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The
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The Work of the Radio Research Board.

THE Radio Research Board was set up in 1920, being one of a number of Research Boards established by the Department of Scientific and Industrial Research. For ten years it had the advantage of having as its Chairman Admiral-of-the-Fleet Sir Henry Jackson, who devoted himself ungrudgingly to the work of the Board. On his resignation and subsequent death in 1929, Lieut.-Colonel A. G. Lee, of the Post Office, was appointed Chairman, and it is over his signature that the "Report of the Board for the Period ended 31st December, 1930,"* has recently been issued. Although there is nothing in this title to indicate whether the period referred to covers six months or twenty years, the fact that the last Report, with similar vagueness, was stated to cover the period ended 31st March, 1929, shows that the present Report deals with a period of a year and nine months.

No Research Board could have justified its establishment more thoroughly than has the Radio Research Board. Under the guidance of various committees it has successfully attacked a number of problems of fundamental importance, and a perusal of the Report impresses one with the high standard of the work done and the importance of the results obtained.

* Published by H.M. Stationery Office, 2s., 90 pp.

The work of the Board has been directed to the study of four subjects, *viz.*, the propagation of waves, direction-finding, the nature and origin of atmospherics, and high frequency measurements.

A question which always arises in such an organisation is the relative importance of fundamental research undertaken without any regard to an immediate practical application, and experiments directed to the solution of an urgent practical problem. This is discussed in the Report which states that "we feel that we must continue such fundamental work, although a higher priority may, in certain cases, be given to experiments whose immediate application is clear, although we feel that work in this second category should continue to form a considerable portion of our programme." While agreeing with this view, we wish that it had been expressed in a better literary style.

Co-operation between Government Radio Departments.

Another question, which is also mentioned in the Report, is the relation between the Board and the Post Office and the Fighting Services, all of which maintain Radio Research Departments. The Post Office differs from the Fighting Services in that there is not the same need for secrecy and also in that it maintains commercial radio services. It is obviously in the public interest that co-operation should be as close as possible and that all the information obtained by one branch should be at the immediate disposal of the others. It is interesting to read, therefore, that arrangements have been made for closer co-operation between the Board and the Post Office, so that the organisation of the Radio Research Board " will be made available to a greater extent for exploring new ideas and new principles in radio developments of special interest to the Post Office." This may, perhaps, be regarded as a natural development from the appointment of Colonel Lee as Chairman of the Board. The Report hints at the possibility of a similar co-operation with the Fighting Services. A somewhat different question is that of problems which are of special importance to the wireless industry. Here again the Report suggests close co-operation in the national interest.

The work on the propagation of waves has to a large extent developed into an organised attack on the ionisation of the upper atmosphere and nobody has contributed more to our knowledge of this subject than Professor Appleton. The utilisation of electro-magnetic waves to explore and map out the ionic stratification of the upper atmosphere must be regarded as one of the most impressive achievements of modern science. As the Report states, " experiments now in progress point to the possibility of realising this object."

Work on Directional Wireless.

It is interesting to note that the Air Ministry and the Board of Trade have been associated with the Board in some of their recent work in the development of Direction Finders which shall be free from those night errors that cause the ordinary direction finder to be so unreliable under certain conditions. The tests have given very promising results.

Preparations are being made to set up in various parts of the world improved apparatus for recording the direction of arrival of atmospheric disturbances. It is hoped in this way to get more definite indications of the exact positions of the sources of atmospherics and to correlate their positions and movements with meteorological data.

Radio Frequency Standards.

Another branch of the Board's activities is the development of radio-frequency standards. Arrangements are at present being made at the National Physical Laboratory for maintaining the two tuning forks which form the basis of the frequency standard at a constant temperature and pressure, and it is anticipated that the frequency at any instant will be maintained constant to an accuracy of one part in a million. Dr. Dye is also continuing his work on quartz standards, and an interesting section on this subject forms part of the Report. It is interesting to note that a quartz resonator was tested at Washington, Berlin and Teddington, and that the frequencies given by the three institutions were within ± 1 part in 100,000, whilst the Teddington figure for a quartz oscillator differed by only 6 parts in a million from the mean of the values determined by five different countries. These examples serve to emphasise the degree of accuracy with which radio frequencies can now be determined.

The Report concludes with a special reference to the abstracts which are published every month in *The Wireless Engineer and Experimental Wireless*, and it is stated that " it is obvious from the correspondence received by the Department that these abstracts are highly appreciated by a wide circle of readers."

Amplifier Tone-control Circuits.*

By M. G. Scroggie, B.Sc., A.M.I.E.E.

THE object of the present article is to provide data for rapidly arriving at suitable circuit constants for compensating or modifying an audio-frequency characteristic by means of a " tone circuit " in parallel with an intervalve resistance coupling. The advantage of this system is that it lends itself to easy and accurate predetermination of characteristics. It is shown how the impedance of such a circuit can be conveniently studied by means of a circle diagram, and from this sets of representative frequency characteristic curves are derived which are applicable to the majority of practically useful conditions, and which enable circuit constants, giving approximately the desired performance, to be seen by inspection. The effects of various incidental elements in the circuit are then considered and shown to be small in most practical cases. Some of the data provided are useful in connection with resistance-coupled amplifiers not employing tone circuits. Finally, some practical points in the design of tone-controls are dealt with.

Types of Circuit.

The simplest tone circuit is an inductance or a capacity in series with a resistance. A combination of inductance and capacity in series or parallel will also be considered. When no tone circuit is present, or at a frequency at which its impedance is infinite, the amplification of the valve in conjunction with its coupling is $\frac{\mu R_1}{R_A + R_1}$, and therefore $p = \frac{R_1}{R_A + R_1}$. At a frequency at which the tone-circuit reactance is zero, the coupling resistance is effectively due to R_1 and R_2 in parallel, *i.e.*, $\frac{R_1 R_2}{R_1 + R_2}$, and hence

$$p = \frac{\frac{R_1R_2}{R_1 + R_2}}{R_A + \frac{R_1R_2}{R_1 + R_2}} = \frac{R_1R_2}{R_AR_1 + R_1R_2 + R_2R_A}$$

These conditions will be referred to as $p_{max.}$ and $p_{min.}$ respectively. The effects of the four principal tone circuits are illustrated in Fig. 1, and they may be used to compensate for conditions which are the inverse of those indicated, or to produce a non-uniformity of frequency characteristic for some special purpose.

General Analysis.

In order to illustrate the performance of the tone circuit clearly, incidental circuit

* MS. received by the Editor, August, 1931.

Principal Symbols Used.

- R_A internal anode resistance of valve (valve impedance).
- R_1 anode circuit coupling resistance.
- R_2 tone-circuit resistance.
- R_3 succeeding grid leak resistance.
- C_1 anode circuit by-pass capacity (including stray capacity).
- C_2 tone-circuit capacity.
- C_3 anode/grid coupling capacity.
- L tone-circuit inductance.
- X tone-circuit reactance.
- R_s resistance in series circuit equivalent to R_p in a parallel circuit.
- X_s reactance in series circuit equivalent to X_p in parallel circuit.
- Z impedance of tone circuit in combination with R_1.
- p ratio of audio-frequency voltage developed across external anode circuit to that theoretically generated in the valve.
- $p_{max.}$ and $p_{min.}$ defined in the text.
- θ defined in the text.
- f frequency $= \frac{\omega}{2\pi}$.
- μ amplification factor of valve.

elements, other than the coupling resistance and the resistance of the valve itself, will be disregarded for the present, leaving the circuit of Fig 2(a). R_2 is first combined with R_1 by replacing R_2 and X $\left(\text{which may be either } \omega L \text{ or } \frac{1}{\omega C_2}\right)$ by their parallel circuit equivalents as in Fig. 2 (b). This circuit may then be replaced by its equivalent in the form of Fig. 2 (c).

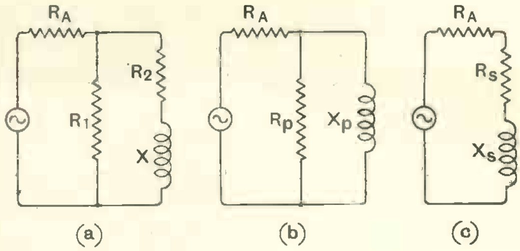

Fig. 2.

The standard equations are :—

$$R_s = \frac{R_p X_p^2}{R_p^2 + X_p^2} \qquad (1)$$

$$X_s = \frac{R_p^2 X_p}{R_p^2 + X_p^2} \qquad (2)$$

$$R_p = \frac{R_s^2 + X_s^2}{R_s} \qquad (3)$$

$$X_p = \frac{R_s^2 + X_s^2}{X_s} \qquad (4)$$

Applying these in the circuit Fig. 2 (b)—

$$R_p = \frac{R_1\left(\frac{R_2^2 + X^2}{R_2}\right)}{R_1 + \frac{R_2^2 + X^2}{R_2}} = \frac{R_1(R_2^2 + X^2)}{R_1R_2 + (R_2^2 + X^2)}$$

$$X_p = \frac{R_2^2 + X^2}{X}$$

Thus the circuit constants of Fig. 2 (c) are :—

$$R_s = \frac{\frac{R_1(R_2^2 + X^2)}{R_1R_2 + (R_2^2 + X^2)} \cdot \frac{(R_2^2 + X^2)^2}{X^2}}{\frac{R_1^2(R_2^2 + X^2)^2}{(R_1R_2 + R_2^2 + X^2)^2} + \frac{(R_2^2 + X^2)^2}{X^2}}$$

which reduces to

$$R_s = \frac{R_1(R_1R_2 + R_2^2 + X^2)}{(R_1 + R_2)^2 + X^2} \qquad (5)$$

Also

$$X_s = \frac{R_1^2(R_2^2 + X^2)^2}{(R_1R_2 + R_2^2 + X^2)^2} \cdot \frac{R_2^2 + X^2}{X} \Bigg/ \left(\frac{R_1^2(R_2^2 + X^2)^2}{(R_1R_2 + R_2^2 + X^2)^2} + \frac{(R_2^2 + X^2)^2}{X^2}\right)$$

which reduces to

$$X_s = \frac{R_1^2 X}{(R_1 + R_2)^2 + X^2} \qquad (6)$$

Eliminating X between equations (5) and

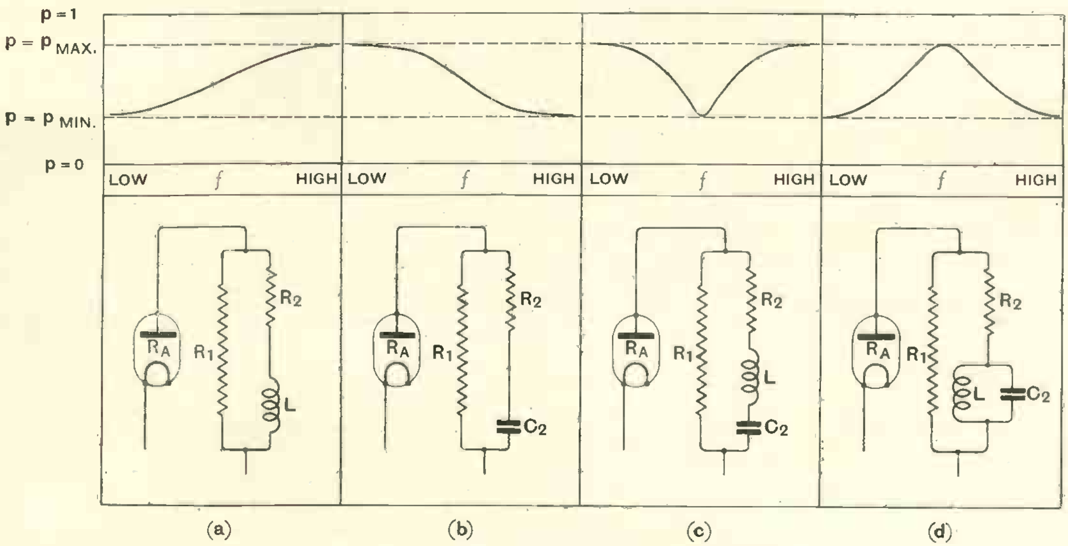

Fig. 1.—*Showing the effects of four principal tone circuits.*

(6) and rearranging :—

$$R_s^2 + X_s^2 - \frac{R_1(R_1 + 2R_2)}{R_1 + R_2} \cdot R_s + \frac{R_1 R_2}{R_1 + R_2} = 0$$

which is the equation of a circle with centre at

$$R_s = \frac{R_1(R_1 + 2R_2)}{2(R_1 + R_2)}$$

$$X_s = 0$$

and radius

$$\sqrt{\left(-\frac{R_1(R_1 + 2R_2)}{2(R_1 + R_2)}\right)^2 - \frac{R_1^2 R_2}{R_1 + R_2}} = \frac{R_1^2}{2(R_1 + R_2)}$$

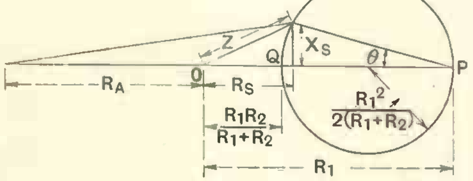

Fig. 3.

If, therefore, the impedance external to the valve be represented by a vector, the point of the vector traces out a circle as X is varied from $-\infty$ to $+\infty$ (Fig. 3.)

p obviously equals the ratio of Z to the vector sum of Z and R_A. The diagram can be drawn to scale quite independently of how X is constituted, as it covers all possible values of X, positive and negative (*i.e.*, inductive or capacitative). The useful fact follows that the form of the frequency characteristic curve (p against X) is unaffected by any other factors than R_A, R_1, and R_2, which may be regarded as two variables, $\frac{R_1}{R_A}$ and $\frac{R_2}{R_A}$. The curve is, of course, in practice drawn on a frequency base, but if X is composed of simple inductance and capacity, the form of the curve is still unaltered, and can be made to fit any specific value of L or C_2 by multiplying by an appropriate scale factor.

The point Q on the circle, nearest the origin, corresponds to zero reactance, leaving R_1 and R_2 in parallel, and is therefore the condition for $p_{\text{min.}}$. The other "dead centre" corresponds to infinite tone-circuit reactance (and therefore zero reactance in the equivalent circuit), leaving R_1 only, and is the $p_{\text{max.}}$ condition. $p_{\text{max.}}$ is generally determined by consideration of valve characteristics, available anode supply voltage, influence of stray capacity, etc. $p_{\text{min.}}$ is one of the principal desired features of the tone control. These having been fixed, the values of R_1 and R_2 follow, and the circle diagram can be drawn right away. It is necessary, however, to find the relation between the points on the circle and X. As X varies from 0 to ∞ as the radius moves through 180° it suggests a tangent function of half the angle. To see if it is so put

$$X = k \tan \theta$$

$$= k \frac{X_s}{R_1 - R_s}$$

then

$$k = \frac{R_1 - R_s}{X_s} \cdot X$$

Substituting the values of R_s and X_s from equations (5) and (6) we find :—

$$k = R_1 + R_2$$

$$\therefore \quad X = (R_1 + R_2) \tan \theta$$

So the diagram of Fig. 3 may be extended to include a scale of X, enabling X to be read off for every position of the vector, or *vice versa*. The X-scale is at right angles to the horizontal R-scale and is $(R_1 + R_2)$ away from P. So it is necessary to draw an X-scale for each value of R_2, or what comes to the same thing, $p_{\text{min.}}$. The straight line joining P to any point on the X-scale cuts the circle at the point which locates the corresponding vector.

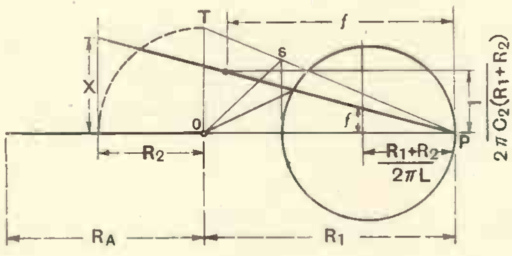

Fig. 4.

If desired the whole construction can be done geometrically; referring to Fig. 4, from O draw a line at 45° to R_1, cutting the nearer vertical tangent to the circle at S. Produce a straight line through P and S to cut a vertical through O at T. Rotate

OT about O to bring it in line with R_A; OT represents R_2 to scale and locates the X-scale. The X-scale is of general application to any type of reactance in circuits of the form of Fig. 1, but having fixed the type of reactance what we want is a scale of frequency.

If the tone circuit reactance is a simple inductance (Fig. 1 (a)) :—

$$X = 2\pi fL = (R_1 + R_2) \tan \theta$$

$$f = \frac{(R_1 + R_2) \tan \theta}{2\pi L}$$

so a f-scale can be erected $\dfrac{R_1 + R_2}{2\pi L}$ from P. On this scale 1 c.p.s. of frequency is equivalent to 1 ohm on the R-scale, which may be inconvenient. If 1 c.p.s. is represented by the same distance as n ohms, shift the origin of the scale to n times the distance from P.

If the tone circuit is type (b) Fig. 1 (capacity reactance) :—

$$X = \frac{1}{2\pi fC_2} = (R_1 + R_2) \tan \theta$$

$$f = \frac{1}{2\pi C_2(R_1 + R_2)} \cdot \tan\left(\frac{\pi}{2} - \theta\right)$$

so the frequency scale for capacity is at right angles to that for inductance and distant $\dfrac{1}{2\pi C_2(R_1 + R_2)}$ from P (or $\dfrac{n}{2\pi C_2(R_1 + R_2)}$ if n is the scale ratio).

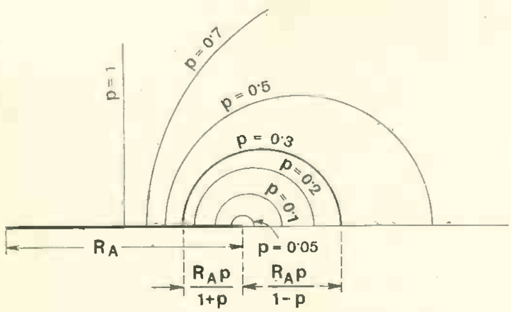

Fig. 5.

To facilitate the derivation of frequency characteristic curves it is convenient to employ a construction for finding points on the circle corresponding to various values of p (the reverse operation is of course easy). Divide R_A internally and externally into two parts, whose ratio is any value of p. The distances from O of these two points are $\dfrac{R_A p}{1 + p}$ and $\dfrac{R_A p}{1 - p}$ respectively. With the line joining these points as diameter draw a circle. If and where this circle cuts the

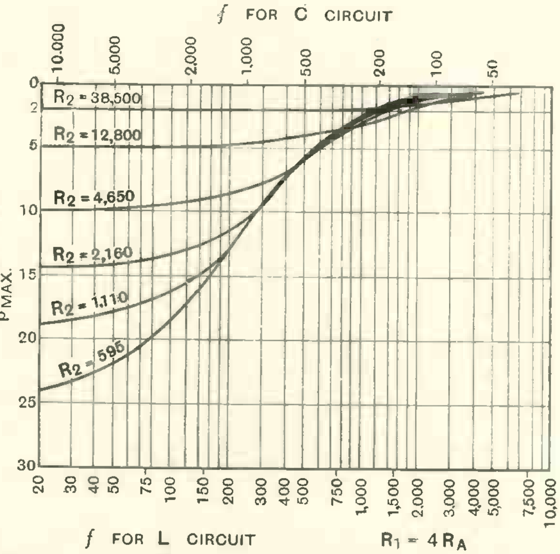

Fig. 6.—*Example* : R_A=50,000 *ohms* ; R_1=12,500 *ohms* ; L=2 *henries* ; C_2=0.05 μF.

impedance circle is the point on it corresponding to the value of p selected (Fig. 5). This diagram is dependent on R_A only.

By solving the two simultaneous equations corresponding to the p and Z circles, one gets an equation connecting X and p, but it is laborious to compute and the graphical construction is much easier, besides giving a picture of what is going on.

Representative Characteristic Curves.

The frequency characteristic curves shown are drawn with a scale of decibels loss with reference to $p_{max.}$. Assuming first of all that $R_1 = 4R_A$, a common ratio in practice with triodes, $p_{max.}$ is 0.8, and a set of curves has been worked out for values of R_2 selected to put $p_{min.}$ 2, 5, 10, 15, 20, and 25 db below $p_{max.}$ (Fig 6.)

$$R_2 = \frac{R_A R_1 p_{min.}}{R_1 - (R_A + R_1)p_{min.}}$$

The table shows the required ratio of R_2 to R_A for these, and, to give concreteness to the example, R_A has been assumed to be

12,500, which applies approximately to many valves commonly used for this purpose, particularly of the I.H.C. type, *but it should be realised that the curves are of the same shape for all examples in which* $R_1 = 4R_A$.

The following other values apply with this assumption :—

$R_1 = 50{,}000$ ohms

$R_2 =$ as in Table

$L = 2$ henries

$C_2 = 0.05\ \mu F$.

$\frac{p_{max.}}{p_{min.}}$ in *db*	$\frac{p_{max.}}{p_{min.}}$	$\frac{R_2}{R_A}$	R_2 (if R_A is 12,500 and R_1 50,000)
2	1.258	3.08	38,500
5	1.788	1.02	12,800
10	3.162	0.37	4,620
15	5.625	0.173	2,160
20	10.000	0.089	1,110
25	17.78	0.0476	595

The curves apply directly not only for the values stated, but for all values of R_A, R_1, R_2, and L, which are in the same proporton and C_2 in inverse proportion. If L is changed to L' without altering the other quantities, the frequency scale must be shifted horizontally so as to multiply all the frequencies by $\frac{L'}{L}$. The upper f scale, which is the lower scale reversed, is located for $C_2 = 0.05\mu F$, and changing this to C_2' necessitates multiplying the frequencies by $\frac{C_2}{C_2'}$. The reverse process, to find the inductance or capacity to give any other frequency characteristic, is obvious.

It will be noticed that at frequencies at which the tone-circuit reactance is high, the larger values of R_2 produce the greater drop, an effect which is reversed when the reactance falls off and the drop consequently becomes pronounced.

By drawing a horizontal line at the level where $\frac{1}{p} = \mu$, a new zero is established for considering the performance of the tone circuit and the valve together; parts of the curve above this line represent an overall gain, and *vice versa*. This is the most desirable form in which the curves should appear when considering any particular case.

To indicate the effect of widely differing conditions, as for example the use of a tetrode or pentode, in which the R_A is large, a similar set of curves is shown in Fig. 7 for

db	$\frac{R_2}{R_A}$	$R_2(R_A = 300{,}000)$
2	0.774	232,000
5	0.257	77,000
10	0.092	27,700
15	0.0433	13,000
20	0.0272	6,670
25	0.0119	3,575

$R_1 = 0.25\ R_A$. The following are typical circuit values :—

$R_A = 300{,}000$ ohms.

$R_1 = 75{,}000$ ohms.

R_2 as in Table.

$L = 10$ H.

$C_2 = 0.01\ \mu F$.

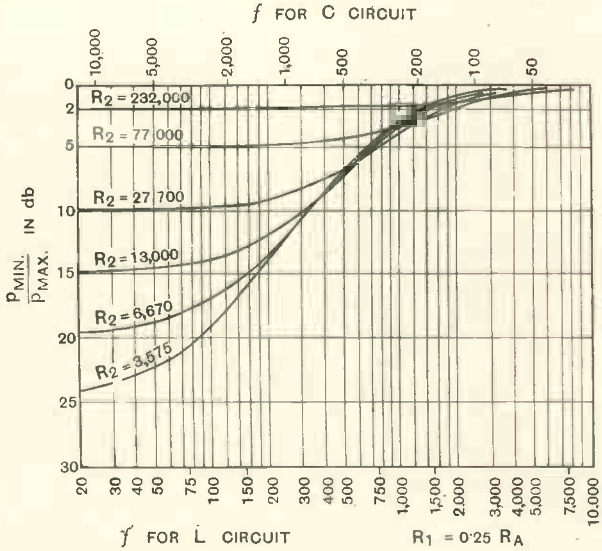

Fig. 7.—*Example : $R_A = 300{,}000$ ohms ; $R_1 = 75{,}000$ ohms ; $L = 10$ henries ; $C_2 = 0.01\ \mu F$.*

but the curves can easily be made of general application as already explained.

Though the circle diagram differs very greatly in proportion from that for $R_1 = 4R_A$, the frequency characteristic curves are remarkably similar. It will, of course, be understood that R_2 must include the A.C. resistance of L (that of C_2 can usually be neglected) as well as the intentional resistance inserted in series.

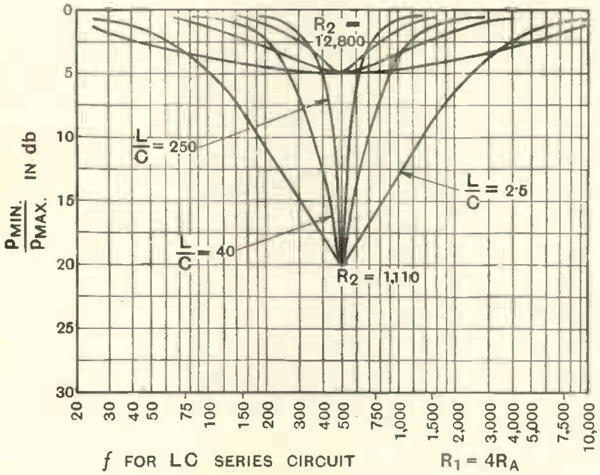

Fig. 8.—*Example :* $R_A = 12{,}500$ *ohms ;* $R_1 = 50{,}000$ *ohms ;* $L = 0.5, 2, 5$ *henries ;* $C_2 = 0.2, 0.05, 0.02\ \mu F$.

Circuits including both Inductance and Capacity.

In a tone circuit including both L and C_2 together a frequency acceptor or rejector results according to whether they are in series or parallel, the height or depth being controlled by R_2, the frequency at the peak by the product LC_2, and the width or "sharpness" by the ratio $\frac{L}{C_2}$. The first two of these three can be adapted to suit the requirements without any further explanation being necessary in the case of L, C_2 and R_2 in series, but the effect of varying $\frac{L}{C_2}$ can best be shown by curves. The constants of Fig. 6 are again selected as an example, with only two values of $p_{\min.}$ (5 *db* and 20 *db*) illustrated, but three different $\frac{L}{C_2}$ ratios which give the same product LC_2.

If f_r is the peak frequency :—

$$f_r = \frac{1}{2\pi\sqrt{LC_2}}$$

and if X_f is the reactance of L and C_2 in series at frequency f :—

$$X_f = 2\pi Lf\left(1 - \frac{f_r^2}{f^2}\right)$$

so the frequency curves can be plotted from those for inductance alone (Fig. 6) by shifting the points from $f\left(1 - \frac{f_r^2}{f^2}\right)$ on the frequency scale of Fig. 6 to f on Fig. 8. These curves are symmetrical on a logarithmic frequency base. They also do a thing that ordinary resonance curves are never guilty of—the sharper curves cross the blunter ones. These curves are useful for estimating suitable circuit constants for suppressing a resonance somewhere else in the system, as for example in a gramophone pick-up. It will be noticed that a much steeper cut-off can be obtained than by the use of a simple L or C circuit, and in cases where the band of frequencies is already limited, as in radio telephony modulation, one half of the tone-circuit curve may be used to give a sharply defined cut-off. The shallower characteristics may be used to compensate for the commonest failing of an amplifier—a falling off at the lowest and highest frequencies.

The case of L and C in parallel is complicated by the resistance in the parallel circuit, as well as R_2 in series, which makes

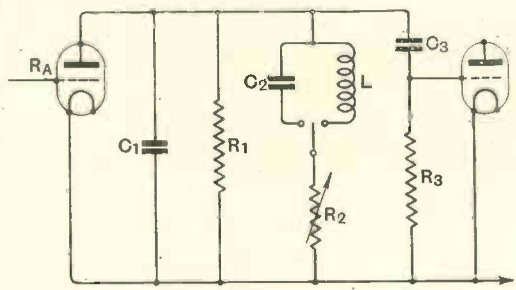

Fig. 9.

it more difficult to illustrate the performance in general. It is also not of such useful application as the others ; but if it is desired to study the action in detail the method will be obvious from the treatment of the foregoing, first making use of equations (1)—(4) to reduce it to the equivalent simple circuit. If resistance in the parallel circuit is negligible, the frequency characteristics

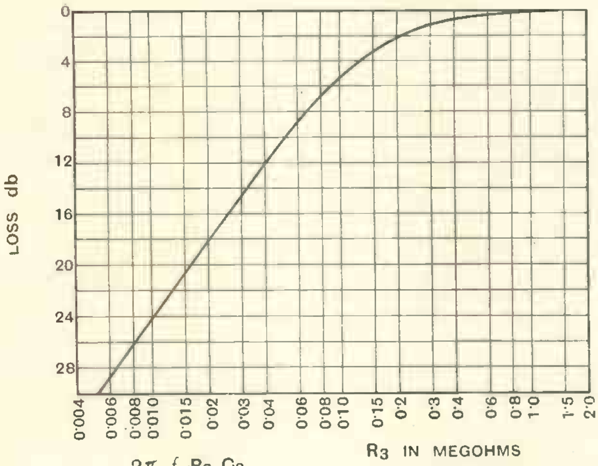

Fig. 10.

are similar to the inverse of those of the series circuit, with the peak touching the zero *db* line ; the effect of parallel resistance is to flatten the peak so that $p_{max.}$ is not attained at any frequency.

Effect of Other Circuit Elements.

In a practical amplifier circuit there are other influences which affect the frequency characteristics, notably :—

(1) Shunt capacity (including valve electrode capacity, and stray circuital capacity, as well as the intentional capacity of the by-pass condenser, if used).

(2) Shunt effect of the circuit formed by the coupling condenser and grid leak of the succeeding valve.

(3) Loss due to impedance of coupling condenser. See Fig. 9. This more complex circuit can be computed by successive reduction to the simple circuits already considered. This adds considerably to the labour, and, although the circle diagram is greatly modified by these other factors, it is fortunate that with reasonable circuit constants the frequency curve is not sufficiently altered to justify the extra work, except perhaps Effect (3), which is very simply allowed for by means of the method described by the writer in *E.W. & W.E.* Dec., 1927, the results of which are shown in convenient form in Fig. 10. The *db* loss shown on this diagram is to be added to that of the main circuit curves. Alternatively it enables suitable grid circuit components to be selected for negligible loss within the working frequency range. This is, of course, utilisable in connection with any amplifier using a grid leak and condenser; also the loss due to Effect (2) in an ordinary resistance-coupled amplifier with no tone circuit may be estimated by considering the grid leak and condenser as a tone circuit.

Some idea of the latitude which is possible with regard to these effects may be gathered from curves relating to a particular practical circuit differing fairly widely from those previously illustrated, with the following circuit constants :—

R_A 12,000 C_2 0.05μF.
R_1 25,000 C_3 0.1 μF.
R_3 100,000 L 2.22H.
C_1 0.002μF R_2 0, 1,000, 3,000, 6,000 11,000, 18,000, 37,000, plus 1,500 in the case of inductance.

The impedance diagram for such a circuit departs so much from the semi-circular form

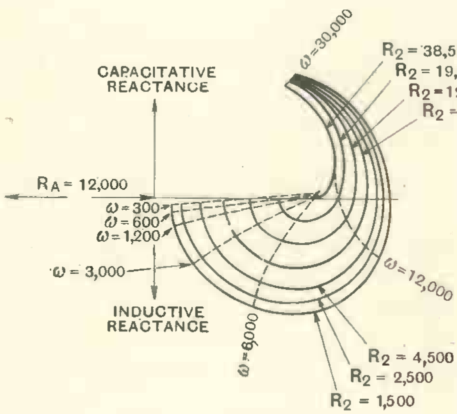

Fig. 11.

(Fig. 11) that one would suppose the frequency characteristics would differ greatly from those of a simple circuit. It will be seen from Fig. 12, however, that they are very similar, and in fact the effect of the extra elements of the circuit is limited almost everywhere to less than one *db*, which is about the least variation in sound level that can be detected by the ear, and at least 2*db* variation in a frequency characteristic goes unobserved by aural test. L and C curves are shown separately, because not only are the extra effects asymmetrical, but the total values of R_2 differ for L and C owing to the coil resistance.

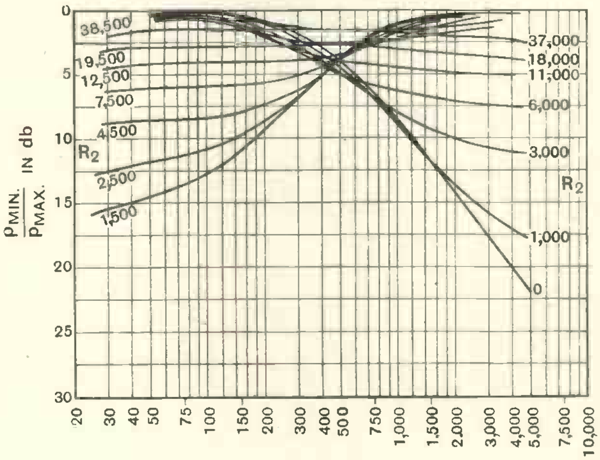

Fig. 12.

Fig. 11 illustrates the L circuit ; the corresponding diagram for the C circuit is even stranger. Fig. 13 shows the impedance " circle " for 2.22H and 0.05μF in series, with $R_2 = 4{,}500$. The effect of the by-pass condenser is to bring the impedance into the upper or capacitative semi-circle at high frequencies, whereas normally the circuit is inductive at high frequencies.

Practical Notes.

It is obvious that special requirements can be met by combining the simpler characteristics by means of circuits connected either with the same valve or with separate valves in cascade, or by the use of more complex tone circuits. The method has been found particularly useful in practice, however, for rapidly estimating suitable circuit constants for the simpler types of compensation, either of a fixed character for a specific effect, or a general-purpose tone-control for broadcast and gramophone

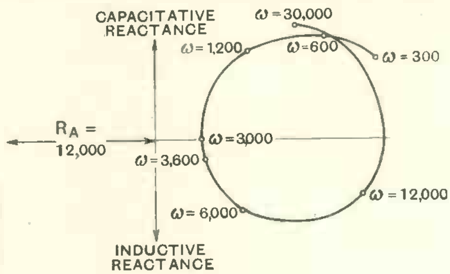

Fig. 13.

amplification. A useful arrangement for the latter purpose includes R_2 variable in suitable steps, and another switch to introduce L, C_2, or a combination of both. It may be desirable to vary L (or C_2) and R_2 simultaneously.

When changing from circuits (*b*) or (*c*) to (*a*) or (*d*) (Fig. 1) the ohmic resistance of the anode feed path is reduced by the inductive path and the operating conditions of the valve thereby altered ; thus R_A is not the same for L as for C. A desirable feature, if the tone circuit is variable, is an arrangement for putting resistance into the anode feed circuit to compensate for the

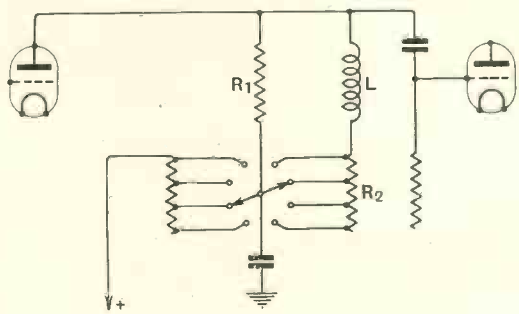

Fig. 14.

reduction (Fig. 14). The capacity from switch to earth must be large enough to offer negligible impedance at signal frequency.

Apparatus for Exhibiting

Some Properties of Coupled Circuits.*

By the late R. C. Clinker and T. H. Kinman.

(Engineering Laboratory, British Thomson-Houston Co., Ltd.)

Special interest attaches to this contribution, for it was the last article written by Mr. Clinker before his tragic death while mountaineering in Wales in August. Our last meeting with him was at the Physical Society's Exhibition in January last, when he demonstrated and explained to us the beautifully ingenious apparatus described in this article. He delighted in devising such apparatus for exhibiting the peculiar properties of coupled circuits. G.W.O.H.

THERE has recently been placed in the Radio Section of the Science Museum a working apparatus which demonstrates, in an interesting manner, the changes of frequency and phase which occur in two H.F.-coupled circuits under certain conditions of tuning and coupling. The apparatus is a modification of one shown at the Physical and Optical Societies' Exhibition in January last, and described in *Nature* of 28th February, 1931, page 324.

Before describing the apparatus under consideration, a brief reference to the effects it illustrates will be advantageous.

Let us take a tunable circuit L_2C_2 (Fig. 1), which is loosely coupled to an oscillating circuit L_1C_1, which is directly excited by a valve, and whose constants control the frequency. If we place in the L_2C_2 circuit an ammeter I, and take readings of the current corresponding to various settings of C_2, we shall obtain a graph somewhat as shown in Fig. 2. Starting with a low value of capacity

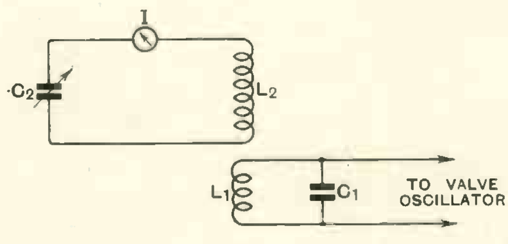

Fig. 1.

the current rises from A to B as circuit L_2C_2 is brought towards resonance with L_1C_1. At a certain point B, however, the current drops suddenly and discontinuously to a lower value at C, and further increase of C_2 traces a curve towards D. Reduction of capacity retraces the graph along DC, and continues it to some point E, at which the current again drops suddenly and discontinuously to a point F on the original curve, which is followed back to A.

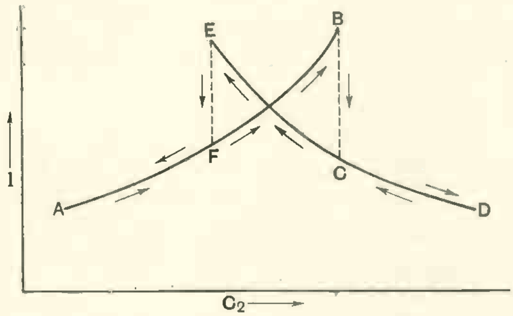

Fig. 2.

Simultaneously with the sudden current jumps the frequency of the system also changes suddenly in value. The effect is, of course, a well known one, and can make itself evident in receiving circuits by sharp "clicks" in the phones. It has been dealt with mathematically by Townsend† and was demonstrated in March, 1920, before the (then) London Wireless Society by one of us. It was treated also in a paper‡ on the Leafield Arc by Lee and Gill.

A similar result is obtained if the capacity is kept constant while the coupling is varied, and this fact is made use of in the working apparatus described below.

The electrical changes which occur may, perhaps, be indicated by the following considerations:—

We will assume that condenser C_2 is fixed

* MS. received by the Editor, September, 1931.

† *Radio Review*, 1919-1920, page 369.

‡ *Journal I.E.E.*, July, 1925, page 703.

in value, and that the coupling is varied. Let the secondary circuit L_2C_2 be initially adjusted so that its natural frequency is slightly higher than that of the primary circuit L_1C_1. With weak coupling the phase of the secondary current *leads* that of the E.M.F. producing it by nearly 90°, and is, therefore, substantially in phase with the primary (or L_1C_1) current. (This will be clear from the considerations that the secondary induced E.M.F. is 90° behind the primary current, and the secondary current is 90° ahead of the induced E.M.F.) As the coupling increases, however, the effective inductance of the secondary circuit increases, and approaches the resonant value for the impressed frequency. This results in a condition of instability when a certain value of coupling is reached. For, as the secondary current vector decreases its lead—with the approach of resonance—the frequency increases, owing to the secondary current moving out of phase with the primary and decreasing the effective inductance of the primary circuit. But increase of frequency brings the secondary current-vector still farther towards the resonant position, raising the frequency still farther, and so on.

The net effect, therefore, when a certain coupling is reached, is that the relative phases of primary and secondary currents jump from "in-phase" to "opposition," *i.e.*, reverse suddenly in relative direction. At the same time the frequency jumps from a lower to a higher value.

On loosening the coupling again, the effects are reversed, but at a different value of coupling, *i.e.*, the coupling must be decreased to a lower value to cause the currents to jump into phase than that to which it had to be increased to cause the jump into "opposition."

It was a consideration of these two properties of the circuit, viz.: (1) The sudden reversal of current direction, and (2) the "overlap" of the critical coupling-values, which suggested to us the possibility of making an apparatus to demonstrate the effect automatically. For the change of current-direction in the two coils means a change from attraction to repulsion, so that if the secondary circuit is pivoted or suspended it can be made to exhibit, by its motion, the direction of the current. Also the "overlap" condition means that impulses may be arranged to occur at the right instants to maintain the motion. Further, two tuned circuits connected to small glow-tubes could be used to show the change of frequency.

After making up a suspended coil model for

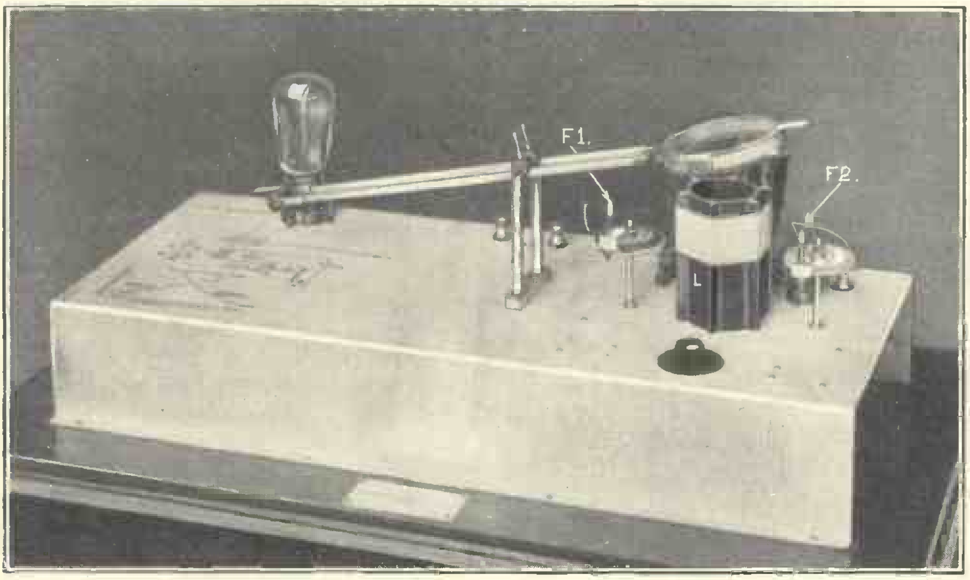

Fig. 3.—*Photograph of a model made up for the Science Museum.*

the Physical and Optical Societies' Exhibition, a model in which a horizontal arm is used was made up for the Science Museum and is shown in Fig. 3.

The essential parts are mounted upon a metal base, under which is the necessary transformer and rectifying valve, etc., to supply the oscillator valve, which is a Mazda PP3/425. The primary coil, seen at *L* in the figure, is fixed, while the secondary coil is at the right-hand end of the "see-saw," with its condenser as counterbalance at the other end. The whole is placed on knife-edge pivots. The two glow-tubes are shown at F_1 and F_2, supported on their respective coils, tuned to the two frequencies.

When voltage is applied the secondary coil is alternately attracted and repelled by the fixed coil and a rocking motion set up. The glow-tubes light up alternately as the frequency jumps from one value to the other.

The model, therefore, demonstrates three effects obtained with tuned coupled circuits:

(1) The reversal of relative current phase in the coils.

(2) The "overlap" effect.

(3) The sudden changes of frequency.

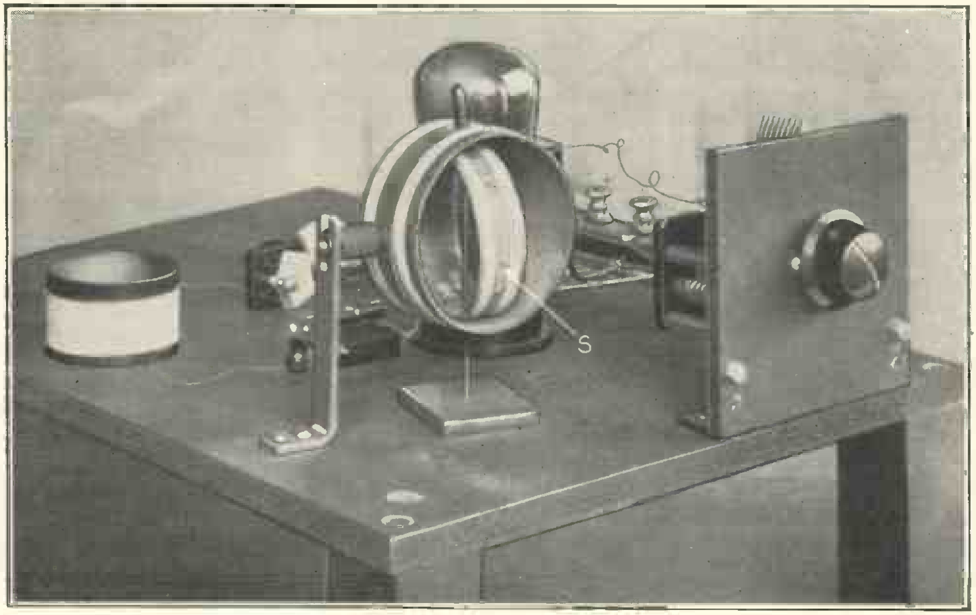

Fig. 4.—*Apparatus designed to demonstrate effects of coupled circuits.*

If desired, a loud speaker may be connected in the plate circuit of the valve, and the points of "jump" indicated by the loud clicks produced.

A further interesting method of showing these effects is by means of the arrangement shown in Fig. 4. Here the secondary coil *S* is mounted with its condenser on a pivot inside the primary, and spins round continuously due to the action of the induced currents.

The foregoing description will make clear how the reversals of the currents due to the varying coupling take place at the appropriate positions to give impulses which keep the coil spinning. It will, of course, once started, run in either direction.

Losses in Liquid Dielectrics at Radio Frequencies.*

By W. Jackson, M.Sc., A.M.I.E.E.

(*Electrical Engineering Dept., College of Technology, Manchester.*)

IN a previous paper† were described a series of high-frequency resistance measurements carried out for the purpose of investigating the dielectric losses associated with the formers of single-layer coils. A number of identical coils were wound on formers of different materials—teak wood, micarta, leatheroid, ebonite, paxoline and cardboard—and their resistances, over a range of wavelength from 300 to 800 metres, compared with that of an air-spaced coil of identical constants. This standard air-spaced coil was wound on a special former from which, after it had been made self-supporting by means of six narrow axial bars, 3/16th inch wide, of paraffin wax, it could finally be removed for measurement. All the coils were of four inches diameter and had 46 turns of bare No. 20 S.W.G. copper wire, the turns being spaced so that the distance between successive centres was .0684 inch. The increase in resistance of the several coils, as compared with the air-spaced coil, was regarded as due, since no increase in self-capacity was noticeable by the "Intercept"‡ method of measurement, entirely to dielectric loss in the coil former. It was seen that the dielectric loss, in the case of the several formers, led, at a wavelength of 400 metres, to a percentage increase in the coil resistance of the following magnitudes.

Former material.	Percentage increase in coil resistance.
Ebonite and paxoline ..	2.0
Teak wood	9.0
Micarta	14.6
Leatheroid	21.2
Cardboard (dry) ..	62.0

Further, the effect of damping the cardboard former was to produce a substantial increase in the already considerable loss introduced by the cardboard.

In analysing the results an attempt was made to account for the increase in resistance due to dielectric loss on the supposition of a constant power factor for the dielectric circuit of the coil self-capacity, on which supposition the added resistance due to dielectric loss should increase as the cube of the frequency. This was found to be the case, a fact which appeared to substantiate the supposition of constant power factor. E. B. Moullin,§ however, finds, in connection with a series of resistance measurements at audio frequencies on a number of similar waxed coils of inductance ranging from 21 to 23 millihenrys, that attempts to express the dielectric loss in terms of constant power factor of the self-capacity were not very successful, and states that the power factor in the case of one of the coils ranges from 28 per cent. at 200 cycles per second to 16 per cent. at 1600 cycles per second.

The present investigation had for its purpose, therefore, the provision of additional information relating to the justification or otherwise of the supposition of a constant power factor of the dielectric circuit. The use of liquid dielectrics for the coil immediately suggested itself, so that, in addition, facility was afforded for gaining information as to the behaviour of liquid dielectrics at radio frequencies, a subject on which little information is available, and to verify the "Immersion" method of measuring coil self-capacity, suggested by Meissner.||

This method consists in observing the change in capacity, as measured on a small vernier condenser, necessary to retune the coil to a fixed frequency on immersing the coil in a liquid dielectric of known specific inductive capacity k. The immersion is assumed to increase the self-capacity k times, so that if K is the capacity change to retune, the self-capacity C of the coil in air of S.I.C. unity, is given by $C = \frac{K}{k - 1}$. Measurements of self-capacity by this method have, in

* M.S. received by the Editor April, 1931.

† *E.W. & W.E.*, Vol. V, May, 1928.

‡ Moullin, Radio Frequency Measurements, 2nd Edn., p. 337.

§ Radio Frequency Measurements, 2nd Edn., p. 368.

|| Jahrbuch der d. Teleg., 1909, Vol. 3.

the past, been carried out on coils associated with a former, so that the dielectric could not justifiably be regarded as having a S.I.C. of unity before immersion, nor could the entire dielectric after immersion be accepted as having a S.I.C. of k. The use throughout the investigation of air-spaced bare wire coils of the type previously mentioned, except that in this case the coils had 48 turns, ought to preclude any such doubt. The common true inductance of the coils used was 189 microhenrys.

For the resistance measurements, the "resistance variation" method was again employed. The resistance as measured necessarily includes the unknown resistance of the tuning condenser. This is not, in the present case, a disadvantage, since the change in resistance resulting from the immersion of an air-spaced coil in various liquid dielectrics is the vital concern. In order that the adherence of a thin layer of dielectric to the coil, as a result of immersion in one liquid, should not be allowed to influence the results from immersion in another, a new coil was constructed for association with each of the several dielectrics.

Self-capacity.

Table I gives the results obtained from measuring the change in tuning capacity necessary at a wavelength of 400 metres on submerging the coils in various dielectrics.

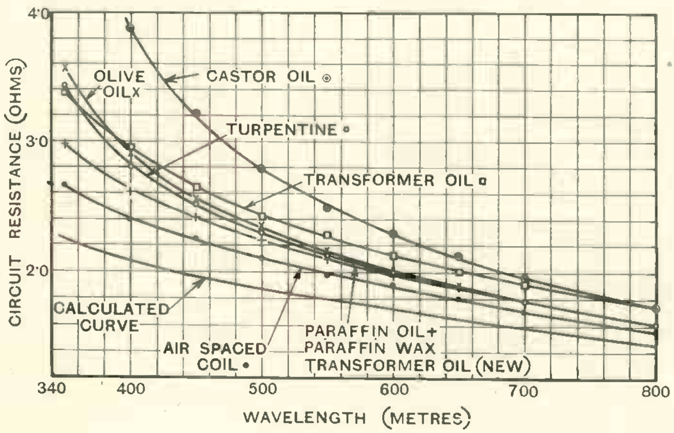

Fig. 1.

Apart from the result of the turpentine immersion, the values of self-capacity derived are in good agreement and give an average value of 1.7 micro-microfarads, a value which does not show close agreement with the value of 4.5 micro-microfarads obtained by the "Intercept" method. In view, however, of the evidence of the above table and the relative complexity of the latter method, the value of 1.7 $\mu\mu$F. justifies priority. Previous experimental evidence* on former-wound coils indicates that the self-capacity in $\mu\mu$F. may be taken as from .52 to .66 times the radius in cms. for single-layer coils. The air-spaced coils used in the above measurements had a radius of 5.08 cms., so that the ratio of self-capacity to radius is given as .34. That this ratio is lower than the figures given, may, perhaps, be accounted for by the contention that the former is responsible for an increase in self-capacity in so far as it must increase the average S.I.C. of the coil dielectric, although as stated in the previous paper, this effect had not been noticeable in comparative self-capacity measurements, by the "Intercept" method, on the air-spaced and former-wound coils there described.

TABLE I.

Dielectric.	Dielectric constant S.I.C. k	Change in tuning capacity K $\mu\mu$F.	k-1	Self-capacity of coil in air $C = \frac{K}{k-1}$ $\mu\mu$F.
Paraffin Oil..	2.2	2.0	1.2	1.65
Turpentine ..	2.23	2.8	1.23	2.3
Transformer Oil (new).	2.0	1.6	1.0	1.6
Olive Oil ..	3.2	3.4	2.2	1.55
Castor Oil ..	4.8	6.4	3.8	1.7
Nitrobenzene	34.0	50.0	33.0	1.5

Dielectric Losses.

Following the determination of self-capacity the high-frequency resistance of the immersed coil was measured at intervals of 50 metres over the wavelength range from 800 to 350 metres. Fig. 1 shows the variation of coil resistance with wavelength corresponding to immersions in paraffin oil,

* Howe, Journ. I.E.E., 1922, Vol. lx., p. 63.

turpentine, olive oil, castor oil and transformer oil. The transformer oil to which the measurements relate was old oil containing appreciable moisture—the measurements on a coil immersed in new transformer oil provided a resistance curve identical, as far as could be appreciated, with that shown for paraffin oil. A coil thickly coated with paraffin wax also gives a resistance-wavelength variation analogous to that for a coil in paraffin oil. The curve for a coil in air, with which the above curves are to be compared, and the calculated resistance curve obtained by use of Butterworth's equation†

$$R_n = R_0\left\{1 + F + uG\frac{d^2}{D^2}\right\}$$

are also given. In this formula, R_n represents the resistance at frequency n cycles per second; R_0 the direct current resistance; $(1+F)=\frac{\sqrt{2}z+1}{4}$; $G=\frac{\sqrt{2}z-1}{8}$ and $z=\pi d\sqrt{\frac{2n}{\rho}}$, where d is the wire diameter in cms. and D the pitch of the turns. The factor u equals $3.29+\frac{b}{a}$ where b is the coil length and a its radius.

The increase in resistance resulting from immersion is due to two factors, namely, the increase in coil self-capacity and the dielectric loss in the circuit of this self-capacity. The coil may be depicted, as in the previous paper, by the equivalent circuit of Fig. 2, where L represents the pure inductance and R the true resistance of the coil, while C is a small condenser representing the self-capacity and r a resistance accounting for the dielectric loss. This can be replaced by an equivalent series circuit consisting of an effective inductance L' and an effective resistance R', where R' is given, at frequency $\omega/2\pi$, by the expression

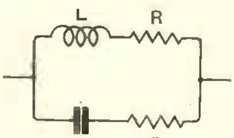

Fig. 2.

$$R' \doteq \frac{R+rL^2C^2\omega^4}{(1-2LC\omega^2)} \doteq \{R+rL^2C^2\omega^4\}(1+2LC\omega^2)$$

provided that the natural frequency of the coil is not approached, *i.e*, provided $LC\omega^2 \ll 1$, as in the present case. For the coil in air it will be necessary to assume no dielectric loss, that is, $r = O$, so that if R'_1 and C_1 represent the effective resistance and self-capacity respectively for the coil in air R'_1 can be written

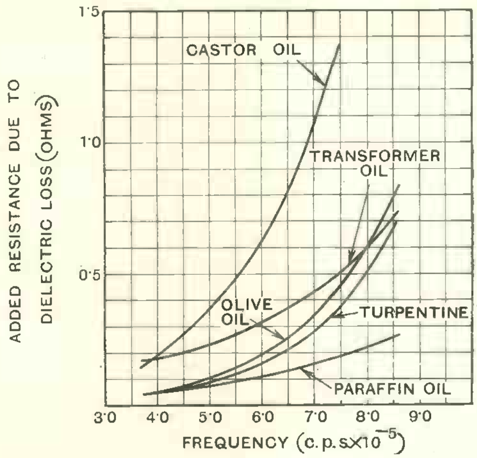

Fig. 3.

$$R'_1 = R\,(1 + 2LC_1\omega^2).$$

If R'_2 and C_2 are the corresponding values for the coil immersed in a dielectric,

$$R'_2 = R(1+2LC_2\omega^2)+rL^2C^2{}_2\omega^4(1+2LC_2\omega^2)$$

The increase in effective resistance is therefore given by

$$R'_2 - R'_1 = 2RL\,(C_2 - C_1)\,\omega^2 + rL^2C^2{}_2\omega^4(1 + 2LC_2\omega^2)$$

That is, the added resistance due to dielectric loss is given by

$$rL^2C^2{}_2\omega^4(1 + 2LC_2\omega^2) = (R'_2 - R'_1) - 2RL(C_2 - C_1)\,\omega^2 \quad \ldots \quad \ldots \quad (1)$$

Since the dielectric circuit consisting of C_2 and r has a power factor $P = rC_2\omega$, this equation can be written

$$PL^2C_2\omega^3(1 + 2LC_2\omega^2) = (R'_2 - R'_1) - 2RL\,(C_2 - C_1)\omega^2 \quad \ldots \quad \ldots \quad (2)$$

The first term on the right-hand side is immediately obtained from the curves of Fig. 1. In the second term, $(C_2 - C_1)$ — the change in self-capacity on immersion—is given in Table I, while the calculated values of coil resistance can be used for R. This latter is justifiable since, as in the previous paper, the difference between the measured resistance of the coil in air and the calculated

† *E.W. & W.E.*, Vol. 3, April, May and July, 1926.

values can be accounted for if the tuning condenser is regarded as having a power factor of the order of 30×10^{-5}. This second term is small, but not negligibly so, compared with the first throughout the frequency range of measurement. Their resultant, representing the added resistance due to dielectric loss, is shown plotted against frequency for the several dielectrics in the curves of Fig. 3.

Since $LC_2\omega^2$ is small compared with unity throughout, particularly at the lower frequencies, equation (2) indicates that if the supposition of a constant power factor P be justifiable the added resistance due to dielectric loss should vary approximately as the cube of the frequency, with a tendency to increase more rapidly than this at the higher frequencies. The curves of Fig. 4 show this added resistance plotted against the cube of the frequency. The supposition of a constant power factor of the dielectric circuit appears to be substantiated in the case of castor oil and paraffin oil, with the latter of which must be taken paraffin wax and new transformer oil. On the other hand this does not explain the behaviour of turpentine and olive oil. For these two dielectrics the added resistance has been plotted in Fig. 5 against the fourth power frequency. From the approach to linearity

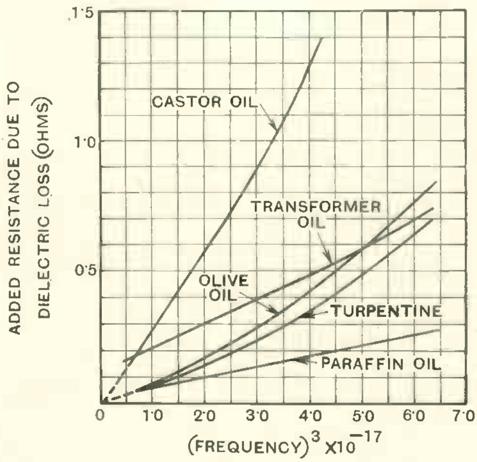

Fig. 4.

of these curves and from the form of the left hand side of equation (1), it would appear that the supposition of a constant value of r, the loss resistance in the dielectric circuit, gives a better explanation of the behaviour. With old transformer oil, the curve of Fig. 3 tends to indicate a superimposed direct conduction effect through the dielectric. This is not unexpected in

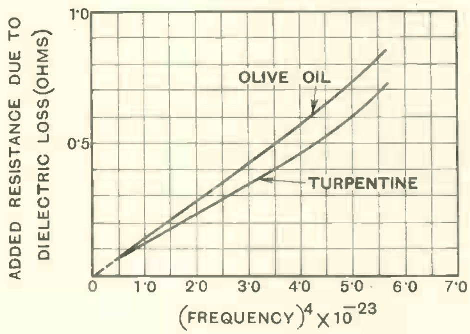

Fig. 5.

view of the appreciable quantity of moisture which the oil was known to contain.

On equating the added resistance due to dielectric loss in the case of castor oil and paraffin oil to the expression $PL^2C_2\omega^3$ $(1 + 2LC_2\omega^2)$, the power factor P of the dielectric circuit is found to be 4.0 and 1.4 per cent. respectively. Unfortunately no results with which these values can be directly compared appear to be available. The losses in castor oil have, however, been measured by Pungs* at frequencies of 20 to 65 cycles by the use of an electrometer method, when he found that at 50 cycles the power factor was of the order of 0.5 per cent. He also found that the losses in paraffin oil were much smaller than those in castor oil, which fact the above results substantiate.

On equating the added resistance in the case of turpentine and olive oil to the expression $rL^2C_2{}^2\omega^4$ $(1 + 2LC_2\omega^2)$, the dielectric loss resistance r is found to have values of approximately 800 and 1000 ohms respectively. These values are not very helpful and for comparison with the values of power factor obtained for castor oil and paraffin oil the apparent power factor has been calculated at 450 metres as 1.7 and 2.0 per cent. respectively for turpentine and transformer oil.

* Archiv f. Elektrot., 1912, Vol. 1, p. 329.

The Gain Control and the Decibel.*

By H. Stanesby.

IN view of the rapidly increasing use of the decibel as the unit of attenuation and amplification, the following article may be of interest to those who require to design gain control resistances.

Consider the input terminals of an amplifier, connected across a variable tapping R_1 on a resistance having a total value R, as indicated in Fig. 1, and let the input impedance of the amplifier be much greater than R, so that the fall of potential along the resistance is not varied appreciably by the position of the tap.

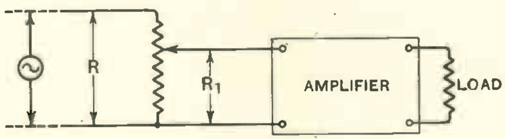

Fig. 1.

If a potential difference be applied between the ends of the resistance, it is clear that the voltage applied to the amplifier can be controlled by varying R_1. This can be arranged conveniently by making connections from suitable points along the resistance, to the contacts of a selector switch, and connecting the selector arm and one end of the resistance to the amplifier.

The ratio of the voltage applied to the terminals of the amplifier to that which could be applied by tapping across the whole of R, is as R_1 is to R, which is also the ratio of the voltages which would be developed across the load; this is assuming, of course, that the amplifier is free from overloading. The power delivered to the load corresponding to these two tappings would be in the ratio $R_1^2 : R^2$, and we can say the power delivered to the load for the tapping R_1 would be D decibels below that corresponding to a tapping across the whole of R, where

$$D = 10 \log_{10} \frac{R^2}{R_1^2}$$

$$= 20 \log_{10} \frac{R}{R_1}$$

* MS. received by the Editor September, 1931.

Further, from the above we get

$$\frac{D}{20} = \log_{10} \frac{R}{R_1}$$

Hence

$$\log_{10}^{-1} \frac{D}{20} = \frac{R}{R_1}$$

and

$$R_1 = \frac{R}{\log_{10}^{-1} \frac{D}{20}}$$

Suppose we wish to determine the value of R_1 which will reduce the power delivered to the load from its maximum value to a value D decibels lower, or, in other words, which will reduce the overall amplification of the amplifier and gain control device, considered as one unit, by D decibels. Having decided upon the total value R of

TABLE I.

Total Resistance = 1,000 ohms. Range = 40 decibels. Steps = 1 decibel.

Sect.	Ohms.	Sect.	Ohms.
1	108.75	21	10.875
2	96.92	22	9.692
3	86.38	23	8.638
4	76.99	24	7.699
5	68.62	25	6.862
6	61.15	26	6.115
7	54.51	27	5.451
8	48.57	28	4.857
9	43.30	29	4.330
10	38.58	30	3.858
11	34.39	31	3.439
12	30.65	32	3.065
13	27.32	33	2.732
14	24.34	34	2.434
15	21.70	35	2.170
16	19.34	36	1.934
17	17.24	37	1.724
18	15.36	38	1.536
19	13.69	39	1.369
20	12.20	40	1.220
		41	10.000

the resistance, the value of R_1 may be calculated by substituting for R and D in the above equation.

In this way it would not be difficult, if somewhat laborious, to find the values of

R_1 corresponding to a series of values of D. For design purposes, however, it is necessary to determine the differences between suc-

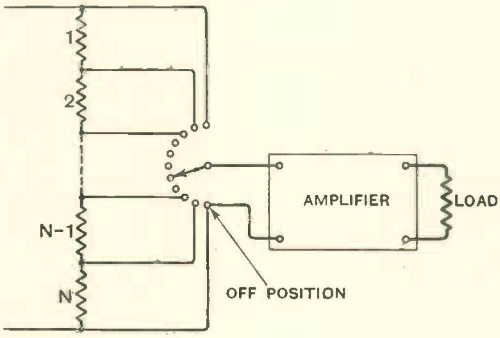

Fig. 2.

cessive values of R_1, as these correspond to the resistances, all of which connected in series with the lowest value of R_1 would constitute the complete gain control resistance, divided into the appropriate steps.

By using the tables given here, nearly all calculations may be avoided. Table I gives values for the sections of a gain control which has a total resistance of 1000 ohms, and operates over a range of 40 decibels in steps of 1 decibel. Table II differs in that the range is 100 decibels in steps of 5 decibels.

Fig. 2 shows the order in which these sections must be connected to form a complete unit.

For a gain control having a total resistance of S ohms, the corresponding resistance values of the sections may be obtained by multiplying those given in the tables by $S/1{,}000$. If the values are required for a control which will operate in larger steps, they may be obtained from the tables by adding together the values of adjacent sections. Finally, if a smaller range of control is desired, the gain control resistance need not be divided into more separate sections than this reduced range demands, and the remaining sections given in the table should be added together to form an Nth section (see Fig. 2), of larger value.

TABLE II.

Total Resistance = 1,000 ohms. Range = 100 decibels. Steps = 5 decibels.

Sect.	Ohms.	Sect.	Ohms.	Sect.	Ohms.	Sect.	Ohms.	Sect.	Ohms.
1	437.7	5	43.77	9	4.377	13	0.4377	17	0.04377
2	246.1	6	24.61	10	2.461	14	0.2461	18	0.02461
3	138.4	7	13.84	11	1.384	15	0.1384	19	0.01384
4	77.8	8	7.78	12	0.778	16	0.0778	20	0.00778
								21	0.01000

SCIENTIFIC AND TECHNICAL ABSTRACTS.

A CONFERENCE on scientific abstracting service was recently held at the Imperial College of Science and Technology at the invitation of Mr. H. T. Tizard, president of the Association of Special Libraries and Information Bureaux. The object of the meeting was to exchange experience and to discuss methods, not with a view to advocating standardisation, but in order to produce a body of information which could be utilised to mutual advantage. The Conference unanimously approved of collecting and reporting on the methods employed by Societies and Industrial Undertakings for collecting and reviewing foreign publications. A small Committee was appointed to issue a Questionnaire to Abstract Organisations and Information Bureaux, and to summarise the replies. One of the main objects is to try and provide a more complete and prompt review of foreign scientific and technical publications, especially in the less understood languages, e.g., Russian, Japanese, etc. The Committee will attempt to indicate precisely what methods have been found successful or ineffective and to analyse the collected experience and opinions. It is hoped that all firms and associations which maintain such organisations will help to promote the efficiency of scientific abstracting in general by taking part in the survey. Copies of the questionnaire may be obtained from Mr. S. S. Bullock, Secretary of the Association of Special Libraries and Information Bureaux, 16, Russell Square, London, W.C.1. It is hoped that replies will be received as early as possible.

Reflection Methods of Measuring the Depth of the Sea.

Paper by Commander J. A. Slee, C.B.E., R.N., M.I.E.E., before the Wireless Section, I.E.E., on 2nd December, 1931.

Abstract.

THE fundamental principle is to make a disturbance in water and to time the return of the echo from the bottom of the sea. The paper records the present state of perfection with which this work can be carried out in practice, and describes the chief methods now in use. The ordinary commercial requirements are twofold. Big-ship navigators are very interested in depths from a little over 100 fathoms downwards, and are particularly anxious to read from 2 to 10 or 20 fathoms of water under keel; trawlers demand much greater depths, at least as great as 350 fathoms, and it seems probable that this requirement will increase in the future.

The problem divides itself into four distinct parts:

(a) To set up the necessary elastic wave in the water.
(b) To detect the return of the echo.
(c) To disentangle the echo from unwanted signals of all kinds.
(d) To make the measurement of time and to indicate the resultant depth of water.

With regard to (a), the elastic wave can be of such a regular and sustained nature that the effects of resonance can be made use of, or it may be so highly damped as to approach to the nature of a single impact. In the case of resonant waves there is a wide choice of practicable frequency. Apparatus now being manufactured comes under one of two headings, (1) "single impact," (2) resonant at a frequency too high for human hearing, the audible-frequency resonant wave being at present out of fashion. In any case, the period during which transmission lasts must be very short indeed in order that at least the greater part of the energy of transmission shall have died away before the echo returns.

A form of multiple hammer has also been used, the blows following one another at a time interval corresponding to the frequency desired. This class of emitter allows greater power to be employed, and has been worked up to a frequency of about 20,000.

A combination of single-impact and audible resonance has also been used, the hammer blow being struck on the end of an elastic steel rod, the longitudinal vibration of which provides the frequency of the elastic wave emitted.

With regard to (b), the present types of receiver are either hydrophones—that is to say, special types of microphones—or employ the piezo-electric principle. The effects of magneto-striction have also been employed for subaqueous receivers of various sorts.

With regard to (c) there are two principal methods, (1) the rough but effectve plan of using so much transmitted power that the returning echo shall be considerably above the noise-level, or (2) the more delicate method of taking advantage of the effects of resonance and of directional reception to select the required signal.

With regard to (d), the most successful methods now in use may best be described as oscillographic. If practically constant relative motion of some kind of index over a scale can be assured, and if transmission takes place as this index passes the zero, its deflection by the returning echo will mark a point on the scale which indicates the depth in fathoms. The index is usually the stylus of an electrolytic or mechanical recorder, or a spot of light which may be deflected by the returning echo, or a spot of light whose brilliance may be varied. With such devices the occurrence of any unwanted signal before the echo returns does not prevent the correct reception of the echo when it does arrive.

The mechanical arrangement of a typical recorder is shown in Fig. 2*. The stylus may record electrolytically or may scratch a white line on lamp-blacked paper. The paper is moved at a speed selected with reference to the depth concerned; the contacts determining the moment of transmission are also actuated by the same mechanism. A practical difficulty is to synchronise the formation of the emission mark with the real commencement of the emission. This is sometimes done mechanically;

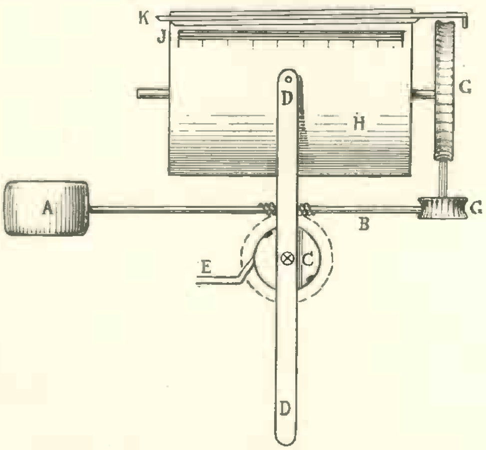

Fig. 2.—*Mechanical arrangement of typical recording oscillograph. A = motor, B = first spindle, C = emitting contact drum, D = double ended stylus arm, E = emitting contacts, G = paper drum, J = scale-marking comb, K = time line bar.*

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

in other cases it is done by allowing the receiver to make the emission mark. The occurrence of an unwanted signal is indicated by an extra mark on the paper. This does not hinder the correct spot from being marked, and so long as these unwanted marks are not too numerous they do no real harm.

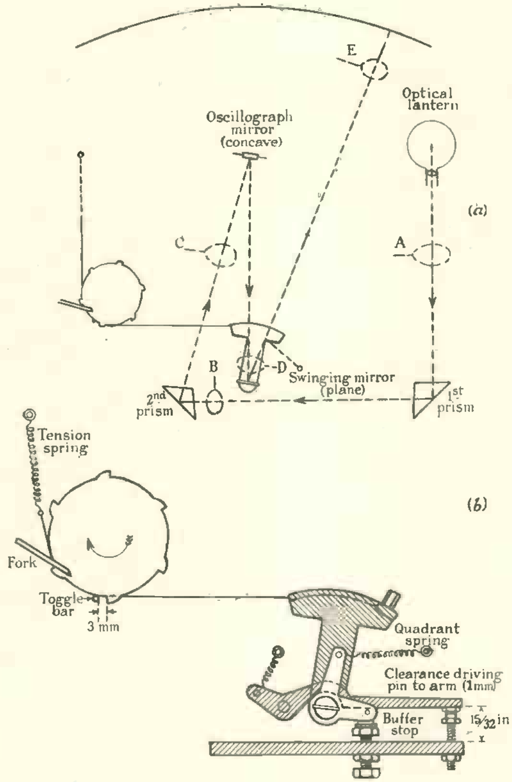

Fig 3.—(*a*) *Optical system. At A, B and C a screen shows an image of the filament. At B a screen shows a rectangle of light. At E there is a sharp spot.* (*b*) *Quick-return system for mirror.*

A non-recording optical system is illustrated in Fig. 3. Emission and return cause the light spot to kick vertically by agitating the reflecting galvanometer, while the swinging mirror makes it traverse the scale at a predetermined speed. The mirror has a quick-return motion and the transmitting contact is worked by a tappet action carried under the mirror spindle, emission taking place when this is opened.

Aural and semi-permanent methods of observation are also briefly described in the paper.

As regards sources of emission, the single-impact emitters now in use are electric or spring-driven hammers or pneumatic hammers. Explosive charges have also been used.

The most remarkable emitter is the high-frequency piezo-electric instrument illustrated in Fig. 4. Its frequency is approximately 37.5 kc/s. representing an elastic wave in salt water about 4 cm. long. A comparatively small disc oscillating at this frequency will give highly directional transmission. The commercial article of 8 inch diameter confines the majority of the energy radiated within a cone having an angle from wall to axis of about 6 degrees.

The construction of the active part of this "projector" is most ingenious. It consists of a thin layer of piezo-electrically active pieces of quartz fitted together in a perfect mosaic, all the parts being fastened together and to the surfaces of two steel discs, between which it is placed, with a special form of cement. Provided that the adhesion due to the cement is perfect between the parts of quartz and between them and the steel, the whole mass acts piezo-electrically as one, and at a frequency which has no apparent connection with that of the quartz alone. The whole is so constructed that its thickness is $\frac{1}{2}$ wavelength at its resonant frequency, and the axial movement of the outer faces when electrically excited at a given voltage at its own frequency is about 17 times that of the quartz-pieces alone. This piezo-electric element, a sheet of quartz pieces mounted between two steel discs, is also a condenser. It is usually mounted with its outer face in contact with the sea, its inner face being highly insulated. Recently the piezo-electric element has been mounted internally, its lower face resting on a steel plug $\frac{1}{2}$ wavelength long. The outer face of this plug is in contact with the sea.

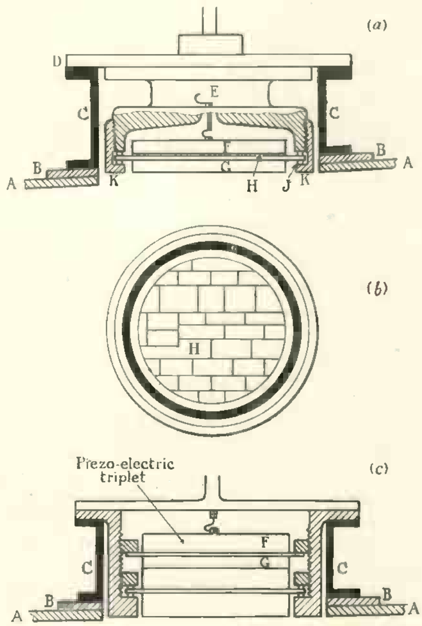

Fig. 4.—(*a*) *Section through a projector as fitted. A = skin of ship, B = stiffening ring, C = hull casting, D = projector mounting, E = projector case, F = inner plate, G = outer plate, H = quartz, J = rubber pads, K = cap.* (*b*) *Section through quartz.* (*c*) *Demountable projector.*

The same construction is also a directional piezo-electric receiver and in practice the same apparatus performs the duties of both transmission and reception.

In "single-impact" systems the emitter and receiver are usually some distance apart and allowance for this fact has to be made, especially in the case of observations in shallow water. With the supersonic system the emitter and receiver are one and the same, and the receiving amplifier is therefore subjected to the full transmission voltage at its input terminals. The piezo-electric projector is excited by means of what may be described as a very small spark transmitter of the quenched-gap type, as shown in Fig. 8. The general connections of the piezo-electric system are in many ways analogous to those of a simple wireless installation, the piezo-electric element representing the active part of the aerial. The system calls for very careful tuning, this being effected by means of a simple type of absorption wavemeter.

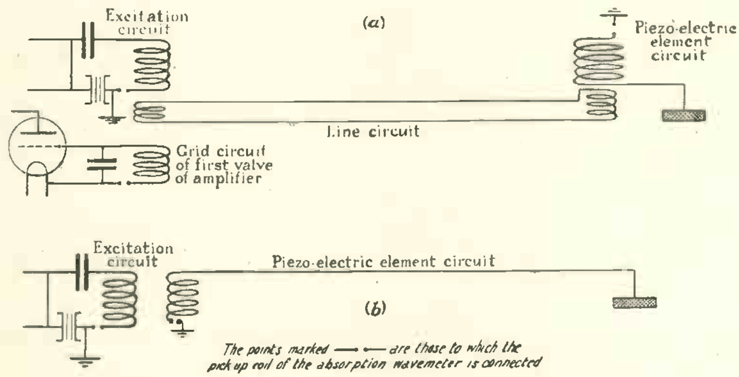

Fig. 8.—(a) *Diagrammatic circuit of piezo-electric sounding system, with indirect connections, showing method of using the absorption wavemeter.* (b) *Diagram of direct-connection installation.*

Various sources of noise are discussed in the paper, e.g., due to ship's motion and roll, turbulence eddies, etc. As regards attainable accuracy, it is shown that the overall limits are not very wide, and the probable figure for, say, the Atlantic Ocean hardly varies by 1 per cent. from the mean value. Even with such discrepancy, reflection sounding remains by far the most accurate method known.

It should be mentioned that the rate of propagation of elastic waves in sea-water may be taken at the average of 4,900 ft. per second. Since navigators usually reckon depth in fathoms, this means a depth of 408 fathoms for each second that elapses between the time of emission and the time of reception of the echo. In other words, the unit of time that has to be dealt with is 1/408 of a second, and the problems of the subject consist in the difficulties of making these measurements with sufficient accuracy and by means which are suitable to the everyday conditions under which they are used.

The paper concludes with a brief discussion of the applications to ice-detection and to aircraft.

Discussion.

The lengthy discussion which followed the reading of the paper was much more nautical than electro-technical in character.

Prof. C. L. Fortescue, who opened the discussion, referred to the special development of sound-reflection methods during the war. He asked for further information on the operation of the oscilloscope of Fig. 3 and on the construction of the piezo-crystal of Fig. 4. Future developments which should be of interest lay in application of the method to aircraft, and to the possible use of horizontal waves in foggy conditions.

Commdr. Bowles asked if the oscilloscope of Fig. 3 was satisfactory in operation at sea. The axis of the mirror seemed a matter of difficulty, while he further suggested that the kick due to the emission at zero time-scale might overlay the echo, expecially in shallow waters. He also dealt with a type of emitter that did not involve docking the vessel for its fitting.

Capt. Dorling referred to the practical navigational use of sound-reflection methods. These were a great safeguard approaching land. A record was exposed showing depths in Norwegian Fjords as indicated by a recording system. In the case of survey work reflection methods were a vital necessity.

Capt. Ramsay also dealt with practical aspects in navigation. From experience he spoke highly of the utility of a recording oscillograph method, also of the accuracy attainable with ear-phone methods in shallow water. All these methods were of particular importance to cable ships.

Mr. Smith said that surveying services were responsible for bringing echo methods into development. For this purpose they were so valuable that motor boats were being fitted for use in shallow waters. A practical point of reflection methods was that sounding could be taken at full speed. He questioned the use of the same instrument as emitter and receiver as a serviceable practice in shallow water, also was not the absorption unduly high with a supersonic frequency of the order quoted.

The author briefly replied to the discussion, and on the motion of the Chairman, Col. A. S. Angwin, was accorded a hearty vote of thanks for the paper.

Correspondence.

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

Transients and Telephony.

To the Editor, The Wireless Engineer.

SIR,—The fact that a vibrating source of sound in an enclosure such as a room sets up a system of standing waves and that the form of this three-dimensional interference pattern varies with the frequency of the source is known to all physicists. It is even mentioned in Dr. McLachlan's pamphlet on Loud Speakers.

In my letter in your November issue I made a brief reference to a recent discussion on loud speakers (*Jour. Inst. Elec. Eng.*, May, 1931, p. 610, etc.). In this several contributors brought forward the hypothesis that some of the resonance peaks observed in experiments on the variation of L.S. output with frequency might be due to the variation of the position of the interference pattern and/or its effect on the acoustic loading of the L.S.

The assertion in Dr. McLachlan's letter in your December number that I had made some " unique discovery " is consequently quite inaccurate.

T. S. E. THOMAS.

Percentage Harmonic Distortion.

To the Editor, The Wireless Engineer.

SIR,—With reference to Mr. L. H. Bedford's letter in your November issue stating that my letter in your August issue contained some very misleading statements, I would like to point out that Mr. Bedford is not entirely free from guilt in this respect.

He states that the new working path $P_3O_3Q_3$ in his diagram, due to the choke resistance, " corresponds point by point to the old path POQ." I do not see, however, that this is necessarily so unless the straight lines joining PP_3, O_1O_2 and OO_3 and QQ_3 are all equal and parallel.

However, the point does not arise as the real working path is still POQ and not $P_3O_3Q_3$.

The change in direct current due to rectification is determined by the point O_2 in the choke fed case as stated by Mr. Bedford, where O_1O_2 is parallel to the slope of the characteristic at O. This does not mean, however, that the working path moves off POQ, but simply that the wave-form of the changes in current between the limits P and Q is now different from what it was in the series case, since the D.C. component has been increased. The maximum and minimum values remain the same, as does the amplitude of the fundamental, but since the maximum value is equal to the sum of the peak amplitudes of the fundamental and second harmonic and the rectified D.C., if the rectified D.C. is increased the peak amplitude of the harmonic must decrease. This was shown mathematically in my previous letter, and I think that if Mr. Bedford tries to prove how the point O_2 is determined he will find that the proof agrees with my mathematics.

If the choke resistance is increased and finally made equal to the load resistance the point O_2 moves along $O_2\ O_1$ and finally coincides with O_1.

In many practical cases the error made by assuming O_2 and O_1 coincide in the choke fed case is negligible, but as I pointed out previously, the difference may become appreciable if the load resistance R is very large and the resistance of the choke R_c is small, since the projection of O_2O_1 on the Y axis is thereby increased.

Mr. Lucas, in his article on " Distortion in Valve-Characteristics " in the November issue, neglects the effect of the difference in resistance between the A.C. and D.C. paths, and wrongly assumes that the equivalent circuit of a transformer-coupled load resistance is as given in his Fig. 1. He is, of course, approximately correct, but this approximation may lead to appreciable error with high values of load resistance and low primary resistance as in the choke fed arrangement.

Incidentally an error in signs appeared in my previous letter, the correct formula for the harmonic ratio in the choke fed case being

$$K = \frac{\{(I_2 + I_1) - 2I_o\}(R_o + R_c)}{(I_2 - I_1)(2R_o + R_c + R)} = \frac{(I_2 + I_1) - 2I_o}{(I_2 - I_1)\left\{1 + \left(\frac{R_0 + R}{R_o + R_c}\right)\right\}}$$

This error would, I think, be obvious to anyone studying my letter.

London, S.W.4. W. GREENWOOD.

To the Editor, The Wireless Engineer.

SIR,—With reference to the point of controversy between the letters of W. Greenwood (August, 1931 issue) and L. H. Bedford (November issue) there is an unfortunate error in the latter's analysis which might be thought to invalidate his conclusions. He states that if O_1 is the centre point of the I_a swing, and O the centre point of the V_g swing, then the difference in currents between these points (*i.e.* $\frac{1}{2}(I_1 + I_2) - I_0$ in Mr. Greenwood's notation) is the " detected current : " it is clear, however, from the usual simple formulae for rectified current and for 2nd harmonic, that this difference O_1 to O is *double* the rectified current. However, if we make this correction, the rest of Mr. Bedford's analysis follows as before : Mr Greenwood's error lies in mixing up the apparent values of I_0, I_1, and I_2 (which only depend upon the load impedance to the input frequency and are those obtained in the usual $V_a - I_a$ diagram analysis) with the actual dynamic values which include the rectified current and which cannot generally be measured.

I may add that I have deduced Mr. Bedford's results mathematically from the general case, and have also checked them in a practical case with a harmonic analyser.

M. V. CALLENDAR.

Lissen Research Laboratory.

Quartz Resonators and Oscillators.

To the Editor, The Wireless Engineer.

SIR,—" H. J. L." in his review of " Quartz Resonators and Oscillators," states that a certain type of luminous resonator " might give higher precision than 1 in 10^4 if other methods of determination than the luminous glow were adopted." In justice to that type of resonator, I should like to refer your readers to p. 122 of the book reviewed, in which it is mentioned that measurements of the frequency of the resonator by four national laboratories, agreed to 1.5 part in 100,000, a result which, at the time, was superior to any other inter-comparisons, whether by resonator, oscillator or transmitted waves. The luminosity was, of course, the sole indicator of resonance.

The legend of Fig. 68 and another passage in which the reviewer claims to have detected misprints, are quite correct as they stand.

Teddington, Middlesex. P. VIGOUREUX.

The Stenode.

To the Editor, The Wireless Engineer.

SIR,—I have read the letter from the British Radiostat Corporation, published in the December issue of *The Wireless Engineer*, and observe that they take exception to certain remarks made by me in the course of my review of the Radio Exhibition at Olympia. In particular, they object to my suggestions that the incorporation of the crystal gate leads to difficulty in handling the receiver, and that frequency-wobble on the part of the transmitter is liable to make reception uncertain, except where the transmitter has its frequency controlled by means of a crystal.

My authority for these comments was, I thought, unimpeachable, for they were derived from no less a person than Dr. Robinson himself, the inventor of the Radiostat. It is possible that in the six months or more that have elapsed since my interview with him he has changed his views ; it is even possible that I misunderstood his remarks at the time, or that my memory of them is at fault. If I have misrepresented him, I offer him my apologies for my stupidity or for the untrustworthiness of my memory.

Reverting to the letter from the Corporation, I would point out that while a very fine " slow-motion " movement on the tuning control may make tuning easier when a station has once been found, it can do nothing to help searching by increasing the proportion of the total tuning-range taken up by any one station. It is primarily upon this that the ease or otherwise of handling a receiver of this type eventually turns.

My remark, or, as I believe, Dr. Robinson's remark—as to the need for accurate frequency-control on the part of the transmitter was made, naturally enough, with reference to European, not American, stations. The Corporation state in their letter that the number of stations with which difficulty is found on this score may be regarded as negligible. As it is usually believed in this country that American frequency-control is well in advance of the average of European practice, their statement, while doubtless above criticism so far as American transmitters are concerned, may quite possibly fail to apply on this side of the Atlantic.

I regret to have to point out that the quotation from my review which the Corporation have chosen as a peg upon which to hang the advertising matter contained in the fourth paragraph of their letter is part only of a sentence. It is a long sentence, dealing with the extra amplification made necessary by the audio-frequency correction that follows the second detector ; the relevant part of it reads : " . . . the extra selectivity is attained at the cost, at most, of only one valve more than would be required for equivalent performance in a superheterodyne receiver using band-pass couplings." There is no peg here—hence, presumably, the Corporation's tactful abbreviation of my rather long-winded remarks.

YOUR REVIEWER.

Variation of the Resistances and Inter-Electrode Capacities of Valves with Frequency.

To the Editor, The Wireless Engineer.

SIR,—I am afraid that I find Mr. Benham's second explanation of his point of view on the question of valve capacities (as given in his letter in your November number) rather more confusing than the first, with which it is not completely consistent. He says, for example, that the displacement current " will still be given by $\frac{dQ}{dt}$." This is, of course, a fallacy, and the portion of Mr. Benham's argument, which is based on it, is therefore misleading. The displacement current varies from point to point of the path, which is the reason why my definition was not based on any single value of it. It follows that Mr. Benham's criticism that my equation does not represent displacement current, is irrelevant to the discussion.

The representation of the inertial effect of the electrons by an inductance, fits in with my own ideas on the subject, as will be evident from my previous letter, and I cannot help thinking that it is the most generally satisfactory way of representing the property.

L. HARTSHORN.

The National Physical Laboratory, Teddington.

Power Rectifiers.

To the Editor, The Wireless Engineer.

SIR,—I was very interested to read Mr. McDonald's article on " Power Rectifier Circuits " in the October issue, having done a considerable amount of experimental work myself upon this most confusing subject. I have found it extremely difficult to generalise from the results of such experiments, and it is therefore particularly interesting to note that Mr. McDonald's various simplifying assumptions, without which the theory appears impossible to formulate, do not introduce any serious errors. There are, however, two or three points in the comparison of full and half wave rectifiers upon which additional light should be thrown.

1. In comparing the hum voltages of the two types for a given condenser size, he states that the

f.w. circuit will give only ½ of the hum voltage of the h.w., but that this hum, being mainly of 100 cy, will be actually more audible when the characteristics of the amplifier and of the ear are taken into consideration. He is, however, overlooking the fact that there is a very large per cent. harmonic in the hum from the h.w. circuit; by measurement with a harmonic analyser, I have found that under average conditions, for the same condenser size :—

(*a*) the total hum is about double for half wave.

(*b*) the 100 cy. harmonic component with the h.w. circuit is generally very nearly as large as the 100 cy. fundamental of the f.w.

(*c*) there are, in addition, appreciable components of 150 cy. for the half wave and 200 cy. for the full wave, the latter being rather the smaller.

Hence we have the conclusion that the half wave hum will be equal to that with the full wave circuit *plus* a large 50 cy. component, and this comparison, of course, still holds when the smoothing circuit and frequency characteristics of the loud speaker and of the ear are taken into consideration.

2. As regards the size of transformer required, I have made some experiments upon a transformer with two equal secondaries which can readily be switched to give half or full wave rectification with a normal U.U. type valve. I found that, for a given D.C. output with approximately " optimum " condenser size, the RMS secondary currents taken from the transformer were identical for the two types of rectification, and hence, from the points of view of output watts, the transformer size should be exactly the same for the two types : the primary current on load was, however, larger for the h.w. circuit (owing to lowering of the permeability of the iron, as suggested in the article) : the extent of this increase was such that the transformer would have to be designed with some 25% extra iron (an increase in volts per turn will clearly not improve matters).

3. As regards size of condenser required : the formulae for " Optimum Capacity " show that we should use from 2 to 3 times the capacity with the half-wave circuit, if we are to have the same volts drop and hum volts as for the full wave circuit. By direct experiment I have found that the ratio is generally between 3 and 4 for equal volts drop : if the criterion is equal hum, the ratio obtained will depend upon the method of comparison for the hum, but will generally lie between 2 and 3.

When these additional points are considered, it will appear that the half wave circuit has not such a superiority as is claimed by Mr. McDonald, but that each type of circuit has its sphere of usefulness : in particular, the h.w. circuit is best for high voltages, and in cheap eliminators (*e.g.*, where a moving coil speaker is not likely to be used).

M. V. CALLENDAR.

Lissen Research Laboratory.

A Direct Reading Modulation Meter.

To the Editor, The Wireless Engineer.

SIR,—I should like to call the attention of the writers of the article " A direct reading Modulation Meter," published in the December number of *The Wireless Engineer*, to the fact that the Modulation Meter they describe is quite well-known and has been used since the beginning of 1929 in several laboratories, including my own.

The full description and theory, with the derivation for the formula quoted by the writers is given, in the *Proceedings of the Institute of Radio Engineers*, of April, 1929, in a paper on " Radio Receiver Testing Equipment," by Kenneth W. Jarvis. Full details of the instrument itself are also given in this paper.

Lancashire. ALBERT HALL.

BOOK REVIEWS.

Wireless. A Treatise on the Theory and Practice of High-Frequency Electric Signalling.

By L. B. TURNER, M.A. M.I.E.E.

Pp. xviii + 528, with 31 Plates and 342 Figures. (Cambridge University Press, 1931. 25s. net.)

In giving unstinted praise to a book, there is always a risk of appearing fulsome. However, the present reviewer has no hesitation in saying unreservedly that this is one of the most important contributions to radio literature that has appeared in recent years. The author is, of course, widely known for his original research in many departments of wireless, as well as for his former book, *Outline of Wireless*, published ten years ago. Since that time the field of wireless communication has been immeasurably widened, with consequent increase in the scope of the present volume.

The aim of the book is to set forth in clear terms, and with rigid mathematical precision, the fundamental principles of high-frequency technique in their practical application to telegraphy and telephony. On the whole the author has succeeded admirably in this object, and though perhaps here and there an occasional topic might be found to have escaped detailed treatment, the reviewer is very conscious that such omissions may well reflect his personal idiosyncrasies rather than any defect in a volume which attains such a high average standard of completeness throughout. One considerable branch of the subject is, however, totally excluded from the author's purview, viz., that of high-frequency measurements, and for this the reader is referred to Mr. E. B. Moullin's standard treatise, of which a second edition appeared some months ago.

The book is thus a comprehensive survey of the theoretical side of wireless, as distinct from the constructional or " design " side. To say this, of course, is not to minimise its importance. On the contrary, it is obvious that no designer to-day can afford to neglect the mathematical studies which are here so ably presented.

An introductory chapter on Signalling Systems is followed by chapters on Electromagnetic Radiation and Propagation of Waves, which contain a valuable summary of existing information on the Heaviside Layer. Chapter IV deals with Oscillatory Circuits, including the theory of coupled circuits and the "rejector." Different types of circuit coupling are analysed, but we could have wished that the "mixed" type of coupling, now so widely used in receivers, had been included in the analysis.

A chapter on the production of H.F. currents is followed by a discussion of Detection. Two "coefficients of performance" are defined. The first of these, $C_{v/v}$ or the $\frac{\text{volts out}}{\text{volts in}}$ coefficient, expresses sensitivity as the relation between the output rectified P.D. and the input high-frequency P.D. The other, $C_{v/w}$ or the $\frac{\text{volts out}}{\text{watts in}}$ coefficient, expresses sensitivity as the relation between the output rectified P.D. and the input high-frequency power. Circuit conditions to obtain maximum values of these coefficients are then obtained.

Chapter VII deals with the general properties of thermionic tubes, and this is followed by a discussion of the Triode as Amplifier. This contains an interesting discussion of the dependence of transformer amplification upon acoustic frequency, the derived formula being illustrated by some illuminating graphs for various practical values. In this connection, attention should be drawn to a particularly valuable feature of the book, viz., the care and thought which have been expended on the diagrams. These are notably clear and explicit.

The subsequent chapter on the Triode as Oscillator deals adequately with the fundamentals of retroaction in triode circuits, discussing incidentally such matters as power output, harmonics, piezo-electricity, etc.

The chapter on the Triode as Rectifier is concerned to apply the analysis of the rectifier discussed in Chapter VI to the special problems of grid and anode rectification. The conditions for optimum "efficiency" coefficients are treated with helpful diagrams and numerical examples. The general analysis of the grid rectifier using Taylor's Series is followed up by the solution for the exponential form of grid characteristic in terms of Bessel Functions. Unfortunately, as the author points out, most grid-current characteristics are far from exponential in form. It might have been well to supplement this section with some reference to methods of graphical integration which may be trusted to yield quite accurate results in the majority of practical cases. This chapter concludes with a valuable summary of the chief characteristics of different types of triode rectifier.

Subsequent chapters on Retroactive Amplifiers and Telephony contain exhaustive analyses of various types of amplifier, including the superheterodyne, as well as a full examination of modulation problems and carrier-wave suppression. The chapter on Telephony contains also a general discussion of the various causes of distortion in a receiver, and concludes with a brief survey of electro-mechanical relations in the production of sound.

The final chapters of the book are devoted in turn to Antennas (in which there is much up-to-date information on modern direction-finding methods), Current Distribution in Conductors, Filters, and Atmospherics.

The volume is eminently practical. For instance, the use of the "decibel" system of notation is illustrated in Chapter XIII by restating in terms of that unit various measures of amplification, etc., which have been already given in alternative forms in different places throughout the book. Again, the use of special "script" symbols to convey R.M.S. values is a praiseworthy idea which it is to be hoped will be widely followed. Throughout the author places great emphasis on the numerical interpretation of the algebraical equations, and by giving numerical examples wherever possible he has contrived to give an unusually "practical" aspect to his subject-matter. On the relation of mathematics to wireless studies, the author's remarks in his Preface are very pertinent. One may be permitted to quote: "Particularly in high-frequency work does a lack of prolonged practical experience make itself apparent. Proficiency with mathematical equations and circuit diagrams is indispensable, but is not sufficient to make the student effective as an engineer." *Verbum sapienti.*

W. A. B.

Siebchaltungen (Filter Circuits).

By W. Cauer.

Pp. 24, with 19 figs., 14 schedules and 68 charts in loose-leaf form. VDI-Verlag, Berlin. 14 RM.

This is an unusual publication in several ways. Its production has been made possible by the support of the Elektrotechnischer Verein; it is not a book, but a 24-page pamphlet, together with a portfolio containing 68 charts; it is very complete, and its compilation has involved an enormous amount of work.

The author has developed a unified general theory, not based on any special circuits, but on certain functions of the frequency which, independently of the individual constructive features of the circuits, permit of their precise characterisation.

The book has been written mainly for the designer of filter circuits, to enable him to solve any problem with the smallest expenditure of thought and calculation, and, at the same time, to arrive at the most economical solution, i.e., the one which involves the smallest number of coils and condensers. The work is necessarily of a mathematical character, and the design of a filter circuit, even with the aid of this work, is not a thing to be undertaken lightly. Five pages of the text are devoted to working through the design of four different filters to given specifications.

This work will appeal to all those who wish to acquaint themselves with the theory of filter circuits, and it should prove invaluable to those engaged in the actual design of such circuits.

G. W. O. H.

Abstracts and References.

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PROPAGATION OF WAVES.

PHENOMENA ACCOMPANYING RADIO TRANSMISSION.—G. Marconi. (*Marconi Review*, Sept.–Oct., 1931, No. 32, pp. 1–8.)

Translation of an address to the Italian Society for the Progress of Sciences. In the historical opening, the 1916 three-layer suggestion of Loewestein (at 11, 75 and 220 km.) is mentioned, while towards the end of the address it is stated that recent measurements on the Sardinia-Italian mainland ultra-short-wave service indicate that these waves are refracted and contained within a space between the earth and a layer somewhat lower than the Heaviside layer: "Could this be that already indicated by Loewestein at a height of only 11 kilometres?" It is also mentioned that definite evidence has also been established at these stations of the existence of echoes, "never before observed, as far as I am aware, with such short waves." As regards long-delay echoes, the writer is inclined to prefer Pedersen's 40 million-kilometer-layer explanation to the group-velocity-reduction theory.

THE ABSORPTION AND DISSOCIATIVE OR IONIZING EFFECT OF MONOCHROMATIC RADIATION IN AN ATMOSPHERE ON A ROTATING EARTH. PART II. GRAZING INCIDENCE.—S. Chapman. (*Proc. Physical Soc.*, 1st September, 1931, Vol. 43, Part 5, pp. 483–501.)

Continuation of the work dealt with in 1931 Abstracts, p. 202. The earth's curvature, and that of the level layers in the atmosphere, is now taken into account. The absorption values as previously calculated "are valid so long as the sun's zenith distance does not exceed 75°, but for greater zenith distances the necessary corrections are of importance. It is shown that the absorption, and resulting ionization or dissociation of the air, should begin to increase before ground sunrise, the interval varying from about 10 minutes at the equator to about an hour at 60° latitude."

DIE SCHWANKUNGEN DES OZONGEHALTES DER ATMOSPHÄRE (The Variations of the Ozone Content of the Atmosphere).—P. Harteck. (*Naturwiss.*, 16th Oct., 1931, Vol. 19, No. 42, pp. 858–860.)

A description of some laboratory experiments which seem to combine well with the theory recently put forward by S. Chapman (*cf.* 1931 Abstracts, pp. 89–90) as to the mode of dependence of the atmospheric ozone content on latitude and time of year.

THE PROPAGATION OF RADIO WAVES IN AN IONISED ATMOSPHERE.—D. Burnett. (*Proc. Camb. Phil. Soc.*, Oct., 1931, Vol. 27, No. 4, pp. 578–587.)

This paper contains a theoretical investigation of the effect of the collisions between electrons and molecules on the propagation of radio waves in an ionised atmosphere. Boltzmann's integral equation for a non-uniform gas is used, with an analysis similar to that used by Lorentz in discussing the motion of free electrons in a metal. The interactions of electrons with one another and with positive ions are neglected. An expression is found for the current density parallel to the electric vector of the incident wave, caused by the collisions. For the case when the frequency of the incident waves is much greater than the frequency of collisions, the condition postulated by Larmor, it is found that absorption is negligible only for the shortest of radio waves, $\lambda \leqslant 120$ metres in an atmosphere of nitrogen. When the frequency of collisions is much greater than the frequency of the incident waves, there is no reduction of displacement current due to collisions if $\lambda \geqslant 170$ m. for a nitrogen atmosphere. If the wavelength is not $\geqslant 170$ m., the dielectric constant is effectively reduced by an amount independent of the wavelength; "the variation of the velocity of propagation with λ arises from the conduction current only and is an effect of smaller order than the absorption."

"The second part of the paper deals with the same problem when an external magnetic field acts on the electrons, and with the reflection and refraction of a plane wave at a plane boundary between an un-ionised medium and an ionised one under these conditions, dealing mainly with the case of long waves when the electrons give rise to a conduction current rather than to a displacement current." The components of the magnetic force in the reflected wave are found.

STRAHLUNG VON ANTENNEN UNTER DEM EINFLUSS DER ERDBODENEIGENSCHAFTEN. D.—STRAHLUNGSMESSUNGEN MIT ANTENNEN (Radiation from Antennae under the Influence of the Earth. D.—Radiation Measurements with Antennae).—M. J. O. Strutt. (*Ann. der Physik*, 1931, Series 5, Vol. 9, No. 1, pp. 67–91.)

An account of experiments made during the summer of 1929 and the spring of 1930 as a sequel to theoretical investigations on the influence of the earth on radiation from antennae (*cf.* Abstracts, 1929, pp. 329, 623; 1930, pp. 91, 278, 387; 1931, p. 28). The aims of the experiments were (1) to measure the electromagnetic constants of the earth for one definite short wavelength and then from theory to calculate the radiation characteristics of antennae, (2) to check by experiment these calculated characteristics. Both polar diagrams in space and propagation along the earth's surface were considered. The wavelength chosen was 1.42 metres.

The apparatus used, and the tests made to ensure that the received signal was that picked up by the receiving antenna only, are described. A rod was used as the transmitting antenna, the rest of the transmitter being carefully screened. The curve of the voltage distribution along the transmitting antenna is shown; the voltage at the free end was found to be greater than that at the end attached to the Lecher wire system.

The height of the transmitter above the ground was varied, but that of the receiver was fixed at about 15 metres. Transmitter and receiver were fitted with horizontal half-wave antennae. Measurements were made over surfaces of sand of different degrees of dampness, over damp earth and fresh water. Diagrams showing the received intensity as a function of the height of the transmitting antenna are given; these show maxima and minima as the theory indicates that they should. The conclusion is reached that the earth's conductivity shows a great increase in all cases for very short waves, but no definite value is found for it.

Polarisation experiments with horizontal and vertical transmitting antennae are also described. In some of these the height of the transmitting antenna above the ground was varied between zero and half a wavelength and the height of the receiver was varied between 1 and 15 metres. The polarisation experiments also led to the conclusion that the earth's conductivity is very much greater for a wavelength of 1.42 m. than for direct current. This conclusion is also reached by examination of a number of radiation diagrams in a vertical plane which were also obtained.

Measurements of radiation along the earth's surface gave firstly that, as predicted by theory, the law of diminution of field strength with distance is the same for both horizontal and vertical antennae: secondly, no theoretical curve can be made to fit the experimental results, as the measured field strength falls off more quickly than any of the calculated formulae would predict. This is explained as due to the finite height (about half a wavelength) above the earth of the half-wave transmitting antennae used in the experiments.

An appendix gives the theoretical derivation of formulae used and a list of recent literature on the subject is added.

BEMERKUNGEN ZU DEN ARBEITEN "ZUR THEORIE DER AUSBREITUNG ELEKTROMAGNETISCHER WELLEN LÄNGS DER ERDOBERFLÄCHE" UND "ÜBER DAS STRAHLUNGSFELD EINER ENDLICHEN ANTENNE ZWISCHEN ZWEI VOLLKOMMEN LEITENDEN EBENEN" (Remarks on the Papers "On the Theory of Propagation of Electromagnetic Waves over the Earth's Surface" and "On the Field Radiated from a Finite Antenna between Two Perfectly Conducting Planes").—R. Weyrich. (*Ann. der Physik*, 1931, Series 5, Vol. 9, No. 5, pp. 513–518.)

The papers referred to were written by the present author (*see* Abstracts, 1928, p. 516, and 1930, p. 101). In this paper attention is drawn to the fact that the full expressions for the components of the electromagnetic field-strength, not only the potentials from which they are derived, must be used in any discussion of the properties of that field. This renders invalid arguments for the occurrence of resonance phenomena deduced in former papers. An expression is found for the Hertzian potential of the field radiated by an unearthed antenna of finite length between two perfectly conducting planes.

ECHO SIGNALS IN JAPAN.—T. Minohara, T. Inoue, and S. Ono. (*Japanese Radio Research Committee*, Reports presented to U.R.S.I. Assembly, 1931, 3 pp. and plates.)

Echo observations on European and American signals lead to the formulation of three sets of conditions in which echoes can occur: (*a*) when the angle between the great circle and the twilight zone is less than 10°, echoes occur in all seasons for 13—35 metre wavelengths; (*b*) when the great circle passes through part of the twilight zone and through daylight and night time *in high latitudes* (above 45°), echoes occur on the same wavelengths even when the angle defined in (*a*) is more than 10°; and (*c*) when the great circle passes through summer night on one side of the earth and through winter daytime on the other, echoes occur for all wavelengths between 16 and 30 metres. These results conform closely with those of T. L. Eckersley. The fact that echoes are less noticed at stations near Tokyo than in England and Germany is explained by the lower latitude of Tokyo. Percentage time retardations, worked out from the observations and allowing for deviation in the upper atmosphere and for variation of propagation velocity during the passage round the globe, vary from 1.7 to 2.7, the average value being a little less than that obtained by Quäck and Mögel (1929 Abstracts, p. 440).

ON THE PROPAGATION OF THE SHORT WAVES.—Anazawa, Asukai, Hattori, Hayasi, Minohara, Nakagami, Tanaka, Tani and Yokoyama. (*Japanese Radio Research Committee*, Reports presented to U.R.S.I. Assembly, 1931, pp. 1–6, and plates.)

A fixed station sent out experimental transmissions on eight short wavelengths, which were received at different points throughout Japan at distances ranging from 30 to 6 700 km. The results are given in the form of numerous curves. Thus Figs. 47 (day) and 48 (night) show the average relation for all seasons between distance and audibility: the hollow representing the skip distance becomes smaller and smaller the longer the wave. "This trend continues till the frequency of about 7 500 kc/s. is reached. The skip hollows move to the left [*i.e.*, towards shorter distances] as the frequency is lowered [from the highest frequency of 18 248 kc/s] and there is just an inkling of the skip hollow at the lowest frequencies tested [down to 2 768 kc/s], but the degree of the drop is negligibly small and the high audibility continues till it drops at long distance." Figs. 28, 29 and 30 show the optimum frequencies and the available frequency ranges as a function of distance, for day and night, in summer, in intermediate seasons, and in winter.

LONG-WAVE RADIO RECEIVING [FIELD STRENGTH] MEASUREMENTS AT THE BUREAU OF STANDARDS IN 1930.—L. W. Austin. (*Proc. Inst. Rad. Eng.*, Oct., 1931, Vol. 19, pp. 1766–1772.)

Cf. 1931 Abstracts, p. 30. Fig. 2 shows the annual averages of the 3 p.m. atmospheric disturbances measured in Washington at 12 500 m. wavelength, as compared with sunspot numbers, from 1918 to 1930 inclusive. "The inverse relationship between the two curves is very striking. It must be remembered, however, that this applies only to daylight long-wave atmospherics; it is quite possible that the night correlation and short-wave correlation may be entirely different." In 1930, long-wave daylight transatlantic signals in Washington began to rise in March, and during the summer reached greater average monthly heights than had been measured before. The August monthly average for some stations was nearly 3 times that of the corresponding month in 1929. Meanwhile, waves below 20 m. were on the average weaker than usual. In the intermediate and broadcast bands nothing unusual was observed.

SCATTERED RADIATION FROM SHORT-WAVE BEAMS.—G.W.O.H.: Mögel. (*Wireless Engineer*, November, 1931, Vol. 8, pp. 579–580.)

Editorial on Mögel's paper dealt with in 1931 Abstracts, p. 604. "While there is much which confirms the ideas propounded by Eckersley, there is also much which is either not explained or is contrary to these ideas and for which Mögel offers no explanation."

ÜBER DEN EINFLUSS DER ELFJÄHRIGEN SONNENTÄTIGKEITSPERIODE AUF DIE AUSBREITUNG DER WELLEN IN DER DRAHTLOSEN TELEGRAPHIE (The Influence of the Eleven-Year Solar Activity Period on the Propagation of [Short and Medium] Waves in Wireless Telegraphy).—H. Plendl. (*Zeitschr. f. Hochf: tech.*, Sept., 1931, Vol. 38, pp. 89–97.)

Propagation tests on these waves by the DVL during 1930 and 1931, gave results which differed from those obtained in 1927 and 1928, suggesting that the 11-year period had an influence on these waves such as it has been shown to exert on long waves. This supposition is here investigated, and the conclusions arrived at are as follows:—whereas the effect on long waves depends chiefly on the change in absorption conditions, the effect on short and medium waves depends in the first place on changes in refraction, and only secondarily on absorption changes. The practical result is that in order to obtain, in a time of minimum solar activity, the same good communication as existed during a time of maximum activity, the wavelength should be increased by (roughly) one-quarter or one-third. Thus optimum waves for certain conditions during a year of maximum activity, of 50, 15 and 10 metres wavelength, were found to be best replaced in a year of minimum activity by wavelengths 65, 20 and 13–14 metres respectively.

ON AN ESTIMATION OF THE HEIGHT OF THE HEAVISIDE LAYER IN BENGAL.—H. Rakshit. (*Phil. Mag.*, Nov., 1931, Series 7, Vol. 12, No. 80, pp. 897–907.)

The height of the Heaviside layer in Bengal is estimated by applying the angle-of-incidence method developed by Appleton and Barnett to natural fading records of signals from the Calcutta transmitter V.U.C. ($\lambda = 370.4$ m.) received at a distance of 76 miles. The receiving station and the aerial systems, with the receiving and recording systems, are described in detail and examples of typical records are shown. "The average lowest height of the ionized layer, which is obtained near about sunset, for various evenings during the month of February 1931 has been found to be 60 km. The height gradually increases with the progress of the night, reaching on an average a value of 85 km. at about 11 p.m. . . The variation of the intensity of fading with the progress of the night can be divided into three types. These are described, and curves are drawn showing their general nature."

THE ATTENUATION OF ULTRA-SHORT RADIO WAVES DUE TO THE RESISTANCE OF THE EARTH: AND AN EXPERIMENTAL DIRECTION FINDER FOR USE ON ULTRA-SHORT WAVES.—R. L. Smith-Rose and J. S. McPetrie. (*Proc. Physical Soc.*, 1st Sept., 1931, Vol. 43, Part 5, pp. 592–612.)

Authors' abstract:—This paper describes an investigation of the attenuation of radio waves, of wavelengths between 5 and 10 metres, when transmitted directly along the earth's surface. A brief description is given of the transmitters employed, one being a fixed installation used with an input power supply of the order of 500 watts, the other a transportable set operated with an input supply of about 50 watts obtained from batteries.

The observations of field intensity were obtained by measurement of the audio-frequency voltage across the telephones of a simple two-valve loop receiver, a brief description of which is given. Measurements were carried out at both Slough and Teddington of the field intensity at various distances from the transmitter up to 700 metres. In some of the experiments a negative attenuation effect was observed in the radiated field over a distance of about 4 wavelengths. Later measurements carried out under more favourable conditions did not show this effect, which was, therefore, attributed to the interference of waves reflected from trees and buildings in the neighbourhood of the transmitter. Some qualitative observations were made at distances up to 20 miles with a single-loop direction-finder. These observations showed that the signal intensity on such short wavelengths depends to a great extent upon the existence of obstacles in the path of transmission. The signal intensity at a distance of 20 miles over a direct air line [the receiver being taken to an elevation of over 500 ft.] was of the same order as that obtained at 4 miles for transmission along the ground.

A comparison has been made between the experimental results and those calculated from a simple wave-attenuation theory, the electrical constants of the earth being taken into account. As a result of this comparison, the value of the conductivity of the earth appears to lie between 5×10^8 and 30×10^8 e.s.u. for the frequencies of 30 to 60 megacycles per second employed. These values correspond to resistivities of from 1 800 to 300 ohm/cm^3. The most suitable value of the dielectric constant of the earth is about 10, although the experimental method does not enable this to be obtained with any great accuracy.

A brief description of some experiments carried out with a single-loop direction-finder on the wavelengths under consideration is appended to the paper.

ZUR FRAGE DES ULTRAKURZWELLEN-RUNDFUNKS (The Problem of Ultra-Short-Wave Broadcasting).—F. Schröter. (*E.N.T.*, Oct., 1931, Vol. 8, pp. 431–436.)

I.—Early Telefunken work: reasons for adopting the 6–8 m. range instead of still shorter waves. The 7-metre transmitter; five stages, the quartz frequency (112 m. wavelength) being doubled four times; power on telephony 300 w.; modulation in the final stage, 70% in depth, giving undistorted transmission of the television bands. The reaction audion attachment for broadcast receivers (Muth and Hermanspann) and its special construction for rigidity, etc. Map showing audibility obtained from the 7-m. transmitter, over Berlin and its environs: with 3 l.f. stages good loud-speaker reception reached in all directions to 15 km., in sparsely built-over directions to over 20 km., and in one spot (a hill) to 60 km. "It is not yet clear whether this last result was due to space waves or the nature of the land. No fading zones due to interference between direct and indirect radiation were observed."

Not only the reaction audion but also the super-regenerative adaptors have now been successfully applied to mains drive. Schriever's plan of transmitting a constant heterodyne wave, at a suitable spacing from the picture modulation wave in television, is mentioned. Interference: the signal/noise ratio is much improved by putting the receiving aerial at roof height and leading down to the adaptor by screened high-frequency cable. Mutual interference in searching with the reaction audion, and its avoidance.

II.—Quantitative consideration of the absorption of radiated 7-metre waves in the sea of houses in a city (Fig. 4). The transmitting height H extends above the absorbing "sea" of thickness d; the receiver height h is taken as always less than d. The formula arrived at for the r.f. voltage in the receiving dipole is $|V| = \frac{60\lambda}{\pi} \cdot \frac{|J|}{r} \cdot e^{-k \cdot \frac{r(d-h)}{H-h}}$ volts, where r is the distance. Direct measurement of the absorption coefficient k has not yet been possible, but from indirect reasoning it is found to be of the order of 0.002; i.e., the average damping for every 500 metres is about 1 neper. Figs. 5 and 6 show the decrease of field strength of a 7-metre wave as a function of receiving and transmitting aerial heights respectively, derived from this formula. A comparison shows the superior importance of extra receiving aerial height over extra transmitting height, though of course local conditions may radically affect this rule. *Cf.* Sohnemann, below.

FELDSTÄRKEMESSUNGEN IM ULTRAKURZWELLENGEBIET (Field Strength Measurements on Ultra-Short Waves [and the Polarisation and Attenuation of Such Waves]).—K. Sohnemann. (*E.N.T.*, Oct., 1931, Vol. 8, pp. 462–467.)

From the Heinrich-Hertz Institute. A field-strength measuring equipment for ultra-short waves is described, consisting of a leaky-grid detector unit, with fixed retroaction, combined with an auxiliary unit giving super-regeneration. For measuring field strengths the drop in anode current may be used, or for greater sensitivity the strength of the l.f. "mush" of super-regeneration can be taken as a measure of the field strength, being measured by a valve voltmeter after suitable amplification. The absolute calibration of the equipment is carried out in the known radiation field of a small transmitter.

As examples of its use, results are given of an investigation of the state of polarisation of 8.9-metre waves at different times of day and under various meteorological conditions. Results somewhat similar to those noted by Peters (1931 Abstracts, pp. 30–31) were obtained, but with the addition of day and night and weather effects; at night the plane of polarisation becomes again vertical and the polarisation approaches the linear condition, whereas by day it is usually strongly elliptical. Under a clear sky, the ratio a/b is 0.42 by day and 0.26 by night; under a somewhat overcast sky the values are 0.31 and 0.08, while in very cloudy weather (apparently by day) the ratio may be as low as 0.05, or may reach zero in very bad rainy weather. In the above, a and b are the values of the vector in the plane of polarisation and of the component at right angles to this. The causes of these results cannot be definitely arrived at from these tests, but "one must assume that in addition to the ground wave there must be inter-action by a space wave, if a direct influence of the atmosphere on the rays is put out of court." Attenuation measurements were also made: over unbuilt-on neighbourhoods, receiving at high points, field strengths obeying the $\frac{1}{r}$ law were observed, but over the built-over parts of Berlin the observed strength was equal to the theoretical strength $\times\, e^{-\alpha r}$, the absorption coefficient α lying between 0.3 and 0.5 (*cf.* Schröter, preceding abstract).

COMMUNICATION WITH QUASI OPTICAL WAVES.—Karplus. (*See* under "Transmission.")

RADIO TESTS ON VARIOUS WAVELENGTHS ON THE LOWER DANUBE (BRATISLAW-RUSE, BULGARIA).—V. Fritsch. (*Elektrot. u. Masch:bau*, 18th October, 1931, Vol. 49, pp. 780–781.)

MEASUREMENTS OF THE PHOTOCHEMICAL ENERGY OF THE MOON OBTAINED DURING THE LUNAR ECLIPSE OF 27TH SEPT., 1931.—G. Blum. (*Comptes Rendus*, 19th Oct., 1931, Vol. 193, pp. 647–649.)

MESURES DES CONSTANTES DE PROPAGATION D'UNE LIGNE AÉRIENNE AVEC RETOUR PAR LE SOL EN FONCTION DE LA FRÉQUENCE (Measurements of the Propagation Constants of an Overhead Line with Earth Return, as Functions of the Frequency).—J. Fallou: Carson: Pollaczek. (*Comptes Rendus*, 21st September, 1931, Vol. 193, pp. 461–463.)

Further development of the work referred to in 1931 Abstracts, p. 608. The Carson-Pollaczek formulae have often been found to disagree with practical results; the discrepancies have been attributed to the non-homogeneity of the ground, and it has been stated that the applicability of the formulae can be improved by attributing to the conductivity of the ground a value inversely proportional to the square root of the frequency.

To investigate this, the writer has measured the propagation constants of a 112-km. 3-phase high tension line, and has compared his results with the Carson formulae, assuming firstly a constant ground conductivity and secondly a conductivity varying inversely as the square root of the frequency. In both cases the conductivity has been taken as $\sigma = 3 \times 10^{-13}$ c.g.s. units at 50 c.p.s. As regards characteristic impedance, the curves in the first case show a maximum discrepancy of less than 5 % and a mean discrepancy about 3 %; whereas in the second case the calculated curve gives an entirely insufficient slope. The superiority of the constant-conductivity assumption is even more marked as regards the apparent resistance of the line; here the constant σ curve agrees admirably with the observed curve, while the other curve suggests that the apparent resistance increases in proportion to the frequency instead of according to the 0.8th power of the frequency as found experimentally; the discrepancy may be as great as 100 % at 40 000 c.p.s.

For this particular line, over plains, the Carson formulae are therefore very satisfactorily confirmed for frequencies between 500 and 100 000 c.p.s. The case studied is too special to allow the conclusions to be generalised, but the facts at least show that the assumption of a σ inversely proportional to the square root of the frequency may lead to extremely incorrect results.

Comparison of Formulae for Attenuation of Travelling Waves.—L. V. Bewley. (*Elec. Engineering*, Nov., 1931, Vol. 50, pp. 909–910.)

A letter on the comparison of the Foust and Menger, Skilling, exponential and quadratic law formulae.

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY.

High-Frequency Atmospheric Noise.—R. K. Potter. (*Proc. Inst. Rad. Eng.*, Oct., 1931, Vol. 19, pp. 1731–1765.)

Author's summary :—A method which has been employed in the measurement of high-frequency atmospheric noise is described. Using this method, measurements of noise over the range from 5 to 20 megacycles made in different parts of the United States and at different times of the year show a distinct diurnal change in intensity similar to that for long-range high-frequency signal transmission. Except during periods of severe local disturbance, noise on the lower frequencies is high during the night, while on the higher frequencies the maximum occurs during the day. Simultaneous observation of crashes on different frequencies also suggests that the received atmospherics are largely transmitted by overhead paths. The variation in high-frequency atmospheric noise intensity during the passage of local electrical disturbance centres is shown. It is suggested that the intensity of atmospheric noise generated by these centres of electrical disturbance is inversely proportional to frequency. Measurement data are included showing the effect of sunrise and sunset, an eclipse of the sun and disturbances in the earth's magnetic field, upon the intensity of high-frequency atmospheric noise. Diurnal characteristics of high-frequency atmospheric noise on directive antennae facing England and South America, and the noise reduction obtained by these arrays, are illustrated. The possible location of distant centralized noise sources is discussed briefly.

Some Investigations on the Deformation and Breaking of Water Drops in Strong Electric Fields.—W. A. Macky. (*Proc. Roy. Soc.*, Oct., 1931, Vol. 133, No. A 822, pp. 565–587.)

" It is important to know the maximum fields which can be attained in thunderclouds, and these, presumably, are determined by the drops present. The deformation of drops may alter their rate of fall under gravity, causing an increase in vertical and a decrease in horizontal fields, and the breaking up of drops into smaller ones would cause a large decrease in the rate of fall. Another important question is the amount of ionisation which might be produced by glowing drops, for very intense ionisation might possibly be usual in thunderstorms in consequence. . . . These questions have all been studied in the present experiments," which deal with drops ranging in radius from 0.085 to 0.26 cm. It was found that the modes of breaking of drops and the luminous discharges occurring confirm Nolan's conclusion (in opposition to Zeleny) that the current is carried by ordinary gaseous ions. Thus, when currents of the order of 20 μA. are passing from a drop, the amount of ionisation produced by the drop in the air will be very great. It is probable, therefore, that such point discharges from drops will be one of the main sources of ionisation in thunderstorms.

When exposed to increasing fields, a water drop of radius r cm. becomes elongated, until at a definite field, given by $F\sqrt{r} = 3875$ v/cm., it becomes unstable, and filaments are drawn out from the ends. Thus no drops greater than 0.15 cm. radius can persist in fields of 9 800 v/cm. Since the discharge field with drops is independent of the pressure, the field inside thunderstorms will in general rise to a value of the order of 10 000 v/cm. before a discharge passes. " This result is important as it bears on the production of high energy beta-particles, in consequence of the high fields combined with the small loss of energy by collision suffered by electrons at the lower air pressure."

Point Discharge Measurements below Thunderstorms.—J. Schonland and C. A. Coppens. (Reference in *Nature*, 1st. Aug., 1931, Vol. 128, p. 200.)

The writers use a suitably insulated point and a portable galvanometer, an arrangement which leaves the observer fairly free to note the meteorological features and the distance of the storm.

Correlations between the Field Changes due to Lightning and the Appearance of the Flashes.—E. L. Halliday. (Short abstract in *Nature*, 1st Aug., 1931, Vol. 128, p. 200.)

Preliminary note on Transvaal observations, photographic records of the field changes due to lightning discharges being combined with visual and photographic observations of the flashes. Of 273 flashes between the base of the cloud and the ground, 257 gave positive field changes and 16 negative. Of 173 positive field changes at distances greater than 7 km., 159 were due to flashes to ground. Of 164 discharges within the cloud at distances greater than 7 km., 150 gave negative changes of field.

Unusual Lightning.—H. E. Beckett and A. F. Dufton. (*Nature*, 1st Aug., 1931, Vol. 128, p. 189.)

A description of lightning which appeared to consist of silent discharges over the surface of a cloud.

Unusual Lightning.—C. J. P. Cave. (*Nature*, 29th Aug., 1931, Vol. 128, p. 378.)

A description of phenomena, similar to those referred to in the foregoing abstract, which appear to be simply cloud to cloud lightning.

Slow Cloud Ionization confirms Direct-Stroke Theory.—C. L. Fortescue. (*Elec. World*, 5th Sept., 1931, Vol. 98, pp. 420–421.)

PROPERTIES OF CIRCUITS.

Untersuchungen über Anodengleichrichtung (Investigations into Anode Detection).—G. Ulbricht. (*Zeitschr. f. Hochf: tech.*, September and October, 1931, Vol. 38, pp. 111–115 and 136–144.)

The literature of anode rectification lacks quantitative data and also (with the exception of Barkhausen's work) confines itself to detection at the lower bend of the characteristic. The present paper gives a systematic investigation, theoretical and experimental (using a cathode-ray oscillograph) into the four types of anode rectification distinguished by Barkhausen. Of Types 1 and 2, the two "pure" anode rectification types in which grid current plays no part, only Type 1, at the bottom bend, is of practical importance, since the saturation bend (on which Type 2 depends) changes so much with filament temperature, and the latest valves display practically no saturation. Of the two "anode-grid distribution" types, Type 3, occurring at the setting-in of grid current, superimposes itself on Types 1 and 2, the setting-in of grid current decreasing the Type 1 and increasing the Type 2 rectification. The effect is the greater the lower the anode potential is at the moment the grid current starts; such a condition particularly occurs with a high ohmic resistance in the anode circuit, and here the setting-in of grid current may be counted on to change the positive Type 1 process into the negative Type 2. The writer's attempts to make use of the bend caused by the setting-in of grid current, for direct rectification, met with no success even with valves giving very high grid currents.

Type 4, to which most attention is given (the whole of the second instalment being devoted to it) is an over-voltage effect and occurs only for low anode voltages and high grid alternating potentials. In cases where the anode circuit contains a high ohmic resistance, the dynamic anode characteristic shows a sharp bend at the point where the decreasing anode potential equals the increasing grid potential; rectification only occurs in the presence of an anode a.c. *potential*, disappearing if the anode-circuit resistance is bridged by a condenser: such rectification, therefore, can only be utilised if the reactance of the self-capacity of the connections is large compared with the inserted ohmic resistance. Thus it is only applicable to low and medium frequencies.

In the case where the anode circuit contains a high a.c. resistance, a second variety of the Type 4 rectifying effect can be obtained if it is arranged that a strong over-voltage condition occurs. For this, a positive grid bias must be provided, and the anode potential must be very small—little higher than the grid bias. *The rectified current can then be extremely high.* If the a.c. resistance takes the form of an oscillatory circuit of high resistance tuned to the frequency to be rectified, the superposition of the alternating grid potential decreases the anode current not only during the negative half-wave but also during the positive. This is because the alternating anode potential sinks far below the grid potential, so that a strong grid current sets in and the so-called "sink" effect occurs in the anode characteristic. This Type 4 rectification with a.c. resistance, unlike the first Type 4, can be applied to high-frequency and modulated high-frequency currents. Quantitatively, it lies between the usual Type 1 and leaky-grid rectification, but it has the advantage over the latter that the proportionality of rectifying effect to grid a.c. potential extends to higher amplitudes. With its help it was possible to receive in Hanover, on one valve, a number of European stations.

Der Widerstandsverstärker als Schwingungskreis (The Resistance-Coupled Amplifier regarded as an Oscillatory Circuit).—K. Schlesinger. (*E.N.T.*, Oct., 1931, Vol. 8, pp. 437–443.)

It is shown that a resistance-coupled stage can be completely represented by a strongly damped oscillatory circuit followed by an ideal (strictly proportional and independent of frequency) imaginary amplifier, coupled galvanically to the circuit damping resistance. A multi-stage amplifier accordingly consists of *n* such circuits, coupled to each other purely galvanically but in such a way as to be free from reflection. Using this equivalent circuit, the relation between phase rotation and the frequency characteristic can easily be obtained. The frequency curve is seen as a resonance curve; each stage amplifies without phase displacement *only at the amplifying optimum;* in passing from this to each of the two "border" frequencies (at which the amplification for each stage is reduced to $1/\sqrt{2}$ of its optimum value) the phase is rotated through $\pm 45°$. Since the optimum frequency is the geometrical mean of these two frequencies, the above gives *a method of determining the optimum frequency (only inexactly readable from the flat characteristic) by a simple bridge measurement.*

Moreover, the procedure is particularly valuable in elucidating the behaviour of such an amplifier as regards transit time. For a two-stage amplifier taken as an example, the transit time for a single impulse is found to be 6.3×10^{-7} sec.; for the lower "border," optimum, and upper "border" frequencies the values are 6.8, 9.0, and 11.8×10^{-7} sec. respectively. The differences become, of course, much more prominent for a larger number of stages (for 6 stages, times of the order of 10^{-5} sec. are involved). The phase curve shows that at the lower frequencies very strong phase distortion comes in. The importance of the subject for television is discussed. *See* also next abstract.

EINSCHALTVORGÄNGE BEIM WIDERSTANDVERSTÄRKER (Switching-on Processes in Resistance-Coupled Amplifiers [Behaviour to Transients]).—K. Schlesinger. (*Zeitschr. f. Hochf: tech.*, Oct., 1931, Vol. 38, pp. 144–147.)

Using the equivalent circuit already obtained (*see* preceding abstract) the writer first investigates theoretically the behaviour of an n-stage resistance-coupled amplifier as regards latent, building-up, transit and decay times, and then confirms his results by oscillographic tests. The relative order of magnitudes of the various times are found to agree with the theoretical results. The transit time ("laufzeit") in this and the preceding abstract is the time after which the output current reaches its maximum.

ÜBER DIE ADMITTANZ LINEARER SCHWINGUNGSSYSTEME (On the Admittance of Linear Oscillating Systems).—M. J. O. Strutt. (*Ann. der Physik*, 1931, Series 5, Vol. 10, No. 2, pp. 244–256.)

A general theoretical investigation of the admittance of damped and undamped mechanical and electrical linear oscillating systems; a graphical representation of the admittance of damped systems as the resultant of two or more circles is found and compared with the curves given by undamped systems. The theory is applied in a general way to the mechanical admittance of driven loud-speaker cones.

SUR UN SYSTÈME ÉLECTRIQUE AUTO-ENTRETENU UTILISANT UN TUBE À NÉON (On an Electrical Self-maintaining System containing a Neon Tube [and a Method of Measuring the Leakage Resistance of a Condenser]).—B. Decaux and Ph. Le Corbeiller. (*Comptes Rendus*, 26th Oct., 1931, Vol. 193, pp. 723–725.)

Analysis of the behaviour of a circuit containing h. t. battery, condenser, and neon tube *all in series*, giving a train of flashes at intervals (*e.g.*) of 20 seconds, and comparison with the more usual circuit in which the condenser discharges through the neon tube in parallel with it. The single periodic solution of the equation of the latter case was given by Liénard as $\frac{dy}{z} = \frac{dz}{\epsilon(1 - y^2)z - y}$; the solution for the all-series case is shown to be identical except that a supplementary term $k\left(y - \frac{y^3}{3}\right)$ is added to the denominator, k being a constant less than one. The circuit gives a simple method of measuring the leakage resistance of a condenser, "more practical than the usual methods."

TUBE AMPLIFIER EQUIVALENT PARALLEL CIRCUIT.—G. D. Robinson. (*Electronics*, Sept., 1931, p. 105.)

The 3-branch network containing e.m.f.s in two branches becomes a simple series circuit if the grid/plate capacity is neglected. A parallel circuit which may be used to replace this series circuit "has previously been published by the author and others separately and independently. It is now intended to show that the parallel substitution for the simple series circuit is merely a simplification of the general parallel equivalent circuit, in which the internal plate resistance, the load, and the grid/plate reactance are all treated as being in parallel."

THE PROBLEM OF PENTODE OUTPUT FIDELITY.—Tulauskas. (*See* under "Acoustics and Audio-frequencies.")

THE APPARENT DEMODULATION OF A WEAK STATION BY A STRONGER ONE.—W. B. Lewis: Colebrook. (*Wireless Engineer*, Oct., 1931, Vol. 8, pp. 538–540.)

Referring to Colebrook's note (1931 Abstracts pp. 610–611), Lewis criticises the comparison of a grid detector to a sluggish recording instrument and gives his reasons: "with a grid detector, in practice, there will as a rule be an appreciable component of the frequency $p/2\pi$ in the detector output, and in this case it is to be expected on general grounds that the extent of the demodulation will be just slightly less than that deduced in the articles referred to." But "the main conclusion . . . remains unaltered, namely, that to avoid cross modulation and distortion as distinct from ordinary heterodyne interference, the ratio of the interfering signal to the main carrier must be kept as small as possible. This may be achieved either by tuning very sharply to the wanted carrier, as in the case of the Stenode receiver, or by enhancing the carrier by the homodyne method as I suggested in an article in this journal" (1929 Abstracts, p. 391).

THE CONDUCTION OF HIGH-FREQUENCY OSCILLATORY ENERGY.—Roosenstein. (*See* under "Aerials and Aerial Systems.")

SIMPLIFIED H.F. CALCULATIONS.—W. A. Barclay. (*Wireless World*, 9th September, 1931, Vol. 29, pp. 266–268.)

"Estimating stage gain." The conclusion of the article referred to in 1931 Abstracts, p. 612.

ON THE MUTUAL LEAKAGE INDUCTANCES IN TRANSFORMERS WITH SEVERAL SECONDARIES.—A. Blondel. (*Comptes Rendus*, 9th November, 1931, Vol. 193, pp. 801–803.)

BEITRÄGE ZUR STABILITÄT ELEKTRISCHER STROMKREISE INSBESONDERE VON WECHSELROMSKREISEN (Contributions to the Theory of the Stability of Electrical Circuits, in particular of Alternating Current Circuits).—J. J. Sommer. (*Ann. der Physik*, 1931, Series 5, Vol. 9, No. 4, pp. 419–457.)

RADDRIZZAMENTO DI TENSIONI ALTERNATIVE CON CIRCUITI COMPRENDENTI UN DIODO, UNA RESISTENZA E UNA CAPACITA (Rectification of an A.C. Voltage by a Circuit consisting of a Diode, a Resistance and a Capacity).—N. Carrara. (*L'Elettrotec.*, 15th Oct., 1931, Vol. 18, pp. 726–731.)

MATHEMATICAL ANALYSIS OF NON-LINEAR CIRCUITS.—Part I. SOME CIRCUITS INVOLVING SATURATION.—A. Boyajian. (*Gen. Elec. Review*, Sept., 1931, Vol. 34, pp. 531–537.)

ÜBER DEN SCHEINWIDERSTAND VON SPULENLEITUNGEN MIT EINER TEILWEISE ODER ZUR GÄNZE UNWIRKSAMEN SPULE (The Impedance of a Loaded Line with a Partially or Wholly Inoperative Coil).—E. Adam. (*E. N. T.*, Sept., 1931, Vol. 8, pp. 404–417.)

TRANSMISSION.

ELECTRICAL OSCILLATIONS OF VERY SHORT WAVELENGTH.—E. W. B. Gill. (*Phil. Mag.*, October, 1931, Series 7, Vol. 12, No. 79, pp. 843–853.)

A description of experiments on the generation of Gill-Morrell oscillations. A valve was used whose anode was large in size compared to the grid. It was joined to a circuit whose fundamental oscillation was of the order of 30 m. and among whose other modes of oscillation were wavelengths of 576 cm., 400 cm., 304 cm. and 248 cm. The experiments were made on these wavelengths only; the study of the conditions necessary to produce the oscillations of these frequencies was sufficient to establish the laws that "for the wavelengths most strongly regenerated, the wavelength λ depends on both the grid-volts V and the grid-current i, but that the possible wavelengths are confined to a band. The long-wave ends of the band obey the law that $\lambda^2 V$ is constant, and the appropriate values of i for these are proportional to $V^{\frac{3}{2}}$. In addition, for all waves in the band given by a definite value of V the relation $\lambda^2 i$ is constant is obeyed. In general, therefore, for any values of i and V we must have $\lambda^2 i/\sqrt{V}$ is constant, which is more general than the old relation $\lambda^2 V$ is constant which applies only to the long-wave limit."

A theory of the oscillations is developed, based on the assumption that oscillations are maintained when the space between the grid and anode is carrying its saturation current, *not* the space between filament and grid.

THE DYNATRON OSCILLATOR: WITH A NEW CIRCUIT FOR VERY HIGH FREQUENCIES.—F. M. Colebrook. (*Wireless Engineer*, November, 1931, Vol. 8, pp. 581–584.)

Author's summary:—"Practical details are given for the application of screen-grid valves to the maintenance of oscillations by the dynatron method. The upper frequency limit of this type of oscillator is about 15 megacycles per second.

"By connecting the control grid through a high resistance to the filament and through a variable condenser to the anode, a new type of oscillation generator is obtained, which can be used for frequencies up to about 50 megacycles per second. Practical details for the design and operation of this circuit are given." Besides going to these much higher frequencies, this new circuit has the advantage over the old of maintaining oscillation over a much wider range of frequencies with a given coil: but it has not the complete freedom from "squegging" possessed by the old circuit—though this trouble can be avoided; nor, probably, as good a frequency stability.

SUR LES OSCILLATEURS À ONDES TRÈS COURTES (Ultra-Short-Wave Oscillators [Positive Grid Connection]).—C. Gutton and G. Beauvais. (*Comptes Rendus*, 3rd Nov., 1931, Vol. 193, pp. 759–761.)

An investigation to clear up the discrepancies between the results of various workers who have used valves of various degrees of exhaustion and have apparently obtained a number of régimes of oscillation in which the amount of residual gas seemed to play an important part. Cylindrical electrodes were employed, and the valve was kept connected to the vacuum pump. The filament temperature was adjusted so that a current of 30 mA. was maintained constant in the grid circuit, the grid being kept at 240 v. above the filament. Plate voltage and vacuum were varied, and the bridge of the Lecher wire system.

Only two distinct régimes were established. The first gave frequencies depending on the natural frequency of the oscillating circuit; the second gave higher frequencies independent of this natural frequency and depending only on the electrode dimensions and potentials; they appeared to correspond to oscillations which could take place in the interior of the valve in the absence of the external circuit, and for the production of which the presence of residual ionised gas was essential.

COMMUNICATION WITH QUASI OPTICAL WAVES.—E. Karplus. (*Proc. Inst. Rad. Eng.*, Oct., 1931, Vol. 19, pp. 1715–1730.)

Author's summary:—This paper deals with electromagnetic waves of from about 0.001 millimetre to 10 metres in wavelength. These waves are called quasi optical waves because their performance is very similar to the performance of visible light.

Due to scattering and absorption in the atmosphere, however, only two relatively small parts of that range can be used for communication, that is, between 5 centimetres and 10 metres and between 0.0008 and 0.002 millimetre.

In the first part of the paper the straight-line propagation characteristics of these high frequencies are discussed. The possibility of concentrating their radiation, and the apparent lack of all disturbances, either atmospheric or man-made, are also emphasised. The feasibility of modulating very high frequencies, and their advantages and disadvantages in various applications, are pointed out. Different ways of producing these high frequencies and of detecting and of measuring them are discussed.

The second part of the paper deals in somewhat greater detail with the design of tube transmitters and receivers in the range of 5 centimetres to 10 metres. In this group of transmitters are tuned-circuit oscillators and electron oscillators of the Barkhausen type. In the group of receivers considered are detector, regenerative, and super-regenerative circuits.

THE CALCULATION, FROM ENERGY CONSIDERATIONS, OF THE LIMITING FREQUENCIES AT WHICH INVERSION OF THE DYNAMIC CHARACTERISTIC OCCURS, FOR VARIOUS REACTION COUPLING METHODS : *and* THE GENERATION OF ULTRA-SHORT WAVES.—J. Sahánek : Hollmann. (*Zeitschr. f. Hochf : tech.*, Oct., 1931, Vol. 38, pp. 160–161.)

Summaries by Hollmann of Czech papers by Sahánek. *See* also Abstracts, 1928, pp. 640–641 ; 1930, p. 506 ; and 1931, p. 613.

FREQUENCY CONTROL EQUIPMENT OF POST OFFICE SHORT-WAVE TRANSMITTERS.—E. J. C. Dixon. (*P.O. Elec. Eng. Journ.*, July and Oct., 1931, Vol. 24, pp. 159–164 and 228–231.)

The first part deals with the quartz oscillators and oven equipment (*cf.* 1931 Abstracts, p. 110). A list is given showing the magnitude of the variations likely to occur in a quartz oscillator owing to changes in temperature, air gap, anode tuning and voltage, and filament voltage, as derived from tests on typical plates. The second part deals with the frequency multiplier equipment, and the paper ends with a discussion of performance curves and an outline of probable future refinements which should give frequency controls accurate to better than 1 part in a million. The present normal variation of the Rugby GBP transmitter is not greater than 50 parts in a million, over a period of a year.

STABILE UND LABILE SCHWINGUNGEN EINES ZWEIKREIS-RÖHRENGENERATORS BEI ÜBERKRITISCHER KOPPLUNG (Stable and Unstable Oscillation of a Two-Circuit Valve Generator with Super-critical Coupling).—P. von Handel. (*Zeitschr. f. Hochf : tech.*, Oct., 1931, Vol. 38, pp. 129–135.)

A theoretical investigation prompted by the observed fact that the usual "ziehen" effect of a self-excited two-circuit generator, with coupling beyond the critical point and inductive retroaction, does not occur when quartz crystal control is used in place of the normal inductive retroaction. A quartz-controlled transmitter can, with suitable tuning, give stable oscillations at a frequency at which oscillation would be unstable, and in practice unobtainable, with inductive retroaction. The writer first reduces a self-excited valve oscillator to an equivalent damping-free oscillatory circuit, and derives the conditions for stability of frequency. He then applies these conditions to the examination first of a single-circuit transmitter and then of a two-circuit transmitter with super-critical coupling, with respect to the stability of various possible points of oscillation.

DIE UNTERSUCHUNG AMPLITUDEN- UND FREQUENZMODULIERTER SENDER (The Investigation of Amplitude- and Frequency-Modulated Transmitters).—W. Runge. (*E.T.Z.*, 22nd Oct., 1931, Vol. 52, pp. 1322–1323.)

A short description of the Telefunken apparatus and procedure dealt with in 1931 Abstracts, p. 149.

NEUE MESSMETHODE ZUR BESTIMMUNG DES MODULATIONSGRADES VON TELEPHONIESENDERN (A New Method of Measuring the Degree of Modulation of a Telephony Transmitter). —J. Kammerloher. (*E.N.T.*, Oct., 1931, Vol. 8, pp. 458–462.)

After characterising the Grützmacher method (1931 Abstracts, p. 149, Runge) as ideal but possibly not well suited to common practice, the von Ardenne trapezoidal oscillogram method (1930 Abstracts, p. 406) as exigent in the matter of exactly plane parallel deflection plates, and its photographic-recording modification as free from error but not very convenient, the writer describes his own cathode-ray oscillographic method in which a stationary figure representing the modulated r.f. is obtained. The modulated r.f. is applied to one pair of plates, while the other pair receives an auxiliary potential proportional to time and strictly synchronous with the modulation frequency, this being attained by the use of the writer's "trip relay" (1931 Abstracts, p. 282) controlled by the modulation frequency. This relay has now been adopted to mains drive, and works well for all frequencies between 10 and about 5 000 c.p.s. Preliminary tests on special glow-discharge tubes promise considerable increase of the upper frequency. Photographed examples are given of the figures obtained, and the accuracy of the results is discussed.

THE SPREAD SIDEBAND SYSTEM ON SHORT WAVE TELEPHONE LINKS [Effect of Selective Fading on a Displaced Frequency Privacy System of Telephony, and Its Avoidance].—L. T. Hinton. (*Elec. Communication*, Oct., 1931, Vol. 10, No. 2, pp. 60–66.)

The effect of selective fading in causing harmonic distortion on an ordinary carrier-and-two-sidebands transmission having been discussed, the writer shows how the effect on privacy systems using frequency displacement is even more serious, and how this has led to the Spread Sideband system which is in successful commercial operation on the Buenos Aires—Madrid radio link. A fixed frequency of, say, 2 500 c.p.s. is added to the speech band from 250 to 2 500 c.p.s., so that an empty space is left next to the carrier, and the spurious frequencies of the second term of the expression for the results of detection can be separated by a low-pass filter cutting off at, say, 5 200 c.p.s. Intermodulation between component frequencies of a sideband fall outside the displaced band after detection, and this source of distortion, though small, is therefore also removed.

More About Economical Crystal Control: Efficient Frequency Doubling—Clearing Up Neutralization — Isolating Sources of Trouble. — G. Grammer. (*QST*, Nov., 1931, Vol. 15, pp. 22–31.)

The Class B Push-Pull Modulator.—L. E. Barton. (*QST*, Nov., 1931, Vol. 15, pp. 8–13.)

A paper on the use of the Class B audio-amplifier to replace the Class A modulator "as a source of audio-power for the complete modulation of the efficient Class C r.f. power amplifier." For definitions and explanations of these amplifier classes, *see* Dart and Atwater, *ibid.*, Sept., 1929.

High Audio Power from Relatively Small Tubes: Application to Transmitter Modulation.—Heising: Barton. (*See* under "Acoustics and Audio-frequencies.")

RECEPTION.

Note sur un nouveau Montage Changeur de Fréquence par Lampe bigrille pour Ondes de 10 à 100 Mètres (A New Two-Grid-Valve Frequency-Changing Circuit for 10–100 Metre Waves).—G. H. J. Horan. (*L'Onde Élec.*, Oct., 1931, Vol. 10, pp. 471–472.)

The writer has found the simple circuit, using a detector valve with regulated retroaction to give beats tuned to an intermediate-frequency amplifier, "little sensitive and not very stable." The circuit he now recommends is very satisfactory in sensitivity, complete stability and ease of adjustment. A grid coil tuned by a variable condenser is connected between the two grids and the −ve end of the filament. The inner grid goes direct to one end of the coil and is thus biased to the voltage of the filament −ve; the other grid is connected to the same end of the coil through a small detector condenser and is positively biased through a leak resistance connected through a potentiometer to filament +ve. The plate circuit contains a reaction coil suitably coupled to the grid circuit. Reaction is adjusted by a differential condenser in series with the plate circuit coil (C_2, Fig. 2). A low intermediate circuit frequency is recommended "to increase the selectivity; 30 kc. is very suitable, enabling a band pass of about 8 kc. to be obtained easily."

The Modern Screened Coil.—A. L. M. Sowerby. (*Wireless World*, 23rd and 30th Sept., and 7th Oct., 1931, Vol. 29, pp. 311–314, 397–400, and 406–409.)

The effect of the screen on the inductance and resistance of the coil is the subject under discussion, and these articles are part of a series of four dealing in very general terms with the more fundamental aspects of the case. Preliminary measurements of a number of coils show that there is no justification for the current belief that so long as the screen is well away from the ends of a coil it may approach the sides quite closely without any harm. The second instalment begins with a consideration of resistance problems, and deals with the distinction between series and parallel losses. The third instalment deals with designing the coil to suit the screen. Practical arrangements are made to determine the alteration of high-frequency resistance when the coil is enclosed in a screen.

Use of a Vacuum Tube Operated Relay to Control Blasting in Radio Receivers.—B. Ephraigm. (*Rad. Engineering*, Sept., 1931, Vol. 11, p. 27.)

It would be possible to adjust the grid voltage of the last l.f. valve so as to cause it to act on the lower bend of the curve, and so to use the plate current surge to operate the relay. This would not be desirable, however, since it would mean distortion in the output. An additional valve is therefore added after the manner of a valve voltmeter, across the secondary of the last l.f. transformer. A magnetic-type relay can be adjusted "to operate on a surge of 1 to 3 milliampères and as low as 200 microampères." It throws in a high resistance shunt across the grid and filament of the last stage. By suitably adjusting the grid bias voltages, the operating tube can be made to take no energy from the receiving circuit and to introduce no distortion into the output.

Hyper-sensitive Detection Systems [using the Autoplex Circuit]. —H. G. Boyle. (*Rad. Engineering.*, Sept., 1931, Vol. 11, pp. 15–16.)

"The sudden and overwhelming popular acceptance of midget sets has once more started the engineer off on the trail of greater amplification per tube." Using the superheterodyne principle for the sake of selectivity, the Autoplex circuit may be applied to the second detector (tetrode) and combined if desired with an oscillating tetrode as the first detector: thus with the addition of an audio output valve (which may with advantage be a pentode) a 3-valve receiver may be obtained with good sensitivity and selectivity.

Investigations into Anode Detection.—Ulbricht. (*See* under "Properties of Circuits.")

The Stenode Receiver and the Side-Band Theory.—J. Robinson: Fortescue. (*Wireless Engineer*, Oct., 1931, Vol. 8, p. 540.)

A reply to Fortescue's letter (1931 Abstracts, p. 615).

The Desirability of Incorporating Automatic Mains Voltage Control in a Receiver.—A. C. Lescarboura. (*Rad. Engineering*, Sept., 1931, Vol. 11, p. 41.)

An overwhelming majority of radio dealers in America vote for the incorporation of this control even if it increases the price of the receiver by three dollars. Valves cause "more trouble in the servicing of sets than all the other ills put together" and a large proportion of valve failure is directly traceable to voltage fluctuations.

Novel Wireless Receiver [recently patented in Holland].—(*Elec. Review*, 14th August, 1931, Vol. 109, p. 259.)

The intention is to limit to the utmost "the use of the third dimension and confine the finished receiver to two dimensions only." All components, excluding valves, have the form of thin flat elements mounted on a solid panel. Resistances and connections are formed by a graphite deposit or cathode sputtering (Schoop, 1929 Abstracts, p. 112). It is claimed that manufacturing costs can thus be considerably reduced, particularly for resistance-capacity coupled amplifiers, in which the grid-leak and coupling resistance can be made of graphite or carbon in gelatine suspension.

Ford Car Planetary Gear Principle for Tuning Dial of Receiver.—American Radiostat Company. (*Rad. Engineering*, May, 1931, Vol. 11, p. 24.)

Luminous Neon Column Operated by Amplified Carrier Wave as Tuning Indicator for Receivers (Fada Automatic Flashograph). (*Rad. Engineering*, Oct., 1931, Vol. 11, p. 40.)

Mass Production of Radio Cabinets.—A. W. Richards. (*Commercial Standards Monthly*, Oct., 1931, Vol. 8, pp. 115–116.)

Communication in the New Waldorf Astoria.—(*Elec. Engineering*, Nov., 1931, Vol. 50, pp. 895–897.)

Directed Radio in Hotels, Hospitals, etc. New System eliminates Wiring for Room Reception—Steel Frame of Building serves as Aerial.—(*Rad. Engineering*, Sept., 1931, Vol. 11, pp. 37–38.)

Several master receivers (each permanently tuned to one station) control miniature transmitters and thus re-radiate the programmes into the steel frame of the hotel. Each room has a single valve receiver with dynamic loud speaker. The re-transmissions cannot be picked up outside the hotel.

Formation of the Institute of Radio Service Men in Chicago.—(*Rad. Engineering*, Sept., 1931, Vol. 11, p. 16.)

Une nouvelle Contribution à la Lutte contre les Perturbations industrielles (A New Contribution to the Fight against Industrial [Power Line] Interference with Broadcast Reception).—S. Manczarski. (*Rev. Gén. de l'Élec.*, 19th Sept., 1931, Vol. 30, p. 101D.)

Summary of an article on the bringing forward to the C.C.I.R., by the Polish administration, of Manczarski's methods of eliminating interference, referred to in 1931 Abstracts, p. 96. The article, in the *Journal télégraphique*, describes the two circuits proposed, one for the case where the power line feeds the receiver and the other where the power line is inaccessible. The method depends on the compensation of coupling between receiver and line.

Prevention of Interference with Broadcast Reception due to H.T. Overhead Lines: the Local Use of H.F. Chokes.—F. S. Mabry. (Short summary in *E.T.Z.*, 12th November, 1931, Vol. 52, p. 1421.)

Über die Möglichkeit, Rundfunkstörungen zu unterdrücken, die durch elektrische Schaltwerke entstehen (The Possibility of Suppressing Interference with Broadcast Reception due to Electrical Make-and-Breaks).—K. Heinrich. (*E.T.Z.*, 29 Oct., 1931, Vol. 52, pp. 1358–1359.)

The property of the half-watt lamp, of greatly increasing its filament resistance in changing from the cold to hot condition, is used to shunt out the discharges of electrical advertising signs and the like, thus considerably decreasing the interference. The process is examined with the help of oscillograms.

Radio Interference Elimination a Co-operative Task.—C. C. Campbell and H. N. Kalb. (*Elec. World*, 29th August, 1931, Vol. 98, pp. 384–385.)

Deals with the main sources of interference other than radio, and gives methods of location and elimination.

A Portable Meter for Tracing and Measuring Interference, embodying a "Standard Noise" Generator.—Gen. Elec. Company. (*Rad. Engineering*, May, 1931, Vol. 11, pp. 46 and 52.)

The Wireless World Three.—F. H. Haynes. (*Wireless World*, 16th September, 1931, Vol. 29, pp. 272–277.)

A selective band-pass receiver for amateur construction. The set, which is chassis-built on an aluminium frame, includes a constant peak band-pass filter of new design comprising a "link" circuit giving negative inductive coupling.

The Wireless World Three, A.C. Model.—F. H. Haynes. (*Wireless World*, 30th September, 1931, Vol. 29, pp. 374–380.)

Constant Peak Band Pass Filters.—W.G.I.P. (*Wireless World*, 16th September, 1931, Vol. 29, p. 297.)

A brief review of recent methods of securing constancy of pre-selection over the tuning range. Systems dealt with include (*a*) one in which the value of the coupling capacity in a filter changes continuously with change of wavelength; (*b*) "mixed" filters in which use is made of a fixed *negative* inductance coupling combined with a fixed capacity coupling; (*c*) the link circuit method. "Now that pre-selectors with constant characteristics are available, attention will have to be given to the design of inter-valve single-tuned circuits having more constant selectivity."

Tendencies in Radio Construction at the Eighth Annual Paris Exhibition.— M. Adam. (*Rev. Gén. de l'Élec.*, 17th Oct., 1931, Vol. 30, pp. 644–649.)

Receivers at Olympia and Other Exhibitions.—(*See* under "Miscellaneous.")

Receivers at the Eighth German Radio Exhibition.—(*Die Sendung*, 25 Sept. and 2 Oct., 1931, Vol. 8, pp. 781–782 and 806.)

Continuation of the series referred to in 1931 Abstracts, p. 615.

AERIALS AND AERIAL SYSTEMS.

The Absorption of Energy by a Wireless Aerial.—J. A. Ratcliffe (*Proc. Camb. Phil. Soc.*, Oct., 1931, Vol. 27, No. 4, pp. 588–592.)

The point of view adopted in this theoretical paper is that the flow of energy into the aerial is produced by the superposition of the incident and the re-radiated fields. " It is the purpose of this paper to direct attention to the fact that a very simple demonstration of the truth of the ' re-radiation ' mechanism of absorption can be given by an application of a well-known theorem in electrodynamics." The proof holds for incident periodic fields of any form and for receiving aerials of any shape.

Remarks on the Papers . . . " On the Field Radiated from a Finite Antenna . . ."—Weyrich. (*See* under " Propagation of Waves.")

Das räumliche Strahlungsdiagramm der Telefunken-Richtantenne (The Space Radiation Diagram of the Telefunken Beam Aerial System).—R. Bechmann. (*E.T.Z.*, 1st Oct., 1931, Vol. 52, pp. 1253–1254.)

Giving the expression for the *total* space radiation, the influence of the ground and the effect of the reflector system both being taken into account. The expression is confirmed by the experimentally determined diagram.

Radiation from Antennae under the Influence of the Earth. D.—Radiation Measurements with Antennae.—Strutt. (*See* under " Propagation of Waves.")

Effect of Aerial Height in Ultra-Short-Wave Broadcasting in Cities.—Schröter. (*See* abstract under " Propagation of Waves.")

The Conduction of High-frequency Oscillatory Energy [Feeder Theory and Measurements].—H. O. Roosenstein. (*Proc. Inst. Rad. Eng.*, Oct., 1931, Vol. 19, pp. 1849–1883.)

English version of the paper dealt with in 1931 Abstracts, p. 36. *See* also same Abstracts, pp. 441 and 147.

Development of Directive Transmitting Antennas by R.C.A. Communications, Inc.—P. S. Carter, C. W. Hansell and N. E. Lindenblad. (*Proc. Inst. Rad. Eng.*, Oct., 1931, Vol. 19, pp. 1773–1842.)

Authors' summary :—" Progressive stages in the development of short-wave directive antennas for long-distance communication are outlined. The scope of development described embraces the period from 1923, beginning with experiments on a transmitting wave antenna at Belfast, Maine, to the present commercial directive antennas used in the world-wide short-wave system of R.C.A. Communications, Inc.

" Various types of directive antennas are theoretically analysed and their performances under practical conditions studied. The effects of seasonal variations, heights above ground and polarisation are considered. The radiation properties of simple wires and the radiation patterns of various combinations of wires are described in detail.

" The economic aspects of these directive antennas as exemplified by the standard antenna models A, B, C, and D are developed." Model A is of the broadside type, consisting of linear arrays of vertical radiators fed with a special transmission system having nearly infinite phase velocity. Model B consists of one or more arrays of parallel long wires, in a vertical plane, which have their ends staggered so as to give a unidirectional beam of vertically polarised waves. Model C is similar but with the wires in a horizontal plane, giving horizontally polarised waves. Model D consists of elements made up of long wires bent into horizontal V's which are used in an array giving horizontally polarised waves.

Principles of Radio Tower Design.—T.W. (*P.O. Elec. Eng. Journ.*, Oct., 1931, Vol. 24, pp. 231–237.)

Radio Towers and Antennas.—N. Gerten. (*Rad. Engineering*, May, 1931, Vol. 11, pp. 21–24.)

VALVES AND THERMIONICS.

Thermionic Valve with Fall of Potential across the Grid.—A. Lo Surdo. (*Nature*, 24th Oct., 1931, Vol. 128, p. 734.)

Summary of an *Accad. dei Lincei* paper. The grid consists of a conductor of suitable form for carrying a current ; by adjusting the intensity and direction of this current the non-uniformity of behaviour of the various parts of the filament/grid space may be diminished or enhanced. In this way it seems possible to increase markedly the amplifying power.

A " Cold " Filamentless Radio Tube.—C. W. Hough : A. Hund. (*Electronics*, Nov., 1931, pp. 182–183.)

A preliminary note on Hund's new valve, which is said to function as oscillator, modulator, or amplifier ; it can be made in various sizes up to 30 watts output capacity. A short note on p. 183 refers to Seibt's work on " cold " valves (1930 Abstracts, p. 632).

The Mains Valve.—W. T. Cocking. (*Wireless World*, 23rd September, 1931, Vol. 29, pp. 308–310.)

The author sums up the advantages of indirect heating. The indirectly heated valve eliminates hum, and owing to the absence of a current in the cathode, involves no restriction of electron flow.

The whole surface of the cathode is at the same potential. The valve has double the amplifying efficiency of other types and is the most efficient detector known.

A 500 KW. WIRELESS VALVE. (*World Power*, Nov., 1931, Vol. 16, pp. 372–373.)

A note on the giant valve recently designed and manufactured by the Metropolitan-Vickers Electrical Company. By replacing the mercury of the vapour pump by oil distillates of special properties, it has been possible to eliminate the liquid air cooling process hitherto used, and to produce a dismountable and continuously evacuated valve in a commercial form.

MODERN MANUFACTURE OF RADIO TUBES.—J. B. Nealey: Grigsby Grunow Company. (*Rad. Engineering*, October, 1931, Vol. 11, pp. 29–30.)

DIRECTIONAL WIRELESS.

PROCÉDÉS DE RADIOALIGNEMENT (Systems of Radio Beacon [particularly Besson's "Associated Loop-and-Aerial" or "Symmetrical Cardioids" System used at La Pallice]).—P. Besson. (*L'Onde Élec.*, Sept., 1931, Vol. 10, pp. 369–416: Discussion, pp. 417–424.)

The writer's system, described and discussed at great length, is claimed to be particularly suitable for marine work where, as a rule, ranges of 20–30 km. are sufficient but where absence of confusion between several axes, the absolute stability of the axis, and the greatest possible accuracy in tracking the axis are the essential points. Reception may be aural, on the interlocked signal principle, or a neon lamp may be used with the same principle; or the transmissions may be modulated at two different frequencies for reception on twin reeds as in the American system. The system lends itself also to being applied to the marking out of sectors of any desired angle, and also to the rotating beacon principle.

The two symmetrical cardioids are obtained in succession by alternating the coupling of the vertical aerial by a mechanical commutator, while keeping the loop currents unchanged. By suitably adjusting the values of the loop and aerial fields, the cardioids can be made to cut each other at very sharp angles, so that the resultant axis is extremely sharply defined.

LA RADIOGONIOMÉTRIE APPLIQUÉE AUX LIGNES AÉRIENNES (Radio Direction Finding Applied to Air Lines [and in particular the Suppression of Night Effects and "Aeroplane Effect," leading to a description of the "Aeropostale" Opposed Frame Radiogoniometer]).—Serre. (*L'Onde Élec.*, Oct., 1931, Vol. 10, pp. 425–457.)

A paper from one of the staff of the Compagnie Générale Aéropostale, dealing with that company's wireless network Paris, Casablanca, Agadir, Senegal, Brazilian Coast, etc. On page 433 the writer emphasises the necessity of loud speaker working, atmospherics in the equatorial regions making headphone reception quite unbearable; he then discusses the choice between direction finding and wireless beacons, and between ground station d.f. and d.f. on board the aircraft. The system adopted for the present is that of ground station d.f., using in general frames with 1.5 metre sides and superheterodyne receivers without r.f. amplification. On p. 436 he begins to discuss the troubles at night, starting with local effects due to moisture on the insulation: the use of calcium chloride to dry the air in the huts has improved matters very much. The differing behaviour at different parts of the route, as regards night effects on d.f., is related, and then (pp. 438–445) the causes of night error are discussed, leading to an outline of the 1919 Adcock system, with brief mention of subsequent improvements.

A statement of certain defects attributed to this system, such as size, cost, susceptibility to atmospherics owing to its use of open aerials in place of loops, and "its complete inability to protect against errors due to a vertical field arriving in a direction which has been deviated with respect to the vertical plane joining transmitter and radiogoniometer," leads up to an explanation of the Company's system of opposed identical frames. The simplest circuit (Fig. 6) consists of two frames in the same vertical plane, equidistant from the ground and connected in opposition. This gives elimination of fields arriving in a vertical direction, but does not eliminate night effect due to an incidence at about 45°—or less, if the vertical component is considerable. To eliminate such fields, the opposed frames instead of being equidistant from the ground must be symmetrical with respect to a plane making 45° with the horizontal (Fig. 10), and a combination of these two systems (Figs. 14 and 15) gives "a practically complete suppression of all possible trouble from reflected fields." The system can also be used as a transmitting beacon, ensuring that it will affect the receiver only by waves transmitted parallel to the earth's surface. The paper is to be continued.

NEW WIRELESS COMPASS.—(*Wireless World*, 7th October, 1931, Vol. 29, pp. 410–412.)

The rotating frame aerial system recently developed at the laboratories of the Matériel Téléphonique in Paris. The equipment, which works automatically, consists fundamentally of a receiving frame rotated at 600 r.p.m. by means of an electric motor, while on the same shaft are the poles of an electromagnet which rotates round a galvanometer-type moving coil. A vertical aerial is used in conjunction with the frame. *Cf.* 1931 Abstracts, p. 43 (Busignies).

AN EXPERIMENTAL DIRECTION-FINDER FOR USE ON ULTRA-SHORT WAVES.—Smith-Rose and McPetrie. (Appendix to paper dealt with under "Propagation of Waves.")

COASTAL AND HARBOUR WIRELESS SERVICES.—Marconi Company. (*Marconi Review*, Sept.–Oct., 1931, No. 32, pp. 9–17.)

ELECTRICITY IN AERIAL NAVIGATION.—(*World Power*, Nov., 1931, Vol. 16, pp. 347–351.)

Electrical Aids to Blind Flying.—A. Klemin. (*Scient. American*, Nov., 1931, Vol. 87, pp. 324–326.)

ACOUSTICS AND AUDIO-FREQUENCIES.

The Acoustical Problems of Broadcasting Studios.—N. Ashbridge. (*Engineering*, 16th and 23rd October, 1931, Vol. 132, pp. 505–507 and 537–539.)

This British Association paper begins with an account of early work on broadcasting studios, and goes on to deal with the latest practice, as adopted at the new Broadcasting House and elsewhere. The precautions against transmission of sound from one studio to another through continuous steel frame construction, common air-conditioning plant, etc., are described. Reverberation time measuring methods are outlined; "in many cases it appears to be the practice to make these measurements only at . . . 512 cycles per second. It is considered highly desirable, however, for broadcasting studios, that all frequencies between, say, 40 and 10 000 cycles per second should be considered, and that the curve should be level over this range within a fairly wide tolerance—say of the order of 20 per cent." In practice, however, one has for various reasons to be content with a testing range of about 100–6000 c.p.s. Complications occur at frequencies above about 5000 cycles, probably due to appreciable attenuation of sound waves in the air at these higher frequencies. McNair's suggested marked increase at the bass end will give "bass blasting," but a slight slope downwards towards the high frequencies may be of some advantage. Artificial reverberation, though preferably replaced for musical purposes by correct balancing of the studio, is very advantageous for special purposes, such as dramatic effects. The question of the number of performers admissible in a studio of given dimensions is discussed, together with the possible steps to be taken when this number has to be exceeded. The placing of the microphone or microphones, and the taking into account of spurious noise and of reverberation time, are dealt with at the end of the paper.

The Acoustics of Famous European Concert Halls, and the Optimum Reverberation Time for Rooms of Various Size and for Various Types of Music.—V. O. Knudsen. (*Journ. Acous. Soc. Am.*, April, 1931, Vol. 2, pp. 434–467.)

Including a suggestion that shutters in the ceiling, with an absorptive material behind them, would allow the reverberation time to be varied to suit the type of music being played.

Het Richtingshooren in de Ruimte (Directive Audition in Space).—J. L. Van Soest and P. D. Groot. (*Physica*, No. 4, Vol. 11, 1931, pp. 103–116.)

Two-dimensional direction-finding by hearing appears possible since hearing deduces two physical quantities from a sound field—a time difference and an intensity ratio. Experiments are described which "call for an extension or alteration of the stereoacoustic theories so far published."

Bemerkungen zur Theorie der günstigsten Nachhalldauer von Räumen (Remarks on the Theory of the Most Favourable Echo Duration in Large Rooms).—G. v. Békésy. (*Ann. der Physik*, 1931, Series 5, Vol. 8, No. 7, pp. 851–873.)

Some Acoustical Problems of Sound Picture Engineering.—W. A. MacNair. (*Proc. Inst. Rad. Eng.*, Sept., 1931, Vol. 19, pp. 1606–1614.)

From the Bell Telephone Laboratories. Among various points dealt with, the necessity is stressed of using the more general reverberation formula developed by Eyring (1931 Abstracts, p. 45) when dealing with comparatively "dead" rooms.

A Simplified Instrumental Method of Measuring Sound Absorption Coefficients.—J. F. Mackell. (*Science*, 28th Aug., 1931, Vol. 74, pp. 224–225.)

Sound is produced in a reverberation room by an organ pipe at constant pressure. A metronome is set vibrating at a given frequency; in coincidence with a given "click" the air is cut off, and at some subsequent "click" a key is pressed which connects a thermo-galvanometer with a simple microphone-amplifier receiver. The metronome is set for other frequencies and the process repeated. From curves thus derived the absorption coefficients are obtained.

Equipment for Simple and Rapid Measurement of Sound-Absorption Properties of Materials.—A. L. Albert and W. R. Bullis. (*Elec. Engineering*, Sept., 1931, Vol. 50, p. 755.)

Abstract of a Pacific Coast Convention paper. The absorptive properties are determined by the effect produced on the electrical characteristics of a loud speaker by sound waves emitted by it and reflected from the material. The loud speaker may be moved backwards and forwards inside a wooden tube at whose end the material is mounted.

A Simple Time-Integrating Device [especially for Reverberation Time Measurement]. —A. G. Granston Richards. (*Journ. Scient. Instr.*, No. 7, Vol. 8, 1931, pp. 225–226.)

Eine Brückenanordnung zur Nachhallmessung bei reinen Tönen (A Bridge Arrangement for Measuring Reverberation Times with Pure Notes).—H. E. Hollmann and Th. Schultes. (*E.N.T.*, Sept., 1931, Vol. 8, pp. 387–392.)

A bridge method enabling a pure note to be used, in which the decay is matched against the discharge of a condenser, and the interference phenomena generally intruding in pure-note methods are balanced out by two auxiliary condenser-rectifier valve combinations connected in opposition in the bridge diagonal.

A Balance Method of Measuring Sound Transmission.—A. E. Knowler. (*Phil. Mag.*, Nov., 1931, Series 7, Vol. 12, No. 80, pp. 1039–1042.)

DIE ANWENDUNG DES TROCKENGLEICHRICHTERS IN DER TONFREQUENZ-MESSTECHNIK (The Use of the Dry-Plate Rectifier in Audio-frequency Measuring Technique).—W. Wolman and H. Kaden. (*Zeitschr. f. tech. Phys.*, No. 10, Vol. 12, 1931, pp. 470–482.)

A Siemens and Halske paper. (i) Circuits. (ii) D.c. characteristic and the efficiency of rectification. (iii) Treatment of the rectifier as controlled equivalent potential source. (iv) The characteristic as an exponential function. (v) Frequency distortion. (vi) Reaction effect of non-linearity. (vii) Temperature compensation. (viii) Indication of the effective value. (ix) Circuit with preliminary valves. (x) Comparison with valve voltmeters. (xi) Practical forms.

NOISE AND ITS MEASUREMENT.—G. W. C. Kaye. (*Nature*, Supplement, 15th Aug., 1931, Vol. 128, pp. 253–264.)

A Royal Institution lecture giving a general account of the subject.

THE RECORDING AND REPRODUCING OF SOUND (Cantor Lecture).—A. G. D. West. (*Journ. Roy. Soc. Arts*, 16th, 23rd and 30th Oct. and 6th Nov., 1931, Vol. 79, pp. 992–1015, 1021–1043, 1048–1069, and 1075–1100.)

Included in the first part is a table of suitable reverberation times for intimate speech, sermon, instrumental solos, solo vocalist, trios to octets, and orchestras, ranging from 0.5 sec. for the first to 1.5–2.5 secs. for the last. Eight considerations in designing a new studio are also given. In the second part, the author mentions the new Fidelytone system of sound-on-film recording (F.K. Crowther) in which a mixed variable area and variable density record (mainly the former) is obtained from the image of a gas discharge. It gives extremely good reproduction of speech, "especially in the higher frequencies which determine the character of 'naturalness' of speech; in fact, a film record made by this system which I heard was, in my opinion, one of the most natural that I have ever heard." Part III deals with the processing of disc records, disc record characteristics and possible improvements, needle and record wear, celluloid and other flexible records, "noiseless" sound-on-film recording, gramophones, and electrical pick-ups. Part IV deals with amplifiers, loud speakers ("the weakest link in the chain,") reproduction from film records, future improvements in recording, etc.

THE BEHAVIOUR OF CONICAL DIAPHRAGMS USED IN ACOUSTIC APPARATUS FOR THE REPRODUCTION OF SPEECH AND MUSIC.—N. W. McLachlan and G. A. V. Sowter. (*Phil. Mag.*, Oct., 1931, Series 7, Vol. 12, No. 79, pp. 771–815.)

Authors' abstract :—This paper deals with the mechanical and acoustical behaviour of coil-driven conical diaphragms under various conditions. Three edge conditions are treated :—(*a*) free; (*b*) reinforced; (*c*) suspension by rubber surround. Case (*a*) is characterised by numerous radial modes at low frequencies, case (*b*) by an absence of these modes and a relatively weak lower register, and case (*c*) by augmentation of the lower register to the level of the upper register. The latter effect is due to the rubber surround acting as an auxiliary resonant diaphragm. The influence of the edge condition on the upper register is aurally unimportant for the standard size of diaphragm used in the experiments. The first centre moving symmetrical mode of a diaphragm 12 cm. radius and apical angle 90° occurs about 900 cycles, and the second and most powerful centre moving symmetrical mode about 2000 cycles. The frequencies of these modes decrease with increase in the apical angle from 90° towards 180°. For a 90° cone they are not seriously affected by variation in the mass of the coil or the thickness of the paper. This points to radial expansion and contraction of circular sections of the cone as a whole, which is concomitant with circumferential tensile and compressive stresses. It is shown that the upper register increases in strength and in range with decrease in the mass of the coil. Owing to transmission and radiation losses, the so-called nodes are actually positions of minimum amplitude.

Experiments have been conducted with aluminium cones 1 mil and 3 mils thick. Although the main resonance was elevated appreciably, the reproduction lacked body.

Difficulties encountered in ascertaining the sound output accurately from resistance measurements of the coil fixed and free are discussed in detail. The question of apparent efficiency is treated. The performance criterion is the total sound output at all frequencies in the acoustic register, and not merely a curve of axial air pressure.

An Appendix is given containing tables of resonance frequencies of different diaphragms, also the static resistance and inductance of 40 and 1000 turn coils situated in and out of the electromagnet. An approximate method of measuring the Accession to Inertia when the diaphragm does not move as a whole is outlined.

NODAL LINES ON VIBRATING DIAPHRAGMS.—N. W. McLachlan. (*Wireless Engineer*, Oct., 1931, Vol. 8, pp. 540–542.)

Calling attention to the wrongness of the tacit assumption that a nodal circle on a centrally driven disc is a position of rest. *See* also preceding abstract. The writer's results probably explain why Strutt obtained no nodes on certain cones (1931 Abstracts, pp. 388 and 502).

ON THE SOUND FIELD IN THE NEIGHBOURHOOD OF AN OSCILLATING PLANE DISK.—R. Ruedy. (*Canadian Journ. Research*, Sept., 1931, Vol. 5, No. 3, pp. 297–301.)

Author's abstract :—With the aid of recent theories (H. Stenzel, N. W. McLachlan, H. Backhaus) the velocity potential and pressure distribution at points in the field of vibrating solid discs of 1 to 20 cm. diameter are calculated for a number of frequencies of practical importance. The graphs drawn from these values apply also to very high frequencies but smaller discs (1 to 20 mm.). They illustrate the gradual transition from spherical distribution to directed transmission.

TRANSIENTS AND TELEPHONY.—T. S. E. Thomas. (*Wireless Engineer*, Sept., 1931, Vol. 8, pp. 485–488.)

Examples are given of the mathematical analysis of the distortion produced on transients by (i) resistance-capacity amplification, (ii) choke-capacity amplification, and (iii) cone loud speakers. In the last case the use of "critical damping" ($r^2 = 4sm$) is discussed. For correspondence *see* Oct., Nov. and Dec. issues, pp. 540, 599 and 661 (McLachlan).

DYNAMIC LOUDSPEAKER DESIGN [OF MAGNETIC CIRCUIT].—J. E. Goeth. (*Electronics*, Sept., 1931, pp. 112–113 and 130.)

Continued from the August issue: the computation for a typical case is given here.

DER TÖNENDE KONDENSATOR (The Singing Condenser [Electrostatic Loud Speakers, especially the Double-Sided Oscilloplane with Aluminium-Magnesium Alloy Diaphragm]). —H. Vogt. (*E.T.Z.* 12th November, 1931, Vol. 52, pp. 1402–1407.)

LOUD SPEAKER ENSURING LOW NOTE FIDELITY.—(French Pat. 705640, Charlin and Toulon, pub. 10th June, 1931.)

Summary in *Rev. Gén. de l'Élec.*, 31st Oct., 1931, Vol. 30, pp. 149–150D. In theory, all notes whose wavelengths are longer than twice the baffle diameter are reproduced only feebly. The invention seeks to remedy this without the use of an inconveniently large baffle.

A LOUD SPEAKER WITHOUT BAFFLE.—(French Pat. 705658, Bethenod, pub. 11th June, 1931.)

See *Rev. Gén. de l'Élec.*, 26th September, 1931, Vol. 30, p. 112D. It uses a second diaphragm driven from the first through an enclosed air space in such a way that a phase difference exists of nearly $\frac{\pi}{2}$.

OVER STRALINGSWEERSTAND BIJ TRILLINGEN VAN EEN KEGELVORMIG MEMBRAAN (On the Radiation Resistance in connection with the Vibrations of a Cone-Shaped Membrane).—A. Th. Van Urk. (*Physica*, No. 7, Vol. 11, 1931, pp. 215–226.)

Author's summary:—The idea of radiation resistance and accession to the inertia of a vibrating body is explained. The values of the radiation resistance for a pulsating sphere of 5.9 cm. radius and for a vibrating circular plate of 8.4 cm. radius are calculated. Experiments to measure the radiation resistance of a paper cone with 90° top angle and 15.5 cm. diameter of the base circle between 50 and 200 c.p.s. are described. Experimental and calculated values are compared and the agreement between both is as good as could be expected.

ON THE ADMITTANCE OF LINEAR OSCILLATING SYSTEMS [APPLICATION TO LOUD SPEAKER CONES].—Strutt. (*See* under "Properties of Circuits.").

EINE ANALYTISCHE THEORIE DES TELEPHONS UND IHRE BEDEUTUNG FÜR DAS EXPERIMENT (An Analytical Theory of the Telephone [and Allied Electromagnetic Instruments] and Its Significance for Experiment).—H. Hecht. (*E.N.T.*, Sept., 1931, Vol. 8, pp. 392–405.)

Previous authors dealing analytically with the telephone problem have complicated their results by taking into consideration the losses in the coil. In the present paper the analysis is so carried out that by neglecting the coil leakage and resistance simple rules and bases for calculation are obtained. If one or other of these factors cannot be neglected, the results cannot be applied directly in practice, but even then the theory points the way to experimental methods of measuring the useful quantities such as the efficiency at different frequencies.

UNTERSUCHUNGEN ÜBER AKUSTISCHE SCHWELLENWERTE. I. ÜBER DIE MESSUNG DER REIZSCHWELLE DER HÖREMPFINDUNG MIT RESONANZTELEPHONEN (Investigations on Acoustic Threshold Values. I. On the Measurement of the Threshold of Sensation of Hearing with Resonance Telephones).—E. Waetzmann and H. Heisig. (*Ann. der Physik*, 1931, Series 5, Vol. 9, No. 8, pp. 921–973.)

MISURA DEGLI SPOSTAMENTI STATICI E DINAMICI DELLE MEMBRANE TELEFONICHE (Measurement [by Ultra-Micrometric Method] of the Static and Dynamic Displacements of Telephone Diaphragms).—G. Sacerdote and E. Gotta. (*L'Elettrotec.*, 25th Oct., 1931, Vol. 18, pp. 755–759.)

ÉTUDE D'UN MICROPHONE POUR LA RADIODIFFUSION (Researches on a Microphone for Broadcasting [Development of a Radio-frequency Circuit for Use with the Wente Condenser Microphone in place of the usual Amplifying Circuit]).—A. H. Reeves. (*L'Onde Élec.*, Oct., 1931, Vol. 10, pp. 458–470.)

Description of the Standard Laboratories' circuit, exempt from background noise, in which the condenser microphone varies the tuning of a r.f. circuit loosely coupled to an oscillator circuit generating a frequency of the order of 600 kc. The two circuits are adjusted in such a way that the working point lies on the steep slope of the resonance curve, so that great sensitivity is obtained. The characteristic of the combination shows a variation of less than 2 db. for all frequencies between 50 and 10 000 c.p.s.; up to 8 000 c.p.s. the curve lies between + 1.5 and − 1.5 db., and then rises slightly and advantageously (in view of receiver defects).

THE RIBBON MICROPHONE.—G. S. Mitchell. (*Elec. Review*, 11th September, 1931, Vol. 109, p. 391.)

The ribbon is of duralumin, approximately 3″ long, $\frac{3}{16}$″ wide, and $\frac{1}{2}$ mil thick. It is corrugated transversely to prevent stationary waves and to keep its natural frequency outside the range normally recorded. *Sounds originating in a plane* *parallel to the face of ribbon have no effect*, and sounds falling normally have the greatest effect. *See* also next abstract.

A NEW RIBBON MICROPHONE WITH PLANE OF ZERO RECEPTION, FOR SOUND FILM RECORDING.—H. F. Olson. (*Sci. News Letter*, 24th October, 1931, Vol. 20, p. 260.)

AN ANALYSIS OF THE SERIES TYPE MIXING CONTROL [for several Microphones].—L. B. Hallman, Jr. (*Rad. Engineering*, Sept., 1931, Vol. 11, pp. 17–18 and 35.)

THE CALIBRATION OF MICROPHONES.—H. F. Olson and S. Goldman. (*Electronics*, Sept., 1931, pp. 106–108 and 130.)

Rayleigh disc in an acoustic transmission line with graded dissipation (as used by RCA Photophone); comparison methods; thermophone; "actuator" method (a grill or slotted plate is slipped into the front opening of a condenser microphone, and an a.c. voltage applied between actuator and diaphragm). Advantages and disadvantages are discussed.

BOUTONNIÈRE MICROPHONE FOR BROADCASTING SPEECHES, IN PLACE OF ARRAY OF FIXED MICROPHONES.—Bell Telephone Laboratories. (*Sci. News Letter*, 5th Sept., 1931, p. 152.)

MOVING-COIL TELEPHONE RECEIVERS AND MICROPHONES.—E. C. Wente and A. L. Thuras. (*Journ. Acous. Soc. Am.*, July, 1931, Vol. 3, pp. 44–55: *Bell S. Tech. Journ.*, Oct., 1931, Vol. 10, pp. 565–576.)

THE DEVELOPMENT OF THE MICROPHONE.—H. A. Frederick. (*Bell Telephone Quarterly*, July, 1931, Vol. 10, pp. 164–188: *Reprint* B. 585, Sept., 1931, 29 pp.)

"An outline of the inventions leading to the development of the present high-quality microphone."

SUR UN NOUVEAU MICROPHONE À CHARBON (A New Carbon Microphone [with a Good Frequency Characteristic]).—M. Marinesco. (Summary in *Physik. Ber.*, 15th Aug., 1931, Vol. 12, p. 1831.)

STUDIO PRACTICE IN "NOISELESS" [SOUND-ON FILM] RECORDING.—G. Lewin. (*Electronics*, Sept. and Oct., 1931, pp. 102–104 and 146–147 and 172.)

See 1931 Abstracts, p. 160 – two. Special technique in the adjustment of the spacing of the light-valve ribbons to obtain the best overall results is outlined. A photoelectric cell photometer is used for checking purposes.

CONTRIBUTIONS TO A METHODICAL VALUATION OF TALKING MACHINES AND SOUND RECORDS.—L. Hajek. (Summary in *Sci. Abstracts*, *Sec. B*, Oct., 1931, Vol. 34, p. 587.)

DER ZUSAMMENHANG ZWISCHEN GRADATION UND FREQUENZGANG BEI INTENSITÄTSTONAUFZEICHNUNGEN (The Connection between Gradation and Frequency Characteristic in Sound-on-Film Recording by the Intensity Process).—R. Schmidt. (*Zeitschr. f. tech. Phys.*, Sept., 1931, Vol. 12, pp. 444–447.)

EFFECTS OF OPTICAL SLITS IN LIGHT-VALVE SOUND RECORDING.—J. P. Livadary. (*Electronics*, August, 1931, pp. 54–56 and 88.)

OPTICAL METHODS FOR REDUCING THE EFFECTS OF PHOTOGRAPHIC PLATE GRAININESS. WITH SPECIAL REFERENCE TO SPECTRAL LINE AND STAR IMAGE MEASUREMENTS.—F. E. Wright. (*Journ. Opt. Soc. Am.*, Aug., 1931, Vol. 21, pp. 485–496.)

See also 1931 Abstracts, p. 562.

SUPPLY AND COST OF 16-MM. FILM FOR THE HOME [FOR SOUND-PICTURE EQUIPMENT].—F. S. Irby. (*Electronics*, August, 1931, pp. 48–50.)

ACOUSTIC POWER LEVELS IN SOUND PICTURE REPRODUCTION.—S. K. Wolf and W. J. Sette. (Summary in *Science Abstracts*, *Sec. B.*, Aug., 1931, Vol. 34, p. 468.)

REPRODUCTION DE LUXE: INAUGURATION OF NEW BRANCH OF THE GRAMOPHONE COMPANY, LIMITED.—(*Electrician*, 11th Sept., 1931, Vol. 107, p. 348.)

ÜBER ELEKTRISCHE SCHALLPLATTENAUFNAHME UND -WIEDERGABE (Electrical Gramophone Recording and Reproduction).—A. Forstmann. (*E.T.Z.*, 20th and 27th August and 10th Sept., 1931, Vol. 52, pp. 1080–1083, 1114–1117, and 1169–1171.)

GRAPHISCHE BESTIMMUNG DER MAXIMALEN LEISTUNGSABGABE VON EIN- UND MEHRGITTERRÖHREN BEI GEGEBENER ANODENBATTERIESPANNUNG UND BEI VOLLER AUSSTEUERUNG DER IM NEGATIVEN LIEGENDEN ARBEITSKENNLINIE (Graphical Determination of the Maximum Output of Single- and Multiple-Grid Valves for a Given Anode Potential and Full Modulation of the Working Characteristic in the Negative Region).—J. Kammerloher. (*E.N.T.*, Sept., 1931, Vol. 8, pp. 371–379.)

Experimental results often yield an output only 50% of that calculated according to various theoretical procedures, owing chiefly to the assumed linearity of the characteristic and the neglect of the bottom bend. The writer shows how to find the true value from the static characteristics, describing the construction of these and the determination of the degree of amplification and the anode efficiency (anode a.c. output/anode power loss), both for triodes and pentodes. His results are excellently confirmed by oscillograph tests on two valves. He ends by pointing out the difference between the maximum output as thus determined and the maximum *undistorted* output : for a triode the ratio of the latter to the former is about 0.7 to 0.8, for a pentode about 0.6 to 0.7.

THE PROBLEM OF PENTODE OUTPUT FIDELITY.—L. Tulauskas. (*Electronics*, Oct., 1931, pp. 142–143.)

The correcting network, arrived at by the methods described, gives a fidelity characteristic for the loud speaker-pentode combination which has a maximum variation in output power of only 1 db. The "European" method of flattening the impedance curve of the speech coil by shunting with a resistance 2 or 3 times that of the speech coil is dismissed as inefficient.

HIGH AUDIO POWER FROM RELATIVELY SMALL TUBES : DISCUSSION.—R. A. Heising : Barton. (*Proc. Inst. Rad. Eng.*, Oct., 1931, Vol. 19, pp. 1884–1885.)

A comment on the paper dealt with in 1931 Abstracts, p. 560. "This circuit instantly commends itself to those interested in audio-frequency power at high power levels. The operation of loud speakers will probably occur to us as its widest field of application, but a very important field also exists in connexion with radio transmitters. It is the latter application that I wish to discuss." The use of the circuit for the modulator in transmitters employing plate-circuit modulation of the power valves increases the modulator efficiency and raises the plate-circuit efficiency to a value double that of the next best system. Moreover, the second harmonic is largely reduced, and the odd harmonics are made so much below the normal value of the second harmonic that much improved quality is secured from valves delivering large amounts of speech-frequency energy.

AN IMPROVED AUDIO-FREQUENCY GENERATOR.—E. G. Lapham. (*Bur. of Stds. Journ. of Res.*, Oct., 1931, Vol. 7, No. 4, pp. 691–695.)

A compact unit using the beat note between a piezo-oscillator (*see* under "Measurements and Standards") and a variable (modified Hartley circuit) oscillator. Output is continuously variable between 50 and 1 500 c.p.s., and the frequency is constant to better than 0.1 c.p.s. over the whole range.

EIN FERNSPRECH-ARBEITSEICHKREIS (A Working Calibration Standard for Telephones [the Setem]).—C. A. Hartmann and E. Döring. (*E.N.T.*, Oct., 1931, Vol. 8, pp. 444–448.)

LA NETTETÉ DANS LES COMMUNICATIONS TÉLÉPHONIQUES (Articulation in Telephonic Communications).—P. Chavasse. (*Rev. Gén. de l'Élec.*, 31st Oct., 1931, Vol. 30, pp. 709–721.)

VOICE TRAINING ON A SCIENTIFIC BASIS.—D. Stanley. (*Elec. Engineering*, Sept. 1931, Vol. 50, pp. 752–753.)

THE DOLLAR COST OF TONE QUALITY.—W. R. McCanne. (*Electronics*, Sept., 1931, pp. 97-98.)

"Nine points of radio receiver design in which increased outlay by the manufacturer makes for greater fidelity of reproduction for the listener."

THE BOTTLE-PIPE RESONATOR.—A. E. Bate. (*Nature*, 15th Aug., 1931, Vol. 128, p. 270.)

A preliminary account of experiments on the relation between the total length of a bottle-pipe resonator and the length of the bottle section when resonating to a frequency of 260 c.p.s.

SONIC SOUNDING BY THE FESSENDEN SYSTEM "FATHOMETER."—(*Rev. Gén. de l'Élec.*, 17th Oct., 1931, Vol. 30, pp. 649-650.)

ELECTRICAL INSTRUMENT GIVES PIANO AND ORGAN EFFECTS.—B. F. Miessner. (*Sci. News Letter*, 26th September, 1931, Vol. 20, p. 200.)

The notes are produced by striking on strings as in a piano, but instead of using a sounding board, the sounds are put "through an electrical translating, amplifying and reproducing apparatus."

PHOTOTELEGRAPHY AND TELEVISION.

LA TRANSMISSION DES IMAGES ET FAC-SIMILÉS (The Transmission of Pictures and Facsimiles).—I. T. and T. Laboratories. (*Génie Civil*, 7th November, 1931, Vol. 99, pp. 469–473.)

An account of the high-speed system dealt with in 1931 Abstracts, p. 332, and already used on the Dover-Calais ultra-short-wave beam.

HELLIGKEITSSTEUERUNG UND LINIENSTEUERUNG (Television depending on Brightness Modulation and on Scanning Speed Modulation).—R. Thun. (*Fernsehen*, No. 3, Vol. 2, 1931, pp. 161–167.)

A paper on the writer's method, outlined in 1931 Abstracts, pp. 273–274, of varying the time during which the beam (of constant intensity) stays at each spot. The advantages, and disadvantages, as compared with the usual brightness modulation, are discussed.

TELEVISION TURNS TO PROJECTION.—A. Dinsdale. (*Rad. Engineering*, Sept., 1931, Vol. 11, pp. 19–20.)

Deals briefly with projection methods of Baird, Alexanderson, and Sanabria.

TELEVISION RECEPTION WITH THE SUPERHETERODYNE.—R. W. Tanner. (*Rad. Engineering*, Oct., 1931, Vol. 11, pp. 23–25.)

The special design necessary is discussed. An intermediate frequency between 400 and 500 kc. is suitable : "harmonic interference cannot be bothersome and image frequency interference is reduced to a point where it can cause no trouble whatsoever." With more than three tuned stages it is difficult to pass the required 80 kc. band without sideband clipping. Even with two or three stages, loose coupling in the i.f. transformers must be avoided. "The screen-grid tube, contrary to general opinion, is not the best tube for a television audio-amplifier." A complete wiring layout using variable-mu valves is given.

FERNSEHEMPFANG AUF KURZWELLE (Television on Short [70-Metre] Waves).—W. Federmann. (*Fernsehen*, No. 3, Vol. 2, 1931, pp. 179–182.)

A paper on the Nauen-Geltow tests on 0.25 kw. A horizontal dipole and a sloping aerial at the transmitter both gave rise to serious distortions due to the space wave; these were greatly diminished by the use of a vertical dipole, but complete success was only obtained when a quarter-wave vertical dipole, with a corresponding reflector, was employed at the receiving end.

TELEVISION AT THE 1931 BERLIN RADIO EXHIBITION.—G. Kette. (*Fernsehen*, No. 4, Vol. 2, 1931, pp. 225–240.)

RECENT DEVELOPMENTS IN TELEVISION.—H. J. Barton Chapple. (*Television*, Nov., 1931, Vol. 4, pp. 334–337 and 362–365.)

TELEVISION NOW ON SCHEDULE.—D. E. Replogle: Jenkins Corporation. (*Scient. American*, July, 1931, Vol. 87, p. 33.)

A short article on the sound-and-television programmes now sent out by the General Broadcasting System in conjunction with the Jenkins Television Corporation, from WGBS and the 5kw. television transmitter W2XCR. The scanner is provided with three lenses of different focal lengths, so that the beam may be focused for a close-up, half length, or long shot without changing the relative positions of subject or scanner. For editorial comment, *see* p. 13.

EINZELHEITEN AMERIKANISCHER KATHODENSTRAHL-FERNSEHSYSTEME (Particulars of American Cathode-Ray Television Systems [Zworykin "Kinescope" and Farnsworth "Oscillite" Systems]).—H. Hewel: Zworykin, Farnsworth. (*Fernsehen*, No. 2, Vol. 2, 1931, pp. 123–128.)

AN EARLY [1902] TELEVISION AND PICTURE TRANSMISSION PROPOSAL.—J. L. McQuarrie and W. W. Cook. (*Elec. Communication*, July, 1931, Vol. 10, No. 1, pp. 34–35.)

The scanning and re-composing was on a spiral principle using two discs, one with a radial slot and the other with a spiral slot extending from centre to periphery: when these discs were rotated, one behind the other, at suitable speeds the effect of a spirally revolving pin-hole was produced, covering the whole area in about one-sixth of a second. A semi-opaque prism combined with a vibrating mirror was used at the receiver.

A SCANNING SUGGESTION [SUPERIMPOSING AN OPPOSITELY CURVED SCANNED AREA, BY TWO PARTIAL SPIRALS ON SAME DISC, PUT INTO ACTION ALTERNATELY].—G. E. Land. (*Television*, Nov., 1931, Vol. 4, pp. 366–367.)

NUMBER OF ELEMENTS, IMAGE DIMENSIONS AND BRIGHTNESS WITH THE MIRROR HELIX.—F. von Okolicsanyi. (*Fernsehen*, No. 4, Vol. 2, 1931, pp. 240–244.)

TECHNICAL PROBLEMS IN CONNECTION WITH TELEVISION.—C. O. Browne. (*Journ. I.E.E.*, Oct., 1931, Vol. 69, pp. 1232–1234: Discussion, pp. 1234–1238.)

THE CATHODE-RAY TELEVISION APPARATUS OF THE GERMAN POST OFFICE.—E. Hudec and E. Perchermeier. (*Fernsehen*, No. 4, Vol. 2, 1931, pp. 244–251.)

THE LIMITS OF PERFORMANCE IN CATHODE-RAY TELEVISION.—H. Peters. (*Fernsehen*, No. 4, Vol. 2, 1931, pp. 261–267.)

An investigation of the limitations imposed by the lack of homogeneity in the velocity of the electrons. They can be partly removed by the use of an equi-potential cathode, but still more by the use of high vacua in place of the plan of introducing gas to concentrate the ray, and by keeping down the velocity disturbance due to the modulation of the intensity of the ray.

ÜBER SYMMETRISCHE KIPPSCHWINGUNGEN UND IHRE SYNCHRONISIERUNG (Symmetrical Relaxation Oscillations and Their Synchronisation).—H. E. Hollmann: Frühauf. (*E.N.T.*, Oct., 1931, Vol. 8, pp. 449–457.)

An exhaustive investigation, both theoretical and experimental, of the symmetrical two-triode circuit suggested by Frühauf and illustrated in 1929 Abstracts, p. 280. In the present paper the date of the *Archiv f. Elektrot.* containing Frühauf's note is given as 1927 in mistake for 1929.

UNSUCCESSFUL TEST OF TELEVISION BETWEEN NEW YORK AND BERLIN.—(*Rad., B., F. f., Alle*, Sept., 1931, p. 416.)

Simultaneous sound and television (Alexanderson) transmissions on two short wavelengths were sent out from New York, but only the sound transmission could be received in Berlin. The tests were arranged by Schaeffer, of the German State Broadcasting Company.

KINOSENDE- UND EMPFANGSANLAGE FÜR HÖHERE BILDPUNKTZAHLEN (Telecinema Transmitters and Receivers for a Large Number of Picture Elements).—G. Schubert. (*Fernsehen*, No. 3, Vol. 2, 1931, pp. 182–187.)

Using mechanical methods, 10 800 elements with a framing frequency of 25 per sec. have been successfully transmitted and received, using discs of diameter about 46 cm. The amplifier had a uniform amplification between 25 and 135 000 c.p.s.

BILDPUNKTZAHL UND BILDPUNKTFREQUENZ (Number of Elements and Element Frequency [and the Use of Screens with Persistence of Glow]).—G. G. Reissaus. (*Fernsehen*, No. 3, Vol. 2, 1931, pp. 187–189.)

The product number of elements × framing frequency, namely the element frequency, cannot well exceed a certain limit; freedom from flicker, if obtained by increasing the framing frequency, must therefore involve a decrease in the number of elements. But with a persistent screen the framing frequency can be decreased, with a corresponding increase in the number of elements; moreover, as Perchermeier suggests, only (say) alternate lines need be scanned each time (provided the subject does not move too quickly), thus making a further increase possible.

MEASUREMENT OF FIDELITY IN TELEVISION SYSTEMS.—A. F. Murray. (*Electronics*, Oct., 1931, pp. 137–138.)

From the R.C.A. Victor laboratories. Application of the oculists' chart and varying shade chart to the purposes of television.

ESSAIS DE CELLULES PHOTO-ÉLECTRIQUES EN FONCTION DE LA FRÉQUENCE D'ILLUMINATION (Experiments on the Behaviour of [Gas-filled] Photoelectric Cells with Varying Frequency of Illumination).—P. Fourmarier. (*Comptes Rendus*, 21st Sept., 1931, Vol. 193, pp. 459–461.)

An Osram gas-filled cell was subjected to a steady illumination on which was superposed a practically sinusoidal component of equal amplitude, ranging in frequency up to 11 000 c.p.s. The steady and the alternating photoelectric currents were measured each by its appropriate apparatus. The former current was independent of the frequency. In the case of high potentials where the ionisation by collision reached an important value, the alternating component diminished rapidly up to 5000 c.p.s. (45% from 0 to 5000 c.p.s. for a potential of 108 volts), showed a distinct horizontal step between 5000 and 6000 c.p.s., and then again diminished. For low potentials, at which ionisation by collision was small, the alternating component decreased only slightly—less than 10% between 0 and 5000 c.p.s. for a potential of 54 volts. The curves showing this component as a function of the frequency, for various potentials, appear to tend towards a common curve at high frequencies: this would be the horizontal obtained at a potential where ionisation by collision is practically nil. The results are explained by the fact that while ionisation by collision is not an instantaneous but a cumulative process, the emission of the primary electrons may be considered as instantaneous. At low potentials the photoelectric current is formed almost entirely of the latter and faithfully follows the variations of illumination, while at high potentials the ionisation by collision is not rapid enough to follow these variations instantaneously.

LIGHT SENSITIVE CELL FOR DIRECT RELAY OPERATION [WESTON PHOTRONIC CELL GIVING 5 MA. IN DIRECT SUNLIGHT].—(*Electronics*, Oct., 1931, p. 165.)

THE SENSITIVITY OF COPPER OXIDE PHOTOELECTRIC CELLS WITH COPPER GRIDS: COMPARISON WITH THE OPTICAL ABSORPTION AND PHOTO-CONDUCTIVITY OF COPPER OXIDE.—L. Dubar: Auger and Lapicque. (*Comptes Rendus*, 19th Oct., 1931, Vol. 193, pp. 659–661.)

Researches suggested by the paper by Auger and Lapicque dealt with in 1931 Abstracts, p. 621.

THE PHOTOELECTRIC EFFECT IN THIN METALLIC FILMS [THEORETICAL INVESTIGATION].—W. G. Penney. (*Proc. Roy. Soc.*, Oct., 1931, Vol. 133, No. A 822, pp. 407–417.)

SUR LE RÔLE DE L'EAU DANS LES PILES PHOTOVOLTAÏQUES (The Part Played by Water in Photovoltaic Cells).—R. Audubert. (*Comptes Rendus*, 20th July, 1931, Vol. 193, pp. 165–166.)

Experiments are described which confirm the writer's hypothesis that the photovoltaic action in these cells is due to the action of hydrogen or oxygen arising from a photolysis of the water present, and therefore that the presence of water is essential.

SUR LE RÔLE DES PHÉNOMÈNES DE PHOTOCONDUCTANCE DANS L'EFFET PHOTOVOLTAÏQUE (The Rôle of Photoconductance Phenomena in the Photovoltaic Effect).—R. Audubert and J. Roulleau. (*Comptes Rendus*, 3rd August, 1931, Vol. 193, pp. 291–292.)

Certain substances giving photovoltaic effects show in the solid state a decrease of resistance under the influence of light, and some workers have attributed to this property an essential rôle in the production of photo-potentials. The writers' researches lead them to the conclusion that such is not the case; if the photoconductance comes in at all (and this can only be supposed to occur for certain of the photo-sensitive substances) it must be considered as a secondary phenomenon.

ÜBER DEN RÜCKGANGSEFFEKT IN ALKALIZELLEN (On the Retrogression Effect in Alkali Cells).—A. E. H. Meyer. (*Ann. der Physik*, 1931, Series 5, Vol. 9, No. 7, pp. 787–825.)

Author's summary:—The photoelectric retrogression effect established by Marx is exhaustively investigated as regards the conditions in which it originates and is observed. The effect is that the boundary potential is lowered when the surface is also irradiated with another, longer wavelength. The retrogression of the boundary potential is investigated quantitatively for potassium, sodium, rubidium and caesium cathodes, and the laws formerly found are shown to be generally true. The constants determined from the measurements are compared with the theoretical results obtained by Marx and the author (1931 Abstracts, p. 274). The theory gives quantitative information concerning the phenomena observed and the interpretation of the constants involved. These are found to be dependent on the dimensions of the apparatus, series number of the metal, and overcompensation.

THE APPLICABILITY OF PHOTOELECTRIC CELLS TO COLORIMETRY.—H. E. Ives and E. F. Kingsbury. (*Journ. Opt. Soc. Am.*, Sept., 1931, Vol. 21, pp. 541–563.)

Including a large number of curves, among which may be mentioned those showing the effect of different series resistances on the response of a caesium oxide cell, the variation in spectral sensitivity produced by simultaneous irradiation with infra-red light (potassium cell treated with bromine), and the sensitivity throughout an equi-energy spectrum of caesium thin film, caesium thin film on magnesium plus sulphur vapour, and sodium treated with krypto-cyanine.

Über die Thermokräfte von mit Wasserstoff beladenem Palladium, Eisen und Palladium-Silberlegierungen (On the Thermo-Electric Forces of Palladium, Iron and Palladium-Silver Alloys with Adsorbed Hydrogen).—R. Nübel. (*Ann. der Physik*, 1931, Series 5, Vol. 9, No. 7, pp. 826–838.)

Among the author's results may be noted a parallelism between thermo-electric force and photoelectric sensitivity.

Selektiver Photoeffekt und Lichtabsorption (The Selective Photoelectric Effect and Absorption of Light).—R. Fleischmann. (*Naturwiss.*, 2nd Oct., 1931, Vol. 19, No. 40, p. 826.)

A letter giving preliminary notice of the results of experiments on the photoelectric effect, which show that thin adsorption layers of atoms of the alkali metals (1) absorb light dichroitically, (2) give a selective optical absorption band *only* when the electric vector of the incident light has a component parallel to the plane of incidence, and (3) give such an optical absorption band in that region of the spectrum in which the selective surface effect of the metal concerned is observed. Thin layers of potassium on glass and quartz foundations were used in the experiments.

Über den äusseren lichtelektrischen Effekt an Phosphoren und seine Abhängigkeit vom Erregungszustand (On the External Photoelectric Effect with Phosphorescent Materials [Alkaline Earth Sulphides] and its Mode of Dependence on the Excitation Condition).—H. Göthel. (*Ann. der Physik*, 1931, Series 5, Vol. 9, No. 7, pp. 865–886.)

Der Spiegeloszillograph in der Fernsehtechnik (The Mirror Oscillograph in Television).—K. O. Kiepenheuer. (*Fernsehen*, No. 3, Vol. 2, 1931, pp. 192–198.)

The Construction and Operation of Capillary Mercury Arcs [free from Decrease of Intensity and Deterioration of Quartz].—R. H. Crist. (*Journ. Opt. Soc. Am.*, Oct., 1931, Vol. 21, pp. 690–697.)

Neon Tube with Metallic Coating on Wall as Positive Electrode.—(*Electronics*, Oct., 1931, p. 165.)

The negative electrode is a plate 1 inch square: the metallic coating covers the entire wall except for a small window. The arrangement is said to prevent the slowing up of the tube in action and to require less output power from the amplifiers.

Die Kerrkonstante des Nitrobenzols (The Kerr Constant of Nitrobenzol).—R. Möller. (*Physik. Zeitschr.*, 15th Sept., 1931, Vol. 32, No. 18, pp. 697–718.)

Beiträge zur Physik der Nitrobenzolkerrzelle I. Untersuchung der Verteilung starker elektrostatischer Felder in der Nitrobenzolkerrzelle (Contributions to the Physics of the Nitrobenzol Kerr Cell. I. Investigation into the Distribution of Strong Electrostatic Fields in the Nitrobenzol Kerr Cell).—F. Hehlgans. (*Physik. Zeitschr.*, 15th Sept., 1931, Vol. 32, No. 18, pp. 718–727.)

The Behaviour of Absorbed Air in the Breakdown of Liquid Dielectrics.—F. Koppelmann. (*E.T.Z.*, 12th November, 1931, Vol. 52, pp. 1413–1416.)

Automatic Mean Amplitude Control in L.F. Amplifiers.—G. Krawinkel and E. Perchermeier. (*Fernsehen*, No. 3, Vol. 2, 1931, pp. 167–173.)

Application of the principle of automatic amplification control, as used in r.f. circuits for counteracting fading, to l.f. amplification control in acoustic transmission or television.

The Input Circuit of Photoelectric Current Amplifiers.—H. Lux. (*Fernsehen*, No. 4, Vol. 2, 1931, pp. 253–260.)

From the Telefunken laboratories.

Papers on the Resistance-Coupled Amplifier and its Behaviour to Transients.—Schlesinger. (*See* two abstracts under "Properties of Circuits.")

Simplicity Extends Light-Control Possibilities [Burgess Radiovisor Bridge].—(*Rad. Engineering*, Sept., 1931, Vol. 11, pp. 21–22.)

"It has remained for the British scientists to develop an entirely new form of selenium cell . . . that handles several times as much current as the usual photoelectric cell . . . does not fatigue in continuous use, and does not deteriorate even after long service." The association is discussed of the Radiovisor bridge with the electrical hair trigger relay mentioned in 1931 Abstracts, p. 628, as a secondary (power) relay.

Papers on Photoelectric Technique in Various Applications.—(*See* abstracts under "Miscellaneous.")

MEASUREMENTS AND STANDARDS.

Two Precision Condenser Bridges.—A. Campbell. (*Proc. Physical Soc.*, 1st Sept., 1931, Vol. 43, Part 5, pp. 564–568.)

From the author's summary:—In Heydweiller's modification of the Carey Foster bridge as ordinarily used (with variable mutual inductance) the capacitance of the condenser can be read directly, but the power factor has to be deduced by calculation. To facilitate direct reading of both capacitance and power factor, the author has developed two bridge systems based on that of Carey Foster. In both of these a fixed mutual inductance is used and there is no added resistance in the condenser arm. . . . When a simple amplifier is used in the detector circuit, a capacitance range of 100 $\mu\mu$F. up to 10 μF. can be obtained and a power factor range from 0.0001 to 0.01 with high accuracy of reading.

A METHOD OF MEASURING THE LEAKAGE RESISTANCE OF A CONDENSER—NEON TUBE CIRCUIT.—Decaux and Le Corbeiller. (*See* abstract under "Properties of Circuits.")

MEASUREMENT OF SMALL CAPACITIES [SUBSTITUTION EQUIPMENT FOR D.C. MAINS OPERATION].—V. V. Sathe and T. S. Rangachari. (*Wireless Engineer*, October, 1931, Vol. 8, pp. 543–547.)

For capacities from 0.002 μF. down to minute values such as the inter-electrode capacities of valves. A vernier arrangement which gives a small definite change of capacity is described which in conjunction with Franklin's artifice for detecting the resonance condition gives an accuracy of about 0.15 $\mu\mu$F. This artifice makes use of the steep slope of the resonance curve instead of its maximum, and involves the tapping into the circuit of a small condenser (of the order of 15 $\mu\mu$F.) which throws the tuning on to the symmetrical point on the other limb of the curve.

THE MEASUREMENT OF CAPACITIES BY MEANS OF VALVES AND A SECONDS CLOCK.—L. Sesta. (*Nuovo Cimento*, March, 1931, Vol. 8, pp. 114–119.)

A STANDARD OF SMALL CAPACITY DIFFERENCES.—A. C. Bartlett. (*Journ. Scient. Instr.*, No. 8, Vol. 8, 1931, pp. 260–262.)

Designed for the measurement of triode inter-electrode capacities. In an earthed metal case, a plunger connected to the case moves axially along a quartz-insulated metal cylinder. The capacity starts at about 50 $\mu\mu$F. and rises by scale divisions of $\frac{1}{100}$ $\mu\mu$F. to about 65 $\mu\mu$F.

A CAPACITIVE POTENTIAL DIVIDER FOR HIGH FREQUENCY MEASUREMENTS.—K. Schlesinger. (*Wireless Engineer*, Oct., 1931, Vol. 8, pp. 532–538.)

The full article foreshadowed in 1931 Abstracts, p. 447.

A SIMPLE METHOD FOR MEASUREMENTS OF RESIDUAL INDUCTANCE ON POTENTIOMETERS AND FOUR-TERMINAL RESISTANCE COILS.—N. F. Astbury. (*Journ. Scient. Instr.*, No. 7, Vol. 8, 1931, pp. 221–223.)

FREQUENCY MEASUREMENT IN THE BRITISH POST OFFICE.—F. E. Nancarrow. (*P.O. Elec. Eng. Journ.*, July, 1931, Vol. 24, pp. 155–159.)

(i) The standard fork and its temperature control—"it can be safely assumed that the change in frequency of the fork on account of temperature is never greater than 5 parts in 10^8." The temperature of the inner oven is adjusted to give a fork frequency of 1000.000 c.p.s. (ii) Pressure and load effects—the fork is not at present sealed against the effect of pressure changes (the extent of such effects is under investigation) but it is maintained under conditions whereby frequent comparisons with unit time are made and hence any change due to pressure is accounted for. An intermediate circuit between fork and multivibrator minimises any possible effect on the frequency of the driving circuit due to the reaction of the load. (iii) Determination of absolute frequency of fork—by phonic wheel driving a cam and thus registering on double-coil syphon recorder which also records time signals. Total maximum error in this method of comparison is of the order of 0.58 parts in 10^6. (iv) Application to measurement of in-coming low and medium radio-frequencies: of medium high and high radio-frequencies. "It is considered that the maximum error in making frequency measurements on the medium high and high frequency ranges should not exceed $\pm$ 3 parts in 10^6."

FIELD-STRENGTH MEASUREMENTS ON ULTRA-SHORT WAVES.—Sohnemann. (*See* under "Propagation of Waves.")

ÜBER DIE SERIENGESETZE DER ELASTISCHEN EIGENFREQUENZEN VON QUARZSTÄBEN. I. TEIL: DEHNUNGSSCHWINGUNGEN (On the Series Law of the Free Elastic Vibration Frequencies of Quartz Rods. Part I: Elongation Oscillations).—E. Giebe and A. Scheibe. (*Ann. der Physik*, 1931, Series 5, Vol. 9, No. 1, pp. 93–136, and No. 2, pp. 137–175.)

An exhaustive practical investigation of the frequencies of free elongation oscillations of quartz rods; they are shown to be frequently disturbed by coupling with other possible modes of oscillation of the rods. Practical hints on the choice of quartz rods for frequency standards are given; the orientation of the axes most unfavourable for the attainment of very high frequencies is that in which the rod axis is perpendicular to the electrical and to the optical axis and the longer side of the rectangular cross-section is parallel to the optical axis. Formulae are given for the calculation of the length of quartz rod necessary to produce a given high frequency.

QUARTZ OSCILLATOR WAVE CONSTANTS.—E. G. Watts. (*Rad. Engineering*, Sept., 1931, Vol. 11, pp. 23–26.)

"An attempt is made here to co-ordinate the results of the prominent investigators in the field, presenting in summarised form the data on the constants of longitudinal and transversely vibrating modes, in so far as it is accurately known." The most recent reference is the "Conference on Piezo-Electricity," *Proc.I.R.E.*, Dec., 1930.

SUR L'ORIGINE DE LA TROISIÈME FRÉQUENCE FONDAMENTALE DES QUARTZ PIÉZO-ÉLECTRIQUES OSCILLANTS (The Origin of the Third Fundamental Frequency of Piezo-electric Quartz Oscillators).—E. P. Tawil. (*Comptes Rendus*, 26th October, 1931, Vol. 193, pp. 725–726.)

According to the laws of Curie, there should be no vibrations in the direction of the optical axis. The writer has shown that such vibrations can be obtained (1929 Abstracts, pp. 581–582) though the third frequency thus arising differs by some 25 % from the Newton's formula followed by the other two frequencies. In the present paper he attributes the production of these vibrations to the inverse action of a phenomenon recently found by him—the disengagement of electricity by the *flexion* of a quartz cylinder cut with its generatrix parallel to the optical axis (1931 Abstracts, pp. 219–220.)

QUARTZ PLATE MOUNTINGS AND TEMPERATURE CONTROL FOR PIEZO OSCILLATORS.—V. E. Heaton and E. G. Lapham. (*Bur. of Stds. Journ of Res.*, Oct., 1931, Vol. 7, No. 4, pp. 683–690.)

Authors' abstract :—" In this paper are described a number of representative types of mountings for rectangular and circular quartz plates to be used as frequency standards. Unless the movement of the quartz plate in the holder is restricted, the frequency will change with each slight jar. A satisfactory holder for mounting a long rectangular quartz plate to oscillate in its extensional mode may be made by clamping the plate centrally perpendicular to its length between two keys, one on the face of each electrode. The electrodes are spaced by quartz washers. A plate mounted in such a holder will be constant in frequency to 1 part in 300 000. Such a mounting has not been found satisfactory for frequencies above 100 kc. as the damping caused by the pressure of the keys is too great.

" A very satisfactory holder for mounting a cylindrical quartz plate for ' thickness oscillation ' may be made by clamping the plate between three screws, mounted radially 120° apart in a ring so that they press into a V-shaped groove cut around the cylindrical surface of the quartz plate midway between the faces [*cf.* and contrast Florisson, 1930 Abstracts, p. 462–463]. The electrodes are spaced on either side of the quartz plate by pyrex washers. Mounted in such a way, the plate has been found to be constant in frequency to 1 part in 1 000 000 in a portable frequency standard with the addition of temperature control of the oscillating circuit. Some discussion is given to the subject of temperature control of the piezo oscillator." A note on this paper is given in *Journ. Franklin. Inst.*, November, 1931, Vol. 212, pp. 633–635.

MICROGRAPHY OF PIEZOELECTRIC QUARTZ.—P. T. Kao. (*Rev. d'Optique*, April, 1931, Vol. 10, pp. 153–161.)

A paper on the writer's hydrofluoric acid etching procedure (1930 Abstracts, p. 641) which gives accurate determination of the axes and detection of electric " twins " by a microscopic examination of the figures thus obtained.

AN INTERPRETATION OF THE EFFECT OF PIEZOELECTRIC OSCILLATIONS ON THE INTENSITY OF X-RAY REFLECTIONS FROM QUARTZ.—B. E. Warren. (*Phys. Review*, 1st Aug., 1931, Series 2, Vol. 38, No. 3, p. 572.) *and* X-RAY REFLECTIONS FROM OSCILLATING CRYSTALS.—R. M. Langer. (*Ibid.*, pp. 573–574.)

These two letters contain suggestions for possible explanations of the phenomena reported by Fox and Carr (1931 Abstracts, p. 570.)

LONGITUDINAL VIBRATIONS OF THIN CIRCULAR QUARTZ PLATES.—I. Koga. (*Journ. I.E.E. Japan*, Feb., 1931, Vol. 51, pp. 16–17.)

PAPERS ON THE PRECISE MEASUREMENT OF TIME : SHORTT CLOCKS, LOOMIS CHRONOGRAPH, BELL TELEPHONE CRYSTAL OSCILLATOR.—Loomis : Brown and Brouwer. (Summaries in *Science Abstracts*, Aug., 1931, Vol. 34, pp. 645–646.)

EIN CHRONOGRAPH FÜR GENAUESTE ZEITREGISTRIERUNG (A Chronograph for the Very Accurate Recording of Time).—P. Lejay. (*E.T.Z.*, 10th Sept., 1931, Vol. 52, p. 1173.)

Description, with a specimen record, of the instrument outlined in a *Comptes Rendus* Note (1929 Abstracts, p. 398).

THEORY OF MAGNETOSTRICTION.—A. Perrier. (*Helvet. Phys. Acta, No.* 3/4, Vol. 4, 1931, pp. 213–237.)

MAGNETOSTRIKTION FERROMAGNETISCHER STOFFE (The Magnetostriction of Ferromagnetic Materials).—G. Dietsch. (*Zeitschr. f. tech. Phys.*, Aug., 1931, Vol. 12, pp. 380–389.)

An investigation by the well-known capacity-change-heterodyne method, in which the sensitivity was increased about 100 times by the use of shorter waves, smaller condenser gap, and longer bars. This allows the investigation to be extended to weaker fields than heretofore. The two transmitting circuits were stabilised against frequency changes due to voltage fluctuations by the introduction of a condenser–high resistance combination in each grid lead (Weihe, 1929 Abstracts, p. 161). The materials investigated included electrolytic nickel and iron, beryllium-nickel alloy and beryllium-permalloy, and stainless steel. The effects of previous heat treatment and extension beyond the elastic limit were examined.

ÜBER DEN QUEREFFEKT DER MAGNETOSTRIKTION (On the Transverse Effect of Magnetostriction).—A. Esau. (*Physik. Zeitschr.*, 15th June, 1931, Vol. 32, No. 12, pp. 483–485.)

MAGNETOSTRICTION AND HYSTERESIS.—W. N. Bond. (*Proc. Physical Soc.*, 1st Sept., 1931, Vol. 43, Part 5, pp. 569–571.)

Author's abstract :—The magnetostriction of unannealed wrought iron is measured, by means of an optical lever of length 0.12 mm., up to an intensity of magnetization of 985 e.m.u. The longitudinal extension and the intensity of magnetization are measured for a cycle of magnetization, both being found to show hysteresis. The extension is approximately proportional to the square of the intensity but seems to depend slightly on the previous magnetic history as well as on the intensity of magnetization. This hysteresis indicates that the extension is a consequence of the magnetization, in the same sense that the magnetization is a consequence of the applied field.

Improved Magnetostriction Oscillator.—(French Pat. 704222, Comp. Thomson-Houston, pub. 15th May, 1931.)

For a long summary, see *Rev. Gén. de. l'Élec.*, 26th September, 1931, Vol. 30, p. 109D.

[Portable] Vacuum Tube Voltmeter of High Sensitivity.—H. J. Reich, G. S. Marvin, and K. A. Stoll. (*Electronics*, Sept., 1931, pp. 109–111.)

For all values of d.c. voltage, to within 0.05 v.; a.c. voltages to within ½% above 20 v. peak, and to within 0.1 v. below 20 v. Fourteen types of valve (including two types of pentodes) were tested to find the one most suitable for such an instrument, and the Type 222 screen-grid valve was found to be the best, with the screen grid used as control element.

A Portable String Galvanometer for Use at Moderate Frequencies.—E. W. Marchant, J. K. Burkitt, and A. H. Langley. (*Journ. Scient. Instr.*, Nos. 7 and 8, Vol. 8, 1931, pp. 209–214 and 241–246.)

Hot-Wire Meter with Automatic Zero Error Compensation.—(French Pat. 706674, Étab. Brion, Leroux, Jeanno et Cie., pub. 27th June, 1931.)

Summary in *Rev. Gén. de l'Élec.*, 31st Oct., 1931, Vol. 30, p. 151D.

A Universal Meter for Laboratory and Workshop: the "Mavometer" with Its Auxiliary Attachments.—(*E.T.Z.*, 5th Nov., 1931, Vol. 52, p. 1390.)

SUBSIDIARY APPARATUS AND MATERIALS.

Grenzleistung des Kathodenoszillographen (The Limit of Performance of the Cathode-Ray Oscillograph).—W. Rogowski. (*E.T.Z.*, 1st Oct., 1931, Vol. 52, pp. 1245–1248.)

Author's summary:—The performance of the Aix-la-Chapelle oscillograph is limited not by the recording intensity of the ray but by the finite velocity of the electrons. The photographic intensity is strong enough for recording speeds far exceeding 63 000 km/sec. It is pointed out that more than two years ago records of one millionth of a second were obtained. Fluorescent intensities of 47 Hefner candles are announced. Technical means are given by which a satisfactory life, in spite of high intensity working, can be obtained with a sealed-off tube. Certain recent objections are refuted.

Die photographische Wirkung mittelschneller Kathodenstrahlen (The Photographic Effect of Moderately Rapid Cathode Rays).—A. Becker and E. Kipphan. (*Ann. der Physik*, 1931, Series 5, Vol. 10, No. 1, pp. 15–51.)

This paper contains an investigation of the photographic effect of cathode rays of velocity range 15–100 kilovolts on three different emulsions of silver bromide.

A Time Base for the Cathode-Ray Oscillography of Irregularly Recurring Phenomena.—G. I. Finch, R. W. Sutton and A. E. Tooke. (*Proc. Physical Soc.*, 1st Sept., 1931, Vol. 43, Part 5, pp. 502–511.)

Authors' abstract:—An account is given of a linear neon-lamp time base by means of which cathode-ray oscillograph traces due to recurring electrical or magnetic phenomena can be accurately superimposed, even though the train frequency be subject to wide and irregular variations. The underlying principle of this time base lies in the use of a glowing neon lamp which is extinguished by energy furnished either by the phenomenon under investigation or by some other phenomenon associated therewith.

Symmetrical Relaxation Oscillations [with a Two-Triode Circuit] and their Synchronisation.—Hollmann: Frühauf. (*See* under "Phototelegraphy and Television.")

The Series Circuit with Neon Lamp and Condenser, giving Train of Flashes.—Decaux and Le Corbeiller. (*See* under "Properties of Circuits.")

High Vacuum Pressure Control Apparatus [Galvanometer Contact controlling Mercury Valve through Valve Amplifier].—T. L. Ho. (*Proc. Nat. Acad. Sci.*, Sept., 1931, Vol. 17, pp. 548–549.)

Phase Measurements with the Cathode Ray Oscillograph.—L. A. Wood. (*Review Scient. Instr.*, Oct., 1931, Vol. 2, pp. 644–648.)

À Propos de l'Essai de Choc des Isolateurs (On the Surge Testing of Insulators).—J. Kopeliovitch. (*Bull. d. l'Assoc. suisse d. Élec.*, No. 19, Vol. 22, 1931, pp. 461–481.)

Impulsverlängerung (The Prolongation of Impulses).—W. Grube. (*Zeitschr. f. Fernmeldetech.*, No. 6, Vol. 12, 1931, pp. 81–89.)

A condenser whose negative plate is connected to the grid of a triode is charged from a battery through a contact momentarily closed by the arriving impulse. It then discharges through a resistance whose value determines the discharge time. So long as the potential remains above a certain value, the grid allows no anode current to pass, and during this time a contact controlled by the anode current remains closed. By a suitable choice of voltage, capacity, and resistance, the time transformation ratio can be made very large. The process is investigated quantitatively.

Siebschaltungen (Filter Circuits).—W. Cauer. (Review in *Rev. Gén. de l'Élec.*, 17th October, 1931, Vol. 30, p. 618.)

Review of a German book for the simple calculation of filters of various kinds.

Simplified Attenuation Network Design.—L. B. Hallman. (*Electronics*, Oct., 1931, pp. 150–151.)

A METHOD OF DETERMINING THE IMPEDANCE OF HOT CATHODE DISCHARGE TUBES.—W. F. Westendorp. (*Review Scient. Instr.*, August, 1931, Vol. 2, pp. 437-446.)

Author's abstract:—By means of a superposed alternating current the negative resistance of hot cathode neon and mercury direct current arcs was measured and found to follow closely the slope of the static characteristic of the neon arc and to be widely different in the case of the mercury arc. At the same time the reactance for the ripple current in the arc was determined. This reactance is explained on the basis of a time lag in the concentration of metastable atoms; from the phase shift the order of magnitude of the lifetime of the metastable atoms is computed, and the result is in agreement with calculations made by others.

AN ELECTRIC TIME MARKER FOR SELF-RECORDING INSTRUMENTS.—L. H. G. Dines. (*Journ. Scient. Instr.*, June, 1931, Vol. 8, pp. 199-200.)

A PRECISION THERMOSTAT FOR TEMPERATURES FROM 25°C. TO 500°C.—J. A. Beattie. (*Review Scient. Instr.*, Aug., 1931, Vol. 2, pp. 458-465.)

A SENSITIVE BIMETALLIC STRIP TEMPERATURE REGULATOR FOR THERMOSTATS. — L. Dubar. (Summary in *E.T.Z.*, 30th July, 1931, Vol. 52, pp. 1006-1007.)

HIGH RESISTANCES MADE FROM METALLIC OXIDES. —E. R. Mann and D. R. Morey. (*Phys. Review*, 15th June, 1931, Series 2, Vol. 37, No. 12, p. 1692.)

Abstract only of a paper on a means of making high resistors (10^8 to 10^{12} ohms) of good quality by mixing metallic oxides in suitable binders of an insulating nature.

NOTE ON JULIUS [ANTI-VIBRATION] SUSPENSIONS. —M. J. Brevoort. (*Review Scient. Instr.*, Aug., 1931, Vol. 2, pp. 447-449.)

A NEW VIBRATION-FREE MOUNTING FOR MEASURING INSTRUMENTS. — R. Müller. (*Zeitschr. f. Instr: kde*, No. 2, Vol. 51, 1931, pp. 95-97: Summary in *Physik. Ber.*, 15th July, 1931, Vol. 12, p. 1556.)

WIRKUNGSWEISE, BAU UND VERWENDUNG VON ELEKTROLYTKONDENSATOREN (Principle, Construction, and Use [and Testing] of Electrolytic Condensers).—W. Hoesch. (*E.T.Z.*, No. 29, 1931, Vol. 52, pp. 928-932: Discussion, pp. 946-948.)

MEASURING THE POWER FACTOR OF ELECTROLYTIC CONDENSERS.—(*Rad. Engineering*, Aug., 1931, Vol. 11, pp. 28-29.)

TELEPHONE CONDENSERS [Foil and "Mansbridge" Types].—R. E. W. Maddison and S. Chapman. (*Elec. Communication*, July, 1931, Vol. 10, No. 1, pp. 39-44.)

BRITISH STANDARD SPECIFICATION FOR EBONITE FOR ELECTRICAL PURPOSES.—British Engineering Standards Association. (Standard Specification No. 234, 1931.)

INSULATING MATERIALS.—"Formapex" Miocarta: "Linapex." (*Electrician*, 21st Aug., 1931, Vol. 107, p. 260.)

SOME ELECTRICAL PROPERTIES OF FOREIGN AND DOMESTIC MICAS AND THE EFFECT OF ELEVATED TEMPERATURES ON MICAS.—A. B. Lewis, E. L. Hall, and F. R. Caldwell. (*Bur. of Stds. Journ. of Res.*, Aug., 1931, Vol. 7, No. 2, pp. 403-418.)

THE PERMITTIVITY AND POWER FACTOR OF MICAS: DISCUSSION.—Dannatt and Goodall. (*Journ. I.E.E.*, Aug., 1931, Vol. 69, pp. 1034-1035.)

Discussion on the paper dealt with in 1931 Abstracts, p. 338.

DIE KONSTANZ DER DIELEKTRIZITÄTSKONSTANTEN BEI EXTREM HOHEN FELDSTÄRKEN (The Constancy of the Dielectric Constant at Extremely High Field Strengths).—A. Güntherschulze and H. Betz. (*Zeitschr. f. Phys.*, 1931, Vol. 71, No. 1/2, pp. 106-123.)

SUR LA THÉORIE DE L'ACCUMULATEUR AU PLOMB (The Theory of the Lead Accumulator).—C. Liagre. (*Comptes Rendus*, 27th July, 1931. Vol. 193, pp. 236-238.)

Two experiments leading to the conclusion that the positive active material is identical chemically with PbO_2 prepared in the laboratory, and that both positive and negative elements sulphate and de-sulphate according to Faraday's law; thus the classical equation (PbO_2 + Pb + sulphuric acid solution in excess $\rightleftarrows$ 2 $PbSO_4$ + sulphuric acid solution) is the true expression of the facts.

À PROPOS DES ACTIONS LOCALES ET DE LA THÉORIE DE L'ACCUMULATEUR AU PLOMB (On Local Action and the Theory of the Lead Accumulator).—L. Jumau: Féry. (*Rev. Gén. de l'Élec.*, 5th Sept., 1931, Vol. 30, pp. 363-365.)

The writer argues against Féry's theory (1929 Abstracts, p. 642) and against the conclusions drawn from the tests of the new type of accumulator referred to in 1931 Abstracts, p. 453.

A STANDARD OF SMALL CAPACITY DIFFERENCES [VARIABLE CONDENSER FOR INTER-ELECTRODE CAPACITY MEASUREMENTS].—Bartlett. (*See* under "Measurements and Standards.")

STATIONS, DESIGN AND OPERATION.

PROPOSED ULTRA-SHORT-WAVE TELEPHONE SERVICES BETWEEN HAWAIIAN ISLANDS.— (*Engineer*, 16th Oct., 1931, Vol. 152, p. 409.)

Selective fading and strong atmospherics rendering short and medium waves unsatisfactory, it has been decided—after successful tests—to establish services on the 5 to 10 metre wavelengths.

Radiotelephone Service is Expanding [Survey including Some Details of the New Service California–Hawaii].—J. J. Pilliod. (*Elec. Engineering*, Sept., 1931, Vol. 50, pp. 748–752.)

Radio Interference.—(*Electrician*, 30th Oct., 1931, Vol. 107, p. 574.)

An editorial note giving the remedies favoured by the B.B.C.—" minimum spacing of 11 or 12 kc. between high powered stations, better geographical allocation of positions in the available medium wave band, and an extension of common wave working between distant stations." It is improbable, however, that the U.I.R. will make any important alterations before the Madrid Conference meets next year.

Papers on Ultra-Short-Wave Broadcasting.—Schröter: Sohnemann. (*See* under " Propagation of Waves.")

Broadcast Station Coverage [and its Estimation].—Westinghouse Company. (*Rad. Engineering*, Sept., 1931, Vol. 11, p. 36.)

Description of the method of calculating the actual audience of KDKA at Pittsburgh; the U.S. Census gives population, families, and families with receivers; a year's continuous research has established that 73% of all receivers are tuned in some time every day and that the daily average number of listeners to each set is 3.1.

GENERAL PHYSICAL ARTICLES.

Classical Electrodynamics and the Conservation of Energy.—W. F. G. Swann. (*Journ. Franklin Inst.*, Nov., 1931, Vol. 212, No. 5, pp. 563–576.)

The apparent difficulty concerning the conservation of energy as applied to the Lorentzian electron is shown to be purely a question of algebra and, if the significance of the equations is properly interpreted, no discrepancy exists.

Relationships between the Energy of Gamma Rays, emitted by an Atom following a Beta or Alpha Particle Emission, and the Fundamental Physical Constants.—A. Bramley. (*Proc. Nat. Acad. Sci.*, October, 1931, Vol. 17, pp. 579–583.)

The Photon considered as a Material Point and treated by Quantum Mechanics: the Existence of Photon Spin.—Al. Proca. (*Comptes Rendus*, 9th November, 1931, Vol. 193, pp. 832–834.)

On a Possible Explanation of the Difference in Wavelengths of the Spectral Lines of a Given Element produced on the Sun and on the Earth.—F. Sanford. (*Science*, 23rd Oct., 1931, Vol. 74, pp. 412–413.)

The Molecular Theory of Electro-Optical Phenomena.—R. de Mallemann. (*Comptes Rendus*, 5th & 19th Oct., 1931, Vol. 193, pp. 523–526 and 651–654.)

A New Relation between Electrical Resistance and Energy of Magnetisation.—W. Gerlach and E. Englert. (*Nature*, 25th July, 1931, Vol. 128, pp. 151–152.)

A letter communicating experimental results which " show definitely that true magnetisation diminishes the electrical resistance proportionately to the true magnetic energy."

On an Electromotive Force Between Two Metals in Relative Motion.—J. B. Seth, B. Gulati, and S. Singh. (*Phil. Mag.*, Aug., 1931, Series 7, Vol. 12, No. 77, pp. 409-429.)

Die elektromotorische Kraft an bewegten Elektroden und das elektrokinetische Potential der Metalle (The E.M.F. of an Electrode in Motion, and the Electrokinetic Potential of Metals).—S. Procopiu. (*Zeitschr. f. phys. Chem.*, A., No. 3/4, Vol 154, 1931, pp. 322-331.)

A New Electron Inertia Effect and the Determination of $\frac{m}{e}$ for the Free Electrons in Copper.—S. J. Barnett. (*Phil. Mag.*, Aug., 1931, Supp. No., Series 7, Vol. 12, No. 76, pp. 349-360.)

The effect investigated is as follows: "If the current in a circular or cylindrical coil of wire free to move about its axis is altered, the free electricity will be accelerated and the coil itself will be accelerated in the opposite direction, the changes of angular momenta being equal in magnitude and opposite in sign."

MISCELLANEOUS.

Communication with Quasi Optical Waves.—Karplus. (*See* under " Transmission.")

Olympia, 1931: Impressions of the Radio Show.—A.L.M.S. (*Wireless Engineer*, Nov., 1931, Vol. 8, pp. 585–594.)

The Trend of Progress [Olympia Show].—(*Wireless World*, 30th Sept., 1931, Vol. 29, pp. 381–396.)

Radio Apparatus for 1932 [Olympia Show].—P. K. Turner. (*Elec. Review*, 25th Sept., 1931, Vol. 109, pp. 463–464.)

From the Great German Radio and Phono Exhibition, Berlin, 1931.—W. Burstyn. (*E.T.Z.*, 5th Nov., 1931, Vol. 52, pp. 1373–1377.)

Faraday Centenary Celebrations, 1931.—(*Journ I.E.E.*, Nov., 1931, Vol. 69, No. 419, pp. 1329–1390.)

THE PRODUCTION OF X-RAYS BY THE PASSAGE OF CURRENT THROUGH MATERIALS OF HIGH RESISTANCE.—G. Reboul. (*Journ. de Phys. et le Rad.*, March, 1931, Series 7, Vol. 2, pp. 86–100.)

More on the subject of the "resistance cells" referred to in 1930 Abstracts, pp. 178 and 413.

A NEW METHOD OF ELECTROLYSIS.—A. Klemenc. (*Science*, 24th July, 1931, Vol. 74, p. 14.)

The negative electrode is suspended above the surface of the liquid and is separated from it by an air space; a stream of electrons is given off from the electrode into the air. The resulting electrical phenomena are quite different from those of ordinary electrolysis; reduction is carried on more easily, and oxidation proceeds much more intensely.

ÜBER EINE NEUE ELEKTRISCHE EINRICHTUNG ZUR MESSUNG KLEINER VERSCHIEBUNGEN (A New Electrical Ultra-Micrometer).—S. Reisch. (*Zeitschr. f. Hochf : tech.*, Sept, 1931, Vol. 38, pp. 101–111.)

After briefly discussing previous ultra-micrometer principles and devices (a bibliography of some 28 items being given at the end), the writer points out the desirability of a linear calibration and the difficulties introduced in obtaining it for such arrangements; he refers also to sources of error, such as those resulting from temperature variation. He then describes his own new arrangement, for which he claims practical freedom from these difficulties. It consists of a *three-plate differential condenser* in which the middle plate can be displaced relatively to the outer, fixed plates, in a direction perpendicular to the plates. The outer plates are supplied with a r.f. voltage, and the movement of the middle plate is measured by measuring the difference of voltages across the two components of the total (constant) capacity. This is accomplished by a direct-reading valve voltmeter consisting of two valves connected in a bridge circuit. The sensitivity claimed is about the same as that given by previous systems.

The complete apparatus is described in detail and a final section discusses a large number of applications, among which are the formation of a balance capable of measuring weights of the order of 5×10^{-9} gm., a measuring apparatus for heat radiation which can compete with bolometers and thermo-elements, a galvanometer, giving a reading in less than 1 second, in which each scale division represents about 10^{-10} volt, and such commercial applications as the control of the thickness of paper and wire during manufacture.

ELECTRONIC OSCILLATORS [ULTRA-MICROMETERS] FOR INDUSTRIAL PROCESS CONTROL.—H. Olken. (*Electronics*, Oct., 1931, pp. 144–145 and 172.)

Among the various applications here discussed is one not previously mentioned in these Abstracts: the use of an ultra-micrometer to show the expansion or contraction of a rayon ribbon held above a quickly moving sheet of newsprint, according to the moisture of the latter. Publishers demand a certain percentage of residual moisture, and moreover, it is costly to dry the paper more than is necessary.

DAS ABSORBOMIKROMETER (Ultra-Micrometer on the Absorbing Wave-Meter Principle [for Strain Tests in Ferro-Concrete, etc.]).—P. Santo Rini. (*E.T.Z.*, 27th Aug., 1931, Vol. 52, p. 1123.)

The capacity change in the test condenser is not made to affect a heterodyne note, as in the usual ultra-micrometer, but is observed by sweeping the rotating condenser of the absorbing circuit and watching the milliammeter in the grid circuit of the test oscillator which contains the test condenser.

AN APPARATUS FOR THE MEASUREMENT OF VERY SMALL DISPLACEMENTS [MEASURING MICROSCOPE AIDED BY QUARTZ POINTER AS LEVER, MEASURING DISPLACEMENTS OF ORDER OF 0.001 MM.].—H. Whitaker. (*Journ. Scient. Instr.*, No. 8, Vol. 8, 1931, pp. 251–258.)

100% EFFICIENT LIGHT PRODUCED IN LABORATORY.—M. Pirani. (*Sci. News Letter*, 6th June, 1931, Vol. 19, p. 357.)

A sodium vapour discharge tube giving heatless conversion of electricity into light energy. It is heated by a furnace on the outside, and is at present only of theoretical value.

ULTRA-VIOLET LIGHT AND HIGH-FREQUENCY CURRENT HARDEN STEEL.—J. J. Egan. (*Sci. News Letter*, 26th September, 1931, Vol. 20, p. 196.)

"Hardening of the small metal parts of typewriters, sewing machines, and the like may be speeded up by the use of high-frequency radio currents, ultra-violet light, and the electric spark." *Cf.* Mahoux, 1931 Abstracts, pp. 228 and 632.

L'AMPLIFICATION DE COURANTS PHOTOÉLECTRIQUES FAIBLES AU MOYEN DE LA LAMPE ÉLECTROMÈTRE PHILIPS (The Amplification of Small Photo-electric Currents by the Philips Electrometer Valve).—R. P. Lejay. (*L'Onde Élec.*, Aug., 1931, Vol. 10, pp. 363–368.)

A fuller account of the work dealt with in 1931 Abstracts, p. 286.

OBJECTIVE PHOTOMETRY BY THE USE OF PHOTOELECTRIC CELLS, AND THE AUTOMATIC TESTING AND SORTING OF INCANDESCENT LAMPS.—W. W. Loebe and C. Samson. (*E.T.Z.*, 2nd July, 1931, Vol. 52, pp. 861–866.)

THE SELENIUM CELL AS COLORIMETER.—A. Mickwitz. (*Zeitschr. f. anorg. Chem.*, No. 1, Vol. 196, 1931, pp. 113–119.)

ÜBER EIN NEUES PHOTOELEKTRISCHES RELAIS ZUR VERGRÖSSERUNG KLEINER BEWEGUNGEN (On a New Photoelectric Relay for Amplifying Small Movements).—L. Bergmann. (*Physik. Zeitschr.*, 1st Sept., 1931, Vol. 32, No. 17, pp. 688–690.)

A description of the application of the selenium attenuating-layer photoelectric cell already described by the author (1931 Abstracts, p. 445) to the observation and registration of small movements such as the motion of a galvanometer mirror, the point of a tuning fork, etc. *See* also next abstract.

ANWENDUNG DES PHOTOELEKTRISCHEN RELAIS IM ULTRAROT (Use of the Photoelectric Relay in the Infra-red).—F. Matossi: Bergmann. (*Physik. Zeitschr.*, 1st Sept., 1931, Vol. 32, No. 17, pp. 690–691.)

A description of the application of Bergmann's selenium attenuating-layer photoelectric cell (*see* foregoing abstract) to measurements in the infrared spectrum.

A PHOTOELECTRIC METHOD OF MEASURING THE SMOOTHNESS OF METAL PLATE.—E. Gerold. (Summary in *E.T.Z.*, 24th Sept., 1931, Vol. 52, pp. 1228–1229.)

PHOTO CELL CIRCUITS: PHOTO CELLS AND THEIR APPLICATIONS.—No. I. COUNTING AND TIMING DEVICES.—R. C. Walker. (*Wireless World*, 23rd September: 14th October, 1931, Vol. 29; pp. 320–322: pp. 444–446.)

PHOTOELECTRIC EQUIPMENT FOR SORTING CARDS INTO 100 COMPARTMENTS.—(*Scient. American* Nov., 1931, Vol. 87, p. 335.)

THE "ELECTRIC EYE" NOW ENTERS INDUSTRY [INCLUDING LIST OF COMMERCIAL APPLICATIONS OF PHOTO-SENSITIVE CELLS].—(*Electronics*, Oct., 1931, pp. 132–135.)

THE CONSTITUTION OF SOLUTIONS DEDUCED FROM ABSORPTION MEASUREMENTS: INFRA-RED ABSORPTION SPECTRA OF LIQUIDS DETERMINED BY THALOFIDE PHOTOELECTRIC CELL.—P. Vaillant: R. Freymann. (*Comptes Rendus*, 19th Oct., 1931, Vol. 193, pp. 654–656: 656–659.)

THE USE OF VALVES IN PHYSICO-CHEMICAL MEASUREMENTS, PART I.—W. Hiltner. (*Chem. Fabrik.*, 30th Sept., 1931, pp. 389–392.)

PIEZOELEKTRISCHE MESSUNG MECHANISCHER GRÖSSEN (The Piezoelectric Measurement of Mechanical Quantities [Vibration, Acceleration, etc.]).—J. Kluge and H. E. Linckh. (*Zeitschr. V.D.I.*, 1st August, 1931, Vol. 75, pp. 1001–1002.)

Further development of the work dealt with in 1930 Abstracts, p. 118.

INVESTIGATIONS, BY PIEZOELECTRICAL TECHNIQUE, INTO THE FATIGUE OF STEEL BARS.—D. Schenk. (*Verhd. d. Deut. Phys. Ges.*, No. 3, Vol. 11, Ser. 3, pp. 42–43.)

PIEZOELECTRIC DEVICE FOR MEASUREMENT OF ENGINE ACCELERATION.—Physik. Tech. Reichsanstalt. (*Zeitschr. f. Instr: kunde*, No. 5, Vol. 51, 1931, p. 239.)

THE MECASCOPE, FOR RECORDING VIBRATIONS OF MACHINES, ETC.—J. Vassillière-Arlhac. (*Bull. d.l. Soc. franç. d. Élec.*, Feb., 1931, Series 5, Vol. 1, pp. 148–153.)

Depending on the relative motion of the two parts of an electromagnetic system (*e.g.*, the moving-coil microphone). Has been used for aeroplane engines, etc.

AN ELECTROMAGNETIC VIBROGRAPH APPLIED TO THE OVER-SPEED TESTS OF TURBO-ALTERNATOR ROTORS.—F. Sieber: Soc. Brown Boveri. (*La Tech. Moderne*, 1st November, 1931, Vol. 23, pp. 735–736.)

APPLICATION OF THYRATRONS TO THE WINDING OF COPPER WIRE UNDER A CONSTANT TENSION.—Rhea. (*Génie Civil*, 9th May, 1931, Vol. 108, p. 485; *see* also *E.T.Z.*, 20th Aug., 1931, Vol. 52, pp. 1097–1098.)

THE TRACING OF DISSYMMETRY AND FLAWS IN FERROMAGNETIC MACHINE PARTS.—J. Peltier. (*Comptes Rendus*, 7th Sept., 1931, Vol. 193, pp. 420–421.)

Continuation of the work dealt with in 1931 Abstracts, p. 287.

UNTERSUCHUNGEN AN BETRIEBSTRANSFORMATOREN MIT DEM KATHODENOSZILLOGRAPHEN (Investigations of Service Transformers with the Cathode Ray Oscillograph).—J. Röhrig. (*Archiv f. Elektrot.*, 19th June, 1931, Vol. 25, No. 6, pp. 420–430.)

AUTOMATIC LOCOMOTIVE CAB SIGNALLING USING VALVE AMPLIFIERS.—(*Scient. American*, July, 1931, Vol. 87, pp. 14–15.)

INVESTIGATIONS ON THE RECOIL OF COMPRESSED AIR TOOLS [USING RADIO TECHNIQUE].—O. Voigt. (*Freiberg Dissertation*: for summary see *Physik. Ber.*, 1st June, 1931, Vol. 12, pp. 1233–1234.)

ELECTRON TUBES IN TRAFFIC-ACTUATED CONTROL SYSTEMS.—(*Electronics*, Sept., 1931, pp. 94–96 and 123.)

"One hundred and sixty-nine municipalities have installed traffic-actuated devices to date." Systems here described include those based on sound amplification, pressure detectors (using condenser-charging timing equipment for controlling the coloured lights), electromagnetic control (buried electromagnet in bridge circuit, balance upset by passage of steel structure of the motor-car), and photoelectric cells (Westinghouse system).

LUMBER MOISTURE CONTENT DETERMINED ELECTRICALLY [PORTABLE APPARATUS USING TWO TUNED NEON FLASHING CIRCUITS].—C. G. Suits and M. E. Dunlap. (*Elec. Engineering*, Oct., 1931, Vol. 50, pp. 787–788.)

The testing circuit has its flashing period controlled by the moisture content, and by adjusting its calibrated condenser is synchronised with the standard circuit flashing about once a second.

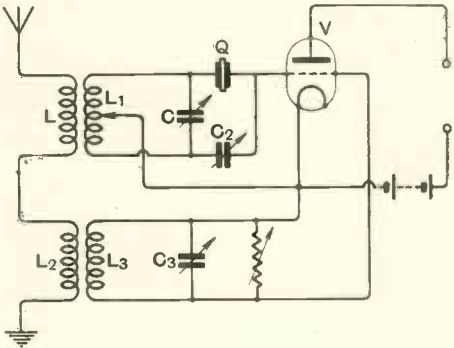
Some Recent Patents.

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.

RECEIVER FOR FREQUENCY-MODULATED SIGNALS.

Application date, 30*th May*, 1929. *No.* 355828.

The valve V has a double input from the aerial. The first aerial coil L is coupled to a circuit C, L_1, which is broadly tuned to the carrier wave, and is connected to the grid through a piezo-electric



No. 355828.

crystal Q, having a fundamental frequency slightly different from that of the carrier wave. Capacity effects across the crystal electrodes are balanced out by a condenser C_2. A second aerial coil L_2 is coupled to a second circuit L_3, C_3, also broadly tuned to the carrier frequency, but connected to the grid of the valve in phase-opposition to the circuit L_1, C_1. The effective grid variations are therefore confined to those passing through the crystal Q. Any extraneous interference, such as a heterodyne beat note, is balanced out by the action of the double input.

Patent issued to J. Robinson.

LOUD-SPEAKERS.

Application date, 4*th November*, 1930. *No.* 356027.

The moving " coil " consists of a single strip of metal, the upper end of which is supported by a slotted flexible membrane secured in turn to the centre polepiece. The two ends of the strip are turned up beyond the plane of the membrane, and are secured to a pair of flexible leads capable of carrying a comparatively heavy current.

Patent issued to A. A. Thornton.

TELEVISION RECEIVERS.

Application date, 11*th July*, 1930. *No.* 354032.

Television signals covering a modulation band of 500 kilocycles on a carrier-wave of one metre are received on a super-regenerative circuit comprising a pair of detector-valves, arranged in parallel and tuned by adjusting the length of the electrode leads, and a " quenching valve " oscillating at a frequency of 500 k.c. By synchronising the scanning and quenching frequencies, overlap due to visual persistence is eliminated and a clearer definition ensured.

Patent issued to The Gramophone Co., Ltd., and W. J. Brown.

GRAMOPHONE PICK-UP ARMS.

Application date 15*th April*, 1930. *No.* 353015.

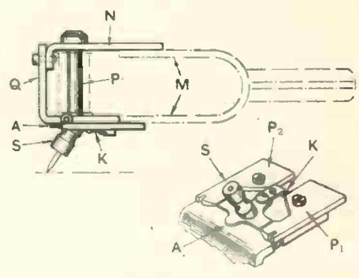
One end of the tone-arm is pivotally mounted in the usual manner on the framework of the gramophone. At the other end of the arm is a vertical fork between which an extension piece is pivoted so as to be capable of independent movement in a horizontal plane. The pick-up is carried at the end of the extension piece. By virtue of the intermediate pivot, the angle between the tone-arm and extension piece will vary as the pick-up moves inwards across the record, thus preserving the ideal tangential contact of the needle with the sound track.

Patent issued to H. Burrows and C. N. M. Ramsay.

GRAMOPHONE PICK-UPS.

Application date, 15*th May*, 1930. *No.* 355227.

In a vibrating-reed movement, suitable for pick-ups, loud-speakers, etc., the armature oscillates between primary magnet-poles, and a positive restoring-force is applied by means of two or more auxiliary pole-pieces. One limb of a U-shaped magnet M is in contact with an iron plate N, which is itself fixed to a brass plate Q abutting against the lower limb of the magnet M. The primary poles P consist of hollow tubes screwed at one end into the



No. 355227.

plate N and fitting into holes in the brass plate Q. The flat armature A of the needle-holder S is pivoted on the plate Q through balls held by a spring K, and is subjected to the restoring-action of two auxiliary pole-pieces P_1, P_2 in contact with the lower limb of the magnet M.

Patent issued to P. Wilson.

FRAME AERIALS.

Application date, 13th June, 1930. No. 355858.

To prevent the necessity of having to rotate a self-contained cabinet set, in order to take advantage of the directional effect of a built-in frame aerial, the windings of the latter instead of lying in the same plane are orientated in different planes, the various ends being brought out to a central switch. This enables any one or more of the windings to be selected at will, according to the orientation of the station to be received.

Patent issued to R. Custerson.

ELECTRIC PICK-UPS.

Application date, 20th June, 1930. No. 357248.

In order to remove the inherent resonance of a sound recorder or pick-up to a point beyond 4,000 cycles, the armature is made of Mu-metal or other alloy of low permeability, so that the reluctance of the metal path falls below that of the air-gap. This enables the moment of inertia of the armature about its axis of rotation to be reduced to 0·06 CGS units, or approximately twice that of a standard gramophone needle about its centre of gravity.

Patent issued to P. W. Willans and H. E. Holman.

HOME-RECORDING.

Application date, 3rd July, 1930. No. 354514.

A combination outfit comprising a radio-receiver, a low-frequency amplifier, a gramophone turntable and pick-up, and a microphone, is characterised by the provision of a rotary switch whereby the apparatus can be rapidly pre-set, at will, either for broadcast reception on the loud speaker, reproduction from a gramophone record, making a record of sounds supplied to the microphone on a blank disc, or the similar recording of any received broadcast item.

Patent issued to The Gramophone Co., Ltd. and A. Whitaker.

CATHODE-RAY TUBES.

Convention date (Germany), 9th November, 1929. No. 356978.

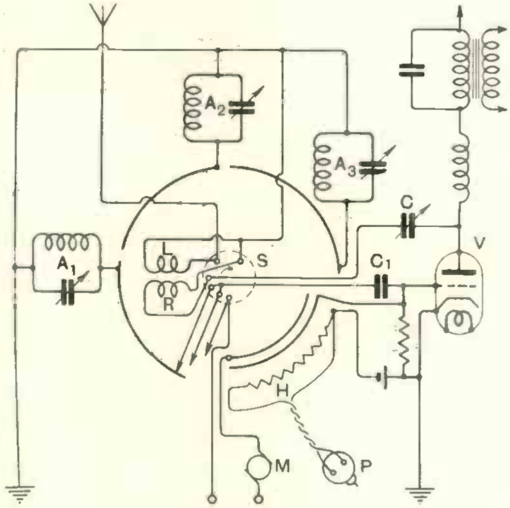
A cathode-ray tube, used for analyzing and synthesizing pictures in television, consists of a hollow body of small cross-section. The tube is heated by radiation from an external winding, and is coated on its inner surface with an electron-emitting material. The anode consists of a disc located at one end of the tube and having a central hole through which the concentrated stream of electrons emerges.

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

PRE-SELECTED TUNING.

Application date, 2nd June, 1930. No. 356726.

Tuning to a number of pre-selected stations is effected automatically by a rotary switch. In the position shown, the grid coil L of a detector valve V is coupled to the aerial circuit A_1, which is tuned to a definite wavelength. Reaction is applied through a coil R and is controlled by a condenser C. Coupling with the aerial is lessened by rotating the switch S in an anti-clockwise direction, this serving



No. 356726.

as a volume control. As the switch S is rotated clockwise the coil L is coupled in succession with other aerial circuits A_2, A_3 tuned to different transmissions. In the sector H the grid of the valve V is connected to a gramophone pick-up P, the grid condenser C_1 being simultaneously short-circuited and a motor M brought into action to drive the turntable.

Patent issued to British Thomson-Houston Co., Ltd., and T. H. Kinman.

TELEVISION SYSTEMS.

Application dates, 14th July, 1930, and 2nd May, 1931. No. 355896.

The intensity of a beam of light is varied in accordance with electrical impulses by transmitting the beam through a moving medium, the optical properties of which are changed by the signalling impulses immediately before the beam enters it. For instance, a solution of sodium sulphate and phenolphthalein is made to flow through a cell containing two electrodes, to which the modulated potential is applied. Coloured striations are produced at right angles to the direction of flow, and the incident beam passes through these. Or again, a circular glass vessel may contain iron filings suspended in glycerine, and a member carrying an electromagnet in advance of a source of light is caused to rotate around the tube. Modulated currents are applied to the magnet and create a concentration of the suspended filings in bands or striations, which then serve to control the intensity of the transmitted light.

Patent issued to G. B. Banks and Baird Television, Ltd.

PHOTO-ELECTRIC CIRCUITS.

Application date, 24th May, 1930. *No.* 355672.

In an arrangement for amplifying the output from a photo-electric cell, both the cell and the valve amplifier are energized from the mains through a filter circuit, comprising series chokes and a resistance, and a number of condensers in parallel across the supply. The anode voltage for the photo-electrical cell is tapped off from a resistance in parallel with the potentiometer feeding the plate of the valve amplifier.

Patent issued to C. Marshall.

PUSH-PULL AMPLIFIERS.

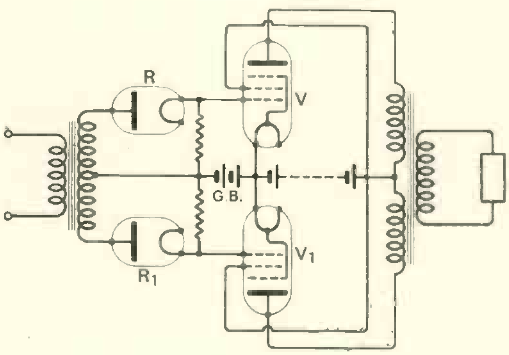
Convention date (U.S.A.), 17th August, 1929. *No.* 357306.

In order to eliminate grid-current distortion from a push-pull amplifier, high-impedance elements, such as resistances, are inserted in series between each grid and the corresponding end of the input transformer. The inserted resistances must be large relatively to the effective grid-to-filament resistance of the corresponding valve-amplifier.

Patent issued to Hazeltine Corporation.

Convention date (Holland), 25th February, 1930. *No.* 355346.

In order to prevent a push-pull pair of valves from operating over non-linear portions of their characteristic curves, and thereby introducing distortion, an auxiliary grid-bias which varies in degree with the voltage input is derived from rectifier devices inserted in the grid circuit. This not only prevents distortion, but considerably increases the power output.



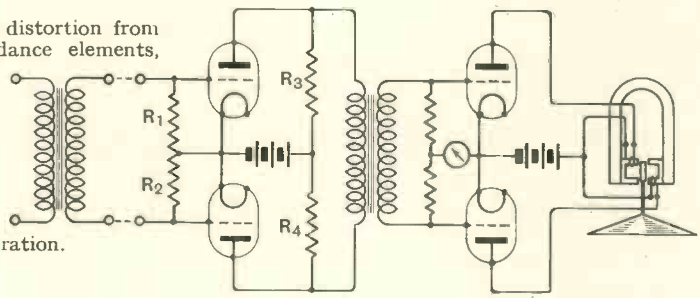
No. 355346.

In a simple form of the invention, two pentodes V, V_1 are each initially biased to the lower end of the straight-line portion of the characteristic curve by a grid battery GB. The additional and variable bias is applied from two rectifier tubes R, R_1 inserted in each grid circuit, as shown. One half-cycle of the input voltage makes the rectifier R conductive and so raises the grid voltage of the valve V, whilst the other half-cycle produces a similar effect on the grid of the valve V_1. Numerous modifications of this basic circuit arrangement are described in the specification.

Patent issued to J. J. Numans.

Convention date (U.S.A.), 16th July, 1929. *No.* 357286.

To prevent distortion, in a push-pull amplifier, due to grid current, without using a permanent high negative bias, the usual input transformer is either replaced or supplemented by a pair of high impedance elements such as resistance R_1, R_2, the mid point being connected to the common filament circuit. The whole of the impressed signal voltage will then at any instant exist only across the valve having the more negative grid, since the valve with the positive grid substantially short-circuits the impedance across it. In other words, it provides an instantaneous connection between the input transformer and the valve filament. Neither grid can at any time become highly positive and draw excessive current, nor can it cause a voltage drop in the input circuit such as will produce distortion. The output circuit comprises a pair of chokes or resistances R_3, R_4, connected in series across the plates of the valves to take the direct-current component, the signal currents passing either directly to the loud speaker or to a further stage of amplification as shown.



No. 357286.

Patent issued to Hazeltine Corporation.

A.C. VALVES.

Application date, 22nd May, 1930. *No.* 355336.

In order to make the electrical centre of the heating-filament in a mains-driven valve easily accessible, the filament consists of two parallel, adjacent, and substantially equal wires, the ends of which are brought out to separate terminals on the valve holder. The terminals can then be readily bridged by an external resistance from which an adjustable tapping can be taken to earth or to any desired point on the circuit.

Patent issued to Lissen Ltd., and R. P. Richardson.

SYNCHRONIZING SYSTEMS.

Application date, 4th June, 1930. *No.* 356247.

The scanning-disc to be synchronized is directly coupled to an alternator. Current from the alternator is combined with separate synchronizing oscillations and fed through a rectifying-device to a coil, which is linked through a closed-iron core with another coil located in the main supply-leads feeding the motor that drives the scanning-disc. The flux through the iron core, and therefore the effective impedance of the coil in the supply mains, is a function of any phase-difference that may exist between the synchronizing oscillations and those generated by the scanning-disc. Since the impedance automatically opposes the creation of any phase-difference, it functions to maintain the scanning disc in step with the synchronizing oscillations.

Patent issued to The Gramophone Co., Ltd., and A. Whitaker.

PHASE MODULATION.

Convention date (*U.S.A.*), *23rd December,* 1929. *No.* 356584.

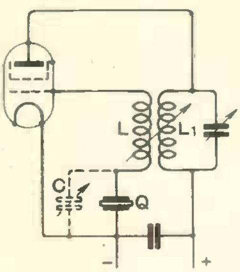
In a high-speed signalling system, in which one phase of the carrier transmits dots, and another dashes, whilst absence of the carrier gives the spacing, the necessary phase-shifts are imparted to the carrier by a separate modulating current. The carrier and modulating currents are generated separately; the phase of the modulating energy is shifted according to the required signal characteristic; and the two components are then combined to give a phase-modulated carrier prior to radiation.

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

CONSTANT-FREQUENCY GENERATORS.

Convention date (*Germany*), *18th December,* 1929. *No.* 356043.

To ensure operation at constant frequency, as for example when broadcasting simultaneously on a common wave, a screen-grid valve is back-coupled through coils L, L_1, and is controlled by a piezo-electric crystal Q connected in the grid circuit so as to prevent the passage of any direct current. Energy losses due to the blocking of the grid circuit are compensated by the high amplification factor of the valve, the screen grid of which is left unconnected as shown. The crystal may be shunted by a condenser C.



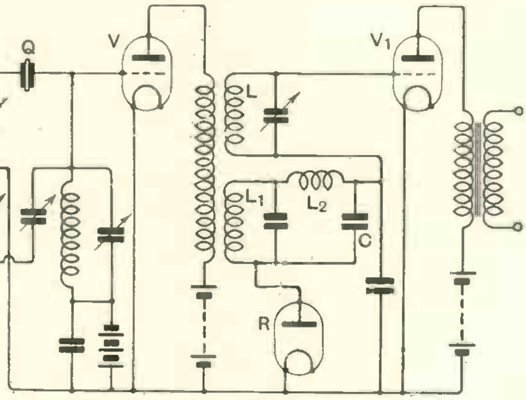
No. 356043.

Patent issued to C. Lorenz Akt.

AUTOMATIC GRID-BIAS.

Application date, 7th May, 1930. *No.* 356782.

Relates to a highly selective type of circuit comprising a piezo-electric coupling, followed by an amplifier stage, the grid of which is heavily biased in order to compensate for the effect of the large reduction in modulation percentage due to the preceding stage. The invention consists in the application of means for automatically adjusting the grid-bias to an optimum value according as the signal voltage fluctuates owing to fading, etc. The input to the first valve V comprises a "balanced" piezo crystal Q. A part of the output from this valve is transferred to the grid of the amplifier V_1 through a coil L in the ordinary way. A second coil L_1 feeds part of the amplified signal energy to a rectifier R, which supplies a varying bias to the grid of the amplifier V_1. A choke L_2 and condenser C serve to smooth the output voltage from the rectifier R.



No. 356782.

Patent issued to H. Andrewes and J. Robinson.

TRANSMITTING-AERIALS.

Application date, 2nd July, 1930. *No.* 356359.

In order to reduce the effect of the supporting mast on the radiation field from a transmitting-aerial, the base of the mast is connected to ground through a combination of inductances and capacities which can be tuned to form either a rejector or acceptor circuit as desired. In this way the mast can be earthed at one frequency and insulated at another.

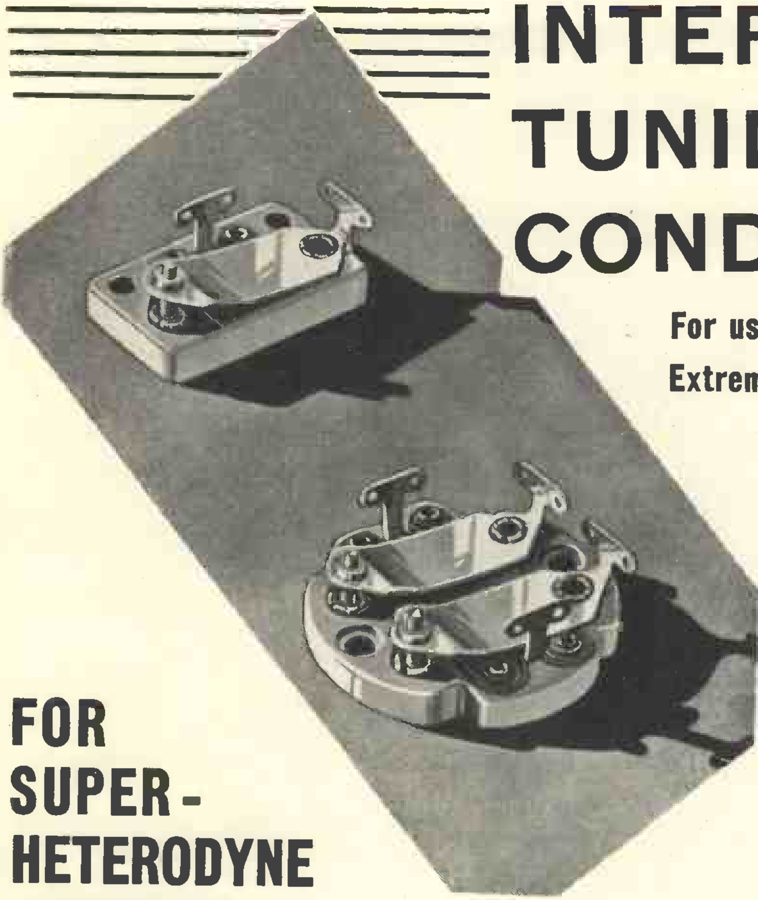
Patent issued to T. C. Macnamara.

Application date, 2nd July, 1930. *No.* 356360.

In order to economise space, whilst at the same time preventing mutual interference between the radiation fields, the same supporting masts are used to suspend (1) a horizontal aerial transmitting on one wavelength, and (2) two outwardly inclined aerials which are both electrically separate from the first aerial and are energized on another wavelength.

Patent issued to H. L. Kirke.

INTERMEDIATE TUNING CONDENSERS



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