Abstracts, p. 268] offers decided advantages over the simple capacity or inductive coupling methods, with little sacrifice of signal strength in the interests of selectivity. Calculations of the relative efficiency of various filters are made and advice is given as to the best method of ganging when the mixed type of coupling is used.

A SUPER-REJECTOR CIRCUIT [THE ECKERT SELECTIVITY ATTACHMENT].—G.W.O.H.: Eckert. (*E.W. & W.E.*, April, 1931, Vol. 8, pp. 175–176.)

Editorial description and criticism of the device dealt with in March Abstracts, p. 152.

GRID CIRCUIT POWER RECTIFICATION.—J. R. Nelson. (*Proc. Inst. Rad. Eng.*, March, 1931, Vol. 19, pp. 489–500.)

Author's summary :—Grid circuit power rectification is investigated by studying the ideal rectifier and applying the results obtained to the case of a tube rectifier. Characteristic curves are used in this study to obtain the optimum conditions for rectification and the order of the output voltage obtainable. Conditions for minimum loading of the circuit preceding the detector are discussed. Audio-frequency discrimination is also studied as a function of grid circuit impedances, and experimentally determined curves showing the magnitude of the frequency distortion are also given.

BIAS DETECTOR OVERLOAD.—J. R. Nelson. (*Rad. Engineering*, March, 1931, Vol. 11, pp. 21–24.)

"The case of most practical interest to-day is that of the so-called linear detector which utilizes input voltage of the order of volts instead of tenths or hundredths of a volt. . . . The above case only will be considered here. Small signal theory becomes very difficult to apply when the input voltage is of the order of volts, so that the detector theory will be studied by means of certain easily measured tube characteristics.

"The method used here consists of first finding experimentally the relation between the power output and the audio-frequency voltage introduced in an external detector plate circuit of the receiver under consideration. The rectification diagram or the relation between the detector input voltage and the rectified output are found next. The audio-frequency voltage in the external detector plate circuit for various carrier voltages and percentages of modulation may be computed from these rectification diagrams. The power output for the given conditions may then be found from the relation between the external detector plate audio-frequency voltage and the power output relations of the receiver."

HIGH LEVEL PLATE CIRCUIT RECTIFICATION.—J. R. Nelson. (*Electronics*, March, 1931, pp. 550–551.)

LINEAR DETECTION OF HETERODYNE SIGNALS.—F. E. Terman. (*Electronics*, Nov., 1930, pp. 386–387.)

Linear detection is best for modulated waves, and also for producing a heterodyne beat between a weak incoming signal and a strong local oscillation (general case of a frequency changer). But it is *not* best, and even produces an appreciable distortion, in the case of the heterodyning of two signals of approximately equal amplitude, *e.g.*, in a note-frequency generator making use of the difference between two inaudible frequencies.

This fact also explains an interference trouble met with in superheterodyne receivers. Suppose that such a receiver uses a local signal of frequency F_0 to beat with the incoming frequency F, and that F_0 is strong enough to give linear rectification at the first detector ; if an interfering signal arrives of the same order of amplitude as F_0 and of frequency F' near to F_0 ; detection of these two frequencies will give rise to distortion—the beat frequency $F' - F_0$ will contain harmonics which will find their way into the intermediate amplifier, provided that the frequency of this is a multiple of one of them.

THE SCREEN-GRID VALVE AT ITS BEST.—Page. (*See* under "Valves and Thermionics.")

LES PARASITES INDUSTRIELS ET LA RÉCEPTION RADIO-ÉLECTRIQUE (Man-made Interference and Radio Reception).—Leduc. (*L'Onde Élec.*, February, 1931, Vol. 10, pp. 49–71.)

Author's summary :—"After demonstrating the need for legal protection for the set-owner against interference, the writer summarises the results of tests undertaken at the Laboratoire Central d'Électricité to develop simple and efficacious arrangements for preventing the production of man-made interference. These tests deal with only a limited number of types of apparatus liable to produce such trouble, and do not pretend to give radical and final solutions ; but they show clearly that the nuisance caused by certain troubles can be suppressed without expensive measures. The last part of the article contains certain considerations on the conditions which should be conformed to by transmitting stations, and on the possibility of a recourse to the Law on the part of a set-owner whose reception is interfered with."

The tests in question deal with :—(i) Advertising signs using neon or mercury-vapour tubes. An earthed screen is effective, and as a rule such a screen can be formed by a suitable design, or modification to the existing design, of the metal framework of the sign itself. (ii) Telephone system (call relays, bells, etc.) : condensers and earthed screening are effective. (iii) Rotating commutators controlling electric signs : the motor is easily silenced by two condensers, but condensers alone will not silence the commutator itself, and the leads must be lead-covered and the cover earthed at several points. (iv) Vibrating rectifiers : good adjustment, combined with the use of condensers across the contacts, almost completely prevents radiation from the conductors, but there is still direct radiation which may cause trouble within a radius of 3 to 5 metres.

(v) D.c. and a.c. generators and motors : here split condensers with their mid-point earthed are effective. (vi) Lifts : no satisfactory solution has at present resulted from the tests on these, as regards the starting and stopping noises. (vii) H.T. power lines : up to 70,000 v. no trouble was found in a receiver situated 200 metres from the line and fed from the a.c. mains. Above this voltage, slight noises were heard which increased as the voltage increased ; these were due to the setting up of brush discharges, and might not begin at the voltage named under other conditions (of atmospheric humidity, etc.). If these troubles are experienced for voltages *below* 70,000 v., the writer considers that a fault in insulation must be indicated. (viii) Medical apparatus : suppressing the spark by condensers would interfere with the working of the apparatus, so one is limited to treating the supply only, condensers across the transformer primary often being effective. Faraday cages are sometimes useful, especially for X-ray apparatus.

(ix) Tramways: Baudot telegraphs. The chief difficulty in the case of the former lies in the trolley contact, and can be reduced by the use of carbon or zinc contacts and by a springy articulation which helps to make the pulley cling to the line even when it has lost its circular form. As regards the Baudot telegraph, Guillot's researches suggest that a combination of a rheostat (set once and for all for any particular installation) with an inductance and a condenser is a satisfactory cure.

ELIMINATING STATIC.—A. B. Calkin. (*Wireless World*, 11th March, 1931, Vol. 28, pp. 258–260.)

Hints on combating static based on the principle that the ratio of signal strength to interference level must be kept as high as possible.

A RAPID METHOD OF ESTIMATING THE SIGNAL-TO-NOISE RATIO OF A HIGH GAIN RECEIVER.—F. B. Llewellyn. (*Proc. Inst. Rad. Eng.*, March, 1931, Vol. 19, pp. 416–420.)

The signal-to-thermal-noise ratio in the input circuit is the limit which can be reached in signal-to-noise ratio. It is shown that a figure of merit for the signal-to-noise ratio is obtained directly by noting how much the total noise output increases when the input circuit is tuned through resonance, in the absence of signal. The signal-to thermal-noise ratio with an input circuit which is so coupled to the antenna and tuned as to give a maximum signal, is 3 db. below the theoretical maximum obtainable. "The effect of mismatching the antenna and input circuit impedances is discussed, and it is concluded that although a small improvement may be obtained in certain ideal cases by making the circuit impedance much higher than the antenna impedance, other considerations indicate that the matched impedance condition gives the best results in practice."

ATTACHMENT FOR ULTRA-SHORT WAVE RECEPTION.—(*Die Sendung*, 10th April, 1931, Vol. 8, pp. 255–257.)

Constructional details to enable readers to convert their broadcast receivers to the 7-metre [7.05 m.?] test transmissions in Berlin (April Abstracts, p. 224).

GALVANOMETER FOR THE DIRECT RECEPTION OF [ULTRA-] SHORT WAVES.—D. C. Gall. (*Journ. Scient. Instr.*, March, 1931, Vol. 8, pp. 109–110.)

A portable arrangement of reflecting galvanometer (with self-contained battery for illuminating the spot) and a "tail" consisting of a copper wire bifilar loop 50 cms. long, one end of which was connected to the galvanometer terminal through a crystal rectifier, while the other end was wound into a helix to form a choke and then connected to the other terminal. The arrangement worked very well for the detection of 2 m. waves, where the presence of a human body completely upset the distribution of the radiation.

REMARKS ON SHORT WAVE AMPLIFIER DESIGN; AND ON AMPLIFICATION MEASUREMENT OF R.F. AMPLIFIERS.—Iinuma.

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

DESIGN TESTS FOR AMPLIFIERS AND COMPLETE RADIO RECEIVERS.—Sylvan Harris. (*Rad. Engineering*, March, 1931, Vol. 11, pp. 25–27 and 34.)

A LONG WAVE RECEIVER FOR SMALL YACHTS.—H. F. Smith. (*Wireless World*, 29th April, 1931, Vol. 28, pp. 446–448.)

Constructional details for a yacht set working only on the long wave broadcast band, the medium band being considered unreliable on account of ships' Morse and other disturbances. Tuned grid coupling is used for the single r.f. stage, which is followed by a regenerative grid detector and a transformer-coupled a.f. amplifier.

MECHANICAL REMOTE TUNING CONTROLS FOR RADIO RECEIVING SETS.—J. C. Smack. (*Rad. Engineering*, January, 1931, Vol. 11, pp. 28–30.)

AERIALS AND AERIAL SYSTEMS.

CALCULATION OF ELECTRIC AND MAGNETIC FIELD STRENGTHS OF ANY OSCILLATING STRAIGHT CONDUCTORS.—R. Bechmann. (*Proc. Inst. Rad. Eng.*, March, 1931, Vol. 19, pp. 461–466.)

The method employed depends on the formation of Hertzian vectors for the given arrangement, and the derivation of the components of the electric and magnetic fields in the usual manner. *Cf.* Feb. and March Abstracts, pp. 97 and 155.

MEASUREMENTS IN THE FIELD RADIATED BY A LINEAR ANTENNA EXCITED IN THE SPACE BETWEEN TWO PARALLEL, CONDUCTING SURFACES.—Bergmann and Doerfel. (*See* under "Propagation of Waves.")

VALVES AND THERMIONICS.

CHARACTERISTICS OF VARIABLE-MU TETRODES.—K. Henney. (*Electronics*, March, 1931, pp. 540–541.)

These valves were referred to in March Abstracts, pp. 156 and 161. The present paper includes the following diagrams:—Fig. 1—Characteristic of preliminary tube showing long plate current/grid voltage curve. Fig. 2—Comparison of mutual conductances of standard screen-grid tube and variable-mu tube. Fig. 3—Curve showing decreased modulation distortion of new tube compared to present type of screen-grid tube. Fig. 4—Methods by which proper bias for new tubes may be secured. A table of "tentative ratings and characteristics" is given. The writer is of the opinion that "it is certain that nothing else so uniquely important has appeared upon the radio horizon. The screen-grid tube clearly suffered from faults which nothing but a radical change in design would remedy. This the exponential, or variable-mu, tube provides. It is more than possible that other screen-grid tubes for the detector position, and a tetrode or pentode (damned by the industry a year ago) will arrive to improve the power end of the receiver."

THE SCREEN-GRID VALVE AT ITS BEST.—W. I. G. Page. (*Wireless World*, 29th April, 1931, Vol. 28, pp. 452–455.)

After summarising the fundamental facts on the working principles of r.f. valves, with particular reference to the modern S.G. type, the author directs attention to the important practical requirements necessary to avoid the condition of flatness of tuning so commonly met with in screen-grid r.f. amplifiers. In addition, the recently introduced metal-sprayed valves are described and their advantages explained. The problems of cross-modulation, modulation distortion and modulated hum are dealt with and a typical screen-grid circuit is given, together with values of components. To mitigate rectification troubles in modern r.f. amplifiers it is suggested that screened pentodes or variable-mu tetrodes may find a field of application.

NEW METAL-SPRAYED VALVES.—(*See* preceding abstract.)

COMPARING DETECTOR VALVES.—W. T. Cocking. (*Wireless World*, 22nd April, 1931, Vol. 28, pp. 427–429.)

Working measurements on the Mazda DC/HL and L.210 battery type valves, with notes on the design of a power grid detector stage and the relative efficiency of battery and mains valves as rectifiers.

THE LIFE OF SMALL VACUUM TUBES.—K. Kajiwara. (*Journ. I.T.T.E. Japan*, December, 1930, p. 1304.)

Assuming that the useful life is ended when the mutual conductance as an amplifier valve decreases by 70 % of its initial value, and the sensitivity as a detector by 50 %, the writer's tests give an average life of about 1,900 hours for the receiving valves types *UX*201A and *UV*199.

A SATURATED DIODE AS AN ANODE RESISTANCE.—J. F. Herd: Rudolph. (*E.W. & W.E.*, April, 1931, Vol. 8, pp. 192–195.)

Referring to the use of this device as a means of obtaining something approaching very closely to the full voltage-factor of a valve [*see* Jouaust and Decaux, *L'Onde Élec.*, July, 1928, *not* July, 1929, as printed: also Rudolph, Jan. Abstracts, pp. 41–42] the writer describes his own application of the scheme to the case of a resistance-battery-coupled amplifier of one or two stages, for work on the wave-form of atmospherics. He gives curves based on measurements made with a few British valves [including a screen-grid valve] of ordinary commercial supply, showing the extent to which the full voltage-factor may be achieved.

DIE MAGNET-CHARAKTERISTIKEN EINES DREI-ELEKTRODENROHRES (The Characteristics of a Triode in a Magnetic Field.)—J. Völker. (*Jena Dissertation*, 1929, 34 pp.; *Zeitschr. f. hochf. Tech.*, March, 1931, Vol. 37, pp. 89–98.)

In spite of the work of Yagi, Forró and others on triodes in a magnetic field, a complete treatment of the characteristics is still lacking by which such triodes can be compared with the diode "magnetrons" studied by Hull and other workers. The present paper describes researches undertaken in order to fill this gap. Preliminary considerations show that the symmetrical design of the Hull magnetron is no longer present in the case of a triode. The field distortion produced by the grid has the effect that a magnetic field parallel to the filament is not perpendicular to the whole electron movement, and that the spectrum of velocities is broadened: each of these results will cause a flattening of the falling characteristic. Whereas with a magnet on there is only *one* critical field-strength—that at which the anode current begins to fall suddenly—in the case of a triode with positive grid and anode voltages there are *three* critical field-strengths to be distinguished, two for the anode current and one for the grid current.

A number of characteristic curves are plotted, showing various effects in the case of a Habann valve (with split anode, but here used as a diode), a Telefunken triode, and a Siemens triode; a four-electrode valve, a gas-filled and an indirectly heated valve were also tested. With the triodes, the anode current characteristic form found in the Hull magnetron was only met with under certain conditions—positive grid and low anode potentials; for anode potentials of 50 v. and over, a maximum appeared at the knee of the curve and the downward slope became less steep, while for negative grid potentials the knee of the curve became markedly rounded. The grid current had no distinctive characteristic shape of its own, being dependent on space-charge effects and the superposition of the anode current. The last part of the paper deals with the setting-in of oscillations in the Habann valve; the dependence of wavelength on anode potential, on filament temperature, and on the position of the valve in the magnetic field; an alternating field causes an earlier setting-in of oscillation but no change in wavelength; a.c. heating shortens the wavelength. Effects of various conditions on the intensity of the oscillations are also studied. As regards oscillations in the triodes, these occur only when the grid or anode is connected to the negative end of the filament and the other electrode is positive.

LIFE OF AN INCANDESCENT CONDUCTOR UNDER CONSTANT AND VARIABLE CONDITIONS.—V. I. Volynkin. (*Westnik Elektrot.*, *Leningrad*, No. 11/12, 1930, Part I, pp. 324–328.)

In Russian. From the author's summary:—"A theoretical analysis of the life of an ideal incandescent conductor, taking evaporation into account, is given. A formula derived for variable conditions is compared with that for constant conditions, and a third formula expresses the result of the comparison. The theory is illustrated by two examples:—(*a*) An electric lamp is run on a pulsating voltage of (i) sinusoidal, (ii) triangular, (iii) rectangular and (iv) trapezoidal wave-form. For a periodic pulsation of the line voltage of ± 5 %, the life is diminished by 6 to 15 %, according to the wave-form, as compared with its value at constant voltage; the least decrease is caused by (ii) and the greatest by (iii). A pulsation of ± 2 % has practically no effect on the life.

"(b) A mine lamp is lit directly from an alkaline accumulator without regulation. The life is decreased by 7 % as compared with its value when the rated voltage is employed. It is shown also that the life of an incandescent tungsten cathode, heated by a current which is kept constant by means of an automatic device (*e.g.*, an iron resistor in hydrogen) is considerably less than if the filament is heated directly from a lead accumulator with no regulation."

CONDUCTIVITY OF OXIDE CATHODES.—N. H. Williams and W. S. Huxford. (*Phys. Review*, 15th Feb., 1931, Series 2, Vol. 37, No. 4, p. 463.)

Abstract only:—The conductive properties of oxide coatings used in the equipotential cathode type of radio tube have been investigated. The inner nickel sleeve served as one electrode, the second being a nickel strip in contact with the outer surface of the oxide. Currents through the coating as measured at constant potential vary with the frequency of the applied electromotive force. A decrease in conductivity of about forty per cent. occurs when the frequency is changed from 1,500 to about 10,000 c.p.s. The decrease starts at lower frequencies for higher values of applied potential. These results indicate a transfer of electrical charges through the coating by ionic conduction, the process being inhibited at the higher frequencies. A method of estimating the relative thermionic activities of core metal and oxide surface is suggested. Fluctuations in the current through the coating were measured on an amplifier tuned to various frequencies from 200 to 40,000 c.p.s. An abnormal increase in "shot" voltage was found for frequencies below 10,000 c.p.s. This result is believed to confirm the hypothesis that positively charged ions are neutralised in the space charge produced by electrons which are emitted thermionically from the activated surface of the core metal.

COLD EMISSION FROM UNCONDITIONED SURFACES.—W. H. Bennett. (*Phys. Review*. 1st March, 1931, Series 2, Vol. 37, No. 5, pp. 582–590.)

THE EMISSION OF POSITIVE IONS FROM METALS.—H. B. Wahlin. (*Phys. Review*, 15th February, 1931, Series 2, Vol. 37, No. 4, pp. 467–468.)

Abstract only.

THE EMISSION OF POSITIVE IONS FROM THORIATED TUNGSTEN.—H. B. Wahlin. (*Phys. Review*, 15th February, 1931, Series 2, Vol. 37, No. 4, p. 473.)

Abstract only.

DIRECTIONAL WIRELESS.

AN AUTOMATIC RECORDER OF SIGNALS FROM A ROTATING BEACON TRANSMITTER.—R. L. Smith-Rose and H. A. Thomas. (*Journ. Scient. Instr.*, March, 1931, Vol. 8, pp. 81–88.)

Authors' abstract:—A description is given of an automatic apparatus which has been developed for the recording of wireless bearings from a rotating beacon transmitter of the type now in operation at Orfordness, Suffolk. The output telephone signal current from a standard type of valve receiver is supplied to a tuned audio-frequency amplifier followed by a rectifier. The output current from this rectifier operates a relay and pen which traces a line record upon a sheet of paper placed on a rotating drum. This drum is arranged to rotate once a minute synchronously with the beacon by means of a phonic motor with tuning-fork control. During the rotation of the drum the pen is moved transversely so that the trace is a spiral line which is interrupted by the Morse code and navigation signals emitted by the beacon, and by the occurrence of the signal minimum at the receiver. The whole apparatus is arranged to give a continuous record of the bearings from one or two beacons over a period of about half an hour. The results of a number of tests carried out with the recorder at a distance of over 90 miles from the beacon show that under normal conditions the difference in bearing given by the recorder and by an observer using the aural signal in a pair of telephones is less than 0.5°. The recorder has been used for studying the performance of a rotating beacon and when suitably developed for the purpose will probably have an application on board ship. For this purpose it may be stated from the tests already made that the apparatus will have a reliable working range of nearly 200 miles with the present type of rotating beacon.

SOME OBSERVATIONS ON THE ORFORDNESS ROTATING BEACON.—R. L. Smith-Rose. (*Journ. I.E.E.*, April, 1931, Vol. 69, pp. 523–532.)

Section 2 summarises and discusses the results submitted by some 160 ships of all descriptions, between July 1929 and April 1930. Section 3 deals similarly with observations made on land, chiefly at the National Physical Laboratory, Teddington. "It is to be concluded that the inauguration of the rotating-loop beacon at Orfordness has achieved a large measure of success among those for whom it was intended, *viz.*, the Mercantile Marine. The beacon has shown itself to be a most useful wireless aid to navigation and is capable of providing bearings to ships at sea to an accuracy of the order of 2°, when the observers have had some little practice and experience at the work." This applies to bearings taken with an ordinary type of ship's 2-valve receiver, for ranges up to about 100 miles at all times and up to about 250 miles in the daytime when conditions as to interference are favourable. But at night time, bearings taken at ranges exceeding about 100 miles are subject to night errors, and since it appears that the working range of the beacon may with advantage be increased above its normal value of 100 miles oversea, it will be desirable in future to develop the beacon along lines which will provide freedom from these errors (*cf.* Smith-Rose and Barfield, *ibid.*, Vol. 64, p. 831). Future rotating beacons may thus be expected to have a reliable working range to the average ship's receiver of anything from 250 to 500 miles.

A RADIO BEACON AND RECEIVING SYSTEM FOR BLIND LANDING OF AIRCRAFT.—H. Diamond and F. W. Dunmore. (*Proc. Inst. Rad. Eng.*, April, 1931, Vol. 19, pp. 585–626.)

See February Abstracts, p. 99.

RADIO BEACONS.—A. Blondel. (*Annales des Ponts et Chaussées*, Vol. 6, 1930, 140 pp.)

THE PRACTICAL CORRECTION OF A WIRELESS DIRECTION-FINDER FOR DEVIATIONS DUE TO THE METALWORK OF A SHIP.—C. E. Horton. (*E.W. & W.E.*, April, 1931, Vol. 8, pp. 195–198.)

Long abstract of an I.E.E. (Wireless Section) paper, with Discussion. The sections deal with :—quadrantal correctors ; semi-circular correctors ; ambiguity of bearing (including a description of the author's new method of sense-finding, which blurs the reciprocal zero *but leaves the true zero as sharp as before and in the original position* : it depends on the use of an auxiliary coil at right angles to, and moving with, the main rotating coil, in addition to the usual open aerial employed to give a cardioid diagram) ; the effect of the ship on the correcting aerials ; and the best position for a direction-finder in a ship (including the behaviour of the correctors during periods of " night effect ").

NEW COMBINATION RADIO EQUIPMENT FOR YACHTS AND CRUISERS.—Pioneer Instrument Co. (*Rad. Engineering*, March, 1931, Vol. 11, p. 24.)

" Secretly developed apparatus combines broadcast receiver, position finder and compass."

EUROPEAN AVIATION RADIO.—Gross : Hull. (*See* under " Stations, Design and Operation.")

SONIC ALTIMETER FOR FOG FLYING.—G.E.C. of America. (*Scientific American*, April, 1931.)

Describes an altimeter designed for aircraft use. The air supply for the whistle is obtained by " bleeding " one of the engine cylinders through a check valve into a small storage tank. Each time the whistle valve sends out a blast, a pointer starts moving uniformly round its scale, from which the height is read directly.

ACOUSTICS AND AUDIO-FREQUENCIES.

PROGRESS IN SOUND-PICTURE RECORDING.—C. Dreher. (*Electronics*, March, 1931, pp. 542–544.)

I. Ground noise reduction (*cf.* March Abstracts, p. 160) :—for variable area system, the older Hanna and Hewlett method has the objection that low modulation is close to the edge of the track. The new McDowell (RKO) method here described keeps the serrations always in the middle of the track, the clear portion of the print being matted out by the action of an auxiliary light-blocking device. For the variable density system, the H.C. Silent plan of biasing the light valve is described. II. Increasing the total volume range by reduction of ground noise and the use of automatic volume control : the " squeeze track " system for variable density recording. III. Microphone developments : beam microphone concentrators : possible future simplification of recording equipment, monitoring booths and recording rooms being eliminated.

RADIO AND SOUND PICTURE STATISTICS FOR 1930. (*Electronics*, March, 1931, pp. 533–539.)

LE FILM PARLANT (Sound Films).—P. Bonneau. (*Ann. des P.T.T.*, Jan., 1931, Vol. 20, pp. 1–38.)

This second instalment of a long paper by the Technical Director of the Gaumont studios deals with the preparation of the films, reproduction (including a defence of the selenium cell properly made and used), and a critical survey of the faults, possibilities and limits of sound films in general, including a comparison of the variable density and variable area systems. The first instalment was in the issue for Dec. 1930, pp. 1009–1051, and was principally concerned with the making of the sound films in the studio and elsewhere.

AN OPTICAL COINCIDENCE GAGE [APPLICABLE TO THE ADJUSTMENT OF SOUND-ON-FILM REPRODUCING MECHANISM, ETC.]—I. C. Gardner and F. A. Case. (*Bur. of Stds. Journ. of Res.*, Feb., 1931, Vol. 6, pp. 229–237.)

A NEW SOUND REPRODUCING SYSTEM FOR THEATRES.—G. Puller. (*Journ. Soc. Motion Picture Engineers*, February, 1931, Vol. 16, pp. 131–143.)

" A description of the new Western Electric sound reproducing system for use in small theatres."

A GIANT LOUD SPEAKER.—(*Electrician*, 27th March, 1931, Vol. 106, p. 467.)

" A loud speaker . . . was mounted on a van in a street near Waterloo Bridge on the south side of the river, and gramophone records and speeches, in which the human voice was amplified two million times, were transmitted a distance of about ½ mile across the river to an audience on Adelphi Terrace, Strand." Reception was quite clear in spite of traffic noises. " The loud speaker had a wooden diaphragm which measured 2½ft. across, ten valves were used, and the actual power radiated was about 20 w." *Cf.* Hoovenaire amplifiers, April Abstracts, p. 216.

HOME RECORDING TO THE FORE.—A. C. Lescarboura. (*Rad. Engineering*, March, 1931, Vol. 11, pp. 43 and 46.)

TONE AND VOLUME CONTROL OF GRAMOPHONE PICK-UPS.—John Harmon. (*Wireless World*, 25th March, 1931, Vol. 28, pp. 313–316 ; 8th April, 1931, pp. 369–371 ; 15th April, 1931, pp. 408–410.)

A series of articles in which the author deals with various types of correcting devices. The two kinds of pick-up dealt with are the attracted reed and the balanced armature. The question of obtaining a uniform level of reproduction is also discussed, and in the concluding article the electrical, as distinct from the mechanical, system of the pick-up is dealt with.

Inexpensive Quality.—(*Wireless World*, 18th March, 1931, Vol. 28, pp. 282–285.)

Discussing the outstanding characteristics of present-day moving-iron type cone loud speakers, and the points to look for in choosing a suitable unit. Suggestions are given for the choice of a suitable output valve and the adjustment of the receiver to improve quality.

Les deux Fonctions fondamentales du Vibromètre, et son Application à l'Électro-Acoustique (The Two Fundamental Functions of the Vibrometer, and its Application to Electro-Acoustics).—K. Kobayasi. (*Ann. des P.T.T.*, Dec., 1930, Vol. 19, pp. 1105–1119.)

French version of the papers dealt with in 1930 Abstracts, p. 341.

Supersonic Interferometers.—E. Klein and W. D. Herschberger. (*Phys. Review*, 15th March, 1931, Series 2, Vol. 37, No. 6, pp. 760–774.)

Recent Developments in Architectural Acoustics.—P. E. Sabine. (*Science*, 6th Feb., 1931, Vol. 73, p. 150.)

Survey of a recent lecture. The reverberation equation was discussed in detail. "The most suitable reverberation time appears to be about 1.4 second."

Progress of Acoustics, with Particular Reference to Applied Acoustics.—F. Trendelenburg. (*Zeitschr. f. hochf. Tech.*, March, 1931, Vol. 37, pp. 105–112.)

First part of a comprehensive survey.

Sur L'Amortissement des Ondes sonores dans un Milieu gazeux homogène (The Damping of Sound Waves in a Homogeneous Gaseous Medium).—Y. Rocard. (*Journ. de Phys. et le Rad.*, Dec., 1930, pp. 426–437.)

The Science of Voice.—D. Stanley. (*Journ. Franklin Inst.*, April, 1931, Vol. 211, No. 4, pp. 405–455.)

The Last Component [The Action of the Ear].—R. T. Beatty. (*Wireless World*, 4th March, 1931, Vol. 28, pp. 231–233.)

Concerning the ear's "extraordinary power of piecing together the fragments and reconstructing the missing parts in music reproduced by loud speaker." It is shown how the synthetic action of the ear is based on the complexity of nearly all musical sounds, *i.e.*, their possession of harmonic overtones which the ear utilises in the manner of a mechanical rectifier, heterodyning two frequencies f, f_1 to produce a third frequency $f - f_1$. Thus the overtones $2f$, $3f$, $4f$, etc., are heterodyned in successive pairs to supply the missing fundamental f.

Some Physical Properties of Speech and Music.—Harvey Fletcher. (*Science*, 6th Feb., 1931, Vol. 73, pp. 150–151.)

Summary of a recent paper.

The Dependence of Vowels on Absolute Pitch.—V. Engelhardt and E. Gehrcke. (*Zeitschr. f. Psychol.*, Vol. 115, 1930, pp. 1–15: *Wiss. Abh. d. Phys. Tech. Reichanst.*, No. 1, Vol. 14, pp. 83–97.)

Vowels recorded at a fixed speed on gramophone discs are reproduced at speeds varying from 35 to 160 r.p.m., and the changes noted. Thus O, when lowered one octave, becomes U.

A Simple Theory of Acoustical Filters.—E. J. Irons. (*Journ. Scient. Instr.*, March, 1931, Vol. 8, pp. 89–93.)

Author's abstract:—The paper gives an account of a simplified theory of acoustical filters which has regard to phase changes in the conduits. The calculated values of the "cut off" frequencies for three filters are shown to be in very fair agreement with Stewart's experimental results (1929 Abstracts, p. 580).

On the Production of Acoustic Waves by means of an Air-jet of a Velocity exceeding that of Sound.—J. Hartmann. (*Phil. Mag.*, April, 1931, Series 7, Vol. 11, No. 72, pp. 926–948.)

Versuch über die Ausbreitung des Schalls an einem schwingenden Quarz (Experiment on the Propagation of Sound in an Oscillating Quartz Crystal).—E. Grossmann. (*Physik. Zeitschr.*, 1st March, 1931, Vol. 32, No. 5, p. 222.)

"Wireless World" All A.C. Quality Amplifiers.—F. H. Haynes. (*Wireless World*, 25th March, 1931, Vol. 28, pp. 308–312.)

A two-stage resistance amplifier for the electrically reproducing gramophone. Small stage gains are provided for, avoiding high note loss. An undistorted power output up to 5 watts is claimed.

Linear Detection in an Audio-frequency Generator using the Heterodyne Principle.—Terman.

(*See* abstract under "Reception.")

The Amplification of a Low-frequency Transformer-coupled Stage as a Function of Frequency and Amplitude.—Watrin.

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

Mesure des Intensités sonores par la Méthode des Scintillations (Sound Intensity Measurements by the Method of "Acoustic Twinkling").—F. Canac. (*Journ. de Phys. et le Rad.*, Feb., 1931, pp. 42–60.)

By "acoustic twinkling" is meant the effect on the ear when two notes of the same pitch but of different intensities follow one after the other in rapid succession. No auditive memory enters into the method, which is capable of great accuracy (errors of less than 1 %).

A New Method of Testing for Distortion in Audio-Frequency Amplifiers.—H. J. Reich. (*Proc. Inst. Rad. Eng.*, March, 1931. Vol. 19, pp. 401–415.)

Author's summary :—A periodic voltage wave consisting of a series of straight lines is distorted into a series of curves when it passes through an amplifier which gives non-uniform amplification. As such distortion can very readily be detected visually with an oscillograph, it affords a means of testing for uniformity of amplification.

Mathematical analysis shows that a "saw-tooth" voltage wave is distorted into a series of exponential curves in passing through a resistance-capacity-coupled amplifier, the distortion being considerable at low audio frequencies if the coupling capacity or the grid-leak resistance is too small. The analysis proves that a falling off in amplification of less than ½ per cent. at low audio frequencies can be detected with ease. In other types of amplifiers the distortion is not necessarily exponential, but curvature of the output wave is in general a sign of non-uniform amplification or phase shift. The method is applicable to the testing of any type of coupling circuit. The apparatus required for this method of testing is very readily constructed and is of general laboratory usefulness.

An Apparatus for Testing Telephones.—V. I. Kovalenkov and O. A. Kvar. (*Westnik Elektrot., Leningrad*, No. 1, 1931, Part I, pp. 20–22.)

In Russian. An interference method of testing the sensitivities, a node being formed at the observation point when the amplitudes given by the instrument under examination and the standard instrument are equal, and the phases in opposition.

The Telephone Instrument Efficiency Tester.—A. Hudson. (*P.O. Elec. Eng. Journ.*, April, 1931, Vol. 24, pp. 31–36.)

Frequency Characteristics of Standard Reference Type Condenser Transmitters and Moving Coil Receivers.—W. West. (*P.O. Elec. Eng. Journ.*, April, 1931, Vol. 24, pp. 27–30.)

Author's summary :—The frequency characteristics are found to depend, both in shape and level, on the acoustical conditions under which the calibrations are made. If these conditions are reasonably similar to those of the Standard Reference method of calibration, the results, based on the use of the Rayleigh Disc, are very similar to those obtained by the Thermophone. When, however, actual use conditions are imitated, differences of the order of 5 : 1 for the transmitters and 3 : 1 for the receivers are found at certain considerable portions of the frequency range.

Making a Deaf Aid.—(*Wireless World*, 15th April, 1931, Vol. 28, pp. 395–398.)

A simple speech amplifier in portable form, consisting of two low-frequency valve stages used in conjunction with a loud speaker movement employed as a microphone.

The Hellertion [Radio Musical Instrument controlled rather like a Violin].—P. Lertes. (*Summary in Electronics*, March, 1931, p. 565.)

Sonic Altimeter for Fog Flying.—G.E.C. of America.

(*See* under "Directional Wireless.")

PHOTOTELEGRAPHY AND TELEVISION.

Über neue Fernsehsender und Fernsehempfänger mit Kathodenstrahlröhren (New Television Transmitters and Receivers using Cathode Ray Tubes).—M. von Ardenne. (*Fernsehen*, April, 1931, Vol. 2, pp. 65–80.)

It becomes more and more clear, says the writer, that at least 8 to 10 thousand elements are necessary to render television worth while, and this number (assuming 15–25 pictures per sec.) can only be obtained, in the case of any known mechanical system, at great cost. The use of the cathode ray tube is clearly indicated as the solution, but the writer points out the difficulties in the way even of this : of all the numerous patented schemes, only the one due to Zworykin, using special tubes, seems to have met with any successful development—at any rate on the transmitting side. In the writer's new system here described, all complicated electrode arrangements are avoided, ordinary tubes (provided with a new fluorescent screen) being used such as are employed in the Test Room. Transmitter and receiver alike use such a tube, with the advantage (beyond the abolition of moving mechanical parts) that in the experimental [wired] lay-out the two pairs of deflecting plates of transmitter and receiver can be paralleled, and synchronism thus obtained without further complication.

This parallel connection is also possible when wireless transmission is used, *since by the employment of multiple modulation* the line- and framing-voltages can be closely coupled to each other and to the light-intensity voltage and transmitted on a common carrier wave. The development of this scheme nowadays presents no fundamental difficulties.

The transmission methods in the case of the transmission of film and of diapositives are first described and illustrated. "The great brightness of the fluorescent spot and the favourable optical conditions" also make it possible to use beam scanning of the actual subject ; at present only for small subjects—but future extension lies in the use of higher anode voltages and currents.

A great improvement which is embodied in the new system is the use of a new fluorescent screen, very thin, very uniform and very sensitive. Outside the tube this new screen gives a spot brightness of about 1.2 candles for 2,300 v. and 0.87 mA. ; for 4,000 v. the brightness may attain 2-3 candles. Visually, the new screen is 8 times, photographically, 2 to 3 times, as efficient as the calcium tungstate screen. Compared with zinc silicate, it has extraordinarily small lag, a great advantage on the transmitting side; while on the receiving side the writer prefers the new screen, combined with a high picture-frequency (20–25 per sec.), to a more persistent screen and a low frequency. In this connection he mentions the desirability of choosing the picture-frequency so that it avoids being a sub-multiple of the mains frequency (these tubes, as described in previous papers, being fed from the mains) in order to prevent mains disturbances forming stationary distortions of the picture.

In a long section the writer discusses the comparative advantages and disadvantages of sine-voltage and trip-voltage scanning—pronouncing, under present conditions at any rate, in favour of the latter. He then describes his method of trip-voltage control (depending on the charging-up of a condenser and its discharge across a neon tube) in which the return stroke can be made to take place at the corner of the picture so that it does not spoil the latter: this can be done by suitably connecting the line- and framing-voltages. In film transmission the return stroke is made harmless more simply, by speeding it up by discharging the condenser with a mechanical contact worked from the film mechanism, instead of with the neon lamp.

The light-intensity control in the receiving tube is by means of the Wehnelt cylinder. For an 8 × 9 cm. picture the brightness is such that the picture can be viewed in daylight, and can be projected in a dark room to give a picture 40 × 40 cm. approx. The paper ends with some photographs of the results obtained, starting with 1,200 elements and ending with the later results with 5,000 elements. Of the distortion visible in the photographs, part is due to the picture being photographed through the glass of the tube, which contained flaws, and part to the angle at which the camera was set. It is understood that still more recently pictures of 10,000 elements have been successfully transmitted.

GEHTS MIT ULTRAKURZWELLEN? (Will Ultra-Short Waves Solve the Problem?)—M. von Ardenne. (*Fernsehen*, Jan., 1931, Vol. 2, pp. 28–31.)

In defence of his suggestion of the use of multiple r.f. modulation of an ultra-short carrier, for television purposes, against a criticism by Busse.

TELEVISION BY CATHODE RAY (FARNSWORTH SYSTEM).—A. Dinsdale. (*Wireless World*, 18th March, 1931, Vol. 28, pp. 286–288.)

A description of the new Farnsworth system in which use is made of controlled cathode rays for both transmission and reception, thus entirely eliminating mechanical scanning. The transmitter tube combines the properties of a cathode ray tube and photoelectric cell. The normal tendency of the cathode rays to spread is overcome by means of a system of coils which focus the beam and produce the necessary traverse of the image. There are two scanning frequencies, each with a saw-tooth wave, the one having a frequency of 12 cycles per second, and the other of 4,800 cycles per second. The highest fundamental picture frequency is 1,200 kc./sec.

In the receiver the incoming picture impulses are transformed into a visible image $4'' \times 2\frac{3}{4}''$ by means of a tube of the hot cathode type known as an "oscillite," scanning being performed with the aid of two sets of coils mounted at right angles as in the transmitter.

Synchronism is achieved through the agency of two saw-tooth wave forms generated at the receiver, similar to those at the transmitter. Advantage is taken of the fact that these currents can be made to induce a strong voltage pulse in the picture frequency circuit during the steep part of their slope. These pulses are used at the receiving end to hold the local generators in step and to turn off the oscillite spot during the return part of its path.

ELECTRICAL SCANNING SYSTEM FOR TELEVISION.—P. T. Farnsworth. (*Rad. Industries*, Nov., 1930, Vol. 5, pp. 387–389 and 401–403.)

PICTURE TRANSMITTER WITH CATHODE RAY TRAVERSING PICTURE FOCUSED ON PHOTO-ELECTRIC SURFACE AT NEGATIVE POTENTIAL. (Am. Pat. 1,790,898, T. W. Case.)

THE SYNCHRONISATION OF TELEVISION RECEIVERS, WITH SPECIAL REFERENCE TO THE USE OF CATHODE-RAY TUBES.—E. Hudec. (*Fernsehen*, Jan., 1931, Vol. 2, pp. 14–28.)

See also Kammerloher (simplified "relaxation oscillation" relay for synchronous time base) May Abstracts, p. 282.

PROGRESS IN TWO-WAY TELEVISION.—H. E. Ives. (*Bell Lab. Record*, Feb., 1931, No. 6, Vol. 9, pp. 262–264.)

Including an illustration of the new neon tube referred to in April Abstracts, p. 218. The small aluminium anode is screwed into a large copper cylinder, so that water cooling is not required.

QUALITY OF TELEVISION IMAGES.—D. K. Gannett. (*Bell Lab. Record*, April, 1931, No. 8, Vol. 9, pp. 358–362.)

Including photographs illustrating the comparative appearance of television images of the same three typical subjects, when 625, 1,250, 6,250 and 12,500 elements are used. The first represents what can be obtained by present methods on an ordinary broadcast band, while the last involves the employment of twenty such channels.

THE RELATIONS BETWEEN NUMBER OF ELEMENTS, SIZE OF PICTURE AND BRIGHTNESS.—Fr. Wiedemann. (*Fernsehen*, Jan., 1931, Vol. 2, pp. 8–13.)

METALLIC MIRRORS FOR SCANNING DEVICES.—W. Friedel. (*Fernsehen*, Jan., 1931, Vol. 2, pp. 1–5.)

An article on Mach's "mirror magnalium" (aluminium-magnesium alloy) which should be invaluable for such mirror devices as von Okolicsanyi's "mirror helix" referred to below.

DIE SPIEGELSCHRAUBE, EIN NEUER BILDZERLEGER (The Mirror-Helix, a New Scanning Device).—F. von Okolicsanyi. (*Fernsehen*, Oct., 1930, Vol. 1, pp. 448–452.)

See May Abstracts, p. 273 (Noack).

HIGH SPEED FACSIMILE PHOTOTELEGRAPHY SYSTEM.—I. T. and T. Laboratories. (*Elec. Review*, 3rd April, 1931, Vol. 108, pp. 588–589; *Electrician*, 3 April, 1931, Vol. 106, pp. 511–512.)

For cheap and reliable transmission of black-on-white line diagrams, printed matter, etc. Need for interrupting the scanning beam is avoided by the very high speed of scanning: even a blank sheet gives the phase-compensation signal 10 times per second, and the amplifiers are capable of passing this frequency. "The production models are expected to work at a speed equivalent to 180,000 words per hour, which is some six times faster than other known methods now in use."

FACSIMILE TRANSMISSION IN THE UNITED KINGDOM.—A. T. J. Beard. (*P.O. Elec. Eng. Journ.*, April, 1931, Vol. 24, pp. 4–5.)

Dealing with the land-line circuits. Although the present agreement between renters and the G.P.O. does not permit the *simultaneous* use of a facsimile transmission circuit for facsimile transmission and voice frequency telegraphy, experiments over circuits allocated for facsimile transmission have proved that with the use of suitable filter networks no difficulty exists in transmitting six channels of voice frequency duplex telegraphy, or two channels of voice frequency duplex telegraphy and one channel of duplex facsimile.

ON THE SUPERSENSITIVE PHOTOELECTRIC TUBE [" GRID-PHOTOELECTRIC TUBE "].—T. Asada and K. Hagita. (*Journ. I.E.E. Japan*, January, 1931, Vol. 51, pp. 25–33.)

In Japanese. Description, illustration and tests of the three-electrode cell dealt with in February Abstracts, p. 102. The grid of the triode is designed so as to have as small a capacity as possible, so that its variation of potential due to the emission of photoelectrons may be large. It is connected with the filament inside the cell, through a very high resistance. As already mentioned in the previous abstract, the sensitivity extends into the infra-red (as well as into the ultra-violet); it is here suggested that if the filament were coated with caesium oxide the cell would be sensitive also to the long infra-red wavelengths. It has no time-lag and a very long life, with constant sensitivity. The writer suggests that the introduction of a screen grid would reduce the capacity of the photosensitive grid and greatly increase the sensitivity of the cell.

PHOTOELECTRIC CELLS AND THEIR APPLICATIONS: A DISCUSSION AT A JOINT MEETING OF THE PHYSICAL AND OPTICAL SOCIETIES.—(Pub. in London, 1930, 236 pp. Summaries in *Trans. Opt. Soc.*, No. 4, Vol. 31, pp. 233–240.)

Among the many papers read, the following may be mentioned. N. R. Campbell—A Theory of Selective Photoelectric Emission, with Special Reference to Thin Films of Caesium on Silver: The Standardisation of Photoelectric Cells. Selényi—The Manufacture, Properties, and Use of Sodium Photoelectric Cells. Davies and Ruff—The Manufacture and Use of the Thin-film Caesium Cell for Sound Reproduction (Mazda caesium cell). Case—Barium Photoelectric Cells (Western Electric): The "Thalofide" Cell. Loughridge—The Manufacture of Photoelectric Cells and their Use in Sound Reproduction (including a discussion of fatigue). Kunz—Photoelectric Cells and Some Applications (including a description of a gold-caesium cell with practically uniform sensitivity throughout the visible spectrum, and a discussion of amplification with two grid valves). Campbell and Stoodley—Time-Lag in Gas-filled Cells. E. B. Moss—A Complete Electrostatic Method for the Measurement of Photoelectric Currents (using a Lindemann electrometer). G. M. B. Dobson and D. S. Perfect—A Method of Comparing Very Small Amounts of Light by means of a Photoelectric Cell and a Valve Amplifier (using a rotating mirror to alternate the two rays). N. L. Yates-Fish—A Theoretical Investigation of the Use of a Photoelectric Cell with a Valve Amplifier. H. A. Thomas—A Theoretical Study of the Amplification of Photoelectric Currents by means of Thermionic Valve Amplifiers. H. Geffcken and H. Richter—Distortion in the Amplification of Photoelectric Currents and a Remedy (*cf.* Schröter, "New Developments," and Wolfson, "Richter and Geffcken Screen-grid Photoelectric Cells," May Abstracts, p. 275). Thirring—Selenium Cells and their Use in Sound Film Reproduction. C. E. S. Phillips—The Manufacture of Selenium Cells. Schröter and Michelssen—Infra-red Sensitive Cells.

CURRENT FROM A BARIUM PHOTOELECTRIC CELL AND ITS INCREASE AT HIGH TEMPERATURES. D. Ramadanoff. (*Sci. News Letter*, 17th January, 1931, Vol. 19, p. 38.)

The current from a barium cell increased greatly as the temperature was raised, reaching a maximum at about 1,364°F. A secondary maximum at 1,040° was only found in the case of intermittent illumination. *See also* next abstract.

PHOTOELECTRIC PROPERTIES OF COMPOSITE SURFACES AT VARIOUS TEMPERATURES AND POTENTIALS.—D. Ramadanoff. (*Phys. Review*, 15th Feb., 1931, Series 2, Vol. 37, No. 4, p. 464.)

Abstract only. *See also* preceding abstract.

FORMATION OF PHOTOGRAPHIC IMAGES ON CATHODES OF ALKALI METAL PHOTOELECTRIC CELLS.—A. R. Olpin and G. R. Stilwell. (*Journ. Opt. Soc. Am.*, March, 1931, Vol. 21, pp. 177–181.)

Olpin's well-known technique for increasing the sensitivity of evacuated photoelectric cells to light, especially to light of long wavelengths, by treating the alkali metal surface with dielectrics such as sulphur, is similar to the technique for sensitising photographic plates to red and infra-red light. The close relationship thus suggested between photoelectric and photographic phenomena is supported by the behaviour of a photoelectric cell thus sensitised when the sensitising material is one of the heavier halogens: the emission of electrons excited by blue light is inhibited by the superposition of red or infra-red light, a phenomenon strikingly suggestive of the destruction of latent images on photographic plates by infra-red light. A still further analogy is described in the present paper: the possibility of forming positive and negative images, sharp and clear in every detail, on the cathodes of potassium and sodium photoelectric cells (vacuum type); these images can be permanently "fixed" by proper treatment. Materials successfully used to bring out these images include sulphur vapour, hydrofluoric acid, bromine, air, etc.

THE EFFECT OF THE TEMPERATURE DEPENDENCE OF THE WORK FUNCTION ON A AND b IN RICHARDSON'S EQUATION.—J. A. Becker and W. H. Brattain. (*Phys. Review*, 15th Feb., 1931, Series 2, Vol. 37, No. 4, pp. 462–463.)

Abstract only.

ÜBER DIE TEMPERATURABHÄNGIGKEIT DES SPERRSCHICHTPHOTOEFFEKTES (On the Variation with Temperature of the Attenuation Layer Photoelectric Effect).—H. Teichmann. (*Physik. Zeitschr.*, 1st March, 1931, Vol. 32, No. 5, p. 216.)

A note of a demonstration experiment showing the mode of dependence of the photoelectric current on the temperature (*cf.* Abstracts, May, p. 274, and February, p. 103).

CORRELATING THE SELECTIVE PHOTOELECTRIC EFFECT WITH THE SELECTIVE TRANSMISSION OF ELECTRONS THROUGH A CATHODE SURFACE —A. R. Olpin. (*Phys. Review*, 15th Feb., 1931, Series 2, Vol. 37, No. 4, pp. 464–465.)

Abstract only.

DIE LICHTELEKTRISCHE ELEKTRONENEMISSION AN DÜNNEN KALIUM- UND CAESIUMSCHICHTEN (The Emission of Photoelectrons from Thin Potassium and Caesium Layers).—R. Fleischer. (*Physik. Zeitschr.*, 1st March, 1931, Vol. 32, No. 5, pp. 217–218.)

ÜBER DEN AUFBAU DER EMITTIERENDEN OBERFLÄCHE BEIM SELEKTIVEN LICHTELEKTRISCHEN EFFEKT (On the Constitution of the Emission Surface in the Selective Photoelectric Effect).—R. Suhrmann. (*Physik. Zeitschr.*, 1st March, 1931, Vol. 32, No. 5, pp. 216–217.)

ÜBER DEN ÄUSSEREN LICHTELEKTRISCHEN EFFEKT AN PHOSPHOREN UND SEINE ABHÄNGIGKEIT VOM ERREGUNGSZUSTAND (On the External Photoelectric Effect in Phosphorus in Various States and its Mode of Dependence on the Excitation Condition).—Hildegart Göthel. (*Physik. Zeitschr.*, 1st March, 1931, Vol. 32, No. 5, pp. 218–219.)

THE EFFECT OF THE PRESENCE OF COLLOIDAL SUBSTANCES ON THE BREAK-DOWN VOLTAGE OF INSULATING LIQUIDS.—P. Böning. (*Zeitschr. f. tech. Phys.*, April, 1931, Vol. 12, pp. 200–202.)

SPECIAL GLOW DISCHARGE LAMPS FOR TELEVISION. — —. Michelssen. (*Funk*, 30th Jan., 1931.)

In an article on glow-discharge lamps and their technical uses, the writer deals with special types for television, including the Leithauser lamp with hollow tubular cathode, using the anode glow and giving a blue-white light, and the Schröter-Ewest type using the glow within a ring-shaped anode, and provided with a heated cathode to reduce the working voltage.

APPLIED OPTICS, PAPERS ON.—Straubel, Joachim, Göler and Pirani, Picht, Jentzsch and Nähring, and others. (*Zeitschr. f. tech. Phys.*, March, 1931, No. 3, Vol. 12, pp. 129–189.)

Subjects dealt with in this special number include the illumination of screens by lens systems, the conduction of light- and X-rays through tubes, etc., etc.

MEASUREMENTS AND STANDARDS.

MEASUREMENT OF RESISTANCE AND IMPEDANCES AT HIGH FREQUENCIES [TRANSMISSION LINE METHOD AND LUMPED CIRCUIT METHOD].—J. W. Labus. (*Proc. Inst. Rad. Eng.*, March, 1931, Vol. 19, pp. 452–460.)

Author's summary:—It is well known that the resistance of a conductor increases with frequency. At very high frequencies the usual methods of measurement fail, especially if the unknown resistance is more than about one hundred ohms.

In the following it is shown that the absolute value of the unknown impedance, when put across the end of a transmission line, is a simple function of the ratio of the currents, measured at the beginning and the end of a transmission line.

This method has been tested out at a wavelength of 21.8 metres, measuring the resistance of a number of grid leaks and of a decade box. The a-c resistance was considerably higher than the labelled d-c value. At the same time, the shunted capacity across the resistors has been measured and values have been obtained which agree with expectations.

In general, this method lends itself to measurement of impedances of any kind; but it only gives the absolute value of the unknown impedance. However, by means of a known capacity or resistance, connected in series or in parallel with the impedance to be determined, the phase of the latter and, therefore, its real and imaginary components are found.

At frequencies corresponding to wavelengths longer than 100 metres the line becomes rather long. In this case another method, as described in the second part of this paper, can be applied. The procedure of the measurement is quite similar to that of the first method; however, the line is replaced by a lumped circuit, consisting of a coil and two condensers.

While the second method works very accurately at frequencies at which the inductance and capacity of the leads can be neglected, the method using the transmission line is preferable at wavelengths less than about 150 metres.

THE HIGH-FREQUENCY RESISTANCE OF COILS: NOVEL METHODS OF MEASUREMENT.—A. L. Green. (*E.W. & W.E.*, April, 1931, Vol. 8, pp. 183–191.)

Author's summary: "It is shown that there are methods of measuring the h.f. resistance of coils which do not require the use of a thermo-junction and calibrated resistances. These methods depend on the condition for oscillation in a triode assembly, and the simplest of them uses the dynatron oscillator. Experimental results show that the condition-for-oscillation procedure can be made to compare favourably with resistance-variation as regards accuracy, and, in the case of the dynatron, there is the advantage that numbers of measurements over a range of wavelengths can be made in a short time." The paper ends with some notes showing how the experimental solution of a design problem, involving the leakage-conductance term b/λ^2 of the Butterworth r.f. resistance equation, can be much simplified by such a method.

RESONANT IMPEDANCE AND EFFECTIVE SERIES RESISTANCE OF HIGH-FREQUENCY PARALLEL RESONANT CIRCUITS [MEASURED BY "DYNATRON OSCILLATOR" METHOD, APPLICABLE TO ULTRA-HIGH FREQUENCIES].—Iinuma. (*See* under "Properties of Circuits".)

APPLICATION OF THE DYNATRON TO THE MEASUREMENT OF DIELECTRIC LOSSES.—H. Iinuma. (*Journ. I.E.E. Japan*, January, 1931, pp. 11–14.)

In Japanese. An extension of the work referred to in the preceding abstract. The method requires no instruments for measuring r.f. currents or voltages, etc., and is therefore very suitable for short waves where the substitution method may encounter serious difficulties. The writer describes tests at 20 megacycles, using 5 screen-grid valves in parallel as a dynatron. The setting-in of oscillation was detected by means of a heterodyne receiver, and the negative resistance was measured with d.c. instruments. Results obtained with some commercial insulating materials are tabulated.

A METHOD OF COMPARING AMMETERS AT VERY HIGH FREQUENCIES.—C. L. Fortescue and L. A. Moxon. (*Journ. Scient. Instr.*, March, 1931, Vol. 8, pp. 94–97.)

Authors' abstract:—"Considerable difficulty has been experienced in comparing ammeters at frequencies above one million cycles per second with a reasonable degree of accuracy. Means of overcoming these difficulties are described, and the final arrangement is reliable up to frequencies of 100 million to within an accuracy of 2 per cent."

The writer points out that the ordinary symmetrical arrangement with the junction of the ammeters directly earthed is not satisfactory in practice. If, as is usually the case with high-frequency ammeters, the current-measuring element is completely screened, the errors can be considerably reduced by earthing the elements (on the "live" side) through balancing condensers; a valve voltmeter, connected between earth and a point on the wire joining the elements and their screens on the "dead" side, is used for preliminary adjustment and then removed. This arrangement is satisfactory for frequencies up to about 10 million; but above this, errors are introduced by the inductance of the wire joining the elements and their screens on the "dead" side. In the final arrangement these errors are greatly reduced by cutting down the length of the connecting wire, and errors due to the capacity to earth of the screens are diminished by reversing the ammeters so that their screens are on the "live" side, earthed through the balancing condensers.

A NEW METHOD OF MEASUREMENT OF RESISTANCE AND REACTANCE AT RADIO FREQUENCIES.—F. M. Colebrook and R. M. Wilmotte. (*Journ. I.E.E.*, April, 1931, Vol. 69, pp. 497–506: Discussion, pp. 518–522.)

The full paper, a summary of which was dealt with in May Abstracts, p. 277. A note added since the paper was written mentions that dynatron oscillators have been substituted for the triode oscillators, for frequencies below 10^7 c.p.s., since they are found superior in constancy of frequency with respect to variation of oscillatory circuit resistance. "Unfortunately the dynatron circuit does not oscillate readily at frequencies higher than this."

MEASUREMENT OF POWER AND EFFICIENCY OF RADIO TRANSMITTING APPARATUS.—G. Pession and T. Gorio. (*Proc. Inst. Rad. Eng.*, March, 1931, Vol. 19, pp. 377–400.)

Authors' summary:—This paper reports the various methods and results of the measurement of power and efficiency in radio transmitting apparatus.

High-frequency power measurements are classified as wattmeter, ammeter, calorimeter and indirect methods. The high-frequency wattmeter method and the methods based on the current and resistance measurements are briefly discussed. The direct and indirect calorimeter methods are upheld by the authors on account of their advantages, which are enumerated.

The experimental results employing calorimeter methods for direct and indirect power measurement are quantitatively reported and the degree of precision obtainable in practical applications is shown.

EIN OBERWELLEN-VOLTMETER (A Voltmeter for Harmonics).—R. Oetker. (*Zeitschr. f. tech. Phys.*, April, 1931, Vol. 12, pp. 205–210.)

In order to measure the "klirr" factor (distortion factor, given by the ratio of the effective value of all the harmonics to the effective value of the fundamental) the harmonics must be measured as a whole. To do this, the fundamental must be eliminated; this can easily be done by a high-pass filter, but ordinarily the transmission ratio (input voltage/output voltage) will be different for the different component harmonics, and the result valueless—since the proportions of the various harmonics are not known. The circuit, therefore, must be arranged so that the transmission ratio is constant for all the harmonics—a problem often giving great trouble.

The present paper shows how this may be achieved, with the result that a simple and accurate arrangement can be designed, direct reading and, if desired, self-registering. The method depends on suppressing the reflection phenomena, which are responsible for the variation of transmission ratio, by means of an asymmetrical quadripole (the "Hoyt" link of Strecker and Feldtkeller) connected between the filter and the voltmeter. In the example taken, this gives an almost horizontal transmission curve between about 150 and 360 p.p.s.

APPAREILS DE MESURES ÉLECTRIQUES À CADRE MOBILE DANS UN CHAMP UNIFORME (Electrical Measuring Instruments with Moving Coil in a Uniform Field).—G. Dupouy. (*Comptes Rendus*, 23rd March, 1931, Vol. 192, pp. 734–737.)

Instead of using a radial magnetic field so as to produce a uniform sensitivity throughout the scale, a uniform (parallel) field may be used which will give maximum sensitivity where it is most needed. Satisfactory damping is obtained by a second ring at right angles to the usual damping ring on which the coil is wound.

ÜBER DEN FREQUENZGANG VON WECHSELSTROM-MESSINSTRUMENTEN MIT TROCKENGLEICH-RICHTERN (The Frequency-dependence of A.C. Instruments embodying Dry-plate Rectifiers).—E. Hormann. (*Zeitschr. f. tech. Phys.*, April, 1931, Vol. 12, pp. 222–224.)

The behaviour of rectifier meters with regard to frequency: the correction of frequency errors: explanation of the positive frequency error. *Cf.* Feldtkeller and Kerschbaum, Abstracts, March, p. 163: Sahagen, May, p. 279.

PHOTOMETRIC MEASUREMENT OF SMALL ALTERNATING POTENTIALS.— –. Haak. (*Funk*, 16th January, 1931.)

The potential to be measured is applied to a small electric lamp (protected if necessary by a series resistance) and the resulting illumination equalised, by an auxiliary lamp, with that given by the same lamp fed by d.c. of measured potential. It is said that with practice the error is only 1 %.

NEW SUSPENSION, PARTICULARLY FOR PORTABLE INSTRUMENTS.—A. J. Lush. (*Rad. Engineering*, March, 1931, Vol. 11, pp. 28 and 30.)

The principle of balancing the whole of the movement weight on one central pivot is retained, another pivot being added at the bottom to act as a guide which is always in contact at its extreme point with the apex of the jewel bearing. This result is obtained by supporting the lower jewel on a very resilient but weak spring incapable of supporting the weight of the movement, or of moving laterally. The arrangement allows the movement to be clamped for transport, as in the older type.

PIEZOELEKTRISCHE QUARZOSZILLATOREN (Piezo-electric Quartz Oscillators).—H. Straubel. (*Physik. Zeitschr.*, 1st March, 1931, Vol. 32, No. 5, p. 222.)

A suggestion that rectangular piezoelectric quartz oscillators should be cut so that the directions of the geometrical boundary coincide with the directions of the natural elasticity of the crystal. The calculated and natural oscillation frequencies of crystals cut in this way agree to a few parts in a thousand and the oscillation follows the geometrical boundary. The nodal lines may be demonstrated experimentally by lycopodium powder.

In the case of crystals with curved boundaries (hitherto cut in the form of a circle), it is advisable to make the distance from the centre of the boundary points proportional to the square roots of the moduli of elasticity of the corresponding directions. Such a crystal will possess a uniform oscillation frequency at all points in its plane.

AN ANALYSIS OF A PIEZO-ELECTRIC OSCILLATOR CIRCUIT.—L. P. Wheeler. (*Proc. Inst. Rad. Eng.*, April, 1931, Vol. 19, pp. 627–646.)

". . . Up to the present time, all of the studies of this nature which have appeared, although yielding important information as to the functioning of these circuits, have been limited as to quantitative results by the (explicit or implicit) assumption of a linear 'characteristic' for the thermionic vacuum tube. In this paper an attempt is made to remove this restriction. The method of attack is that used by Appleton and van der Pol in their study of the phenomena of 'oscillation hysteresis' in the simple tuned plate self-oscillating circuit, and is an adaptation to circuit problems of the 'perturbation' methods of mathematical astronomy."

The principal results are contained in an expression giving the resulting a.c. plate voltage as a function of the plate tuning capacity and the valve and circuit parameters. The limitations of the analysis are discussed.

CHARACTERISTICS OF GAP-LESS QUARTZ HOLDERS.—S. Matsumara and K. Hatakeyama. (*Journ. I.T.T.E. Japan*, December, 1930, p. 1264.)

In Japanese. With special reference to short waves. No mechanical resonance phenomena were found on varying the thickness of the upper electrode. Variations in weight and area of upper electrode, and in the position of the quartz plate with respect to the electrodes, gave a variation in frequency of a few parts in 100,000. The quartz did not break when used in a push-pull oscillator with 5-watt valves operated at 10 % overload.

BEITRAG ZUR SCHAFFUNG EINER ZEITNORMALE ÄUSSERSTER KONSTANZ (Contribution to the Creation of a Time Standard of Extreme Constancy).—O. Meisser and H. Martin. (*Physik. Zeitschr.*, 15th March, 1931, Vol. 32, No. 6, pp. 233–243.)

Discussion of a procedure capable of comparing two periodic processes with an error of a few ten-millionths, in the space of about 10 minutes. It is based on the work of Schuler (1930 Abstracts, pp.

52 and 167) combined with the photographic coincidence method due to Martin of Jena.

B.B.C. Time Signal and the Moon.—F. Addey. (*Wireless World*, 4th March, 1931, Vol. 28, pp. 228–230.)

A short account of the use of the transit telescope at Greenwich Observatory to obtain standard time, and a description of the standard clock.

Standard Frequency Station W1XP: the Key Station of the A.R.R.L. Standard Frequency System.—H. A. Chinn. (*QST*, Jan. 1931, Vol. 15, pp. 27–36.)

A Variable-Capacitance Cylindrical Condenser for Precision Measurements, and a Wavemeter for Short Wavelengths.—E. B. Moullin. (*Journ. I.E.E.*, April, 1931, Vol. 69, pp. 507–518: Discussion, pp. 519–522.)

The full paper, a summary of which was dealt with in May Abstracts, p. 277. In the discussion, Gill suggests that practically the only undesirable feature is the irregular scale, but Moullin proposes now to make instruments with rotors so shaped as to give a more uniform scale.

The Dynatron Frequency Meter.—G. Grammer. (*QST*, October, 1930, Vol. 14, pp. 9–19.)

Force Between Unequal Reactance Coils Having Parallel Axes.—H. B. Dwight and R. W. Purssell. (*Gen. Elec. Review*, July, 1930, Vol. 23, p. 401.)

The formula for the mutual inductance of the two coils is given, from which the force formulae are derived. A formula in zonal harmonics is also derived for the axial component of the magnetic field near a thick solenoid.

The Magnetic Field of a Circular Cylindrical Coil [Mathematical Calculation].—H. B. Dwight. (*Phil. Mag.*, April, 1931, Series 7, Vol. 11, No. 72, pp. 948–957.)

Formulae are given for the magnetic field of a circular cylindrical coil which cover nearly all the field except a region near the section of the coil.

On Formulae for the Impedance of Oscillatory Circuits.—A. I. Drodjin. (*Westnik Elektrol., Leningrad*, No. 1, 1931, Part I, pp. 22–26.)

Units used to express the Wave Lengths of Electromagnetic Waves.—H. D. Hubbard. (*Bur. of Stds. Miscell. Pub.*, No. 117, 24th Nov., 1930, 4 pp.)

Beschlüsse der Internationalen Elektrotechnischen Kommission (IEC) über Grössen und Einheiten (Resolutions of the International Electrotechnical Commission [I.E.C.] on Magnitudes and Units).—(*Physik. Zeitschr.*, 1st March, 1931, Vol. 32, No. 5, pp. 230–231.)

SUBSIDIARY APPARATUS AND MATERIALS.

Die Verwendung des Kathodenstrahloszillographen zur Aufnahme raschest verlaufender Vorgänge (The Use of the C.-R. Oscillograph for Recording Very Rapid Processes).—W. Krug. (Dresden Dissertation: for Summary *see Physik. Ber.*, 1st March, 1931, Vol. 12, pp. 519–520.)

The writer first emphasises the importance of preventing the natural period of the oscillograph circuits (deflecting plates and their leads, etc.) from affecting the response to very rapid processes: series resistances are impracticable, so he examines theoretically the damping effect of resistances in parallel with the plates and shows them to be effective. By suitable arrangement of the cut-out and time systems then described, the ray can be brought into action within 10^{-8} sec. After discussing the possibilities and variations of these circuits, the writer gives examples of spark discharge oscillograms taken at unprecedentedly high recording speed. He goes deeply into his contention that the "steps" found by other workers in discharges at atmospheric pressure are due to the above-mentioned influence of the natural circuit frequencies.

Refinements in Linear Time-Scale for Cathode Ray Oscillograph.—F. Bedell. (*Journ. Opt. Soc. Am.*, March, 1931, Vol. 21, pp. 142–143.)

Summary only. Any tendency for the time-scale to be distorted, shown by a pinching together of successive wavelengths at left or right, is corrected by a biasing or equalising voltage applied to the amplifying valve for the time-scale. For higher accuracy still, a remaining error due to a cloud of ions between the deflecting plates (affecting the vertical as well as the horizontal scale) may be avoided by applying a bias to the plates themselves. *See* also January Abstracts, p. 51.

Das Braunsche Rohr als Lichtquelle (The C.-R. Tube as Source of Light).—W. Rogowski and E. Rühlemann. (*Arch. f. Elektrot.*, No. 5, Vol. 24, pp. 691–692.)

A short note on the luminous output of a Rogowski-Flegler-Tamm oscillograph tube. At 55 kv. potential and a recording current strength of 75 mA., the value found was 35 Lumen/Watt, for a Buchler zinc sulphide screen; the writers do not think that any much greater value can be expected with any other material.

Linear Time Scale for Voltage Range up to 1,000 Volts.—C. K. Stedman. (*Phys. Review*, 15th Feb., 1931, Series 2, Vol. 37, No. 4, pp. 474–475.)

Abstract only. A circuit for a linear time base using a Thyratron valve is described.

Current Oscillograms of the Surge Generator of the High-Voltage Laboratory of the Electro-Institute.—I. S. Stekolnikov. (*Westnik Elektrot., Leningrad*, No. 1, 1931, Part II, pp. 5–6.)

A circuit is described for the cathode-ray oscillograph study of the high-voltage surge generator. Two oscillograms showing the discharge current are given.

A Note on the Timing of Electrically Independent Transient Circuits for High-speed Oscillographic Work.—L. B. Snoddy and J. C. Street. (*Gen. Elec. Review*, April, 1931, Vol. 34, pp. 258–259.)

The use of ultra-violet light from an auxiliary gap to "trip" the discharge in a 450 kv. impulse circuit.

Experiments on the Catching-up of Atoms in a Magneto-cathodic or Cathodic Beam.—Henriot, Goche and D.-Hénault.

(*See* under "Miscellaneous.")

Surface Charge Figure (Dust [Lichtenberg] Figure) and its Applications.—Y. Toriyama. (*Tech. Rep. Tôhoku Univ.*, No. 4, Vol. 9, 1931, pp. 1–19.)

See 1930 Abstracts, p. 346.

A Radio Method for Synchronizing Recording Apparatus.—T. Parkinson and T. R. Gilliland. (*Proc. Inst. Rad. Eng.*, March, 1931, Vol. 19, pp. 335–340; *Bur. of Stds. Journ. of Res.*, Feb., 1931, Vol. 6, pp. 195–198.)

Each recorder drum is driven by a synchronous motor of the type used for clocks; the control station has its transmitter modulated by the same 60-cycle supply which drives its own clock. Synchronisation over 16 km. was satisfactory with one 250-watt valve at the transmitter. A method is described for marking the records simultaneously so that they can be superposed.

Mercury Arc Rectifiers for Radio Transmitters.—R. H. Osborn. (*Electric Journal*, Feb., 1931, Vol. 28, pp. 123–124.)

Description of a 30 A., 7,500 V. rectifier of the mercury pool type, designed for KDKA's new broadcasting station.

Mercury-arc Power Rectifier Auxiliaries and Accessories.—E. S. Waterman. (*Gen. Elec. Review*, April, 1931, Vol. 34, pp. 228–234.)

Propriétés Électriques du Contact Métal-Sulfure de Cuivre (Electrical [Rectifying] Properties of the Metal—Copper Sulphide Contact).—J. Cayrel. (*L'Onde Élec.*, Feb., 1931, Vol. 10, pp. 72–80.)

Author's summary:—Researches [are described] which go to show that the rectifying phenomena previously observed by the writer in samples of artificially-formed Cu_2S should actually be attributed to a mixture Cu_2S + impurity CuS. This mixture possesses a mixed conductivity, pure Cu_2S being an ionic conductor and CuS a metallic conductor.

The admirable researches of M. Pélabon [Feb. Abstracts, p. 110] on the copper oxide rectifier confirm the results obtained by the writer in the case of the sulphides, in so far as the sulphides and oxides of copper are comparable and in spite of the profound differences separating the two cases (a mixture, as compared with a system of layers of clearly defined chemical composition).

New Selenium [Rectifier] Cell. (*Wireless World*, 15th April, 1931, Vol. 28, p. 398.)

Description (with illustration) of a new dry plate selenium rectifier produced by the South German Apparatus Works.

Sur la Résistivité Électrique du Silicium (The Electrical Resistance of Silicon).—Ch. Bedel. (*Comptes Rendus*, 30th March, 1931, Vol. 192, pp. 802–804.)

The writer has succeeded in making good electrical contact with pure silicon and thus in determining the resistance of the element. The great effect produced by a small iron content is brought out in these results.

Variations with Temperature and Frequency of Dielectric Loss in a Viscous, Mineral Insulating Oil.—H. H. Race. (*Phys. Review*, 15th Feb., 1931, Series 2, Vol. 37, No. 4, pp. 430–446.)

The Losses in Variable Air Condensers.—W. H. F. Griffiths. (*E.W. & W.E.*, March, 1931, Vol. 8, pp. 124–126.)

In wireless work the losses of a condenser have usually to be added to those of an associated inductance. The losses of the inductance are conveniently stated collectively as effective (series) resistance at a given frequency. It is therefore convenient also to collect the three forms of condenser loss into one quantity—the effective resistance—which may be added arithmetically to that of the inductance and to any other associated resistance. The writer shows that this complete expression for the effective resistance of a condenser is $R = R_s + \frac{\alpha}{\omega C^2} + \frac{1}{\beta\omega^2 C^2}$, where R_s is the actual conductor resistance (varying but little over a wide range of frequencies), α is a constant proportional to the power-loss factor of the insulating material, and β is a constant (the insulation resistance).

The value R will not, however, convey at a glance the quality of the condenser: a much truer idea of the efficiency of the essential components of an oscillatory circuit (whether condensers or inductances) is given by a statement of the ratio of resistance to reactance, *i.e.*, by the power-factor. A number of curves are given showing the effect, on the power-factor of a variable air-condenser, of dielectric loss, series and parallel resistance, and of varying frequency in the presence of a high series resistance somewhere in the conductor systems and a low insulation resistance. The series resistance is appreciable for frequencies above 10^4 per sec. and the parallel resistance becomes appreciable for frequencies below this. A final diagram shows that for every setting of an ordinary variable air condenser (not a special low-loss design) *there is a particular frequency or range of frequencies* at which the dielectric loss of the solid insulating material is not increased to any serious extent either by high conductor resistance or faulty insulation resistance.

THE STABILITY OF IMPREGNATING COMPOUNDS IN ELECTRICAL FIELDS.—S. S. Gorodezky and V. A. Karassev. (*Westnik Elektrot., Leningrad*, No. 11/12, 1930, Part II, pp. 176–187.)

The method here described for testing the stability of viscous and liquid insulating materials depends on the increase in the emanation of heat at the moment of change. Data, thus obtained, are given for a series of materials for cable impregnation.

THE PERMITTIVITY AND POWER FACTOR OF MICAS. —C. Dannatt and S. E. Goodall. (*Journ. I.E.E.*, April, 1931, Vol. 69, pp. 490–496.)

Authors' summary :—Attention is drawn to the electrode difficulty in testing mica, and tests are described which show the order of contact effect which may be obtained with ordinary mercury electrodes. Means are described by which electrode contact effect with mica may be entirely eliminated, and test results are given proving this point. Finally, test results on the power factor and permittivity of ruby, green, and amber micas are given, together with the variations produced by changes of stress and temperature. It is shown that over the range of samples tested, the properties of each grade lie within close limits, but that the properties are widely different for the different grades.

THE EFFECT OF THE PRESENCE OF COLLOIDAL SUBSTANCES ON THE BREAKDOWN VOLTAGE OF INSULATING LIQUIDS.—P. Böning. (*Zeitschr. f. tech. Phys.*, April, 1931, Vol. 12, pp. 200–202.)

THE DESIGN OF RADIO-FREQUENCY SIGNAL GENERATORS.—J. R. Bird. (*Proc. Inst. Rad. Eng.*, March, 1931, Vol. 19, pp. 438–451.)

A discussion of the general layout of oscillator, attenuator and receiver so that stray voltage errors may be avoided. "The importance of accounting for all circuit details, particularly of wiring elements, is stressed. The impedances of certain connections, particularly of the output connections from generator to measured receiver, are shown to be important. Shielding is considered in some detail."

AMERICAN STANDARD SPECIFICATIONS FOR DRY CELLS AND BATTERIES.—Bureau of Standards. (*Bur. of Stds. Circular*, No. 390, 9 pp.)

EXPERIMENTAL RESEARCHES ON THE PHYSICAL PROPERTIES OF COLD-DRAWN THIN IRON WIRES.—M. M. Tschetwerikowa. (*Westnik Elektrot., Leningrad*, No. 11/12, 1930, Part III, pp. 149–164.)

A THERMOMETER FOR PRECISION CALORIMETRY.— T. C. Sutton. (*Journ. Scient. Instr.*, March, 1931, Vol. 8, pp. 98–103.)

AN AUTOMATIC RECORDING CAMERA FOR DISCONTINUOUS OPERATION.—C. G. Sumner. (*Journ. Scient. Instr.*, March, 1931, Vol. 8, pp. 104–109.)

A VACUUM-TUBE TIME SWITCH.—W. K. Kearsley. (*Gen. Elec. Review*, Feb., 1931, Vol. 34, pp. 128–129.)

Depending on the leakage-time of a condenser : two Thyratrons are used, with a glow tube to limit the charge in the condenser.

MEASUREMENT OF EXTREMELY LOW PRESSURES BY THE IONISATION-MANOMETER.—R. Sewig. (*Zeitschr. f. tech. Phys.*, April, 1931, Vol. 12, pp. 218–221.)

MAGNIFYING MECHANISM SUITABLE FOR THERMOSTATIC CONTROL.—Erb. (*See* abstract under "Miscellaneous.")

VARIABLE HIGH RESISTANCE GRID LEAKS.— W. E. Boyd. (*Nature*, 4th April, 1931, Vol. 127, pp. 521–522.)

A letter advocating the use of suitable photoelectric cells, connected as described, as very high resistances ; they can also be made to act with controlled variability as variable grid leaks.

FILAMENT TRANSFORMER.—H. B. Dent. (*Wireless World*, 8th April, 1931, Vol. 28, pp. 372–373.)

Constructional details and winding data for the quick assembly of small transformers.

STATIONS, DESIGN AND OPERATION.

EUROPEAN AVIATION RADIO.—G. C. Gross : L. M. Hull. (*Proc. Inst. Rad. Eng.*, March, 1931, Vol. 19, pp. 341–352.)

Gross (Federal Radio Commission) gives a brief account of the subject, based on observations made on an inspection trip over the major European airways. "The direct communication with aircraft has been perfected to a highly efficient degree at all the major airports of Europe, considering the scarcity of frequencies and the congestion and interference that must inevitably result when several aircraft are in the air at one time in the same locality." "The use of high frequencies for aviation radio in Europe is still in a highly experimental stage."

In the subsequent discussion, Hull says that the European transport companies have paid the penalty of the pioneer in that the ground-work of their safety communications systems was laid before practical operating knowledge was available on methods which are extensively used in America. However, "it is probably true that the American system of aviation radio, under existing conditions, is less useful to the individual flying his own airplane than the European system under complete government ownership."

AIRCRAFT RADIO DEVELOPMENT.—Bell Laboratories. (*Bell Lab. Reprint*, 27 pp.)

Reprint of a series of articles in Bell Laboratories Record, presenting a connected story of the development of the Western Electric aircraft radio equipment.

ULTRA-SHORT WAVE WORKING IN MOSCOW AND SUBURBS.—Shmakov. (*See* abstract under "Propagation of Waves.")

TELEPHONY ON 18 CENTIMETRES.—I.T. and T. Laboratories. (*Wireless World*, 15th April, 1931, Vol. 28, pp. 392–394.)

Describing the demonstration of telephony on an 18-centimetre wavelength between Dover and Calais, carried out by the International Telephone and Telegraph Laboratories on 31st March, 1931, in co-operation with the Laboratories of Le Matériel Téléphonique, of Paris.

The transmitting and receiving instruments each employ a paraboloidal reflector some 10ft. in diameter from which the waves are radiated in a narrow beam accurately directed on the distant receiver. The radiation system, or doublet, is about two centimetres in length and is connected by a short transmission line to a "micro-radion" valve employed for generating the r.f. oscillations. The radiated power is of the order of half a watt.

It is necessary to have virtual optical visibility between the transmitter and receiver. *See* also *Nature*, 11th April, 1931, p. 564; *Engineer*, 10th April, 1931, p. 413.

SYNCHRONIZED [COMMON WAVE] BROADCASTING SUCCESSFUL IN SIX-MONTH TEST.—(*Sci. News Letter*, 17th January, 1931, Vol. 19, p. 39.)

Deals with the recent tests on synchronising WHO and WOC, referred to in May Abstracts. In addition to a "newly developed crystal control that is much more precise than older devices of the same kind," an adjustment is made every 15 minutes under the advice of a monitoring station about half way between the two stations. One complete revolution of the control dial varies the WOC carrier frequency only by one part in a million.

RADIATION MEASUREMENTS OF KLAGENFURT, LINZ, STUTTGART AND WITZLEBEN BROADCASTING STATIONS.—Thomson and Thierer. (*See* abstract under "Propagation of Waves.")

PAUSEN UND ZEITANGABEN (Interval Signals and Time Signals [in Broadcasting]).—K. Bangert. (*Zeitschr. f. Fernmeldetech.*, 30th December, 1930, Vol. 11, pp. 184–185.)

NEW WAVE-CHANGES, NEW BROADCAST STATIONS, INTERVAL SIGNALS, ETC. (*Rad., B., F. f. Alle*, April, 1931, pp. 190–192.)

Referring to the cock-crow interval signal of "Radio-Béziers," the writer hopes that the disastrous experience of the Dutch short-wave station will not be repeated; a cock was brought before the microphone and throughout the Dutch East Indies, in the small hours of the morning, every cock awoke and joined in.

CIRCUIT EQUIPMENT FOR PROGRAM DISTRIBUTION. —R. A. Leconte. (*Bell Lab. Record*, Jan., 1931, Vol. 9, pp. 233–237.)

Problems encountered in the design of repeater equipment and loading for programme circuits.

TEN YEARS OF BROADCASTING.—C. W. Horn. (*Proc. Inst. Rad. Eng.*, March, 1931, Vol. 19, pp. 356–376.)

The writer is General Engineer, National Broadcasting Company, New York. He finishes his review by advocating a general increase in power. "We must overcome the belief existing at present, that even 50,000 watts is high power, and train our minds to think correctly in hundreds of kilowatts."

STANDARD FREQUENCY STATION W1XP OF THE A.R.R.L. SYSTEM.—H. A. Chinn. (*QST*, Jan., 1931, Vol. 15, pp. 27–36.)

ACCURATE RADIO FREQUENCY TRANSMISSIONS ON 5,000 KC.—Notes from the U.S. Bureau of Standards. (*Journ. Franklin Inst.*, April, 1931, Vol. 211, No. 4, pp. 511–512.)

In the improved type of standard frequency transmission upon 5,000 kc/s already announced, signals are now transmitted from 1.30 to 3.30 and 8.00 to 10.00 p.m., American eastern standard time, three Tuesdays in the month. The transmitting set is in a temporary location at College Park, Maryland.

The present antenna system is a horizontal dipole one-eighth wave-length above the ground. The power in it is less than 200 watts but signals have been utilised more than 2,000 miles away.

Reports on the reception of signals in various localities are asked for; the information desired includes time of reception, approximate field intensity, and degree of fading. The accuracy of the transmissions is within one part in a million. Rapid expansion of the service is planned.

THE RADIO TELEPHONY TERMINAL.—W. H. Scarborough. (*P.O. Elec. Eng. Journ.*, April, 1931, Vol. 24, pp. 53–58.)

The London Radio Telephony Terminal here dealt with is at present the technical control point for seven commercial channels—one long wave and three short wave circuits between Europe and the U.S.A., Canada, Cuba and Mexico; one short wave service to Australia, by which through connections can also be made from America to Australia; one short wave Marine Telephony service to certain ships on the Atlantic routes; and one short wave service to S. America.

GENERAL PHYSICAL ARTICLES.

MÉCANIQUE QUANTIQUE DES CHOCS DE SECONDE ESPÈCE (Quantum Mechanics of Collisions of the Second Kind).—L. Goldstein. (*Comptes Rendus*, 23rd March, 1931, Vol. 192, pp. 723–734.)

A POINT OF ANALOGY BETWEEN THE EQUATIONS OF THE QUANTUM THEORY AND MAXWELL'S EQUATIONS.—M. Fahmy. (*Proc. Phys. Soc.*, 1st March, 1931, Vol. 43, Part 2, pp. 124–126.)

Author's abstract:—It is known that there is a close analogy, exhibited by the use of five-dimensional tensor notation, between the electromagnetic equations in free space and the first and second-order equations of the quantum theory. In the present paper an analogy is traced between two tensors, one of which is related to the magnetic and electric moments of a doublet while the other represents the electric and magnetic field-strengths.

ELEMENTARY LIGHT QUANTUM.—E. Klein. (*Zeitschr. f. Phys.*, No. 5/6, Vol. 64, pp. 431–438.)

If only one kind of light quanta exists for all frequencies, the colour of the light depending on the number of quanta emitted per second, the phenomena of reflection, interference, Doppler and Compton effects can be explained. Certain difficulties arise in the case of refraction.

THE VELOCITY OF LIGHT.—Gheury de Bray.

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

THE ROLES OF DISCRETE AND CONTINUOUS THEORIES IN PHYSICS.—A. Ruark. (*Phys. Review*, 1st Feb., 1931, Series 2, Vol. 37, No. 3, pp. 315–326.)

The writer aims at showing how physical facts can be formulated by the use of difference calculus, that is, essentially with the aid of rational numbers. A method is outlined by which experimental results in dynamics or electrodynamics may be described mathematically, without any implications concerning the state of a system at times when it is not being observed, or concerning the causal connections customarily implied by the use of continuous analysis.

APPLICATION OF GAUSS'S THEOREM AND COULOMB'S LAW TO THE SURFACES OF SEPARATION IN DIELECTRICS.—A. K. Kotelnikoff. (*Rev. Gén. de l'Élec.*, 14th Feb., 1931, Vol. 29, pp. 264–267.)

RESEARCHES ON THE THERMODYNAMICS OF HYSTERESIS.—A. Guilbert. (*Bull. d. l. Soc. franç. d. Élec.*, Feb., 1931, Ser. 5, Vol. 1, pp. 175–202.)

RECOMBINATION IN MERCURY VAPOR.—H. W. Webb and D. Sinclair. (*Phys. Review*, 15th Jan., 1931, Series 2, Vol. 37, No. 2, pp. 182–193.)

ELECTROMOTIVE FORCE OF DIELECTRICS.—K. Lark-Horovitz. (*Nature*, 21st March, 1931, Vol. 127, p. 440.)

ZUR DEUTUNG DER STROMLEITUNG IN DIELEKTRISCHEN FLÜSSIGKEITEN BEI HOHEN FELDERN (On the Meaning of the Conduction of Current in Dielectric Fluids under Strong Fields).—A. Nikuradse. (*Naturwiss.*, 6th March, 1931, Vol. 19, No. 10, pp. 233–234.)

ON THE CHARGE DISTRIBUTION AND DIAMAGNETIC SUSCEPTIBILITY OF ATOMS AND IONS.—G. W. Brindley. (*Phil. Mag.*, March, 1931, Series 7, Vol. 11, No. 71, pp. 786–792.)

DÉCHARGES DE HAUTE FRÉQUENCE DANS L'AZOTE EN PRÉSENCE DU MERCURE (H.F. Discharges [λ = 10 m.] in Nitrogen in the Presence of Mercury).—R. Zouckermann. (*Comptes Rendus*, 16th Feb., 1931, Vol. 192, pp. 409–411.)

PHOTOPHORESIS AND THE INFLUENCE UPON IT OF ELECTRIC AND MAGNETIC FIELDS.—F. Ehrenhaft. (*Phil. Mag.*, Jan., 1931, Series 7, Vol. 11, No. 68, pp. 140–146.)

ON THE DISTRIBUTION OF ELECTRIC FORCE AND RISE OF TEMPERATURE IN THE GLOW DISCHARGE.—J. M. Holm. (*Phil. Mag.*, Jan., 1931, Series 7, Vol. 11, No. 68, pp. 194–221.)

HIGH FREQUENCY AND DIRECT CURRENT DISCHARGES IN HELIUM.—F. L. Jones. (*Phil. Mag.*, Jan., 1931, Series 7, Vol. 11, No. 68, pp. 163–173.)

HIGH FREQUENCY DISCHARGES IN MERCURY, HELIUM AND NEON.—C. J. Brasefield. (*Phys. Review*, 1st Jan., 1931, Series 2, Vol. 37, No. 1, pp. 82–86.)

THE APPLICATION OF THE CLASSICAL STATISTIC CONCEPTIONS TO THE WAVE MECHANICS.—J. Ullmo. (*Comptes Rendus*, 12th Jan., 1931, Vol. 192, pp. 87–89.)

CONOIDAL PROPAGATIONS IN UNDULATORY GEOMETRY: WAVES DERIVED FROM THE ELLIPSOID.—A. Buhl. (*Comptes Rendus*, 9th February, 1931, Vol. 192, pp. 323–325.)

À PROPOS DE L'ÉLECTRICITÉ, L'ÉTHER ET LES QUANTA (Electricity, the Ether, and Quanta).—F. Prunier: R. Ferrier. (*Rev. Gén. de l'Élec.*, 17th Jan., 1931, Vol. 29, pp. 83–90.)

CONTRIBUTION TO STUDY OF EFFECT OF ELLIPTICAL POLARIZATION UPON ENERGY TRANSMISSION. R. V. Baud. (*Journ. Opt. Soc. Am.*, Feb., 1931, Vol. 21, pp. 119–123.)

THE PRODUCTION OF AN INTENSE BEAM OF HYDROGEN POSITIVE IONS.—L. R. Maxwell. (*Review Scient. Instr.*, February, 1931, Vol. 2, pp. 128–140.)

UNDERSÖKNINGAR BETRAFFANDE ÖMSESIDIGA INDUKTIONEN MELLAN PARALLELLA, I ÄNDPUNKTERNA JORDADE LEDNINGAR (Investigations on the Mutual Induction between Parallel Conductors Earthed at the Ends).—G. Swedenborg. (*Teknisk Tidskr.*, Feb., 1931, pp. 17–28.)

OBSERVATIONS D'UNE ÉMISSION PARTICULIÈRE PAR LA CATHODE MÉTALLIQUE REFROIDIE D'UN ARC ÉLECTRIQUE (Observations on a Peculiar Emission from the Cooled Metallic Cathode of an Electric Arc).—G. Laudet. (*Comptes Rendus*, 26th Jan., 1931, Vol. 192, pp. 202–203.)

NOUVELLE HYPOTHÈSE SUR LE RAYONNEMENT ET SUR L'OPTIQUE DES CORPS EN MOUVEMENT (A New Hypothesis on Radiation and on the Optics of Bodies in Motion).—A. Sesmat. (*Comptes Rendus*, 2nd March, 1931, Vol. 192, pp. 548–551.)

ORIGIN OF COSMIC RADIATION.—Jeans.

(*See* under "Atmospherics and Atmospheric Electricity.")

IONISED GASES AND COULOMB'S LAW.—Jonescu.
(*See* under "Propagation of Waves.")

MISCELLANEOUS.

METHODE ZUR ANGENÄHERTEN LÖSUNG VON EIGENWERTPROBLEMEN MIT ANWENDUNGEN AUF SCHWINGUNGSPROBLEME (Method for the Approximate Solution of Eigenvalue Problems, with Applications to Oscillation Problems [Mathematical Investigation]).—W. Meyer zur Capellen. (*Ann. der Phys.*, Series 5, 1931, Vol. 8, No. 3, pp. 297–352.)

TRANSIENTS AND FOURIER INTEGRAL.—N. N. Krylov. (*Westnik Elektrot.*, *Leningrad*, No. 1, 1931, Part II, pp. 1–4.)

In Russian. Author's summary :—The application of Fourier integrals to the integration of differential equations for transient current is investigated. Examples of such applications are given and the advantages of the method are shown.

ON ROTATIONS IN ORDINARY AND NULL SPACES.—S. A. Schelkunoff. (*Am. Journ. of Math.*, Jan., 1931, Vol. 53, pp. 175–185.)

A METHOD OF WEATHER FORECASTING.—R. C. Colwell. (*Phys. Review*, 15th Feb., 1931, Series 2, Vol. 37, No. 4, p. 464.)

Abstract only :—It has been shown before (1930 Abstracts, pp. 388–389) that when a high pressure area covers both Pittsburgh and Morgantown, the day signal from KDKA is stronger than the night signal, while for a low pressure area, the night signal is the stronger. Hence the ratio of the day to the night energy received from KDKA at Morgantown will give some indication of the atmospheric conditions between the two cities. In this method of forecasting, a fading curve is taken for about one hour before sunset and three hours after sunset. The area is measured with a planimeter and the ratio of the day to night energy is calculated for each day. If this ratio is greater than one, fair weather is indicated, whereas, if the ratio drops to one half, a storm is approaching. In addition to this ratio, barometer readings are taken and wind directions observed. A storm area passing north of Morgantown will cause a low barometer and a south wind. If the storm centre passes to the south, the energy ratio from a station to the north is no longer reliable and readings must be taken upon a station to the south.

EXPÉRIENCES SUR L'ENGAGEMENT D'ATOMES DANS UN FAISCEAU MAGNÉTO-CATHODIQUE OU CATHODIQUE (Experiments on the Catching-up of Atoms in a Magneto-cathodic or Cathodic Beam).—E. Henriot, O. Goche and F. Dony-Hénault. (*Journ. de Phys. et le Rad.*, Jan., 1931, pp. 1–11.)

Atoms of various substances (*e.g.*, carbon, sodium, sulphur) can be caught up in a magneto-cathode or a cathode beam of electrons. Once thus engaged they become part of the beam and follow its deflections. They can be disengaged at points where the beam is sharply curved.

WIRELESS PROGRESS IN 1930.—(*Engineer*, 9th Jan., 1931, Vol. 151, p. 41.)

In a survey of "Electrical Engineering in 1930," this section deals with progress in Wireless, particular attention being given to Post Office work. The next two pages deal with electrical research in general and miscellaneous developments.

ENGINEERING RESEARCH IN THE POST OFFICE.—B. S. Cohen. (*P.O. Elec. Eng. Journ.*, April, 1931, Vol. 24, pp. 6–16.)

TELEPHONE CABLES.—J. Collard. (*Electrician*, 27th Feb., 1931, Vol. 106, pp. 316–317.)

Balancing methods for the elimination of induced noise in cables.

DEVELOPMENTS IN THE ART OF TELEGRAPHY [CHIEFLY CARRIER CURRENT TELEGRAPHY].—R. B. Steele. (*Rad. Engineering*, March, 1931, Vol. 11, pp. 35–42.)

METHODS OF LOCALISING OR SUPPRESSING RADIO INTERFERENCE DUE TO INDUCTION, SURGES, ETC., IN CANADA.— –. Merriman. (*Engineering Journ.*, *Canada*, Sept., 1930 : Summary in *Génie Civil*, 21st Feb., 1931, Vol. 98, p. 201.)

MAN-MADE INTERFERENCE WITH RADIO RECEPTION, AND ITS PREVENTION.—Leduc.

(*See* under "Reception.")

ÜBER DIE VERWENDUNG SICHTBARER UND UNSICHTBARER, INSBESONDERE ULTRAROTER STRAHLEN FÜR NACHRICHTENÜBERMITTLUNG UND VERKEHRSSICHERUNG (On the Application of Visible and Invisible—particularly Infra-red—Rays for Transmission of News and Safeguarding of Traffic).—G. Gresky. (*Physik. Zeitschr.*, 1st March, 1931, Vol. 32, No. 5, pp. 193–212.)

A general account of modern developments in the use of light and infra-red rays as means of communication. The use of photoelectric and selenium cells for demonstrating the presence of radiation is described and an account is given of the effect of atmospheric conditions on the wave propagation. Applications to optical telephony and determination of heat sources are generally described. A comprehensive bibliography is appended.

THE ERB AMPLIFYING MECHANISM, FOR SMALL MOVEMENTS : APPLICABLE TO THERMOSTATS, ETC.—A. Erb. (*Génie Civil*, 21st. Feb., 1931, Vol. 98, pp. 193–195.)

Depending on the tilting of a bar gripped between a fixed fulcrum and a fulcrum carried on the part whose motion is to be magnified.

THE DIRECT MEASUREMENT OF WAVELENGTH AND DAMPING OF ELECTROMAGNETIC WAVES IN ROCK [GEOPHYSICAL PROSPECTING].—Petrowsky.

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

ALL-WEATHER SEXTANT USING INFRA-RED PHOTO-ELECTRIC CELL.— –. Macneil. (*Electronics*, March, 1931, p. 562 : picture only.)

PHOTOELECTRIC METHODS FOR THE EXAMINATION AND ANALYSIS OF LIQUIDS.—P. Jakuschoff. (*Zeitschr. V.D.I.*, 4th April, 1931, Vol. 75, No. 14, pp. 426–428.)

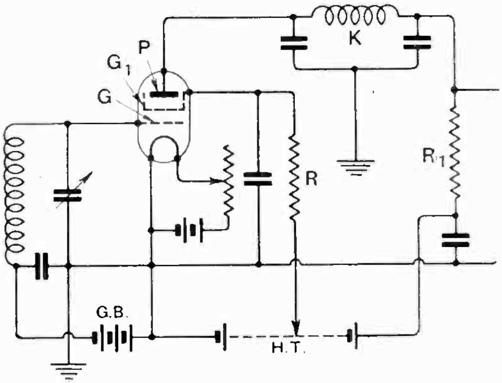
Some Recent Patents.

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.

SCREENED GRID DETECTORS.

Convention date (U.S.A.), 20th July, 1929. *No.* 338613.

When using a screened-grid valve as a grid-bias detector, the range of input voltage is increased by inserting a resistance R, in the connection from the grid G_1 to the H.T. supply, of such value that the effective voltage on that grid drops automatically as the signal voltage on the grid G increases. This has the effect of increasing the maximum R.M.S. audio output in the plate circuit before overloading sets in. Initial grid-bias is applied from a source GB. The radio choke K in the plate circuit is earthed at each side through condensers as shown. Coupling to the next stage is through the resistance R_1.



No. 338613.

Patent issued to Radio Frequency Laboratories, Inc.

THERMIONIC FILAMENTS.

Application date 16th October, 1929. No. 339057.

A core of oxidised aluminium wire is coated with an electron-emitting substance. The wire is oxidised by making it the anode in a weak solution of chromic acid. Caesium is then deposited electrolytically upon the oxidised surface from a solution of the bromide in pyridine; or caesium hydroxide may be pasted on the wire core and dried in vacuo.

Patent issued to The Gramophone Co., Ltd.; W. F. Tedman; and F. Ellington.

Application date 14th November, 1929. No. 339451.

A refractory core of tungsten or nickel, or an oxide-coated filament, is coated with a tartrate of caesium or barium, and is then heated in an atmosphere of carbon dioxide. The residue on the core contains the carbonate of the electron-emitting metal, together with free carbon. The filament so prepared is mounted in a valve and subjected to the usual treatment.

Patent issued to The Gramophone Co., Ltd. and G. B. Baker.

SUPPLY CONNECTIONS.

Application date 3rd September, 1929. *No.* 338251.

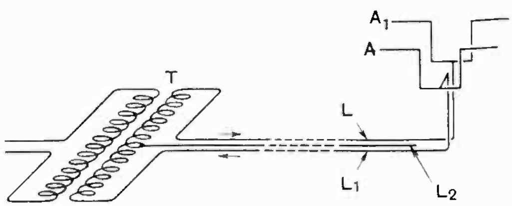
The receiver is provided with a multi-contact plug adapted to connect the set either to H.T. and L.T. batteries or to A.C. or D.C. mains units when fitted with a similar coacting socket. The contact points are so spaced that wrong connection is impossible. The fitting is particularly useful with portable sets, allowing a change-over from one type of supply to another with the minimum of inconvenience.

Patent issued to C. S. Agate and J. E. Rhys-Jones.

BEAM AERIALS.

Application date 26th August, 1929. No. 338873.

The invention is designed to reduce any adverse effect of the feed-lines upon the directional characteristic of beam antennae. The Figure shows a grid aerial A backed by a similar reflecting system A_1 as used for short-wave reception. The transmission lines, L, L_1 connecting both aerial systems to the transformer T feeding the receiver, are arranged in close proximity, being separated by only a small fraction of the working wavelength and being equally spaced throughout their length. Theoretically the currents flowing in the lines L, L_1 are equal and opposite in phase, but in practice it is found that the line from the reflector A_1 carries less current than the other. An open-ended counterpoise L_2 is therefore inserted between the two lines, from a mid-point tapping on the transformer. The third line serves also to lessen the height factor and to reduce the overall impedance of the system.



No. 338873.

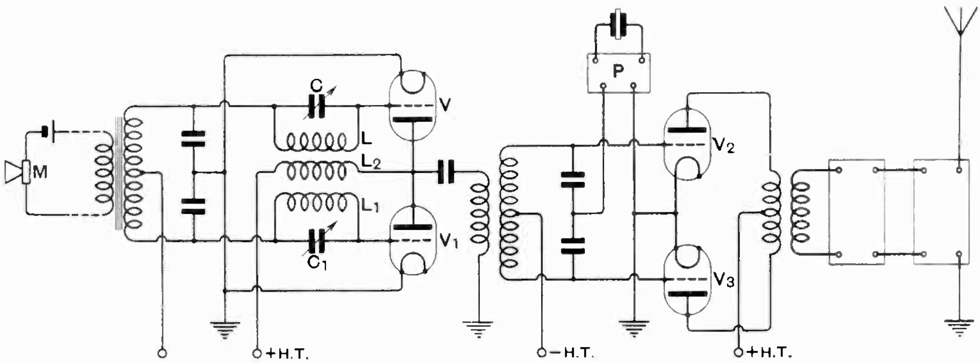
Patent issued to Standard Telephones and Cables, Ltd.

MINIMIZING FADING EFFECTS.

Convention date (U.S.A.), 19th November, 1928.
No. 339459.

Fading is sometimes reduced by applying automatic volume or "gain" control to the amplifiers at the receiving end. But when ordinary methods of modulation are employed if a gain control of short "time constant" is used, it may partly destroy the signal modulation, whilst a control of longer time constant will not respond effectively to rapid variations in fading. This difficulty is overcome by transmitting the signal as a frequency-modulated carrier wave, and tuning the gain-control circuits at the receiving end so broadly as to be equally responsive to all frequencies in the working range. Once the modulated carrier has passed through the gain-control unit in the receiver, the frequency modulations are converted into amplitude modulations and then rectified in the ordinary way. The Figure illustrates the method used for transmitting speech as a frequency-modulated carrier. The valves V, V_1 are fed in push-pull from the microphone M. The circuit L, C is tuned to a different frequency to the circuit L_1, C_1, though the two circuits combined cover the frequency-range of the speech to be transmitted. Normally the action of the common back-coupling coil L_2 forces both valves to oscillate at the same frequency. However, when speech is applied to the grids, each valve "takes charge" alternately, and so varies the frequency of oscillation between the limits set by the circuits L, C and L_1, C_1. The resultant frequency-modulated oscillations are then applied to a carrier-wave generating system V_2, V_3 stabilized by a piezo-crystal control P.

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



No. 339459.

Convention date (U.S.A.), 11th December, 1928.
No. 339499.

Relates to a system in which a number of different aerials are linked to a common receiving station, the particular aerial at which the signal is strongest at any moment being selected, either exclusively or predominantly, to control the effective strength of reception. This system obviously involves a constant change-over from one aerial to another as the incidence of fading varies. According to the invention the "gain" in the amplifiers is controlled only in part by the pick-up from the selected aerial, the signal energy from the remaining aerials being also utilised in such a manner that as the signal pick-up from any one aerial becomes predominant it "takes charge" of the common receiver gradually and imperceptibly.

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

CONTROLLING TONE OR QUALITY.

Convention date (Germany), 31st October, 1928.
No. 340060.

To restore certain harmonics which may have been weakened or lost in transmission, or to alter the musical "colour" of an orchestra to suit personal tastes, or even to convert a bass voice to a baritone or tenor, a "transfer member" is interposed in the link of transmission or reception. One or more of the fundamental frequencies are first filtered out, and are then utilised to produce or emphasise the required harmonic frequencies in the transfer member. This consists of a number of valve amplifiers connected together through variable couplings. The impedance of the couplings is modified to produce the required effects, either directly, or by indirect means such as the capacity effect of the moving hands of a supervisor or conductor.

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

DIRECTION-FINDING GEAR.

Application date 23rd August, 1929. No. 338601.

The rotating aerial is installed in the most desirable position on board ship, *i.e.*, where re-radiation effects are least in evidence, and convenient manipulation is secured from a distance by means of telemotor apparatus. The hydraulic motors are of small size, about 10in. by 4in., each comprising a fixed piston and movable cylinder. One cylinder is formed with a rack which gears with a control handle, whilst the other rotates the shaft of the distant frame aerial.

Patent issued to F. Woods.

POTENTIAL DIVIDERS.

Convention date (Hungary), 12th October, 1928. No. 337793.

A number of glow discharge tubes, such as neon lamps, are connected in series or series-parallel, the points of connection being provided with tappings. The arrangement permits the taking-off of any desired potential from a direct-current source, the derived voltage remaining constant irrespective of variations in the load. This holds good even when the current-source has a high internal resistance. Constant potentials can also be taken from a fluctuating current-source, having a small internal resistance, if a correspondingly high external resistance is connected in series with the source.

Patent issued to Laszlo Koros.

GRAMOPHONE PICK-UPS.

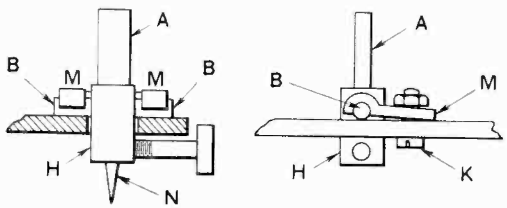
Application date, 15th July, 1929. No. 336648.

The moving armature consists of a permanent magnet, preferably a tube or rod of cobalt steel, mounted on a stirrup of spring steel. The stylus or needle is held firmly in a V-shaped recess inside the tube by interaction with the record. The arrangement prevents "rattle" and gives an improved frequency characteristic with minimum wear upon the record.

Patent issued to H. E. Holman.

Application date 2nd July, 1929. No. 337780.

In a pick-up specially designed for mass manufacture, a tongue-type armature, which is centred inside the bore of the bobbin by packing-strips of rubber, is provided with lateral bearing-rods *B*, *B* clamped down on to the surface of the case by hook-shaped members *M*, *M*, which are bolted to the casing at *K*. The needle *N* is fixed by a grub-screw on the holder *H*. The bearing rods *B* are preferably only a fractional part of a millimetre in diameter, and are thinly coated with rubber. One



No. 337780.

of the rubber packing-strips is arranged to project between the end of the armature and the coacting magnet-face, so as to prevent sticking.

Patent issued to P. D. Tyers.

Application date 7th August, 1929. No. 337811.

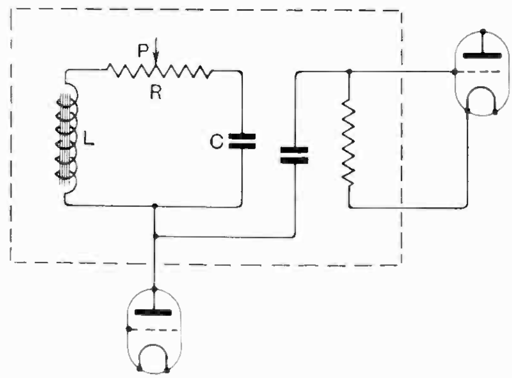
The armature is loosely mounted inside a rubber bushing inserted in the core of the bobbin in such a way that the vibrations imparted to the needle by the record track cause it to roll in an oscillatory manner inside the bushing. The bore of the bobbin may be almond-shaped instead of circular in section, to promote the rolling action, and the needle may be used alone without a separate armature. The arrangement is such that there is no metallic or other rigid contact or connection between the needle and any other part of the structure of the pick-up.

Patent issued to F. W. Lanchester.

VARIABLE-IMPEDANCE COUPLINGS.

Application date 15th August, 1929. No. 337494.

A variable-impedance unit, suitable for use as a tone control, consists of a choke *L*, condenser *C*



No. 337494.

and resistance *R*, forming a series circuit. By adjusting the tapping point *P*, the impedance of the unit as a whole can be made mainly resistive, inductive, or capacitative. When used as an intervalve coupling, as shown, the frequency-amplification curve can be varied at will to modify the tonality of speech, or to emphasise the lower notes of an orchestral performance, or to compensate for loud-speaker imperfections. Amplification increases with frequency as the tapping point *P* is moved towards the choke *L*, and *vice versa*.

Patent issued to C. H. Smith.

NAVIGATIONAL WIRELESS.

Application date 3rd August, 1929. No. 337469.

A number of unmanned wireless stations are placed along the route, each station comprising a differently tuned receiver and transmitter. A control transmitter, which may be located at a distant point, or carried on an aeroplane, is used to start the local transmitter at each of the unmanned stations. The received control signals automatically energise relays which bring each local transmitter into operation, as required, to emit a characteristic "call" signal for the information of the pilot. Each transmitter is automatically cut out after a predetermined interval.

Patent issued to Graham Amplion, Ltd., W. J. Ricketts and D. Sinclair.

PIEZO-ELECTRIC OSCILLATORS.

Convention date (Germany), 3rd November, 1928.
No. 340361.

The crystal is mounted inside a glass bulb between pairs of terminals connected to four plug-pins at the base of the bulb. The crystal is supported at two or more nodal points of vibration, pieces of damping-material, such as yarn, being inserted between the crystal and the supports in order to avoid any vibration being transmitted to the latter. The bulb contains neon or helium gas at a pressure of 1.3 mm. of mercury. Under these conditions the phenomenon of light-emission at resonance is produced at relatively low exciting voltages.

Patent issued to E. Giebe and A. Scheibe.

LOUD SPEAKERS.

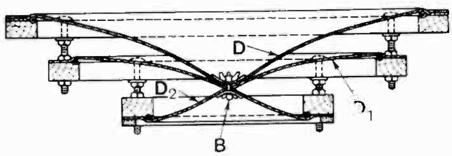
Convention date (U.S.A.), 25th September, 1928.
No. 319665.

The armature is arranged to vibrate in a plane substantially parallel with that of the pole-faces. The *N* and *S* pole-pieces are both bifurcated so as to form two coacting gaps separated by a central space. The armature consists of two strips of silicon steel carried on non-magnetic bars of German silver, which are connected at each end to anchoring springs. The magnetic strips only partly overlap the pole-faces; so that as the armature vibrates laterally, the total flux across both gaps remains substantially constant throughout, *i.e.*, from the position where the flux is a maximum across one of the gaps to the other end of the stroke where it is a maximum across the second gap.

Patent issued to Farrand Inductor Corporation.

Application date 4th November, 1929. No. 339075.

A composite loud speaker is provided with three diaphragms D, D_1, D_2 with their apices bolted together at B. The peripheries are secured to separate frames, as shown, so that they can be



No. 339075.

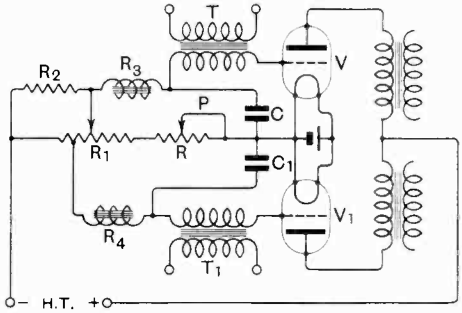
independently tensioned. The different curvatures ensure a uniform response over the whole range of audible frequencies.

Patent issued to S. J. Bush and N. Steele.

PUSH-PULL AMPLIFIERS.

Application date 10th October, 1929. No. 339053.

Relates to a method of controlling volume and adjusting balance in a push-pull arrangement. The valves V, V_1 are fed from transformers T, T_1, which, though shown separately, may form a single winding. The cathodes are connected through resistances R, R_1 to the H.T. negative. A short-circuiting tap P enables the grid-bias to be adjusted to any desirable value. The secondary windings of the transformers T, T_1 are connected to variable tappings on a resistance R_1 which serves to compensate for any initial difference in the character-



No. 339053.

istics of the two valves, V, V_1. A safety resistance R_2 prevents the grid of the valve from being insulated should the sliding tap to the resistance R_1 make imperfect contact. The chokes R_3, R_4 and condensers C, C_1 serve as filters to prevent mains hum.

Patent issued to S. G. S. Dicker.

MINIMIZING FADING.

Convention date (Germany), 17th December, 1928.
No. 339757.

In short-wave telegraphy on wavelengths of 100 metres of less, each Morse signal element is transmitted as a number of impulses of very short duration. For instance each "dot" may be broken up into a number of wave trains, each of the order 1/1000th of a second. The period of successive wave-trains may be varied cyclically throughout the duration of a complete signal impulse. The invention is intended to prevent fading caused by the overlapping of out-of-phase signal components.

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

PIEZO-ELECTRIC LOUD-SPEAKERS.

Convention date (U.S.A.), 12th September, 1928.
No. 318934.

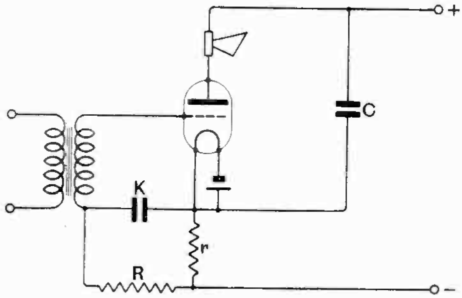
To convert electric into acoustic energy, two plates cut perpendicular to the electric axis of a Rochelle salt crystal are mounted close together, with an intervening electrode of tin foil and two outer electrodes of the same material. Under the action of an electrostatic field, one crystal plate contracts in the same direction as the other expands, thus setting up an amplified torque which is imparted to an arm driving the diaphragm of the loud-speaker. The actuating arm is secured to a free-edge portion of the assembled crystal plates. The arrangement is capable of handling comparatively large amounts of energy within the limits of response and fracture of the piezo crystals.

Patent issued to E. W. C. Russell.

ELIMINATING MAINS "RIPPLE."

Convention date (Sweden), 29th January, 1929. No. 339851.

Output "hum" is eliminated by simultaneously impressing on the grid an alternating component, opposite in phase and $1/\mu$ times the strength of that present in the H.T. supply. As shown applied



No. 339851.

to a low-frequency amplifier, the mains or rectifying-unit is shunted by a condenser C, and a biasing resistance r is inserted between the filament and negative H.T., in parallel with a high resistance R and condenser K. For a valve with an amplification factor of μ, the desired condition is secured when $KR = \mu Cr$, this expression being independent of frequency.

Patent issued to Telefonaktiebolaget L.M. Ericsson.

DIRECTION-FINDERS.

Application date, 13th August, 1929. No. 339664.

In order to provide a continuous and positive indication of the bearing or direction of the wave-front, irrespective of any movement of the axis of reference, the search-coil of a fixed Bellini-Tosi or Adcock aerial system is continuously rotated, and the output from the search-coil is fed, together with a reference current provided by a local alternator of constant frequency, to a phase-meter, such as a synchroscope, power-factor-meter or oscilloscope. The required bearing is then indicated directly as a phase difference between the alternator or reference current and the amplified signal currents.

Patent issued to Sir A. Whitten Brown.

TELEVISION RECEIVERS.

Application date 26th October, 1929. No. 340356.

In order to ensure correct framing of the received picture, a mechanical phase-adjusting link is interposed between the scanning-disc and the driving-motor. A worm on the shaft of the motor engages a worm-wheel on the shaft of the scanning-disc. The motor itself is moved bodily along a fixed guide or bracket by means of a screw, so that the setting of the driving-worm can be adjusted relative to the shaft of the scanning-wheel.

Patent issued to The Gramophone Co., Ltd., and M. Bowman-Manifold.

WIRELESS RECEIVERS.

Application date 5th September, 1929. No. 339316.

A circuit designed for reception on one or other of two different wave-bands comprises a switch-over input circuit followed by two high-frequency stages and a detector. The anode impedance in the first H.F. stage is arranged to have a resonance frequency within the short-wave band, whilst the second H.F. stage is made resonant within the long-wave range. The arrangement enables maximum average amplification to be obtained over both wave-bands without loss of stability.

Patent issued to The Gramophone Co., Ltd. and R. K. Spencer.

MAINS RECEIVERS.

Application date 2nd December, 1929. No. 340389.

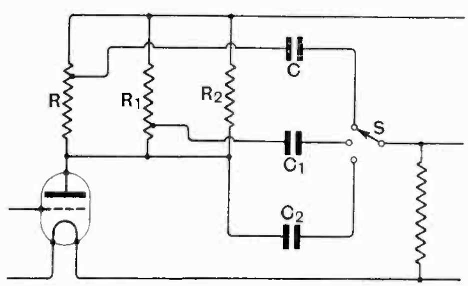
In a mains-driven set, the flexible cable through which power is drawn from the mains serves also as an aerial. In order to isolate the high-frequency signal voltages from the mains, the plug-in connection contains two chokes, one in series with each of the leads, and a shunt condenser. Similar chokes are also inserted at the end of the leads nearest the supply transformer, and are shunted by a pair of condensers in series. The input to the set is connected to the supply leads between the two last mentioned condensers and earth.

Patent issued to The Gramophone Co., Ltd., and W. J. Brown.

TONE-CORRECTING CIRCUITS.

Application date 27th September, 1929. No. 340317.

A tone control network, designed to vary the frequency-amplification response of an amplifier or transmission line, consists of a network of anode resistances R, R_1, R_2 and condensers C, C_1, C_2 of different values, connected through a switch S to the input of the succeeding stage of amplification. Attenuation or emphasis of any desired frequency band depends upon the value of



No. 340317.

the condenser in circuit, whilst the overall attenuation for each position of the tone-control switch S depends upon the value of the resistance in series with that condenser.

Patent issued to N. H. Clough, Marconi's Wireless Telegraph Co., Ltd., and The Gramophone Co., Ltd.