THE

WIRELESS ENGINEER

AND

EXPERIMENTAL WIRELESS

Vol. XI. OCTOBER, 1934 No. 133

Olympia Radio Show

Tasks of the Designer

THE Wireless Exhibition at Olympia is the occasion which now presents itself with regularity year by year when the public has the opportunity of seeing, conveniently in one place, the commercial interpretations by the radio manufacturers of the designs which have been completed at an earlier date by each firm's technicians.

We deliberately use the expression "commercial interpretations," because in fairness to the designers it should be remembered that the final receiver is seldom the ideal design of its creator since in the process of commercial production compromises have to be effected in order to simplify production and keep down the price.

When, therefore, we criticise some feature in the design of a receiver, we should not jump at once to the conclusion that the designer knows no better, and we should further consider whether the incorporation of the offending feature in the form in which we and perhaps the designer would have liked it would not have complicated production or increased cost, or, what is perhaps even more important, have rendered the final receiver more susceptible to breakdown in service.

Having made these observations, we can proceed to record as our general impression of the Show that there are gratifying signs of improvements in quality, both of reproduction and workmanship, and that there is now a better selection of good apparatus available than in previous years. We must, however, add that in our opinion, the bulk of the receivers on view showed evidence that, assuming the designers had done their part satisfactorily in the first place, those who had followed after them and been responsible for the "commercial interpretation" of their designs, had often been guilty of exceeding a "poet's licence" in carrying out their tasks.

We feel strongly that the policy of manufacturers should be in the direction of allowing more scope to the capable designer whilst at the same time placing greater responsibility on his shoulders, and that there should be some check upon tendencies to produce the cheapest possible receiver, which is so often done at the expense of a good design.

In this issue we publish, as has been our custom in past years, a general report dealing with representative exhibits of special technical interest. The report does not pretend to do more than give an impression of outstanding trends in progress.

Notes on the Measurement of Radio Frequencies*

By W. H. F. Griffiths, F.Inst.P., A.M.I.E.E., M.I.R.E.

THE present necessity for accurate measurement and control of radio frequencies is so great and the subject so specialised, that it is felt that the radio engineer is in need of a few notes on this subject.

Among engineers much doubt exists as to the method of measurement to be employed for various accuracies. Moreover, even among the specialists, doubt exists as to the accuracies to be expected from various types of wavemeters and as to the factors by which those accuracies are limited.

This may be largely due to the fact that the specialists have for years concentrated upon the development of single frequency standards—valve maintained tuning fork and piezo-electric crystal oscillators—because it was thought impossible to obtain a sufficient degree of accuracy and stability with valve oscillators the frequencies of which are governed, primarily, by values of inductance and capacity.

Because of this doubt, in many quarters it is still argued that a harmonic wavemeter governed by a single frequency standard is necessary for accuracies of the order 0.01 per cent., and that valve oscillators of continuously variable frequency are not sufficiently accurate for use as sub-standards for this accuracy.

The American view is, presumably, to be found expressed in the report of the standards committee of the Institute of Radio Engineers for 1933, in which the following statement occurs in the chapter on "The Measurement of Radio Frequencies."

In dealing with the resonant circuit wavemeter of continuously variable frequency, the report states:

"Although the method is relatively inaccurate, the convenience and facility with which measurements may be made continue to make it one of the more useful methods of the radio laboratory. Wavemeters adaptable to a wide range of frequencies are often accurate to 0.5 per cent. Carefully constructed and calibrated wavemeters of limited range, maintained under very favourable conditions, may be relied upon to about 0.1 per cent. With suitable precautions this may be extended to better than 0.03 per cent."

It is evident that this is the unfortunate position in America, because one of the best known radio instrument makers of that Country goes further and explains that in resonant circuit wavemeters, ". . . as a result of . . . inherent errors, the best accuracy obtainable from commercial models of wavemeters, when the calibration is relied upon for an extended period of time, is from 0.1 per cent. to 0.25 per cent." After which they state that "a comparison of these figures with the allowable frequency tolerances on commercial radio stations shows why the wavemeter has yielded to other instruments and other methods."

The position in this country is rather different, however, since the Author claims to construct, commercially, *wide* range generating wavemeters of 0.01 per cent. accuracy (good enough for commercial radio-station tolerances) having a continuously variable range of 30–30,000 metres and capable of being used from 10–30,000 metres by harmonic range extension. It will be observed that this wavemeter is not of "limited range" and it has not to be "maintained under very favourable conditions," since it is not even necessary to control the temperature of the laboratory in which it is used.

Simple Heterodyne Oscillator Method of Frequency Measurement for Accuracies up to 0.005 Per Cent.

For frequencies below 150 kc/s the C.C.I.R. recommendation for tolerance is 0.02 per cent. and above 150 kc/s 0.005 per cent. It is seen, therefore, that the simple method of direct heterodyning between the fre-

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

quency to be measured and a continuously variable oscillating wavemeter is almost good enough for the measurement of any commercial station. Indeed, the author's wavemeter[1] *can* be depended upon to 0.005 per cent. if occasional checks are made in the form of comparisons with standard frequency transmissions. In using this simple method for measurements of such high accuracy it becomes necessary to use a known audio frequency to produce slow interference beating with the heterodyne beat note. A simple hand tuning fork of 1,000 per second frequency may be used for this purpose, it is then a simple matter to adjust the wavemeter to exactly 1 kc higher or lower than the wave being measured and to subtract or add this frequency respectively from the interpolated result. It will be found necessary to use this interference beating principle on all frequencies up to, say, 4,000 kc/s, at which frequency it will be found that the ultimate accuracy of measurement is equivalent to the silent space between two moderately low heterodyne beat notes on either side of resonance. For frequencies higher than 500 kc/s a very ordinary 0.5 per cent. accuracy tuning fork is good enough, but if the whole range of frequencies down to 10 or 20 kc/s is to be covered an ordinary physical laboratory hand fork of 0.1 per cent. accuracy is necessary.

As the wavemeter is a dynatron oscillator adjusted for low amplitude operation, it is well not to risk loss of accuracy by attempting to modulate the output from this instrument in order to obtain slow synchronisation beating at exact resonance by the rectification of this modulated wave in the receiver. Nor is this necessary when using modern oscillating wavemeters which are calibrated in frequency so as to remove all doubt as to the sign of the heterodyne beat note with respect to the resonant frequency.

The author's dynatron wavemeter has been raised to the level of a precision instrument largely because of the development of his thermal compensated inductances which are used as range coils and the novel features of the carefully designed and soundly constructed variable air condensers with which he associates them. The accuracy is also due, however, to some extent to the use of the dynatron principle of oscillation. These features have been discussed already in a previous article by the present author[2], but it should be mentioned that the direct range of the wavemeter has now been extended up to 10,000 kc/s and that it has now a linear scale of frequency.

Because of the feeble dynatron oscillation of this wavemeter it is impracticable to provide automatic rectification for the direct aural reception of the heterodyne beat note. For the calibration of laboratory oscillators or near by transmitters, however, an inductively coupled detector valve is incor-

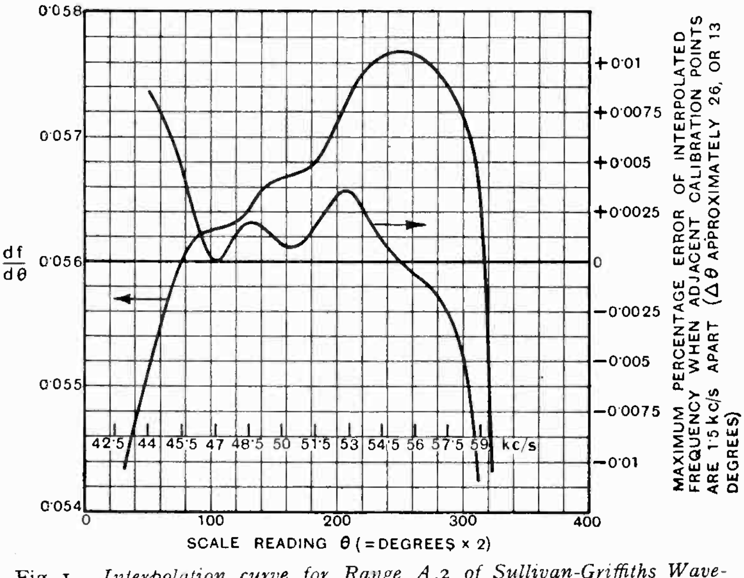

Fig 1.—*Interpolation curve for Range A.2 of Sullivan-Griffiths Wavemeter No. 989/'33. The scales appropriate to the curves are indicated by the arrows.*

[1] The Sullivan-Griffiths substandard Dynatron Wavemeter manufactured by Messrs. H. W. Sullivan, Ltd., London, S.E.15.

[2] "The Simplification of Accurate Measurement of Radio Frequency," *The Wireless Engineer*, May and June, 1933.

porated. In the anode circuit of this valve telephones may be connected direct or any ordinary audio amplifier may be substituted for the telephones without change of calibration. Alternatively, for the measurement of very weak signals, such as the frequencies of distant transmitting stations, the "pick-up" from the wavemeter is also amplified by the selective radio receiver which is used for the normal reception of the signal.

Interpolation Accuracy

The calibration of the wavemeter consists of a number of degree scale settings corresponding to definite frequencies at about 12 equal frequency intervals throughout the whole range of the variable air condenser. For frequencies intermediate between these, simple arithmetic interpolation is all that is needed. The degree of conformity to linear law of frequency is so good that the error due to this simple interpolation is not greater than 0.01 per cent. and for the greater part of the scale is much less than 0.005 per cent. as will be seen in Fig. 1. The curves of this figure show the variations of $df/d\theta$ throughout the range of the variable condenser and errors of interpolation due to these variations. The curves are plotted from the results of a National Physical Laboratory calibration on a typical wavemeter[3] and are interesting in that the agreement between them is most marked—the interpolation error at any point on the scale increasing as the slope of the $df/d\theta$ curve steepens. The open scale of $df/d\theta$ will perhaps give the impression of quite ordinary conformity to law but it should be noted that the corresponding finely drawn curve of frequency plotted against scale reading would be *absolutely* straight if kept within the limits of a page of this journal.

Stability of Generated Frequency

The stability of frequency of this wavemeter is of the order of a few parts in 10^6 in a laboratory of fairly constant temperature. The temperature coefficient is 5 parts in 10^6 per degree Centigrade—which is remarkably low when one considers that the temperature coefficients of linear expansion of ordinary metals are from 3 to 5 times this value.

The settling down of generated frequency from the time of switching on is given in Fig. 2. From this curve it will be seen that a stability within the accuracy of the wavemeter (1 part in 10^4) is obtained immediately upon switching on. The stability of frequency improves to 1 part in 10^5 after 10 minutes and to 1 part in 10^6 after 40 minutes. The frequency generated is independent of changes of supply voltages—the frequency changes by less than 2 parts in 10^6 for 5 per cent. changes of cathode heater volts, control grid volts or screen grid and anode volts.

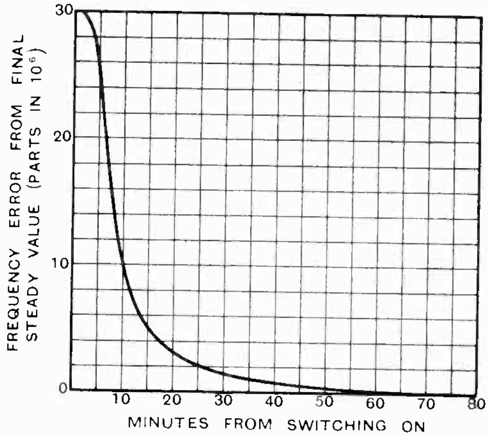

Fig. 2.—*The settling down of frequency of Sullivan-Griffiths Wavemeter No. 989/33 with S4VB valve No. 989/3 at a frequency of 400 kc/s. It should be noted that the laboratory temperature was constant only to 0.5°C. and that the temperature coefficient of frequency of the circuit was* -6×10^{-6} *per °C.*

Calibration Independent of Valve Ageing and Replacement

The calibration of the wavemeter is unaltered by valve replacement and the maximum change of frequency due to the ageing of a valve during its "life" is less than 1 or 2 parts in 10^5 and is thus well within the long period accuracy of calibration.

It is seen, therefore, that for all work involving accuracies up to 0.01 per cent. or, under best conditions, 0.005 per cent.,

[3] The law conformity of this wavemeter has been improved considerably since the article was written, by a design modification to the variable condenser, and the final interpolation inaccuracy will, it is thought, be at least halved in consequence.

and stabilities up to 0.001 per cent., the simple and flexible method of direct heterodyning is now possible. For better accuracies however, the more cumbersome method of harmonic selection from a single frequency controlled generator must be resorted to. The accuracy ultimately obtained from these fork or crystal controlled multivibrator systems, at frequencies other than exact multiples of the fundamental frequency of the arrangement and certain other well defined frequencies associated with them, is limited invariably by the method of interpolation employed. It will be shown that the above mentioned sub-standard dynatron oscillating wavemeter may be adapted for use as an interpolation oscillator for these harmonic wavemeters.

Methods of Interpolation for Harmonic Wavemeters for Accuracies up to 0.001 Per Cent.

Standard Harmonic Wavemeters comprise usually a series of multivibrators having fundamental frequencies of 1kc/s, 10 kc/s and 100 kc/s. All of these harmonic-rich generators are controlled synchronously by a single frequency standard oscillator, and the frequencies of the harmonics obtained from them are therefore all known to the same accuracy as that of this oscillator.

The outputs from these multivibrators are, in effect, a number of standard frequencies at intervals of 1 kc/s, 10 kc/s or 100 kc/s depending, to some extent, upon the actual order of frequency required. As an example it may be said that 100 standard frequencies at 1 kc/s intervals are available from 1 kc/s to 100 kc/s when using the 1 kc/s multivibrator. When using the 10 kc/s multivibrator 90 standard frequencies are available from 100 kc/s to 1,000 kc/s at intervals of 10 kc/s. Similarly when using the 100 kc/s multivibrator 90 standard frequencies at 100 kc/s intervals are available from 1,000 kc/s to 10,000 kc/s. When using the 1 kc/s multivibrator it is obvious that a locally situated generator can be adjusted exactly to synchronism with any of the 100 standard frequencies from 1 kc/s to 100 kc/s by direct heterodyning in the following manner. The generator frequency is adjusted until the heterodyne beat frequency is reduced below the audible limit. At the centre of this normally "silent" band where, with unmodulated heterodyning frequencies, the beat frequency is inaudible, slow pulsations occur. This phenomenon is a periodic swelling, at the frequency of heterodyning, of a note of 1,000 cycles per second which is heard due to rectification of what is, in effect, the 1 kc/s modulation of the harmonic frequency being selected and used.

By more finely adjusting the generator frequency, the frequency of this slow pulsation may be reduced so as to be slow enough to count with accuracy until, near exact synchronism, the period may be increased to many seconds. It is obvious that the accuracy of setting the generator to any one of the standard frequencies may be increased to a very high order by making use of this phenonmenon which will hereafter be termed synchronisation beating.[4] Similarly, when using the other multivibrators, a local source can be adjusted exactly to synchronism with any standard frequency of the other series of harmonics, the 1 kc/s modulation persisting in the 10 kc/s and 100 kc/s multivibrators.

For such a system of measurements or adjustments it is only necessary to be able to identify the harmonic order of the frequency being used. An ordinary laboratory generating wavemeter of 0.1 per cent. accuracy will suffice for this purpose by the method of direct heterodyning with the frequency being adjusted, because the intervals between successive harmonics of any series are never more than 1 per cent. of the actual frequency.

For the measurement of *fixed* frequencies of distant transmitters (or *fixed* local sources) however, it is necessary to interpolate between the standard frequencies. One method of accomplishing this is to heterodyne both the frequency to be measured, and the adjacent pair of standard frequencies which embrace it, with a stable interpolation

[4] There is, of course, no difference between heterodyne beating and synchronisation beating except that the former is usually understood to be appreciated as a musical note and need not, therefore, be assisted by modulation, whereas the latter is the same beating reduced to frequencies below the audible limit and appreciated only by the periodic changing of amplitude of a modulation frequency.

oscillator[5] having a very open and perfectly linear scale of frequency.

The scheme will, perhaps, be better understood by referring to the schematic diagrams of Fig. 3.

The received signal wave f is first heterodyned with the stable interpolation oscillator as shown in diagram 3A, both frequencies being received on the selective radio receiver. The oscillator must be set *exactly* to resonance with f and its scale reading noted. If the frequency being measured is modulated the exact[6] position of resonance will be apparent by the lengthening period of the synchronisation beating or pulsations which are heard after the signals have been rectified in the receiver, which is set in a non-oscillating condition. If the frequency f is not modulated these helpful slow synchronisation beats will not be heard in the vicinity of exact resonance unless the receiver is put into an oscillating condition and set off resonance to produce a suitable audio heterodyne note for the purpose. Yet another method of exactly setting the oscillator against the incoming unmodulated frequency using a non-oscillating receiver is to detune the stable oscillator by 1 kc/s and thus obtain slow synchronisation beating between the 1 kc/s heterodyne note then heard and the output from the 1 kc/s multivibrator. The setting of the oscillator will then be $f - 1$ kc/s, the sign being immediately apparent because of the frequency calibrated scale.

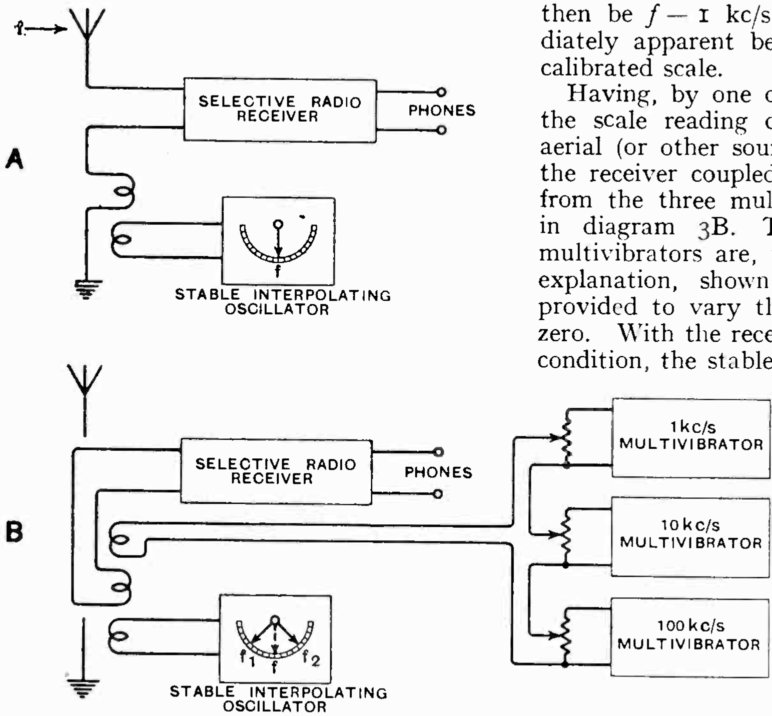

Fig. 3.—*The scheme of measurement of a* fixed *signal frequency.*

Having, by one of these methods, found the scale reading corresponding to f, the aerial (or other source) is switched off and the receiver coupled instead to the output from the three multivibrators as indicated in diagram 3B. The outputs from the multivibrators are, for the purposes of the explanation, shown in series and means provided to vary the output of each from zero. With the receiver in a non-oscillating condition, the stable oscillator is now set to resonance with the nearest lower and higher frequency harmonics, $f1$, $f2$, from the multivibrator. The scale positions of these embracing harmonic frequencies are engraved on the oscillator scale to an accuracy of 1 part in 10^4 and their *exact* settings on a degree scale are found by the slow synchronisation beating phenomenon described previously.

Simple arithmetic interpolation between

[5] The interpolation oscillator necessary for the method about to be described is that already mentioned as a special adaptation of the author's previously described Sullivan-Griffiths substandard Dynatron Wavemeter.

[6] At exact resonance no synchronisation beating will, of course, occur but when the ratio of beat frequency to signal frequency is less than the permissible inaccuracy of measurement, exact resonance is said to be obtained. Moreover, very slow synchronisation beating is often more desirable than no beating, for the latter condition may be one of exact synchronisation due to a "pull-in" effect, against which one must always be guarded. If slow beating is obtained, it is possible to detect the presence of this "pull-in" effect, which is, however, unlikely to occur when a high gain selective radio receiver is employed as described here, owing to the loose coupling which is then permissible between multivibrator and interpolation oscillator.

these two scale readings will give the value of f or $f - 1$ to an accuracy limited only by the scale reading accuracy of the oscillator, its degree of linearity of frequency law and its frequency stability throughout the duration of the measurement.

The Sullivan-Griffiths Sub-Standard Wavemeter as an Interpolator

If the author's substandard dynatron wavemeter be used as the stable interpolation oscillator the interpolation accuracy is of the order 1 part in 10^5 for the scale is more open in the model adapted for high accuracy interpolation and the curves of Fig. 1 are much improved upon in consequence of this. The stability of the oscillator is more than sufficient for the purpose and, moreover, for the more rapid measurement of stations or other lower accuracy wavemeters to an accuracy of 1 part in 10^4, the oscillator may be used alone without the more cumbersome multivibrator system, by unskilled personnel. The value of an interpolation oscillator having a high calibration accuracy of its own cannot be over estimated for not only in cases of breakdown is it useful as a standby substandard but it is also useful for numerous tests at accuracies between 0.1 and 0.01 per cent.

Scales engraved directly in harmonic frequencies corresponding to each of the 290 standard frequencies already given, provide a great simplification in the use of the complete equipment and are effective in inspiring confidence to the operator when selecting frequencies of a high harmonic order.

Limiting the Interpolation Intervals

The scale distance corresponding to a constant frequency interval (1 kc/s, 10 kc/s or 100 kc/s depending upon the position on the frequency spectrum) must vary appreciably throughout the whole frequency range over which that interval is used. It so happens therefore that at the low frequency ends x, y and z of each of the groups of standard frequencies depicted in Fig. 4, long scale distances occur between successive harmonics. These distances are too great to permit interpolation to 0.001 per cent. accuracy. Such accuracy is only possible when the frequencies between which the unknown frequency is being interpolated are less than 3 per cent. apart. The standard frequencies embraced within the three frequency bands x, y and z, from 10 to 35 kc/s, from 100 to 350 kc/s and from 1,000 to 3,500 kc/s respectively, are, therefore, too widely spaced to permit accurate direct interpolation on the scale of the interpolation oscillator. These spaces are, however, still further subdivisible, to an accuracy equal to that of the multivibrator control standard, by other slow synchronisation beating phenomena.

When using frequency intervals of 1 kc/s the natural 1 kc/s modulation of the harmonic frequencies provides other slow synchronisation beats when the oscillator is varied off the exact synchronisation setting. These occur at scale settings corresponding to heterodyne beat notes of 800, 750, 666.6, 500, 333.3, 250 and 200 and are due to the synchronisation beating between these notes themselves or harmonics of them and the difference tones due to the interference between the beat notes and the permanent modulation note

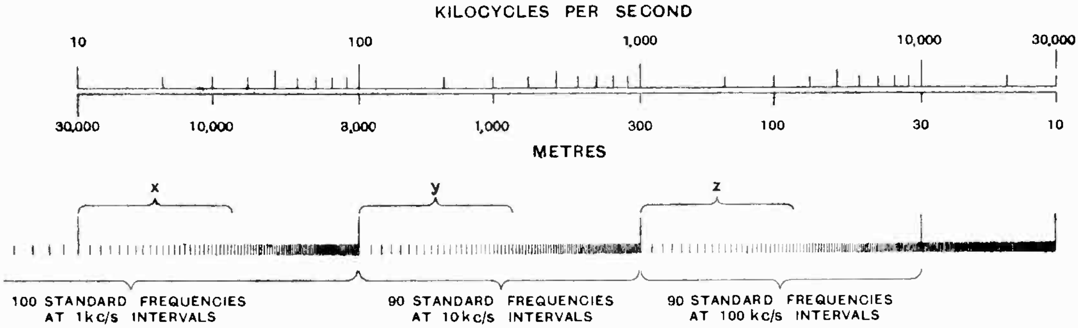

Fig. 4.—*Showing how, in a harmonic wavemeter, the frequency spectrum is subdivided into groups of standard frequencies of different intervals many of which are still further subdivided in the manner of Fig. 5.*

of 1,000 per second. The gaps between adjacent harmonics from 10 to 35 kc/s are in this way well bridged by other equally standard frequencies.

Similarly, when using frequency intervals of 10 kc/s the natural 1 kc/s modulation of the harmonic frequencies provides other slow synchronisation beating points at nine equidistant points—exactly 1 kc/s apart—between each adjacent pair of harmonics. When the heterodyne beat note is 1, 2, 3, 4 and 5 kc/s on either side of a standard harmonic setting therefore, other equally standard frequencies are readily distinguished which effectively fill the 10 kc/s gaps from 100 to 350 kc/s.

At the higher frequencies the same procedure cannot be adopted owing to the use of the much larger frequency intervals of 100 kc/s. However, the high degree of frequency stability of the oscillator permits another method of subdividing the larger scale distances of this range (from 1,000 to 3,500 kc/s) in the following manner. The scale is set to a standard harmonic frequency of the 100 kc/s series with the aid of the engraved scale as usual. The output of the 100 kc/s multivibrator is then reduced to zero and replaced by that of the 10 kc/s multivibrator. Commencing from the already identified frequency of the 100 kc/s series the oscillator scale is rotated slowly through a noted number (up to 5) of 10 kc/s intervals towards the required frequency f. At 10, 20, 30, 40 and 50 kc/s distance from the known standard frequency slow synchronisation beating will occur and so the interpolation distance on either side of f is reduced to limits for which the interpolation accuracy of 1 part in 10^5 is possible. The bridging of the 1 kc/s, 10 kc/s and 100 kc/s scale intervals is shown in Fig. 5. It is the author's considered opinion that the extreme accuracy and stability are bound to fall off considerably above 10,000 kc/s owing to the extremely poor decrements and relatively high capacity instabilities naturally associated with ultra high frequency resonant circuits. For this reason it is his definite policy to limit the range of the most accurate wavemeters to this frequency and the Sullivan-Griffiths stable interpolating oscillator does not extend beyond 10,000 kc/s. When measuring frequencies between 10,000 kc/s and 20,000 kc/s, therefore, the first harmonic (2n) of the oscillator is first heterodyned by the signal frequency being measured and the oscillator fundamental is then measured in the ordinary manner. Frequencies between 20,000 kc/s and 30,000 kc/s are treated in a similar manner except that the second (3n) harmonic of the interpolating oscillator is heterodyned and measured.

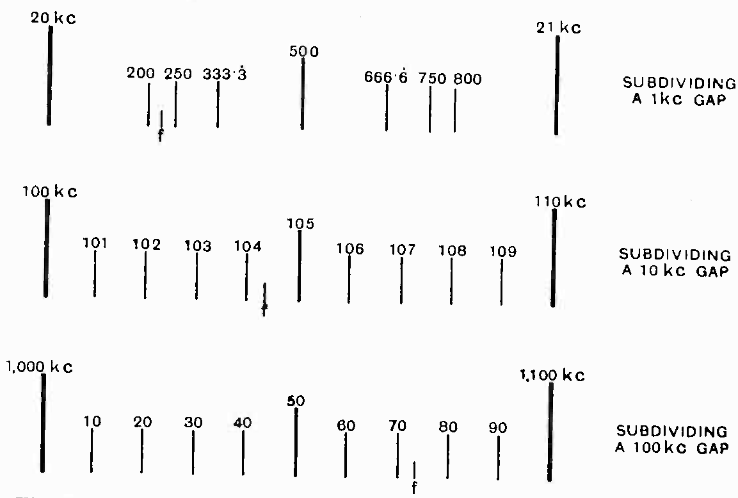

Fig. 5.—*Showing how the wider intervals between the standard frequencies of Fig. 4 are still further subdivided by exact multiples or other exact means.*

The Beat Note Measurement Method of Interpolation

An obvious alternative method of interpolation between the standard harmonic frequencies is that of measuring the frequency of the audio heterodyne beat note between the signal wave being measured and the nearest harmonic. For this method the frequency interval between successive harmonics must be limited to twice that of the highest heterodyne beat note which can be heard with ease. For this reason the method is usually limited to harmonic systems having 10 kc/s intervals and the total range of direct measurement limited to 100–3,000 kc/s. In this method, also, a stable oscillator is used, the accuracy of which, however, need not exceed 0.05 per cent. since the calibration is only necessary for identification of harmonics and not for interpolation. The procedure consists of transferring the frequency, f, to the stable oscillator by the slow beat method and then matching the heterodyne beat note between the oscillator and the nearest standard harmonic frequency against a continuously variable audio oscillator of the heterodyne type. Slow beating, either aural or visual, is obtained between the beat note and the audio oscillator which must have a range of 0–5,000 cycles per second and a linear scale of frequency.

The accuracy of interpolation is limited by the calibration accuracy of the audio oscillator. This limitation is usually very serious for heterodyne beat notes approaching 5,000 per second. The calibration accuracy of even the best precision grade heterodyne oscillators of this range cannot be guaranteed for a considerable period to be better than 0.5 per cent. which, at a frequency of 5,000, produces an error of 25 cycles per second. This frequency error in turn limits the overall accuracy of interpolation to 0.025 per cent. at a frequency of 100 kc/s, 0.008 per cent. at 300 kc/s and 0.0025 per cent. at 1,000 kc/s. Not until the extreme high frequency end of the range of measurement is reached does the accuracy approach 0.001 per cent.—the accuracy which, it will be remembered, remains constant throughout the entire range of measurement when using the high grade open scale oscillator method of interpolation which, for this reason, is seen to be preferable. Moreover the audio oscillator method provides no sub-standard "stand-by" wavemeter, except for accuracies up to 0.05 per cent. Another slight objection to the audio-oscillator method is that of limited *direct* range. Because of this limitation, frequencies above 3,000 kc/s have to be transferred to the stable oscillator by heterodyning their fundamentals with harmonics of the latter and frequencies below 100 kc/s are transferred by heterodyning their harmonics with the fundamental of the stable oscillator.

Crystal and Fork Standards of Frequency

The best accuracy to which any fixed frequency such as a distant transmitter can be measured is, as has already been shown, of the order 1 part in 10^5, unless such frequency is very closely adjusted to a nominal frequency which is a multiple either of 1 kc/s (if less than about 300 kc/s) or of 10 kc/s (if less than 3,000 kc/s) or of 100 kc/s if greater than 3,000 kc/s.

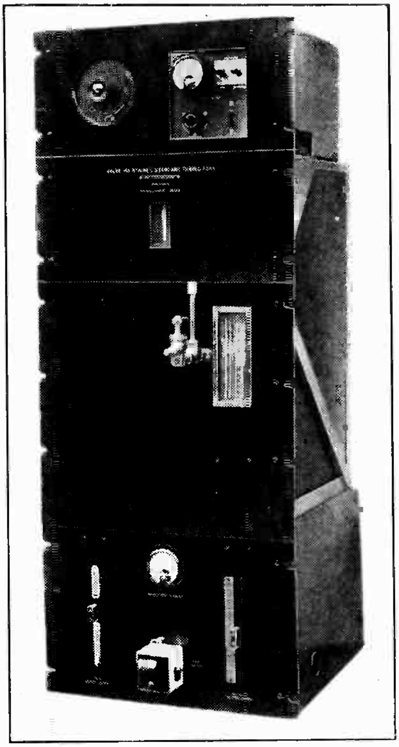

Fig. 6.—*The Sullivan Valve Maintained Tuning Fork developed from the original N.P.L. design.*

If the station or source to be measured happens to be within a few cycles per second of these standard frequencies it may be measured to the accuracy of the crystal or fork controlled standard oscillator which governs the frequency of those standard frequencies. Or, of course, local transmitters or sources may be adjusted to these frequencies to the same degree of accuracy. Moreover, secondary standard oscillators may be calibrated at these frequencies to the same accuracy if they are sufficiently closely adjusted.

Sub-standard wavemeters need nothing better than 1 part in 10^5 accuracy for their calibration and so the accuracy of interpolation is sufficient for this work.

It is, however, necessary to give some idea of the accuracy of the various fork and crystal standard oscillators at present available commercially.

Piezo-electric Crystal Governed Standards Oscillators

The accuracy of a crystal controlled standard oscillator for the ultimate control of a harmonic wavemeter may be as high as 2 or 3 parts in 10^7 to nominal frequency. As an example of this accuracy and stability over a long period it may be stated that over a period of eighteen months a valve oscillator, frequency controlled by a particular type of crystal[7], was reported, by an official body, to have been constant to within 3 parts in 10^7 *without temperature control.*

Standard harmonic wavemeters are now available employing this type of crystal standard, temperature controlled, although the temperature coefficient of the crystal uncontrolled is only 3 parts in 10^6 per degree C.

Valve Maintained Tuning Fork Standards

The accuracy of a valve maintained Tuning Fork standard for the ultimate control of a harmonic wavemeter may be as high as the crystal standard given above, but only if both the temperature of the fork and the pressure of the atmosphere in which it is vibrating are kept constant to within fine limits by elaborate temperature control devices and in an evacuated chamber.

It is only necessary to control the temperature of the crystal to within $\pm$ 0.1 degree C and, since it is mounted in an evacuated glass envelope, no pressure control is necessary. The fork, however, must be controlled to at least $\pm$ 0.01 degree C and it must be worked in a pressure constant to within $\pm$ 0.5 mm of mercury. Such a Fork Standard *is* constructed commercially[8] with temperature and pressure control to finer limits than these and is illustrated in Fig. 6.

In a preliminary report on one of these standards the Union Internationale de Radiodiffusion (Brussels) gives the frequency measured to an accuracy better than 1 part in 10^7 on three successive days as follows :—

13.3.34	at 10.00	1000.0002_5
13.3.34	at 18.00	1000.0003
14.3.34	at 10.00	1000.0003
14.3.34	at 18.00	1000.0003
15.3.34	at 10.00	1000.0003

It will be seen therefore that there appears to be very little to choose between crystal and fork standards as regards frequency stability over short periods. Over long periods the calibration constancy is extremely good in both types of standard, and although the author is rather inclined to favour the crystal on account of its small dimension, lightness and permanently sealed mounting, he would ask to be excused from comparing their long period constancies quantitatively.

[7] The Lucas-Sullivan nodally mounted and evacuated Quartz Crystal Standard.

[8] The Sullivan Valve Maintained Tuning Fork developed from the original N.P.L. design.

The Industry

THE new Ferranti car set is of the single-unit type, complete with loud speaker, and is designed for mounting under the dash. It is intended for direct control, primarily by the front-seat passenger, but can be operated by the driver.

The Central Technical College, Suffolk Street, Birmingham, have issued a syllabus of a part-time course of technical training designed to meet the requirements of the radio industry.

The well-known Schottky screen grid valve patent has been annulled as the result of an action brought by Tungsram in the Czechoslovak Patent Court.

Practically all the well-known valve manufacturers have now issued their " Valve Guides " for the current season. In most cases these little publications contain useful additional information which is well arranged ; the manufacturers concerned will supply free copies to readers.

Belling and Lee have just issued a 6d. booklet entitled " Cutting the Crackle out of Radio " which deals with man-made interference in all its aspects.

The Rymill Expedition, which left recently for the Antarctic, expects to establish communication from there with Portishead ; the expedition's schooner is fitted with a Plessey set.

A recent Colvern publication (Radio List No. 13) contains much technical information concerning Ferrocart coils.

The Radio Exhibition

A Technical Survey of Olympia, 1934

ONCE again the majority of the receivers exhibited were superheterodynes; but a number of refinements have been introduced which the listener should look for when purchasing a new receiver this year. Automatic volume control is universal on all but local-station or small battery sets, is frequently of the "quiet" type (*i.e.*, the receiver will give no output until a carrier of a certain minimum strength is available), and is accompanied by special precautions to ensure accurate tuning. There is generally also some means of reducing high-note response when listening to weak signals, so as to decrease the disturbance from side-band splash and background noises; this may be achieved by variable selectivity, or merely by a tone-control in the audio-frequency side of the receiver. Another great convenience is the adoption of switching to enable the loud speaker in the receiver to be disconnected when an external or "extension" loud speaker is in use; in the Milnes superheterodyne, which employs a pentode output stage, a small load is provided by a resistance, in case the internal speaker be switched off when there is no external one connected.

In battery receivers the disappearance of the original form of Class "B" output stage is noticeable; there has been a large increase in the use of quiescent push-pull since the valve manufacturers introduced double-pentode valves in the one bulb, and the zero-bias Class "B" valves are rapidly being replaced by the new types which employ a negative bias of 4 to 6 volts. Also conspicuous by its absence is the d.c. mains receiver, which has been replaced by the "universal" type, which will work on either d.c. or a.c. mains. This is practically a d.c. receiver with the addition of a rectifier—usually a half-wave valve rectifier, which may employ a whole-wave valve with the two anodes in parallel for the sake of low voltage drop. On d.c. mains the rectifier prevents the application of reverse voltage to the receiver, and thus makes possible the use of electrolytic smoothing condensers. All but the smallest of these receivers have a filter for protection against radio-frequency currents in the mains; in the Philips receiver model 472U (which incidentally is a 2-H.F. "straight" set in their "Superinductance" series) the chokes

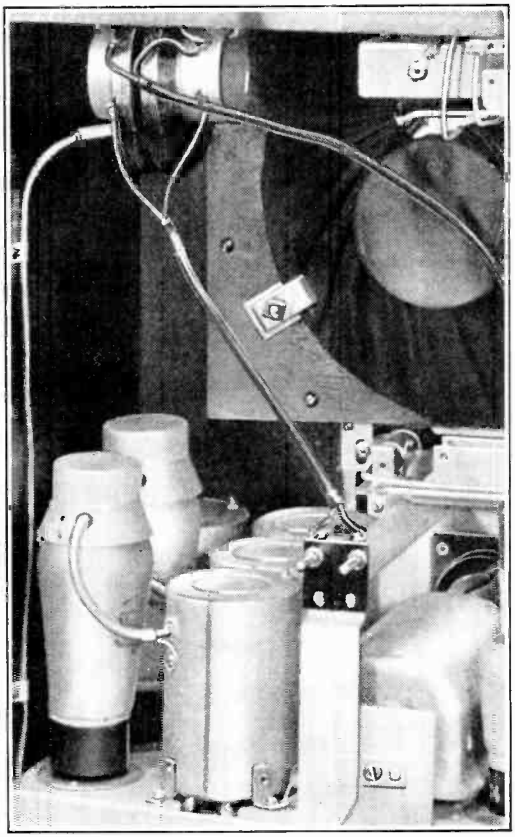

Fig. 1.—*Mains filter in Philips Universal receiver mounted in the top of the cabinet.*

employed for this purpose happen to be accessibly mounted, and can be seen in Fig. 1.

A.V.C. and Tuning Arrangements

Automatic volume control has introduced some special problems, which are receiving a great deal of attention this year. For the reduction of inter-station noise, the largest receivers last year employed "quiet" A.V.C., the universal system being the use of an over-biassed audio-frequency amplifying valve which was released by an incoming signal exceeding a certain value. The simpler forms of this system are now obsolete owing to the disadvantage that a signal of border-line strength might result in the A.F. valve functioning at its lower bend, with consequent distortion; relays were employed in a few receivers to ensure positive action, but have not proved popular. The nearest approach to the original method is to be found in the R.G.D. model 1202, but with the important difference that there are virtually two stages of amplification between the rectified carrier and the release voltage for the A.F. valve, for a duo-diode-triode valve is used in a circuit where amplified A.V.C. potentials are developed across a resistance in its cathode lead. Part of the A.V.C. potential is then applied to the grid of a pentode, whose anode circuit controls the bias of the A.F. valve. This ensures an extremely rapid change of bias when the critical value of signal strength is exceeded. The Mazda triple-diode-triode valve introduces a new method of obtaining Q.A.V.C.; for it is possible to use one of its diodes for signal rectification, a second for delayed A.V.C., and the third to control the first or signal rectifying diode. This third diode is preferably fed from a stage of the receiver where the degree of A.V.C. control is small, so as to secure a clear distinction between strong and weak signals, and on receipt of a sufficient signal removes a delay voltage which had previously been applied to the signal diode. Another special arrangement is employed in the larger Ekco receivers (the A.C. 85 and A.D. 95, which are a.c. mains and universal superheterodynes respectively) where the circuit is such that a large negative bias is applied to the frequency-changing and I.F. valves until the input reaches a predetermined value. Apart from these and other systems of genuine Q.A.V.C., there is a regrettable tendency to describe all receivers as possessing "quiet" A.V.C., though they may use only a manual sensitivity-limiting device, or in at least one case on the strength of a claim to a low internal noise level.

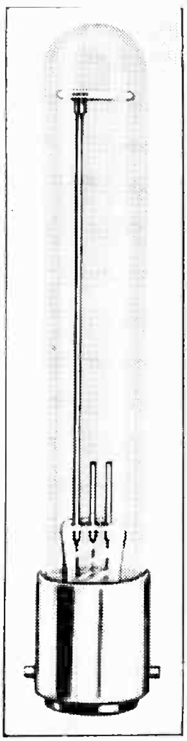

Fig. 2.—*Cossor Neon tuning indicator.*

Difficulty in tuning a receiver to resonance by ear alone is an undesired consequence of A.V.C., and since it is most noticeable on sensitive receivers, which are usually highly selective, the result of inaccurate tuning can be very unpleasant. There are now two types of visual tuning indicator in use, the mechanical or milliammeter type and the neon tube. The latter (Fig. 2) is a small discharge tube with the electrodes so arranged that with increasing applied potential the discharge gradually spreads along the length of the tube. Either type is normally operated through the change in anode current of a valve controlled by A.V.C. Though perhaps a slightly less sensitive indicator than the mechanical type, the neon tube lends itself more readily to incorporation in the actual tuning scale, thus lessening the effect of having two separate dials to watch while tuning. In fact the Sunbeam Model 32 superheterodyne uses the neon as the pointer for a translucent scale. In the interests of simplicity of operation some manufacturers, such as C.A.C., Ekco, and McMichael, have adopted what are described as "anti-screech" circuits, in which the use of a tuning indicator is avoided by feeding the A.V.C. rectifier from a circuit which is less selective than the one supplying the signal rectifier. The effect of this may be most easily understood by considering an idealised case in which the circuit feeding the A.V.C. rectifier has a level response over some 30 kc/s, while the signal circuit has a highly selective response curve (Fig. 3). As the receiver is tuned through a station, its gain (as controlled by A.V.C.) will remain constant as long as the carrier remains within the curve (a); the signal output on the other hand follows the curve (b) and reaches a maximum at resonance, since the gain is meanwhile held constant. In practice the circuits will not have response curves even approximating to those shown in the figure, but the general principle is effective. It is preferable not to rely upon the early stages of the receiver for the unselective circuit to supply A.V.C., since the voltage available is relatively small there; Ekco therefore have an additional circuit fairly tightly coupled to the last I.F. transformer, so that the coupled-circuit effect gives a double-peaked response curve of the necessary width. On two of the H.M.V. models, the "High Fidelity" and "Duo-Diffusion" Autoradiograms, the Q.A.V.C. system ensures accurate tuning by the exact converse of the system just described. For if we imagine the frequency scale of Fig. 3 to be reduced so that curve (a) has a band-width just sufficient for the signal, while (b) becomes very narrow (effective width of the order of 1 kc/s), then in these H.M.V. receivers the voltage which both releases the "Q" valve and works the tuning indicator is derived from the selective circuit (b); consequently a station is observed neither visually nor aurally until exactly tuned to resonance on this very sharp circuit. A further refinement is the adoption of a large time-constant in the "Q" circuit, so that as the tuning dial is rotated stations are indicated visually at once but not heard until after a slight delay; it is thus possible to tune from one station to another in silence, without hearing a medley of sounds from the intervening transmissions.

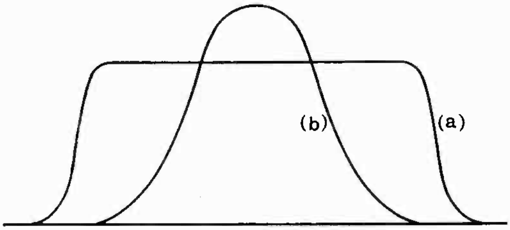

Fig. 3.

It is now generally realised that high-quality reception of weak signals is impossible, and an important advance in the design of the more ambitious type of receiver is the provision of some means of varying the selectivity according to reception conditions. The radiogramophone produced by Birmingham Sound Reproducers is probably unique in employing a mechanical method of varying the coupling of the I.F. transformers combined with a switch which at a certain stage brings into action a 9 kc/s whistle filter. The more usual method is to employ a switch to control the coupling reactance, and the most comprehensive switching system is employed in the H.M.V. "High Fidelity" Autoradiogram (*Auto*radiogram signifies that an automatic record changer is fitted), giving the choice of a response up to 3, 5, 7 or 8 kc/s. To avoid the production of a double-peaked response curve, the circuits are loaded with resistances in the wide-band positions; but for 3 kc/s the coupling is sub-optimum, so that the resistances are removed and the increased magnification of the tuned circuits then compensates the loss of signal strength due to loose coupling. For gramophone reproduction there is a separate two-range scratch filter, and there is also a two-way tone-control.

An entirely different solution of the problem has been adopted by R.G.D. in the model 1202 radiogramophone, which is normally a superheterodyne receiver employing a signal-frequency amplifying stage, frequency-changer and I.F. amplifier, and a second detector followed by a tone-correcting stage and a paraphase A.F. amplifier with an output of 6 watts. For high-fidelity reception of strong signals, however, the I.F. amplifier is completely eliminated, the output of the signal-frequency stage being fed directly to the second detector; at the same time the tone-correcting circuit is suitably modified. The frequency response can be further limited when necessary in operation as a superheterodyne by the addition of a whistle filter or the elimination of the tone correction; consequently the upper limit of the receiver's frequency response may be set to about 4, 5, or 10 kc/s.

The McMichael "Twin Speaker Superhet" makes for simplicity of operation by employing an automatic tone control, which limits the high-note response whenever the signal strength falls below a critical value by means of the circuit outlined in Fig. 4. An additional steep-slope triode V_2 is used, whose grid and cathode are connected across the signal diode's load resistance, so that on strong signals it is biased back to zero anode current. As soon as the carrier strength falls this valve comes into operation, and the "Miller effect" operating through the anode-to-grid capacity throws a large capacitive load on its input circuit, i.e. a capacity across the signal diode's load, which by-passes the higher audio frequencies. It will be noticed that until the carrier reaches a certain minimum value there is a positive bias on the grid of V_2 from the resistance R_{10}; the grid-cathode conductivity of this value then practically shorts the A.F. load in the absence of a signal, so that true Q.A.V.C. is obtained. The triode V_2 also serves as A.F. amplifier for gramophone reproduction.

A special feature of any superheterodyne is the frequency changer, and this year valves have been so improved that the conversion conductance (ratio of I.F. anode current to signal-frequency grid voltage) is usually of the order of 1 mA. per volt. There are a number of heptodes, but by converting the "mixer" section from a tetrode to a pentode Mullard have produced an "octode." An alternative frequency changer made by both Mullard and Mazda is the "triode-pentode"; this is really a pentode mixer with a separate triode oscillator, but with both valves mounted in the same bulb and having a common cathode. External oscillator coupling is of course necessary with the triode-pentode. A few of the largest receivers still employ a separate oscillator, and of these the most interesting is the R.G.D. All-Wave Radiogram, model 1203, which uses a pentode as a Dow electron-coupled oscillator.* In this oscillator the control grid and first screening grid of a pentode are employed as grid and anode of a triode oscillator, and automatically modulate the anode current. The suppressor grid serves as screen between this oscillator and the anode, so that coupling between the oscillatory circuit and the anode from which the output is derived is purely electronic, and the external circuit should have no effect on the frequency of oscillation.

A further feature of this R.G.D. receiver is that the signal-frequency amplifying stage is retained even on the short wave-bands. The more usual practice on all-wave receivers is to dispense with a signal-frequency

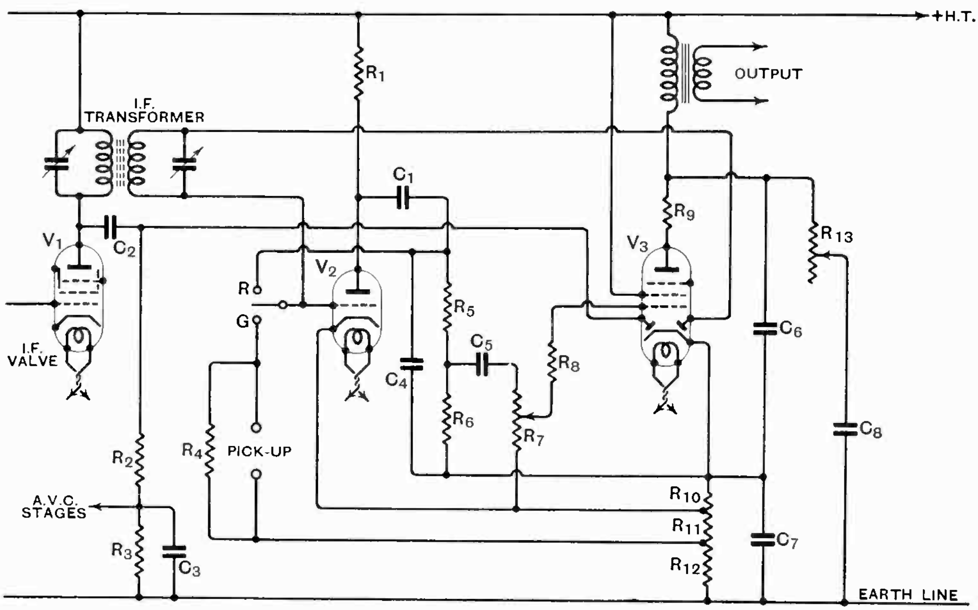

Fig. 4.—*Automatic tone-control in McMichael superhet.*

* *W.E. & E.W.*, Dec., 1933, page 648.

stage entirely (Allwave International Radio and Television) or to eliminate it for short waves, as is done in the H.M.V. " High Fidelity " Autoradiogram by employing an entirely separate oscillator for short waves feeding directly into the I.F. amplifier. Another point in all-wave receivers is the

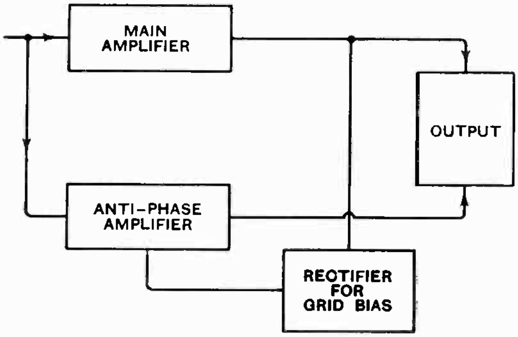

Fig. 5.—*H.M.V. Contrast Amplification.*

shortening of the time constant of the A.V.C. as far as possible, to deal with the high-speed fading which occurs on short waves.

Audio Frequencies

The chief novelty on the audio-frequency side is the commercial introduction of expansion of the volume range of the received signals.* It is well known that limitations such as background noise make it necessary in a normal transmission system to compress the full desirable range of some 70 db. into about 30 db.; under the title of " Contrast Amplification " the H.M.V. " High Fidelity " model has an optional contrast expander. The principle of the method employed is indicated in Fig. 5. In parallel with the main amplifier is shown another valve connected in anti-phase, and with its grid bias controlled by the signal strength. On a very strong signal, the anti-phase valve is biased completely out of action, so that it has no effect on the output of the receiver; but weaker signals are reduced still further by the anti-phase output produced by this valve when it has a smaller bias.

In loud speakers the general tendency is to divide the frequency range between two or more units, but exceptions are Hartley-Turner and H.M.V., both of whom claim to cover a very wide frequency range with a single moving-coil unit. (The large H.M.V. radiogram employs two speakers, but they are a pair of identical units, the purpose being to share the large power output of 10 watts which is available, and to give better distribution of high frequencies). One of the H.M.V. speakers has the unusual feature of an elliptical cone whose central portion is of aluminium, the remainder being paper; the elliptical shape is intended to reduce the concentration of high notes. In the past one of the objections to the built-in speaker has been cabinet resonance, but Ekco claim to have turned this to advantage: it is stated that co-ordination of cabinet and speaker design has resulted in the combination possessing a better response curve than the speaker alone.

The electrostatic speaker is no longer prominent, probably because the piezo-electric or crystal type, as made by Rothermel-Brush, is more convenient for connecting directly in parallel with a moving-coil unit. But commercial practice is to use a special moving-coil unit for the high notes, usually with a separate feed or a filtering circuit between it and the low-note speaker; for example the Pye CR/RG/AC Radiogram

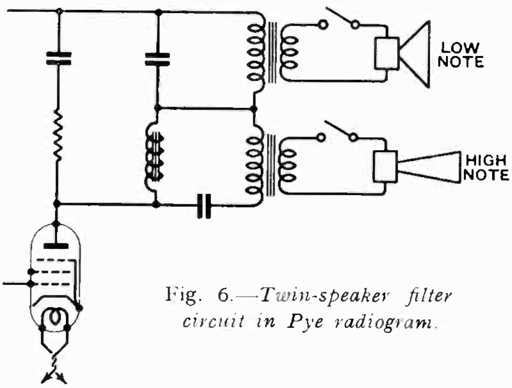

Fig. 6.—*Twin-speaker filter circuit in Pye radiogram.*

employs the output circuit of Fig. 6. The R.G.D. model 1202 employs three speakers in all, a pair of units with 8in. and 6in. cones connected directly in parallel, and a high-note unit, which has a small horn, fed from a separate output transformer in which leakage inductance can be kept very

* For a general discussion of expansion of the volume range, see " Expanding the Music," *Wireless World*, Aug. 24th, 1934, p. 150.

low. The R.G.D. model 703 employs only two speakers, but of these the high-frequency unit has a speech coil wound with aluminium wire. A new alloy of nickel and aluminium has proved valuable in the construction of permanent magnets for speakers. It has a very high coercivity, so that it is possible to reduce the length of the magnetic circuit (which is fixed by consideration of the demagnetising effect of the poles) with consequent saving in the weight of magnet material.

The ear must always be the final link in the chain between the source of sound and the observer's brain ; and the researches of the Multitone Electric Co. into the design of deaf-aids has resulted in a very interesting system described as " Unmasked Hearing." The idea is that when the general intensity of speech or music is raised to a high level, the high frequencies, which are largely responsible for the intelligibility of speech, are masked by the excessive intensity of the middle register. Demonstration was very convincing : speech, which was so loud in telephones as to be mainly unintelligible, became clear and more natural when the other ear was supplied with the output from an amplifier dealing with high frequencies only, and without any reduction in the intensity of the original sound. Apart from deaf-aids (the system has already been used in deaf-and-dumb schools) the principle should be useful to persons of normal hearing in noisy surroundings, for example, aeroplane pilots. Another feature for the deaf is the installation of headphones in cinemas, which is being undertaken by Ardente and Ossicaide.

Valves

Apart from the special frequency-changing valves which have already been mentioned, interest is centered in the new ranges of " Universal " valves. They are indirectly heated valves, some manufacturers employing a heater current of 0.2 amp. and others 0.3 amp. ; with a few exceptions in the case of output valves, the heater voltage is 13, so that they may be used either with heaters in series for " Universal " mains receivers, or in parallel for 12-volt car radio installations. These valves are made in a limited number of types, the usual range being fixed and variable-mu H.F. pentodes, frequency changer (heptode, octode, or triode-pentode), steep-slope " HL " triode, double-diode-triode, output pentode (in the Mazda range a double-diode output pentode) and mains rectifier. The alternative heater currents adopted by different manufacturers limit interchangeability in valves which are intended for series connection, and

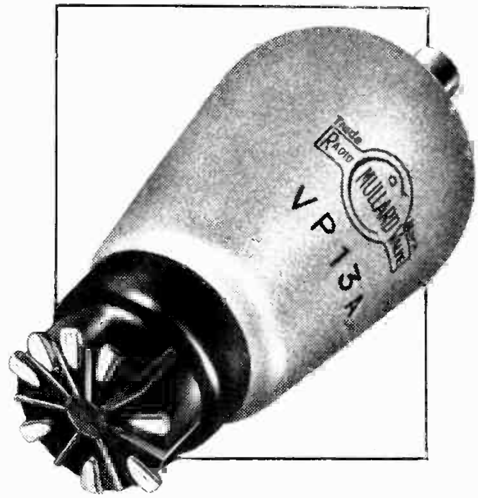

Fig. 7.—*Mullard " Universal " valve with side-contact base.*

the Mullard universal valves have the further distinction of a new base with side contacts in place of the usual pins, and the grid connection taken to the top cap of the valve in place of the anode. The chief advantage of the new base appears to be reduction in overall length, but it is also claimed that dielectric and leakage losses and contact resistance are less than in the pin type, while the better insulation of the grid with its lead at the top should certainly be an improvement.

A feature of the Mazda H.F. pentodes is that they have been designed for a very high screen voltage, obtained through a voltage-dropping resistance from the anode instead of from the usual potentiometer. The consequent change in screen voltage, which occurs when the screen and anode currents are varied by changes in the A.V.C. potential on the control grid, improves the variable-mu characteristics of the valves. In a number of commercial receivers the Mazda double-diode output pentode, which was briefly mentioned last year, is serving as rectifier and complete audio-frequency amplifier ; but for gramophone reproduction some further A.F. amplification must be provided. Several manufacturers have arranged for the last I.F. valve to be employed as resistance-coupled A.F. amplifier for this purpose : it is interesting to contrast the Sunbeam 5-valve Universal Superhet., where the last I.F. valve is always an A.F. amplifier as well, since a reflex circuit is used, with a separate diode detector and pentode output valve. Special arrangements occur in the McMichael Twin Speaker Superhet., where a triode is used which also functions in the A.V.C. circuit on radio as described above, and in the Pye SP/AC, which uses the triode section of the triode-pentode frequency changer as first A.F. amplifier for gramophone reproduction.

The Ediswan power valve, type E.S.75, now has an anode cut from a solid block of graphite. Graphite anodes are already in common use in America, their advantage being better radiation of heat ; the resultant lower anode temperature is chiefly valuable in reducing grid current owing to the lower temperature of the whole electrode assembly. A most unusual type of anode structure is employed in "362" valves (see Fig. 8) for which it is claimed that secondary emission is practically eliminated, so that tetrodes have characteristics equivalent to the usual pentodes. It is quite possible that the concentration of the electron stream on the small area presented by the edge of the corrugated strips would have this effect ; for there may well be a definite and quite small saturation value to the density of secondary emission which can be obtained from any surface. A practical feature in the construction of "362" valves is the protection of the metallising on the bulbs by a transparent insulating coating. The introduction of "Catkin" valves marked an advance in the design of indirectly heated receiver valves, and now we have the "K" series of Osram 2-volt battery valves. They employ the same type of electrode assembly and seal as the "Catkin," but the envelope is made of glass, though greatly reduced in size.

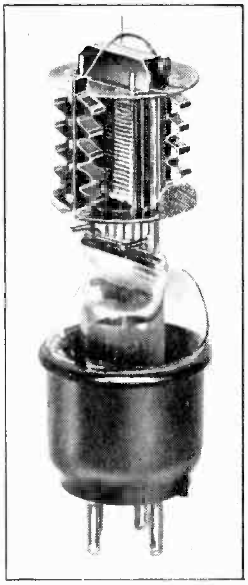

Fig. 8.—"362" *screened grid valve.*

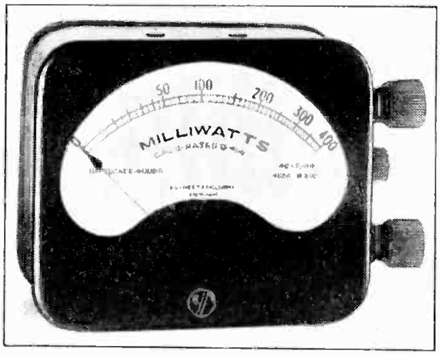

Fig. 9.—*Everett Edgcumbe output meter.*

Meters

The frequency range of Westinghouse metal rectifiers is being steadily increased, as evidenced by the new Westector type WX, which can be used as detector in radio receivers for frequencies up to 1,500 kc/s. The experience gained in this field has led to improvement of the instrument type rectifier, so that meters can now be accurate for all frequencies up to 100 kc/s, and will give qualitative indication on frequencies of 1,000 kc/s.* An interesting application of the rectifier type voltmeter is the measurement of audio-frequency power ; meters of specified resistance are calibrated to read V^2/R directly in milliwatts, as illustrated in Fig. 9, a model by Everett Edgcumbe & Co. In a different class, an interesting addition to the Ferranti range of electrostatic voltmeters is model No. 709, which gives full-scale deflection for only 150 volts. This is a normal pointer instrument with a 2½in. scale, but is spring-mounted in a cast-iron case to protect the suspension from shock.

* At the time of writing, the new rectifier is not yet fitted to all commercial meters.

Of the several modulated oscillators for receiver testing which were exhibited, one of the most interesting is made by the Wm. F. Brown Radio Co. in both mains and battery versions. It employs a single tetrode valve as dynatron with optional self-modulation up to a maximum depth of 30 per cent., and the special circuit employed (probably an amplitude-limiting device) is claimed to make the calibration independent of modulation, change of supply voltage and change of valve. The output voltage is stated to vary by only 10 per cent. to 15 per cent. over any tuning range, and the frequency bands covered are 1,500 to 550 kc/s, 300 to 150 kc/s, and 150 to 95 kc/s. An A.F. output of about 1 volt can be obtained from the internal modulating circuit, and conversely the oscillator may be modulated from an external source ; there is a control to vary the depth of either external or self-modulation. A dummy aerial is included in the output circuit. A pair of the special-circuit dynatron oscillators is used in an A.F. heterodyne oscillator, which covers the range from 20 to 20,000 c/s. ; an a.c. voltmeter is included in this oscillator which may be used to measure either the voltage being delivered by the oscillator or the voltage at the output of apparatus under test.

An interesting use of cathode ray tubes was the Varley demonstration of the response curves of radio-frequency tuned circuits, in connection with "Permeability Tuning."* The voltage developed across the tuned circuit was amplified and fed to a pair of plates of the tube, and the time-base synchronised with the variation in frequency of the local oscillator feeding the tuned circuit ; consequently the resonance curve of the circuit was traced out on the screen, and by an adequate speed of repetition appeared as a constant image. Apart from its use in research and measurement, the cathode ray tube is regarded as the natural basis of the television receiver of the future ; for either purpose, special interest attaches to the Ediswan hard tube which this year replaces the gas-focused type. It is intended for an anode potential of 1,800 volts ; in addition to freedom from origin distortion, higher modulating and writing speeds, and longer cathode life, it is claimed that the hard type may be modulated in intensity with less loss of focusing than occurs in the gas-focused type. It is also stated that in practice the electron velocity is not much in excess of that in the soft tubes, for the screen runs no hotter and the sensitivity is of the same order (greater than ½ mm. per volt).

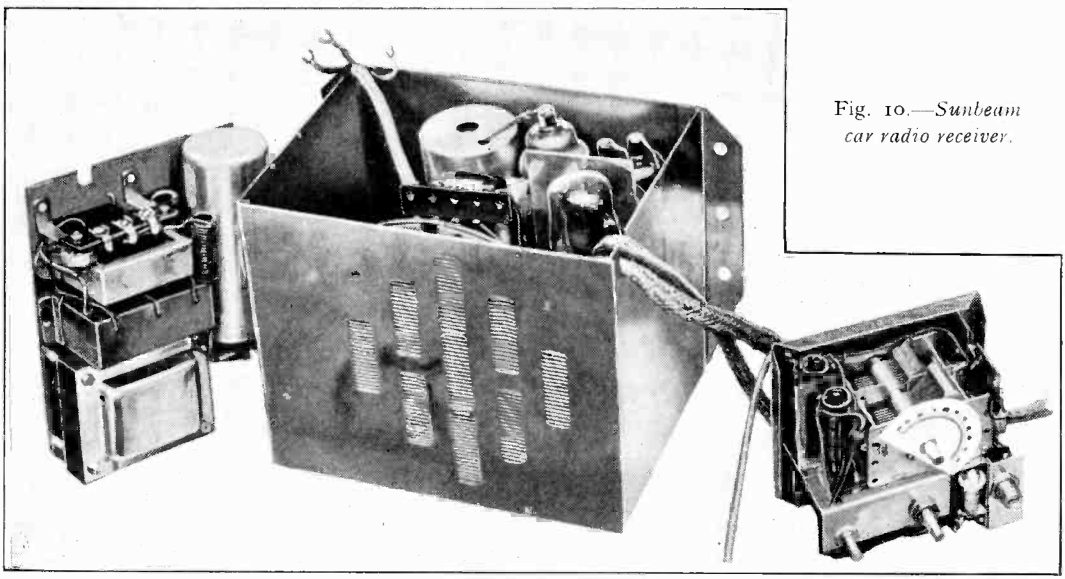

Fig. 10.—*Sunbeam car radio receiver.*

* For an account of this tuning system, see "Permeability Tuning," *Wireless World*, Aug. 17th, 1934, p. 139.

A convenient source of high-voltage d.c. is found in the Westinghouse type "H" metal rectifier, which is a very compact form of rectifier for currents up to 10 mA. Single units are made for voltages up to 650 (this largest size is 13in. by $\frac{7}{16}$in.) but voltage doubling or series connection may be employed for higher potentials.

There are now several manufacturers of screened transmission lines with their associated transformers, to avoid pick-up of electrical interference in aerial down-leads, and in the largest H.M.V. radiogramophone the receiver-end transformer is already built into the set. But on short waves, where a horizontal doublet aerial is efficient, an alternative method is the use of a twin down-lead transposed at short intervals; convenient insulators which serve to space and transpose the two wires are made by Stratton & Co. (Eddystone), the arrangement being described as a "Crossfeeder" aerial system. The same firm also makes a range of small variable condensers specially designed for use at high and very high frequencies; the moulded insulating material employed is a new composition known as DL.9, and the losses in these components should be quite small. It is interesting to note that "Mycalex," a particularly good insulating material, has been employed in the construction of Wearite short-wave coils and valve holders. Litz coils are used considerably in tuned circuits on the actual broadcast frequencies, and for intermediate-frequency circuits where these are tuned to 465 kc/s.

Car radio receivers are largely held back until the Motor Show; but the Sunbeam receiver illustrated in Fig. 10 is of interesting and original design, for the aerial tuning circuit and frequency-changing valve are actually built into the control unit, so that connection between this and the main receiver unit (which contains also the vibratory H.T. generator) is purely electrical, in place of the usual mechanical remote control of tuning and volume. D. A. B.

U.R.S.I. Meeting in London

THE Union Radio Scientifique Internationale (U.R.S.I.) has been meeting in London between 11th and 19th September for its Fourth Plenary Session. In the absence, through illness, of the President of the Union (Prof. A. E. Kennelly, Dr. W. H. Eccles, F.R.S., acted as president for the London meeting.

The Union consists of various scientific bodies in each of the participating countries, and discusses problems with the view to guiding wireless research and experimental work in different parts of the world. Particular attention is, naturally, paid to matters of a wide-scale and international character.

The work of the Union is divided between five Commissions:

I. Measurements and Standards.—*President:* Dr. E. H. Rayner (Great Britain).
II. Propagation of Waves.—Dr. J. H. Dellinger (U.S.A.).
III. Atmospherics.—Prof. E. V. Appleton (Great Britain).
IV. Liaison.—Prof. A. E. Kennelly (U.S.A.).
V. Radio Physics.—Dr. B. van der Pol (Holland).

Commission IV did not meet during the London congress, but a special Polar Year Commission assembled under the presidency of Prof. E. V. Appleton, to discuss the results of the recent International Polar Year between August, 1932, and August, 1933.

For the purposes of the London meeting, sub-Commissions were established for the following subjects:

COMMISSION I.

Frequency Standards Measurements.—*Chairman:* Dr. Rayner.
Field Strength Measurements.—*Chairman:* Dr. Smith Rose (Great Britain).

COMMISSION II.

Measurements of the Ionosphere.—*Chairman:* Prof. E. V. Appleton
Sunspot Relations.—*Chairman:* Mr. R. A. Heising.
Interaction of Radio Waves.—*Chairman:* Dr. van der Pol.
Eclipses.—*Chairman:* Prof. S. Chapman (Great Britain).

COMMISSION III.

Origin of Atmospherics.—*Chairman:* Dr. H. Norinder (Sweden).
Propagation of Atmospherics.—*Chairman:* Mr. Watson Watt (Great Britain).
Measurements.—*Chairman:* M. R. Burean (France).

COMMISSION V.

Physics of the Upper Atmosphere.—*Chairman:* Prof. R. Mesny (France).
Short Waves.—*Chairman:* Dr. K. W. Wagner (Germany).
Theory of Oscillations.—*Chairman:* Dr. van der Pol.

COMMISSIONS II AND V.—JOINT COMMITTEE.

Theory of Propagation of Waves in the Ionosphere.—*Chairman:* Mr. T. L. Eckersley (Great Britain).

The meetings of the Union were held in the rooms of the Royal Society, Burlington House, Piccadilly, the delegates being welcomed at the opening session on 11th September by Prof. J. C. McLennan, Vice-President of the Society, on behalf of the President, Sir Frederick Gowland Hopkins. The first work of the congress then consisted of the appointment of the various Committees already stated, which then proceeded to arrange and hold the meetings for the different subjects of discussion. Towards the end of the Congress full sessions of each Commission were then held to receive and discuss the reports from the Committees and make final resolutions.

In addition to the scientific meetings, the delegates, during their stay, made visits to various establishments of Wireless interest.

On the evening of Tuesday, 18th September, the delegates were also entertained to dinner at Grosvenor House, Park Lane, by H.M. Government, with the Postmaster-General, Sir Kingsley Wood as chairman and principal speaker.

The Design of A.V.C. Systems

The Use of Metal Rectifiers

By W. T. Cocking

(*Concluded from page 482 of last month's issue.*)

I.F. Amplified A.V.C.

IT has been shown that D.C. Amplified A.V.C. is by no means perfect although it offers considerable improvement in some respects over the simpler Delayed Diode A.V.C. system. Another method is available, however, which largely combines the advantages of the two older methods without their disadvantages; unlike them, however, it is usually only applicable to the superheterodyne, for its efficiency may vary greatly with the frequency of the signals upon which it operates.

I.F. Amplified A.V.C. is essentially the same as Delayed Diode A.V.C., but an additional stage of I.F. amplification is provided, usually for A.V.C. purposes only. There are many possible arrangements, principally because the amplifier can be of so many different types, but one highly satisfactory arrangement is that shown in Fig. 18. A single duo-diode-triode is used for A.V.C. purposes and the triode grid is fed with I.F. potentials from the primary of the last I.F. transformer. If the full voltage developed across this primary be required for operating the A.V.C. amplifier, C_1 will naturally be joined directly to the anode of the last I.F. valve. It often occurs, however, that this voltage is too great, and it is usually necessary to apply only a fraction of it; this is conveniently arranged by connecting C_1 to the potentiometer $R_1 R_2$ connected across the last I.F. transformer primary.

The triode cathode is biased positively with respect to the earth line by the voltage drop along R_4 and R_5 due to the passage of its own anode current through these resistances. The grid is returned to the junction of R_4 and R_5 through the resistance R_3, and is consequently negative with respect to the cathode. The constants are so chosen that the valve is biased to work as an amplifier, and its anode circuit load impedance is an H.F. choke. A resistance could be used, of course, or a tuned circuit, but a choke seems the simplest and is satisfactory in practice. In general, the inductance of the choke

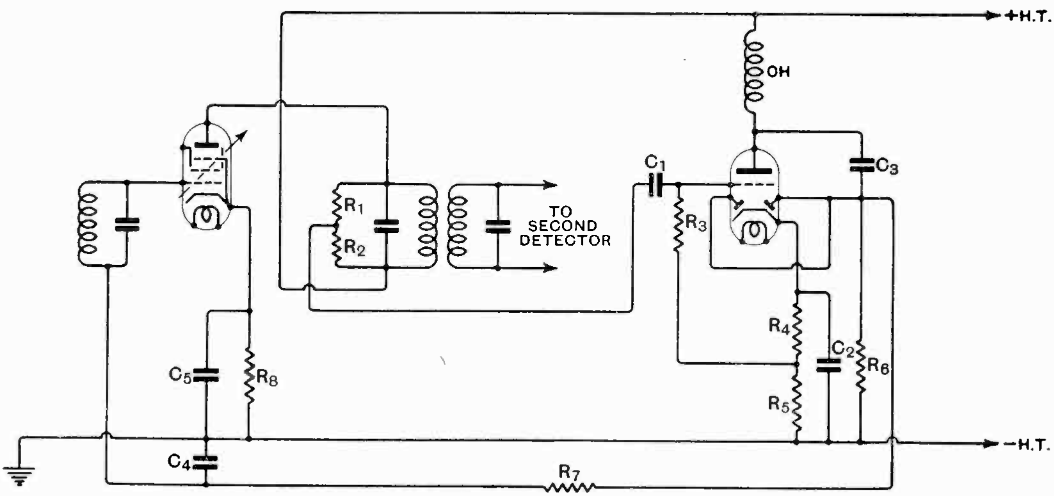

Fig. 18.—*I.F. Amplified A.V.C. is similar to Delayed Diode A.V.C., but a stage of A.V.C. amplification is included.*

should be such that with the various stray capacities it resonates at a frequency somewhat lower than the intermediate frequency, otherwise there is a possibility of the system becoming unstable due to feed-back through the triode anode-grid capacity.

The amplified I.F. potentials developed across the load impedance are applied through the condenser C_3 to the diode, the load impedance of which is the resistance R_6. Since the diode is returned through R_6 to the earth line, and the cathode is positive with respect to the earth line, the diode anode is negative with respect to the cathode. The voltage drop along R_4 and R_5, therefore, forms the delay voltage of the diode rectifying system. When the signal input to the diode exceeds the delay voltage, rectification occurs and the diode anode becomes negative with respect to the earth line, and this potential is applied to the controlled valves as grid bias through the usual filter R_7 and C_4. The operation of the circuit, in fact, is exactly the same as that of the Delayed Diode A.V.C. system save that the A.V.C. diode is preceded by a stage of amplification. Considering this amplifier as part of the A.V.C. system, therefore, the only difference between this and the Delayed Diode arrangement is that it will operate with a much smaller input, the input required being in fact that for the delayed diode arrangement divided by the amplification of the amplifier.

It will thus be obvious that the design of the system calls for no special comment. The delay voltage is determined in the manner already described; the voltage applied to the A.V.C. amplifier will be the H.T. voltage available less the delay voltage, and the grid bias required for operation as an amplifier with this voltage can then be found in the usual way from the valve curves. When this is known, the anode current will also be known, and R_4 and R_5 can then be calculated immediately. The diode load resistance is not critical and the usual value of 1 megohm seems satisfactory, while R_7 and C_4 can also have the usual values. C_3 is not critical, and for a frequency of 110 kc/s a capacity of 0.001μF. has been found satisfactory. The values selected for C_1 and R_3 will obviously depend somewhat upon the particular coupling to the I.F. transformer, but 0.001μF. and 1 megohm respectively seem to meet most requirements. The choke is the only other component requiring mention. Apart from governing the amplification, the anode circuit load determines the magnitude and nature of the input impedance of the A.V.C. system. If the anode load be capacitive, then the input impedance will be positive and it may be of low value; if the load be inductive, however, the input impedance may be a

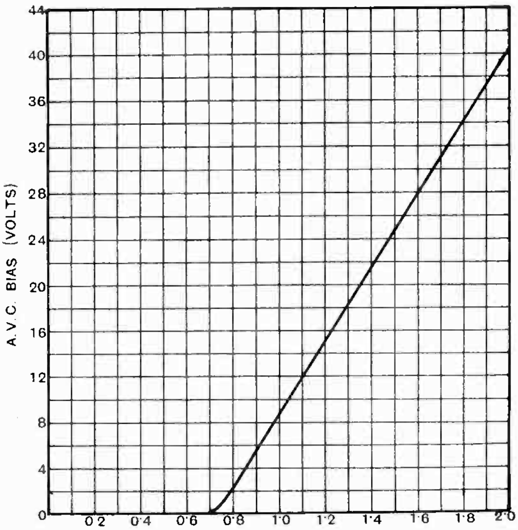

Fig. 19.—*A.V.C. Bias/Input for I.F. Amplified A.V.C.*

negative resistance of low enough value to cause instability. In general, therefore, it is wise to make the load capacitive, and this may be done by choosing a choke of high enough inductance.

When this is done the input impedance may be low enough seriously to damp the I.F. circuit to which it is connected, and so reduce the amplification and selectivity of the I.F. amplifier proper. In general, however, it is unnecessary to connect the A.V.C. system across the whole of the I.F. transformer, and it will usually suffice if the condenser C_1 of Fig. 18 is connected to the circuit by means of a potentiometer, or alternatively to a tapping on the I.F. transformer primary. The effect of the A.V.C. system in damping the I.F. circuit is then very greatly reduced, and may prove negligible. It should be noted that the system is not confined to a duo-diode-triode valve, and it could be employed with an ordinary triode and a separate diode or its equivalent.

The duo-diode-triode, however, is particularly applicable to this arrangement, for the triode grid is brought out at the top of the bulb with the result that the anode-grid capacity is unusually low and the input impedance is likely to be higher.

In order to illustrate the effectiveness of the system the curve of Fig. 19 is included, and shows the A.V.C. bias voltage developed for various inputs at 110 kc/s applied between C_1 and the earth line. When taking this curve an MHD4 valve was used, and the components had the following values: $C_1 = 0.001\mu$F., $C_2 = 1\mu$F., $C_3 = 0.001\mu$F., $R_3 = 1M\Omega$, $R_4 = 2{,}000\Omega$, $R_5 = 15{,}000\Omega$, $R_6 = 1M\Omega$ $R_7 = 1M\Omega$, and $C_4 = 0.1\mu$F. The effectiveness of the arrangement is well brought out.

Before proceeding to a consideration of other systems, it may be pointed out that there are many possible modifications of the I.F. Amplified A.V.C. circuit. The amplifier can be a screen-grid or H.F. pentode type of valve with beneficial results as far as the input impedance is concerned. Higher amplification would also be possible, particularly if a tuned coupling were used to the delay diode. A valve of this type, however, is considerably more expensive than a duo-diode-triode, and a separate diode would have to be used. For economical use of the circuit with a screen-grid type of valve, a multiple valve would be needed combining one or two diodes and an H.F. pentode in the same bulb; moreover, the control grid of the pentode would have to be brought out at the top of the bulb. Such valves are available in America.

It is but rarely that the amplification obtainable with the triode will prove insufficient, however, and for general purposes this valve may be considered entirely satisfactory. Even with this valve, however, there are many alternatives to Fig. 18. It is hardly possible to use one of the diodes for signal rectification purposes, on account of the increase in the effective grid-anode capacity, but it would certainly be possible in some cases to use the triode as the last I.F. amplifier instead of amplifying for A.V.C. purposes only. The system would then resolve itself into ordinary Delayed Diode A.V.C. using a triode for the last I.F. stage, and it might be thought that there would be no advantage. This is not the case, however, for the triode would not be controlled for A.V.C. purposes, and it is capable of a considerably greater undistorted output than a screen-grid valve. The distortion limitation of the ordinary arrangement, therefore, would be reduced.

Another alternative arrangement would permit the triode to be used for signal rectification purposes, and also as the first stage L.F. amplifier. The triode is connected as an ordinary power grid detector, and signal rectification and L.F. amplification follow normal practice. Instead of making the anode circuit load impedance low at the input frequency, however, it is made high by the omission of the usual by-pass condenser and the provision of a suitable H.F. choke. Amplified potentials of the input frequency, therefore, appear across the anode load and these are applied to the diode for rectification, the delay voltage being provided by the drop along the cathode resistance. The arrangement is shown in Fig. 20 and is self-explanatory. The disadvantage of the system, of course, is that the triode is more easily overloaded since it must handle both the input signal and the modulation frequency potentials.

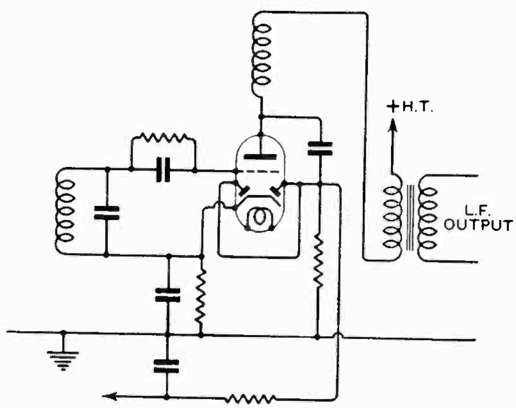

Fig. 20.—*I.F. Amplified A.V.C. applied to a grid detector.*

With most of the systems described the diode rectifier may be replaced by a metal rectifier such as the Westector without any great difference in the results. Two Westectors may be used for Delayed Diode A.V.C. with entire satisfaction, and valves may be retained solely for amplifying purposes. The only differences to be expected when using Westectors instead of thermionic diodes are first that the shunt capacity across the rectifier is higher, secondly, that there is a maximum permissible input voltage which it is sometimes easy to exceed, thirdly, that the rectification characteristics may be somewhat different, and fourthly, that the internal resistance even in the nominally non-conductive direction is not infinite, so that in certain circuits the rectifier may act as its own load resistance.

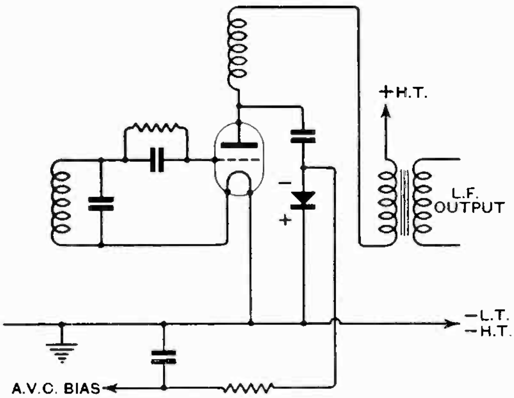

Fig. 21.—*A popular form of A.V.C. using a Westector.*

The chief applications of the Westector in modern practice are in the Delayed Diode A.V.C. circuit in cases where its use enables a valve to be saved, and in the I.F. Amplified A.V.C. system with the particular arrangement of Fig. 20. The details of the circuit applied to a battery operated receiver are given in Fig. 21 and the arrangement is very simple indeed and forms the basis of many commercial A.V.C. units for adding automatic volume control to existing receivers. This is a case of the Westector acting as its own load resistance, and the operation can best be understood by visualising the Westector as a diode in parallel with a very high resistance. In this particular arrangement A.V.C. is not delayed, but this can be simply arranged as in Fig. 22. The battery *E* provides the delay voltage and the resistance *R* is given a value of about 1 megohm. A further modification of this system is shown in Fig. 23 in which two Westectors are used in a voltage doubling circuit. If the capacity of the rectifiers forms a large proportion of the anode circuit load of the valve, this arrangement cannot be expected to provide twice the bias voltage of the circuit of Fig. 21, for the anode circuit load impedance would be smaller and the amplification reduced. There is no doubt, however, that with a suitable arrangement an increased output voltage can be secured by these connections, especially when using the new low-capacity type Westectors.

It should be noted that all the methods of obtaining A.V.C. which have so far been described, with the exception of the Simple and Delayed Diode and the D.C. Amplified systems, are open to the objection that the bias voltage obtainable will be dependent upon the frequency of the detector input. This fact is only unimportant in the superheterodyne, and it is likely to prove very serious in straight sets. With the arrangement of Fig. 20, for example, the A.V.C. bias for a given input will only be constant irrespective of frequency if the amplification of the triode is constant at all frequencies. Obviously this cannot be the case, and in general, the A.V.C. bias will fall off seriously at high frequencies. Now it is just at high frequencies that A.V.C. becomes most important for the reason that fading is then most prevalent.

Matters are even worse when using an ordinary type Westector in the circuit of Fig. 21, for the Westector capacity is higher than that of a valve. The point is well brought out by the curves of Fig. 24 which show the A.V.C. volts obtainable for different inputs to the triode at a number of different frequencies. Although the arrangement is highly satisfactory at 110 kc/s, and indeed throughout the long waveband generally, A.V.C. confers very little benefit at 1,500 kc/s. The writer understands that a new type of Westector is now available for these circuits, and that the capacity has been considerably reduced, so that good A.V.C. is

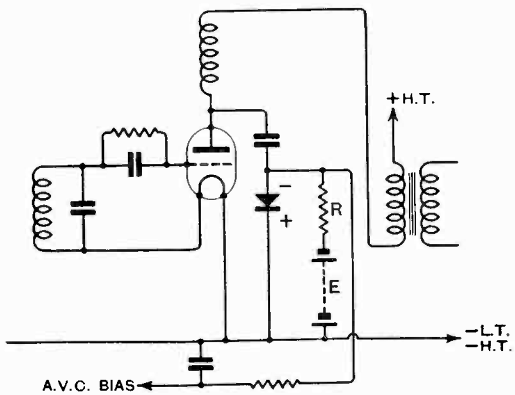

Fig. 22.—*Delayed A.V.C. with a Westector.*

obtainable even at frequencies around 1,500 kc/s. Nevertheless, it must be remembered that stray wiring capacities must be reduced to a minimum if satisfactory results are to be obtained.

Anode Bend A.V.C.

Only one other system of importance remains to be described, and this is the method embodying a separate anode bend

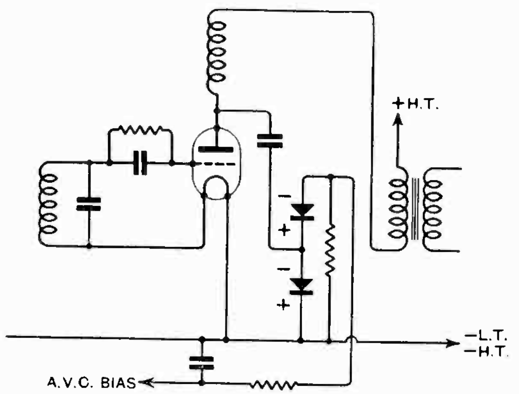

Fig. 23.—*The use of Westectors in a voltage doubling circuit.*

rectifier for A.V.C. purposes. The arrangement is shown in Fig. 25 and it will be seen that the total H.T. supply must be greater than that required by the controlled valves, for the A.V.C. rectifier supply must be negative with respect to the earth line. In the absence of a signal the triode is biased beyond the anode current cut-off point so that there is no current flowing through the anode circuit load resistance R_1 and no voltage drop across it. The control grid of the controlled valve is then returned to the earth line through the usual filter circuit and R_1, so that the bias on this valve is only that due to its own cathode biasing resistance. When a sufficiently strong signal is applied to the A.V.C. valve, anode bend rectification occurs, anode current flows, and there is a voltage drop across R_1; the anode of the A.V.C. valve, therefore, and consequently the grid of the controlled valve, become negative with respect to the earth line.

If correctly adjusted this system is capable of giving good results and a wide range of control. The amount of delay is adjusted by the bias voltage applied to the A.V.C. valve and a smaller delay can be used than with many other systems for the A.V.C. bias voltage increases very slowly for an increase of signal strength when the input voltage is only slightly greater than the delay voltage. As the input is increased further, however, the A.V.C. bias increases much more rapidly. One great disadvantage of the system is that the voltage between negative H.T. and the earth line must be much greater than the maximum A.V.C. bias if an adequate output is to be obtained without grid current overloading in the A.V.C. valve. Although 40 volts may prove sufficient for a small range of control, as much as 120 volts may be needed if overloading on a local station is to be avoided.

A more serious drawback is that the circuit constants may require alteration when using different valves of the same type. The A.V.C. valve must be biased slightly beyond the current cut-off point, and valves seem to exhibit their maximum variation in characteristics in this region, so that the bias needed to give zero anode current with one specimen may be very different from that with another. The performance of a receiver including this system of A.V.C. may be affected, therefore, by valve replacements, unless provision be made for re-adjusting the bias on the A.V.C. valve.

Another effect to be found at its greatest with this system of A.V.C. is that of a variable time constant. It has been observed that the time constant varies with signal strength, and the effect sometimes seems a little peculiar. It is due to the variation of the

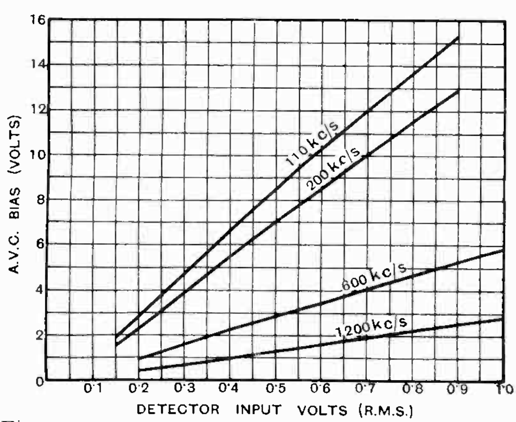

Fig. 24.—*The dependence upon frequency of a particular A.V.C. system.*

internal resistance of the A.V.C. valve with different input voltages. With no input, the internal resistance is infinity, but with a large input it may be as low as 50,000 ohms.

Although this system is capable of meeting most requirements judged solely on the basis of its performance, it is falling into disuse on account of the increased operating voltages which it requires, and because simpler methods are now available. At one time it was practically universal in America, but although it is still used there, it appears to be rapidly dying. In this country it has never been popular, and the writer cannot now call to mind a single commercial receiver embodying it. It seems that it must now be considered as a method not for general use but of academic interest and suitable only for special purposes.

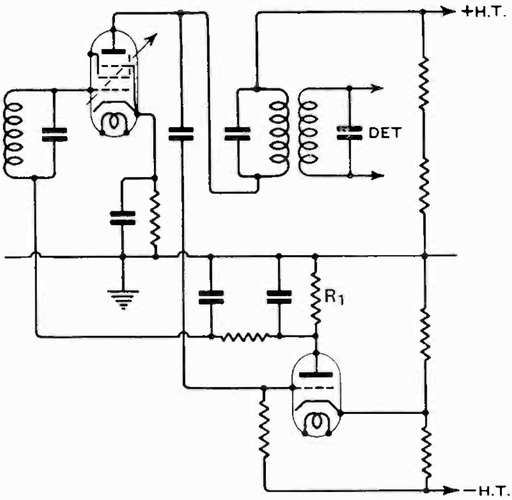

Fig. 25.—*Anode-bend A.V.C.*

Before concluding some mention should be made of the question of manual volume control. The function of A.V.C. is to maintain the detector input approximately constant on all stations, but even if this were performed exactly a manual volume control for varying the sound output of the loud speaker would still be necessary. This manual volume control should operate entirely in the L.F. circuits, and it should obviously precede the first L.F. valve to avoid overloading due to any imperfections in the A.V.C. system. Circuits are occasionally seen which do not include such a control but in which manual control is effected by varying the aerial input, or the grid bias on the controlled valves, in the same manner as in a receiver not equipped with A.V.C. Such volume controls remove most of the advantages of A.V.C., for in any position other than that of maximum volume the set must be operating with an input to the A.V.C. valve less than the delay voltage, and consequently with no A.V.C. bias. As a result, if the station fades so that the signal input to the set is reduced, the sensitivity of the set cannot rise to counteract the fading. Only if the fading results in an increased input to the set can A.V.C. have any effect.

In spite of this a form of volume control operating on the early stages is a useful adjunct to the normal manual volume control fitted in the L.F. circuits. Such a control may be essential for local reception unless the A.V.C. system gives an exceptionally wide range of control, but in a sensitive receiver it is also useful deliberately to reduce the sensitivity while searching. Such a control is often switch operated and termed a " noise suppressor." In one position of the switch the sensitivity of the receiver is at its maximum, in the other it is reduced to such a value that with the set tuned to no station background noises are tolerable. The precise arrangement adopted varies in different cases, but it is usual to include a suitable value of additional bias resistance in the cathode circuit of one of the valves in the amplifying chain and to short-circuit it by a switch when maximum sensitivity is needed. The tuning procedure is then to open the switch while searching, but when the desired station has been tuned in the switch should be closed, except in the case of local reception, so that the full sensitivity will be available should fading occur.

Such schemes are simple and inexpensive, but too often the operator forgets to open the switch before mis-tuning his receiver. Many attempts at automatic methods of inter-station noise suppression have been made, therefore, but up to the present they have not found wide application in any country. The systems are usually complicated and require an additional valve, so that they add appreciably to the cost of a receiver. In addition, with certain methods there is often serious distortion at a particular value of signal input. The most successful system which the writer has handled employs a mechanical relay controlled by an additional valve which is itself controlled from the A.V.C. system. This article, however, is not the place for a discussion of Q.A.V.C., for it is really a separate subject in itself.

Abstracts and References

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PROPAGATION OF WAVES

DIE STÖRUNGEN DER IONOSPHÄRE (The Disturbances of the Ionosphere [Herzogstand/Kochel Echo Measurements, September, 1932, to January, 1934]).—W. Dieminger, G. Goubau and J. Zenneck. (*Hochf:tech. u. Elek:akus.*, July, 1934, Vol. 44, No. 1, pp. 2–17.)

The apparatus has already been described (Abstracts, 1933, p. 320): the distance between stations was only about 5 km, so that the waves producing the echoes were propagated at least approximately vertically. The resolving power was such that disturbances at 12 or 6 seconds' intervals (according to the speed of the slip) could be separated. Since the recorded effective heights were seldom constant, or even only slowly changing, over a long period, the question arises as to what constitutes a " disturbance " : it is here understood to mean a process in which the change in effective height takes place in a short time such as 10 seconds and is large enough to represent an appreciable percentage change in carrier concentration. A change which takes place slowly (in quarter hours or hours), and merely represents a marked difference in height compared with a " quiet " day, is spoken of as " abnormal ionisation " : the two phenomena are quite distinct, and the latter will be dealt with in a later paper.

The chief wavelengths used were 80 and 150 m, but 250, 500 and 1 000 m were also employed. It is pointed out that for the F layer, and to a smaller degree for the E layer also, frequencies near the critical frequency are particularly effective in showing disturbances, since with them—as Appleton has shown—a very small percentage change of carrier concentration will produce a great change in height. Three types of disturbance are recognised :—Type A, in which the heights fluctuate rather quickly on either side of an average (normal) value, as in Figs. 2 (diagrammatic), 3 and 4 (compare with " quiet day " record, Fig. 1). This is due to an interpenetrating mechanical movement between clouds of greater and less carrier concentration.

Type B, seen diagrammatically in Fig. 5, consists in a sudden decrease of height below the normal. " This case is shown in the F layer in Fig. 6." When this type of disturbance is found in the E layer it can hardly be attributed to anything but a sudden increase of carrier concentration in this layer, due to some ionising cause ; but when it occurs in the F layer an alternative reason is a *decrease* of carrier concentration in the *lower* layer which increases the group velocity and thus diminishes the total path time. This second explanation holds in those cases in which the lower layer shows marked disturbances corresponding to sudden decreases in carrier concentration (type C disturbances—see below) : probably Fig. 6 is an example, for although the first E-layer reflection shows hardly any trace of such disturbance, the second E-layer reflection (2 × E) shows it very clearly. Here, the fact that the same wavelength is reflected from both layers shows that the frequency is very nearly critical, and it is only in this case that the lower layer can have a marked effect on the path time of the waves passing on to, and back from, the upper layer. If other frequencies reflected from the lower layer show no marked disturbances in this layer, this is no proof against the possibility of the second explanation, in view of the always strongly marked gradients of carrier concentration in the lower layer. The true type B disturbance, due to a more or less sudden increase in carrier concentration, is regarded as a comparatively infrequent phenomenon.

Type C (Figs. 7–10) is the reverse of type B, being a more or less sudden increase of effective height above the normal value, due generally to a decrease of carrier concentration ; as in type B, there is a second possible cause of this type of disturbance when it occurs in the upper layer, namely, an *increase* of carrier concentration in the layer below, but here again this reason can only hold good when the frequency used is not far from the critical frequency for the lower layer. Variations of type C are types C_1 and C_2 ; in C_1 (represented in Fig. 12, magnified from Fig. 11) the suddenly appearing change in carrier concentration disappears gradually, instead of equally suddenly as in type C ; in type C_2 (Fig. 13), which occurs only on particularly disturbed days, the effective height takes on all possible values in quite short intervals of time. In many cases of type C_2 the heights fall back to a definite minimum value which may be regarded as the normal value, so that the disturbance may be regarded as an irregular type C; but in other cases the behaviour is so irregular that it can only be said that a very strong disturbance is present.

In many cases these three main types of disturbance can be clearly distinguished. In other cases, when there is extremely strong disturbance, or where disturbance is only weak and produces merely a thickening of the curves (as in Fig. 8, E layer), it may be doubtful which type is involved. In such a case a multiple reflection usually gives a much better indication than a once-reflected wave, as in Fig. 6 (already pointed out) and Figs. 8, 14 and 15.

Sections III and IV of the paper deal with the condition of the ionosphere during the various types of disturbance, and the causes producing them. Some of the results of these sections may be summarised as follows :—The disturbances are seldom present throughout the whole vertical extent of the observable ionosphere. It is much more common that a disturbance is strong in one region and occurs not at all, or quite slightly, in the other. It is almost definitely established, also, that under certain conditions only a thin layer within one of the regions may be subject to disturbance: this is suggested by records which indicate that owing to the splitting action of the earth's magnetic field, producing different effective heights for the right- and left-handed wave components, one component may show a marked disturbance and the other none at all.

In the horizontal direction the disturbance zone appears to have an extent which in certain conditions may be as small as 1 km or under. It seems likely that the movements of the ionosphere in the horizontal direction may sometimes have velocities of the order of 1 km/sec.

Those disturbances which represent a decrease in carrier concentration (and these are much more common than those representing an increase), and at any rate some of those which represent a mechanical intermingling of the ionosphere, are very probably due to the action of masses of cometary dust, partly connected with meteoric showers but partly penetrating into the atmosphere without any connection with these. This hypothesis is supported by a letter from Hoffmeister (*see* next abstract) with reference to his Sonneberg observations of the "luminous streaks," of non-auroral origin and unconnected with strong magnetic disturbances, which he attributes to cometary dust.

EINE BISHER UNBEKANNTE KOSMISCHE EINWIRKUNG IN DEN OBEREN LUFTSCHICHTEN (A Cosmic Influence, Hitherto Unknown, in the Upper Atmosphere [Dust-Clouds indicated by "Luminous Streaks"]).—C. Hoffmeister. (*Naturwiss.*, 6th July, 1934, Vol. 22, No. 27, pp. 458–460.)

This note describes a phenomenon of illumination in the night sky, now named "luminous streaks" (Leuchtstreifen), consisting of weak illumination in streaks or patches. It can only be observed under very favourable circumstances but has already been described by the writer several times (Hoffmeister, *Mitt. der Sternwarte zu Sonneberg*, 1927, No. 11; 1931, No. 19; 1934, No. 26). This phenomenon is now found to be probably very closely connected with the occurrence of disturbances in ionospheric ionisation (see preceding abstract). The general conclusion of the writer is that "in the paths of many comets there are moving dust clouds of cometary origin, besides the meteors arising from the disruption of the comet's head; these dust clouds enter the earth's atmosphere and cause the appearance of luminous streaks and ionisation disturbances."

ZUSAMMENHANG ZWISCHEN SCHEINBARER UND WAHRER HÖHE DER IONOSPHÄRE UNTER BERÜCKSICHTIGUNG DER MAGNETISCHEN DOPPELBRECHUNG (Relation between Apparent and True Heights of the Ionosphere, taking into account Magnetic Double Refraction).—G. Goubau. (*Hochf:tech. u. Elek: akus.*, July, 1934, Vol. 44, No. 1, pp. 17–23.)

The mathematical relation between electron density and refractive index for two elliptically polarised waves has already been dealt with in detail by many other workers. The present writer concentrates on the calculation f the path times of signals under the influence of magnetic double refraction, and the consequent relation between the experimentally determined "apparent" heights of reflection and the "true" reflection heights. His calculation is based on the following assumptions :—(1) The effect of ions is neglected. (2) The force on an electron is represented by $\mathfrak{K} = e\,(\mathfrak{E} + 4\pi\,.\,a\mathfrak{P})$, so that by putting $a = 0$ or $a = \frac{1}{3}$ the alternating effect term $4\pi/3\,.\,\mathfrak{P}$ (which must be introduced for bound electrons but whose application in the case of free electrons in an electron/ion mixture "is at present not agreed upon") can either be omitted or included. In the curves given in the present paper it is assumed that $a = \frac{1}{3}$, but it is intended to give the corresponding curves for $a = 0$ in a supplementary paper. A theoretical difference in results is to be expected only in a small band of frequencies below the resonance frequency ("Class 2" dispersion curves in Mary Taylor's paper, 1933 Abstracts, p. 263); this frequency zone, which is distinguished by the fact that for $a = \frac{1}{3}$ the refractive index for the extraordinary ray increases with increasing electron concentration and reaches infinity, is omitted in the present treatment. (3) The effect of electron collision is neglected; this does not fundamentally alter the general results if the region in the immediate neighbourhood of the resonance frequency is omitted. (4) and (5) The path-time calculation is based on vertical incidence at the ionosphere and on the relation $T = 2\,.\int_{u=c}^{u=0} 1/u\,.\,dh$, where u is the group velocity varying with the height h.

Part II deals with the calculation of the group velocity. The denominator in the expression for the refractive index n (equation 1) is represented by a function ϕ, giving a convenient expression 1a for n which can be introduced into the well-known formula connecting phase and group velocities (6th line of Part II) in such a way that the ratio c/u is obtained in a form (equation 3a) which is very convenient for numerical calculation. It is by this formula that the curves of c/u_1 and c/u_2 (for the ordinary and extraordinary rays respectively) are obtained, which are seen in Figs. 1 to 4 for various wavelengths, on the assumption of certain characteristic values for the components of the earth's magnetic field parallel and perpendicular to the propagation direction: the diagrams also include the values of n_1 and n_2. In all these diagrams the abscissae represent values of x, where $x = (1 - a) \cdot \delta/\omega^2$—see equation 1—so that the null points for n, for ordinary and extraordinary ray respectively, are given by $x_1 = 1$ and $x_2 = 1 \pm \omega_0/\omega$. It is seen that for the ordinary ray the shapes of the curves, both for refractive index and group velocity, are approximately the same at all the different wavelengths, whereas for the extraordinary ray their shapes are entirely different for frequencies above and below the resonance frequency, which lies between the 150 m and 250 m frequencies at a wavelength of 214 m. For frequencies above the resonance frequency c/u_2 increases steadily, while for frequencies below it first increases, reaches a maximum (not coinciding with that of n_2) and decreases to a minimum, finally rising towards infinity in the neighbourhood of a point of reflection (zero-point of n_2). Whether this behaviour holds good for very low frequencies is not examined here.

The c/u curves of Figs. 1–3 are drawn in Fig. 5 as functions of electron concentration. In these new curves the ordinary ray is denoted by "o," the extraordinary by "a.o." The conclusions derived from them are discussed in Part IV, which includes experimental results to be published fully in a later paper: thus it appears from Fig. 5 that the group velocity of the extraordinary ray of the 150 m wave, until the neighbourhood of a reflection point is reached, *is greater than* that of the extraordinary component of the 250 m wave. To reconcile this with the experimental result (IVb) that the path-time of the extraordinary 250 m ray is *smaller* than that of the extraordinary 150 m ray, it must be assumed that the electron-density gradient close to a point of reflection for the 150 m extraordinary ray is very small. "This assumption is, however, such a special one that it does not appear justifiable. There is here, therefore, a discrepancy between theory and observation. . . ."

Part III deals with the calculation of the path time. In section 1 a linear increase of the electron density with height is assumed. For the calculation of the path time from entry into the layer to arrival at the point of reflection it is necessary to integrate between the points $x = 0$ and $x = 1$ (for the ordinary ray) and $x = 0$ and $x = 1 \pm \omega_0/\omega$ (for the extraordinary ray): *see* above. $\int dx/u$ can be found graphically from the c/u curves such as Figs. 1–4, but the method fails in the neighbourhood of the reflection points, since c/u here approaches infinity. For these zones, however, the integrations can be carried out easily with the help of the approximations for c/u_1 and c/u_2 given in equations 10 and 11, the interval ξ (given by $x = 1 - \xi$) being chosen very small so that the approximation is close. From this path time t the full "apparent" height may be found by $h_s = c\ (t + t_0)$, where t_0 is the path time from transmitter to lower limit of ionosphere. Fig. 6 shows the relation between "true" heights (light curves) and "apparent" heights (heavy curves) calculated from the lower limit upwards, so that the height h_0 between the earth's surface and this limit must be added to the ordinates. Here, as before, the suffixes 1 and 2 represent the ordinary and extraordinary rays respectively, so that the path time difference would be $2 \cdot (h_{s1} - h_{s2})/c$. Whether these differences can be observed, *i.e.* whether the oscillogram will show a "separation" of the apparent height, depends on the resolving power of the equipment. Generally, two signals can be completely separated if the difference between the apparent heights ≥ 20 km. If, therefore, only one echo is found in spite of magnetic double refraction, as is usually the case except for frequencies near the critical frequency, and there is no appreciable thickening, the reflection-height difference for the two components must < 10 km. Thus if an 80 m wave (or a 250 m wave) shows no separation of apparent height, there must be (on the linear density-increase assumption) an electron density gradient greater than 1.2×10^4 (increase per km) for the former wave, or 2.8×10^4 for the latter.

Section 2 of Part III examines qualitatively how conditions are changed if the density increase is *not* linear. Three cases are considered, for frequencies higher than the resonance frequency:—(a) the gradient increases with height, (b) it decreases with height, and (c) the waves have to penetrate an "intervening layer" (a "small maximum of concentration not sufficient to cause reflection"). In case (a) it is shown that for a constant difference between "true" heights $(h_1 - h_2)$ the difference between the apparent heights $(h_{s1} - h_{s2})$ is smaller than in the case of a constant electron gradient: it may even become negative $(h_{s2} > h_{s1})$. In case (b) the difference between the apparent heights is greater than in the case of a constant gradient. In case (c) the extraordinary ray is retarded more than the ordinary: the measured separation of the apparent heights becomes less and may, as in case (a), even become negative.

Dealing then with frequencies below the resonance frequency, section 2 of Part III points out that since the group velocity of the extraordinary ray, in regions of low electron density, is smaller than that of the ordinary ray, and since the ordinary ray is reflected by a smaller density than the extraordinary, there must be a value of x between 0 and 1 for which the two velocities are equal. Beyond this point $u_1 < u_2$. The behaviour of the group velocity is thus much more complex than for frequencies greater than the resonance frequency, and it is impossible to generalise on how the spacing of apparent heights will be affected by increasing or decreasing gradients.

Part IV deals with the connection between the separation of the apparent heights (*see* above, section 1, Part III) and the apparent heights themselves, at various frequencies. The experimental material employed here consists of two results: (a) If the 80, 150, 250 and 500 m waves are reflected simultaneously from the bottom layer, they yield apparent heights which differ little from one another. No height separation is found. (b) If the 80, 150 and 250 m waves are reflected simultaneously from the upper layer (the 500 m wave is almost invariably reflected only from the lower layer), the 250 m wave yields the lowest apparent height (provided it is not too close to the limiting wavelength), the 150 m wave a distinctly greater height, and the 80 m wave a still greater. Only with the 80 m wave is a height separation observable at certain times. The relation between the theoretical results and these experimental data are discussed: one discrepancy has already been noted (*see* above). Apart from this, the experimental results "are easily reconciled with the theory." Thus the absence of any observed separation in the case of the 250 m wave is explained by the effect of electron collision (neglected in Part I), which is here shown to have a marked influence at this wavelength. The absorption-coefficient/collision-number curves for the 250 m and the 150 m waves, Figs. 9 and 10, suggest that the extraordinary component of the longer wave might be reduced to 1/7th by the there-and-back passage through only 1 km of layer, whereas that of the shorter wave might be reflected with the same order of amplitude as the ordinary ray. If it is concluded that the extraordinary component of the 250 m wave is absorbed, it might be deduced that the sense of polarisation of the echoes would always be that of the ordinary ray; other workers have found, in fact, that this polarisation is predominant. There is no doubt, however, that some of the extraordinary component is also present; this may be because the ordinary ray, on its return journey, may have a small part of its energy converted into an extraordinary component. The possibility of such a splitting-off of one component from the other may perhaps be supported by the occasional occurrence of "multiple splitting" indicated in Figs. 23–25 of the preceding paper (*see* Dieminger, Goubau and Zenneck, above).

OPTICAL [Short-Wave] PATHS IN THE IONOSPHERE.—F. H. Murray. (*Amer. Journ. Math.*, April, 1934, Vol. 56, No. 2, pp. 259–268.)

The writer states that the object of this paper is the development of analysis of optical paths in magnetically doubly-refracting media, for calculation of the approximate path of a short-wave beam in the ionosphere. He assumes Hartree's form of the matrix connecting the electric displacement and electric field (Abstracts, 1931, p. 143: *see* also Goldstein, 1929, p. 40, and Appleton, *Proc. Phys. Soc.*, 1925, Vol. 37, p. 16D) and takes an electric vector of the form $E = Fe^{-ikS}$. From this he deduces a partial differential equation of the first order and fourth degree for S, "which can be considered the equation of Jacobi for a system of differential equations in the Hamiltonian form." He finds that "the trajectories of the Hamiltonian equations are tangent to the Poynting vector of energy flow in the first approximation, if the absorption is negligible." He assumes that the Hamiltonian function H can be written $H = H_1 H_2 H_3 H_4$, and that "the method of successive approximations can be applied to each wave form [*i.e.* each factor of H] independently of the others"; and considers that therefore "no splitting up of a plane wave occurs on entering the ionised region if this wave is suitably polarised at the transmitter close to the earth's surface," so that "it would be possible, with a sufficiently concentrated short-wave beam, to transmit just one wave form to a distant receiver."

The writer outlines the theoretical methods but gives concrete results only for the first approximation to S (*i.e.* a linear form for S); he obtains the expression for the refractive index (*see* papers referred to above) with an arbitrary co-ordinate system: the expression for the polarisation is also given, with its limiting form for zero electron density. He indicates how to take into account the sphericity of the earth, and finds an expression for the limiting ratio of the effect of absorption on the two components for very short waves in the case of longitudinal propagation; he finds that the right-hand component has the relatively smaller absorption.

FLUCTUATIONS IN THE TIME OF PROPAGATION OF SHORT RADIOELECTRIC WAVES.—B. Decaux and J. B. Galle. (*Comptes Rendus*, 25th June, 1934, Vol. 198, No. 26, pp. 2239–2241.)

"We have ascertained that the difference in the path time of waves received at the same point and emitted by two stations of different wavelengths (342 and 1 500 m) did not remain constant but varied from one instant to another. These variations reached, at certain times of the night, values which sometimes represented a considerable fraction of the duration of the direct transit. As the properties of the upper atmosphere particularly affect the propagation of short waves over great distances, we determined to study these path-time fluctuations for a short-wave station at a distance from the receiver." The 24.15 m telephonic station at Pontoise was modulated at 1 000 c/s by tuning-fork signals transmitted by telephone line from the Laboratoire National. The Pontoise signals were received in Algeria and the 1 000 c/s receiver output was used to modulate the Algiers transmitter (24.65 m). This transmission was received at Noiseau and sent by telephone line to the Laboratoire National. It was thus possible to observe, on a cathode-ray oscillograph with two pairs of deflecting plates, the Lissajous' figures produced by the interference of the 1 000 c/s current direct from the tuning fork with that proceeding from the receiver after the go-and-return journey Paris/Algiers. Every variation of the passage time produced a deformation of the Lissajous' figure: the Noiseau receiver had an anti-fading device, so that the curve displacements due to amplitude variations were small and of a different character to those due to change of phase.

Two series of tests were made, one between 9^h and 10^h GMT on 5th June and the other near sunset on 7th June, between 19.30 and 21^h. In the day-time test the Lissajous' figure was very stable, variations corresponding only to 2.5 ten-thousandths of a second being obtained for the path time. In the evening test, on the other hand, the figure changed shape continually and rapidly, indicating path-time variations of *more than a thousandth of a second* in a path time which was of the order of a hundredth of a second. Tests on wavelengths around 33 m furnished the same results. On several occasions the elliptical figure, corresponding to the combination of two vibrations of the same frequency, changed into the figure-of-eight shape characteristic of an octave interval. This is explained as follows:—the 1 000 c/s modulated waves may be regarded as the result of the interference between three systems of waves of different length, the carrier and the two modulation waves 1 000 c/s above and below the carrier: if fading causes the carrier to disappear while the side-waves persist, the latter will produce a 2 000 c/s frequency which will interfere with the tuning-fork 1 000 c/s frequency to give the figure-of-eight shape.

Similar tests on longer waves have been made between Strasbourg (349 m) and Paris. Tests between 22 and 23^h showed the same rotations of the Lissajous' figure as on the short waves: they were, however, less rapid, and the phenomenon of the carrier disappearance was less marked.

EIN VERFAHREN ZUR FORTLAUFENDEN REGISTRIERUNG DER SCHEINBAREN HÖHE DER KENNELLY-HEAVISIDE SCHICHT MITTELS WILLKÜRLICH AUFEINANDERFOLGENDER IMPULSE BELIEBIGER UND WECHSELNDER DAUER (A Method for Continuously Recording the Effective Height of the Kennelly-Heaviside Layer by Randomly Spaced Impulses of Arbitrary and Varying Length).—E. Scholz. (*E.N.T.*, July, 1934, Vol. 11, No. 7, pp. 262–264.)

The time-base movement in the cathode-ray oscillograph is started by the finish of the ground-wave signal. The time-curve of this signal is therefore lost, but the important feature, the signal amplitude, is recorded. The echo is prevented from affecting the time base by an arrangement which blocks the latter circuit from the moment when it is set in action to the moment when it stops.

A typical record is seen in Fig. 3: the blot of light at the right represents the repose position of the spot (time-base condenser charged). At this spot, on the arrival of the ground-wave signal, the amplitude of the latter is recorded. The square-topped pulse of the ground-wave signal is converted in the time-base circuit, by a filter section, into two short impulses in opposite directions (Fig. 2b), and only the second of these, at the end of the signal, acts on the grid bias of V_2 (Fig. 1) so as to discharge the time-base condenser C. Traces of the very rapid right-to-left flick of the spot, representing this discharge, are seen towards the top left of the record. Then the spot begins to mark out the thick time base from left to right, as the condenser C charges up. About at the mid-point of the time base the echo is seen: the distance of this from the left-hand end of the time base gives the path-time difference.

The blocking (mentioned above) of the time-base circuit during its action is produced by taking the p.d., existing across the charging resistance R during the charging of C, to the inner grid of V_1, thus blocking the anode current of the latter valve. This blocking is removed during the discharge of C, since sufficient current does not then flow through R. The vertical deflecting plates receive the signals either directly, in the case of short pulse signals, or through a filter section, when signals are worked on which are longer than the echo path time: in this case the end of the echo is recorded, true to amplitude, as a short pulse.

The present note is a preliminary communication from a longer paper by the writer, to be published shortly, on the ionisation of the ionosphere.

CONTINUOUS RECORDING OF RETARDATION AND INTENSITY OF ECHOES FROM THE IONOSPHERE [by making the Pulse Signals De-focus or Re-focus the Time Base: Width of Gap or Spot gives Intensity, Distance between Initial Edges gives Equivalent Height].—L. C. Verman, S. T. Char and A. Mohammed. (*Proc. Inst. Rad. Eng.*, July, 1934, Vol. 22, No. 7, pp. 906–922.)

For a preliminary note *see* 1933 Abstracts, p. 614 (two). Of the various workers in the field whose methods are now cited, " Hollmann and Kreielsheimer have described a system for intensity and height recording (January Abstracts, p. 29) which does not seem to be adequate enough to record complicated reflection patterns when a large number of echoes are present and some of them all very close to each other. Such a study may yield additional information with regard to the variations in the ionisation content, mechanical movements such as turbulence and winds in the ionised regions, comparative attenuation of the various components of reflection, etc." It is suggested that the objection of low resolving power could be removed by the use of a television type of tube in which the intensity of the ray could be modulated by the variations of voltage on the focusing cylinder. Other improvements are also suggested (pp. 921–922).

First results, at Bangalore on 4 Mc/s, show that the less retarded component of magneto-ionic splitting from the F layer is present most of the time. Whenever the more retarded component does occur it has a stronger intensity than the less retarded; " towards the late evening hours, just before disappearing, when the F layer rises and exhibits magneto-ionic splitting, the intensity of the less retarded component is extremely low compared with the other component." Tentative deductions are discussed on pp. 918–921.

In their description of the pulse generator the writers record that " when an attempt is made to stabilise directly a pulse frequency by means of a standard frequency which is a submultiple of the former, it is observed that the successive pulses are not evenly spaced but that there exist groups of pulses, the frequency of the groups being that of the standard voltage control. . . . This sort of fine-grain discrepancy must also occur in the multivibrator circuits so commonly used for multiplying frequency."

EXPERIMENTS ON THE RECORDING OF FADING BY CATHODE-RAY OSCILLOGRAPH WITH THE SIMPLEST POSSIBLE EQUIPMENT [One Two-Stage Loewe Valve as H.F. Amplifier, etc.].—J. Lončar. (*Elektrot. u. Masch:bau*, 15th July, 1934, Vol. 52, No. 28, pp. 328–329.)

IONOSPHERE STUDIES AT FAIRBANKS, ALASKA [Maximum Ion Density may be 100 km or more above Position of Maximum Auroral Brilliancy: Swinging Doppler Shift to Signal Frequency produced by Auroral Activity: etc.].—H. B. Maris. (*Proc. Inst. Rad. Eng.*, June, 1934, Vol. 22, No. 6, p. 685: short summary only.)

Echoes of Radio Waves [Short-Wave Long-Delay Echoes due to Ordinary Ray penetrating E Layer and being repeatedly reflected, with Rotation of Polarisation, between E and F Layers in Region of Low Attenuation?].—N. Janco. (*Proc. Inst. Rad. Eng.*, July, 1934, Vol. 22, No. 7, pp. 923–925.)

Luminous Night Clouds.—C. Störmer. (*Nature*, 11th Aug. 1934, Vol. 134, p. 219.)

A record of an observation of luminous night clouds in southern Norway on the night of June 30th/July 1st, 1934, at a height of the order of 80 km. *See* also 1933 Abstracts, pp. 497–498.

The Vertical Distribution of Ozone in the Atmosphere.—F. W. P. Götz, A. R. Meetham and G. M. B. Dobson. (*Proc. Roy. Soc.*, 2nd July, 1934, Vol. 145, No. A 855, pp. 416–446.)

The average height of the ozone in Switzerland is found to be about 22 km above sea-level; the ozone is distributed mainly between the ground and 35 km. "The form of the vertical distribution appears to depend chiefly on the total amount of ozone present."

The Ultra-Violet End of the Spectrum of the Night Sky [including the apparent Presence of Rays of Emission in the Region of the Hartley Absorption Band of the Atmospheric Ozone].—J. Gauzit. (*Comptes Rendus*, 2nd July, 1934, Vol. 199, No. 1, pp. 29–31.)

Atmospheric Investigations with the Light [Ultra-Violet Quantum] **Counter Tube in Arosa** [Application to Investigation of "Umkehr" (Reversal) Effect and of Ozone Content at Lower Levels].—F. W. P. Götz, M. Schein and B. Stoll. (*Helvet. Phys. Acta*, Fasc. 5, Vol. 7, 1934, pp. 484–488.)

Kurzwellenerfahrungen im drahtlosen Überseeverkehr von 1926–1934 (Short-Wave Results on Wireless Transoceanic Services in 1926–1934).—H. Mögel. (*Telefunken-Zeit.*, June, 1934, Vol. 15, No. 67, pp. 23–39.)

"Since the last publication of the reception curves and most favourable traffic times for the short waves on the various transoceanic services [Quäck and Mögel, Abstracts, 1929, p. 165], six years have elapsed. This is just about the half of the eleven-year solar activity period. Since the year 1927/28 may be taken as the maximum, and 1933/34 as the minimum, of solar activity, results are now available over a full half-period. As has already been shown in several papers [Plendl, 1932, p. 334] a change in propagation conditions occurs in this time, which produces a marked displacement of the serviceability of the various wave-groups. Many frequencies, particularly the higher ones above 20 000 c/s, are less suitable for long-distance working during the minimum. On practically all the lines, moreover, a greater number of frequencies are necessary than in the earlier years of greater solar activity. This may be partly due to the optimum frequencies on some lines not having been discovered or utilised. The choice of the best working-waves is often very difficult, since the propagation conditions in the last few years have, in part, changed in jumps, and different conditions exist on different lines. The changes are very considerable, so that the short-wave services must make complete allowance for them. The whole technique of short-wave communication is still so young that it has been impossible, up to the present, to get a complete solution to the problem. From many sides, therefore, the wish has been expressed that the reception statistics of the transoceanic services, published in 1928, should be brought up to date, so as to enable a comparison to be made between the propagation conditions for maximum and minimum solar activity." This is done in the present paper, with the help of elaborate coloured plates as in the previous communication. Some of the conclusions drawn are as follows:—

The displacement of the optimum frequencies is greater in the night-wave zone than in the day-wave zone. The difference in ionisation between summer and winter is greater in 1933/34 than in 1927/28. But in interpreting the data it must be remembered that in the years of maximum solar activity (1927/29) the working waves were kept not below 14.5 m for engineering reasons connected with transmitter and receiver design, although the waves below 15 m were, for many lines, in the centre, or even upper half, of the useful day-wave band. "To-day, in the minimum of the 11-year period, the various communication companies naturally tried to use these frequencies as long as possible, so as to make as much use as possible of their transmitting and receiving aerials, even though the waves gradually became worse and worse and fell to the lower half, or lower limit, of the useful band. In consequence, the difference between day- and night-waves becomes particularly marked." Figs. 14 and 15 show the variation, as a function of the distance (from 1 000–12 000 km), of the day-wave band and the night-wave band respectively, for both the maximum and the minimum parts of the solar-activity cycle; while Fig. 16 shows on one diagram both day- and night-wave favourable values, also as a function of the distance, for the same two periods. A further evidence of the decreasing ionisation is the displacement of the round-the-earth echo band, which in 1927/29 was 14–20 m and in 1933/34 is 20–30 m. Effects of the varying solar activity which are not shown in the diagrams are the fading periods, lasting hours or days, due to rapid changes of activity: their strength and frequency increase with increasing activity. The time-connection between them and magnetic disturbances has been dealt with in a previous paper (1931, pp. 144–145.)

Short-Wave Communication over Distances of 100 to 1 000 Kilometres [with Curves and Empirical Formulae for the Choice of Day and Night Waves].—Kolesnikov. (*See* under "Stations, Design and Operation.")

On the Propagation of Waves of 150 m to 2 000 m Wavelength, according to the Madrid and Lucerne Conferences.—(*L'Onde Élec.*, May, 1934, Vol. 13, No. 149, pp. 220–224.)

Seventy-Five-Centimetre [Micro-Wave] Radio Communication Tests [Shore to Boat: Excellent Telegraphic Communication over 88 Miles—5 Times Optical Range: Fading or "Unsteadiness": Use of Yagi Directors and Reflector: B-K Circuits for Transmission and Reception].—W. D. Hershberger. (*Proc. Inst. Rad. Eng.*, July, 1934, Vol. 22, No. 7, pp. 870–877.)

Study on the Propagation of Ultra-Short [and Micro-] Waves in Tunnels.—A. Arenberg and W. Peicikov. (*L'Onde Élec.*, June, 1934, Vol. 13, No. 150, pp. 261–269.)

Analysis of a result obtained in the tests dealt with in 1933 Abstracts, p. 558. It was found that in a concreted tunnel of constant cross section there was a periodic variation of the intensity of reception between the transmitter and the receiver, while in tunnels of variable cross section this variation disappeared. Wwedensky has suggested that the result is due to a phenomenon analogous to that found with a tube with reflecting internal walls and one end closed by a screen with a small window; on bringing up a source of light to this window, bright and dark rings on the internal walls can be observed from the other end of the tube, due to multiple reflection from the walls. Working on this general theory the writers obtain results which agree well with the experimental observations. The absence of the variations in the less regular tunnels is explained by diffused reflection of the side rays.

The Quasi-Optical Propagation of Micro-Waves.—Hollmann. (*See* abstract under "Transmission.")

Dependence of the Dielectric Constant of Air upon Pressure and Frequency [Measurement by Capacity–Resistance Bridge].—A. R. Jordan, T. W. Broxon and F. C. Walz. (*Phys. Review*, 1st July, 1934, Series 2, Vol. 46, No. 1, pp. 66–72.)

The Absorption of Ultraviolet and Visible Light by Water.—L. H. Dawson and E. O. Hulbert. (*Journ. Opt. Soc. Am.*, July, 1934, Vol. 24, No. 7, pp. 175–177.)

Propagation of a Train of Periodic Waves at the Surface of Water [and the Experimental Proof of the Different Velocities of the Front and Rear of a Wave Train in a Dispersive Medium].—J. Baurand. (*Comptes Rendus*, 9th July, 1934, Vol. 199, No. 2, pp. 122–123.)

Anomalous Dispersion in the Magnetron.—Giacomini. (*See* under "Valves and Thermionics.")

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

On the Diurnal Variation of Atmospherics during the Polar Night [Scoresby Sound Results (Radiocinemograph) compared with Paris Directional Records: Deductions].—M. Douguet and R. Bureau. (*Comptes Rendus*, 9th July, 1934, Vol. 199, No. 2, pp. 160–163.)

"It is known that the principal and universal characteristic of atmospherics is to present a nocturnal maximum which is particularly accentuated on frequencies around 30 kc/s (10 000 m). This maximum is attributable to the night, which favours the propagation of waves coming from very distant sources. The records on 27 kc/s obtained by the French Polar Year station at Scoresby Sound provide information on what happens to this diurnal variation when the alternation of day and night disappears, as it does during the polar night in regions of high latitude." A daily maximum appears at times when the sun is furthest below the horizon: this is comparable with the nocturnal maximum in temperate regions. It occurs in two stages: the "first appearance" is a rise in the curve at a time varying between 15^h 30 and 19^h (GMT), and the "second appearance" (often a very vigorous rise) follows at a time which varies very little, about 21^h. The quasi-nocturnal atmospherics disappear usually between 9^h and 11^h.

A comparison of these results with the goniometric records taken in Paris during the same period shows that the common hour for the "second appearance" at Scoresby Sound is the same as that for the most frequent appearance at Paris of an atmospherics source in the south-west: this confirms the explanation given by Bureau (1932 Abstracts, p. 518) of the regularity of the nocturnal directions at Paris, namely that the atmospherics appear at the moment when the night begins to reach the sources—which puts the eastern limit of these as the east of Brazil. The "first appearance," much more uncertain and irregular than the second, both at Scoresby Sound and at Paris, is probably attributable to African sources.

But the writers consider that the Scoresby Sound results are above all interesting as regards the moment of disappearance and its cause. It may be attributed either to a disappearance of the sources themselves, or to the arrival of day at the sources, or to the arrival of the sun, at the zenith of Scoresby Sound, at the altitude of the ionised layers. The writers decide in favour of the second explanation: "It seems practically proved, to-day, that the very distant sources only appear when night covers the whole path, and that the day world-sources are localised in the continents: now the hours of disappearance observed at Scoresby Sound correspond to the moment when the whole American continent south of 15°S has just emerged into the daylight hemisphere. The sources would thus be distributed over the tropical regions to the south of a line from east Brazil to the Pacific coasts (south of Peru). If this hypothesis is confirmed, the polar night records of atmospherics assume a great interest, for they furnish a comprehensive view of the distribution of world-sources in the hemisphere of which the recording station forms the pole. The times of appearance and disappearance of the daily maximum depend on the arrival of night and day at the sources, since the receiver itself remains all the time in the night."

FREQUENCY DISTRIBUTION OF THE INTENSITIES OF RADIO ATMOSPHERICS [from 10 to 60 kc/s: Agreement between Observed Values and Values Calculated by Propagation Formulae].—K. A. Norton. (*Proc. Inst. Rad. Eng.*, June, 1934, Vol. 22, No. 6, p. 682: short summary only.)

THE EVOLUTION OF TROPICAL STORMS, *and* THE POLAR FRONT AND THE FORMATION OF TYPHOONS.—Ch. Poisson. (*Comptes Rendus*, 25th June, 1934, Vol. 198, No. 26, pp. 2273–2275: 9th July, 1934, Vol. 199, No. 2, pp. 159–160.)

DEVELOPMENT OF THE LIGHTNING DISCHARGE.—B. F. J. Schonland, H. Collens and D. J. Malan. (*Nature*, 4th Aug. 1934, Vol. 134, pp. 177–178.)

This letter gives " a brief account of some further results obtained with the Boys lightning camera," now modified so that the order of the component strokes of a discharge can be determined. 145 separate strokes were photographed. 65 clearly showed the two-fold character previously reported (Abstracts, 1933, p. 616, and May, p. 262) and the results " suggest that the leader–main stroke sequence is the most common type of development in the discharge to ground. . . . The polarity of the cloud-base in the majority of these flashes is negative."

The new material shows that the " downward-moving leader blazes the branches as well as the main trunk of the discharge and that the subsequent main stroke, in its upward course, turns aside to follow the branched leader down such a branch until it catches up with it." More important, however, is that " there is a characteristic difference between the leader to the first stroke of a discharge and the leaders to subsequent discharges along the same track. While the latter are of a continuously-moving, dart-like character followed by a fainter luminosity, the first leader is a luminous streamer extending in a discontinuous step-by-step manner from cloud to ground. The length of each step is about 50 metres, and, after completing a step, the streamer luminosity practically disappears for a time of the order of 10^{-4} second . . . the record of this type of leader is usually only a series of elongated dots extending from cloud to ground and separated considerably from one another along the time axis by the camera motion during the extinction period."

The stepped leader has not been found in conjunction with any strokes other than the first of a series along the same track and " no continuous dart-like leaders have been found blazing the way for first strokes." " Electromagnetic radiation from such steps would be on a wavelength of approximately 30 km, which is that of the ripple on many atmospherics. The sound waves emitted would have a frequency of about 10 000 and could produce the sound of tearing linen sometimes reported for a close discharge."

LIGHTNING " STRIKES TWICE AND EVEN TEN TIMES " [American Results with Boys Camera].—(*Gen. Elec. Review*, July, 1934, Vol. 37, No. 7, pp. 349–350.)

THE DEVELOPMENT OF THE LIGHTNING FLASH AND ITS INFLUENCE ON THE ATMOSPHERIC ELECTRICAL FIELD.—V. Aigner. (*E.T.Z.*, 26th July, 1934, Vol. 55, No. 30, pp. 751–752: summary of Berlin Dissertation.)

LIGHTNING INVESTIGATION ON TRANSMISSION LINES. IV [Currents from 4–63 Thousand Amperes measured by Surge Crest Ammeter: of 64 Readings, all but 2 showed Currents of Negative Polarity].—W. W. Lewis and C. M. Foust. (*Elec. Engineering*, August, 1934, Vol. 53, No. 8, pp. 1180–1186.)

LIGHTNING INVESTIGATION ON A 220-KV SYSTEM [during 1931/33].—E. Bell. (*Ibid.*, pp. 1188–1194.)

LIGHTNING PERFORMANCE OF 132-KV LINES [for Past 9 years].—P. Sporn and I. W. Gross. (*Ibid.*, pp. 1195–1200.)

COUNTERPOISE TESTS AT TRAFFORD [for reducing Tower Footing Surge Impedance so as to give Added Protection against Lightning].—C. L. Fortescue and F. D. Fielder. (*Elec. Engineering*, July, 1934, Vol. 53, No. 7, pp. 1116–1123.)

THEORY AND TESTS OF THE COUNTERPOISE.—L. V. Bewley. (*Ibid.*, August, 1934, Vol. 53, No. 8, pp. 1163–1172.)

A NEW SURGE-CREST AMMETER.—C. M. Foust and G. F. Gardner. (*Gen. Elec. Review*, July, 1934, Vol. 37, No. 7, pp. 324–327.) Improved design and technique for the instrument referred to in 1933 Abstracts, p. 151, r-h column.

THE RECENT DEVELOPMENT OF SURGE ARRESTERS IN H.T. SYSTEMS.—D. Müller-Hillebrand. (*E.T.Z.*, 26th July and 2nd Aug. 1934, Vol. 55, Nos. 30 and 31, pp. 733–738 and 765–767.)

PENETRATING POWER OF ASYMMETRIC COMPONENT OF COSMIC RADIATION.—S. A. Korff. (*Phys. Review*, 1st July, 1934, Series 2, Vol. 46, No. 1, pp. 74–75.)

The conclusion is reached that " in the equatorial latitudes a large fraction of the particles which produce the west excess are of far too low energy to have ever been able to come from outside into our atmosphere through the blocking effect of the earth's magnetic field. The counting tubes are excited predominantly by secondaries produced within the earth's atmosphere."

REMARKS ON SUPER-NOVAE AND COSMIC RAYS.—W. Baade and F. Zwicky. (*Phys. Review*, 1st July, 1934, Series 2, Vol. 46, No. 1, pp. 76–77.)

THE RESULTS OF THE SCIENTIFIC MISSION TO ERITREA FOR THE STUDY OF THE COSMIC RAYS.—B. Rossi, I. Ranzi and S. de Benedetti. (*La Ricerca Scient.*, May, 1934, 5th Year, Vol. 1, Supp. to No. 9/10, pp. 559–605.)

RESULTS OF THE DUTCH COSMIC RAY EXPEDITION 1933: II AND III. THE MAGNETIC LATITUDE EFFECT OF COSMIC RAYS: A MAGNETIC LONGITUDE EFFECT: *and* ABSORPTION PHENOMENA OF CORPUSCULAR COSMIC RAYS. —J. Clay and others. (*Physica*, July, 1934, Vol. 1, No. 9, pp. 829–838 and 839–848.)

COSMIC RAYS INSIDE THE EARTH. I AND II.—J. Clay and others. (*Physica*, June, 1934, Vol. 1, No. 8, pp. 659–662 and 663–664.)

SECONDARY COSMIC RAYS FROM THE WALL OF AN IONISATION VESSEL.—J. Clay and P. M. van Alphen. (*Ibid.*, pp. 665–666.)

PROBABILITY FLUCTUATIONS OF FOURFOLD COINCIDENCES IN GEIGER-MÜLLER COUNTERS, PRODUCED BY COSMIC RAYS.—M. R. van der Loeff. (*Ibid.*, pp. 667–672.)

ELECTRICAL "TIDES" SUGGESTED AS CAUSE OF SUNSPOTS [Venus and Earth responsible for Eight-Year Cycle: Venus, Mercury and Earth for Eleven-Year Cycle].—F. Sanford. (*Sci. News Letter*, 30th June, 1934, Vol. 25, No. 690, p. 404.)

PROPERTIES OF CIRCUITS

RESONANT LINES IN RADIO CIRCUITS [particularly at Ultra-High Frequencies: Theoretical Treatment and Suggested Applications].—F. E. Terman. (*Elec. Engineering*, July, 1934, Vol. 53, No. 7, pp. 1046–1053.)

Previous work referred to in this paper includes that of Conklin, Finch and Hansell (Abstracts, 1932, p. 93), Mouromtseff and Noble (1932, p. 636), and Sterba and Feldman (1932, pp. 585–586). "It is the purpose of the present paper to present the fundamental properties of resonant lines when used as substitutes for the circuit elements commonly employed at high frequencies. In particular, the possibilities of resonant lines as a means of developing high impedances, highly selective circuits, low-loss inductances and capacitances, and high voltage step-up ratios will be investigated, and the best proportions for each purpose determined." The performance "is vastly superior to that of any ordinary type of circuit or circuit element."

EIN SATZ ÜBER ELEKTRISCHE NETZWERKE UND MIT EINER ANWENDUNG AUF FILTER (An Electrical Network Theorem with an Application to Filters).—B. van der Pol. (*E.N.T.*, July, 1934, Vol. 11, No. 7, pp. 233–237.)

"It is the purpose of this Note to prove the following general theorem:—Given a passive, linear and constant network which is at rest up to time $t = 0$. At this instant a unit of e.m.f. is applied in the branch m. Let it generate the current $i_k(t)$ in the branch k. We consider, further, a second network, derived from the first in such a way that every L is replaced by a C^* and every C by an L^*, where $1/\omega_0 C^* = \omega_0 L$ and $1/\omega_0 L^* = \omega_0 C$, for an arbitrary frequency ω_0; all resistances remaining unchanged ($r^* = r$). The second system is thus derived from the first by 'reflection' with respect to the frequency ω_0.

"In the reflected system let the unit of e.m.f. again act at time $t = 0$ in the branch m and let it excite in the branch k the current $i_k^*(t)$. Then our theorem states that the current $i_k^*(t)$ in the reflected system can be calculated from the current $i_k(t)$ in the original network by means of the integral

$$i_k^*(t) = \int_{\tau=0}^{\infty} \omega_0 \sqrt{t/\tau} \, . \, J_1(2\omega_0\sqrt{t\tau}) \, . \, i_k(\tau) d\tau \quad .. \quad (1)$$

Here J_1 is the Bessel function of the first order. If, in addition, $i_k(t)$ contains no initial impulse, (1) can be simplified [by partial integration and elimination of the part in front of the integral sign, since the system is originally at rest: *see* bottom of p. 235] to

$$i_k^*(t) = \int_{\tau=0}^{\infty} J_0(2\omega_0\sqrt{t\tau}) \, . \, di_k(\tau)/d\tau \, . \, d\tau."$$

The latter integral is actually given in a slightly different form, $di_k(\tau)/d\tau$ being replaced by the abbreviation $i'_k(\tau)$.

After proving these two parts of his theorem by the symbolic method, the writer illustrates its application by taking first the case of an ordinary oscillatory circuit in a series connection, and then by deriving, from the indicial admittance of a low-pass filter, a new expression for the corresponding indicial admittance of a high-pass filter with the same cut-off frequency ω_1, in the form of an integral of two Bessel functions, namely,

$$i_n^*(t) = \sqrt{C/L} \int_{s=0}^{\infty} J_0(2\sqrt{\omega_1 ts}) J_{2n}(s) ds,$$

where $s = \omega_1 \tau$. In a similar form the thesis holds also for mechanical systems. *See* also below.

A THEOREM ON ELECTRICAL NETWORKS WITH AN APPLICATION TO FILTERS.—B. van der Pol. (*Physica*, May, 1934, Vol. 1, No. 7, pp. 521–530.) In English: *see* above.

ON THE APPLICATION OF VECTOR DIAGRAMS TO THE STUDY [and Practical Calculation] OF ELECTRIC FILTERS.—A. Harkevitch. (*L'Onde Élec.*, June, 1934, Vol. 13, No. 150, pp. 245–260.)

TIME CONSTANT AND SELECTIVITY OF CIRCUITS COUPLED BY ELECTRONIC VALVES [Time Constant of a Chain of Circuits always considerably less than Product of the Time Constant of Each Circuit and the Number of Circuits: also, for given Time Constant, Selectivity of Chain is less than that of Single Circuit with that Time Constant].—G. Fayard. (*L'Onde Élec.*, May, 1934, Vol. 13, No. 149, pp. 225–230.) *See* Mesny, below.

TIME CONSTANTS, BUILDING-UP TIMES, AND DECREMENTS.—R. Mesny: Fayard. (*L'Onde Élec.*, June, 1934, Vol. 13, No. 150, pp. 237–243.)

"In a recent article [*see* preceding abstract] M. Fayard has calculated the building-up time of an alternating current in a system of n identical amplifying circuits in series; he arrives at the conclusion that the time constant θ_n of such a system is much lower than n times the value θ_1 of that for one circuit alone. He opposes this result to that given by other writers.

"We propose to show:—that this divergence arises from the fact that the definitions adopted by the writers are not the same; and that the generally accepted idea of the time constant only agrees in exceptional cases with the phenomenon it is supposed to characterise, namely the duration of the establishment or the disappearance of a current." Thus in a simple circuit where the current dies down according to the relation $i = Ie^{-at} \sin \omega t$, where $a = R/2L$, the time constant θ_1 is defined as the time necessary for the current to decrease from unity to the value $1/e$: then $\theta_1 = 1/a = 2L/R$. The relation may therefore be written $i = Ie^{-t/\theta_1} \sin \omega t$, and since $e^{-3} = 0.05$ and $e^{-4} = 0.018$, it is concluded that a current disappears (or builds up) practically in a time equal to 3 to $4\theta_1$.

In this case the quantity θ_1 gives exact information on the time of disappearance or building up; but directly a simple circuit is replaced by a system of circuits the position is changed: the exponential function is replaced by a function $\phi(t)$, such that $\phi(0) = 1$, so that $i = I\phi(t) \sin \omega t$. In finding the equivalent circuit, therefore, using the definition of time constant already given, it is necessary to look for a quantity Θ such that $\phi(\Theta) = 1/e$. The discrepancy between Fayard's results and those of other writers (the example taken is that of Rocard, 1933 Abstracts, p. 97) is due to Rocard's adhering to the usual definition whereas Fayard replaces the $1/e$ by 0.1. The present writer considers that the former procedure gives little useful information and is liable to lead to confusion.

The paper goes on to discuss the convenient use of the time constant in an expression for the coefficient of selectivity of a simple circuit, and shows that the same kind of difficulties arise when its use is extended to a series of circuits. Finally, it is suggested that the modern habit of neglecting decrements and concentrating on time constants is a mistake, for "experiment shows that decrement has a very interesting property, which does not seem to have been brought to light: it is practically independent of frequency for circuits 'equally carefully designed'"—a vague phrase but one "easily understood by technicians." Thus the average coil used in receivers has a decrement of the order of 1/30; carefully designed coils, 1/60 to 1/100; and special coils for the laboratory, a decrement descending below 1/250.

OSCILLATEURS SYMÉTRIQUES ET MULTIVIBRATEUR (Symmetrical Oscillators and the Multivibrator).—J. Mercier. (*L'Onde Élec.*, May, 1934, Vol. 13, No. 149, pp. 197–219.)

Author's summary:—"After setting out some generalisations on symmetrical oscillators and showing that all these can be classed in quite a small number of typical categories, the writer begins their theoretical study. Their action is double, and the valves may work in parallel or in opposition. It is the latter mode which is generally considered. Under certain conditions the first mode cannot occur; it actually corresponds to a certain output in h.f. on the part of the h.t. source, and a simple blocking choke renders it impossible. In the opposition mode, on the other hand, this output is zero, the current in the symmetrical components of the circuit being always equal and of opposite sign.

"The second part examines the multivibrator, which is nothing more or less than a symmetrical oscillator of aperiodic circuit. Even in the absence of grid current the oscillations are of the relaxation type. The study is analogous to that of the symmetrical oscillators, but the action in parallel is always damped, so that it is only necessary to derive the oscillating conditions for the opposition mode. There are two successive régimes, one of amplification so long as the valves are not saturated, and the other a damped régime when they are saturated and when the circuit is, as it were, left to itself, since the resistances shunting it are then infinite. But the charge and discharge of the condensers remain always aperiodic.

"If the dynamic characteristics are taken as straight lines limited by the straight lines of zero and saturation current, the theoretical study can be carried fairly far. In any case it is shown that the problem is completely determined. It is shown also that the period depends closely on the time constant of the circuits. The form of the discharge makes it clear, also, why it is so easy to synchronise together an ordinary oscillator and a multivibrator." The paper ends with the diagram of one of the several other symmetrical circuits which are capable of yielding oscillations of the same type. The analysis of this circuit, along the same lines, would be easier, but the classic multivibrator is more simple in practice.

THE GRAPHICAL DETERMINATION OF RESULTANT AND INPUT RESISTANCES IN COMPLEX CIRCUITS.—H. Reppisch. (*Funktech. Monatshefte*, July, 1934, No. 7, pp. 255–259.)

AUTO-TRANSFORMER CIRCUIT ANALYSIS.—W. J. Creamer. (*Rad. Engineering*, July, 1934, Vol. 14 No. 7, pp. 16–18.)

ON THE INDUCTIVE HEATING [Confirmation of Theoretical Formulae for Eddy Current Losses in a Long Conductor in an Alternating Magnetic Field].—J. L. Snoek: Strutt. (*Physica*, June, 1934, Vol. 1, No. 8, pp. 745–748.) Confirmation of Strutt's 1927 work.

THE ACTION OF A H.F. ALTERNATING FIELD ON SUSPENDED METALLIC RINGS AND DISCS.—Taylor. (*See* under "Measurements and Standards.")

TRANSMISSION

MAGNETRON OSCILLATIONS OF A NEW TYPE.—K. Posthumus. (*Nature*, 4th Aug. 1934, Vol. 134, p. 179.)

This new type of magnetron oscillation is obtained by raising the magnetic field above the critical cut-off value in a split-anode magnetron, with, preferably, four anodes connected together in opposite pairs. The frequency is determined approximately by the following equations:—$\omega = 2V_a/r_a^2H$ for a 2-plate magnetron, and $\omega = 4V_a/r_a^2H$ for a 4-plate magnetron. [V_a anode potential, r_a anode radius, H magnetic field].

Eccentric arrangement of the filament facilitates the onset of oscillation. With an anode diameter of 1 cm, strong oscillations are obtained down to 40 cm (output 30 watts).

THE INFLUENCE OF THE MAXWELLIAN VELOCITY DISTRIBUTION [of Electrons emitted from Filament] ON THE PRODUCTION OF DECIMETER [Micro-] WAVES.—M. von Ardenne. (*Naturwiss.*, 17th Aug. 1934, Vol. 22, No. 33, p. 561.)

The influence of variations of the velocity of emission of the electrons on the production of ultra-short waves first becomes important when a high degree of constancy of the emitted frequency is required; fluctuations in transit time appear to give rise to partial damping of the waves, so that the frequencies produced cover a small band. The effect may be decreased by suitable choice of circuit conditions.

SEVENTY-FIVE-CENTIMETRE RADIO COMMUNICATION TESTS [and a Simplified Theory of Barkhausen-Kurz Oscillation Mechanism].—Hershberger. (*See* under "Propagation of Waves.")

ERZEUGUNG UND ANWENDUNG KÜRZESTER UNGEDÄMPFTER ELEKTRISCHER WELLEN (The Generation and Employment of Undamped Micro-Waves [Comprehensive Survey]).—H. E. Hollmann. (*Hochf:tech. u. Elek:akus.*, August, 1934, Vol. 44, No. 2, pp. 37–60.)

With over 80 literature references, including Russian. The survey is divided into five parts:—I. Oscillations in regenerative circuits with positive anode: (a) the limit of retroaction, and (b) ultra-dynamic characteristic inversion. II. The brake-field method: (a) pure electron oscillations, (b) the electronic generator as a coupled system, (c) theory of space-charge oscillations, (d) pigmy waves, (e) inversion oscillations, (f) the influence of gases, and (g) special valves and oscillating arrangements. III. The general behaviour of an ionised space at ultra-high frequencies. IV. The magnetron: (a) the cylindrical diode in a magnetic field, and (b) the split-anode magnetron. V. Practical employment of the micro-waves: (a) reception, and (b) quasi-optical propagation.

RESONANT LINES IN RADIO CIRCUITS [particularly at Ultra-High Frequencies].—Terman. (*See* under "Properties of Circuits.")

TRANSMISSION LINES AS FREQUENCY MODULATORS [Eighth-Wave Transmission Line with One End acting as part of Oscillatory Circuit of Transmitter, the Other End beingclosed by a Modulated Resistance: Absolute Linearity with Negligible Amplitude Modulation].—A. V. Eastman and E. D. Scott. (*Proc. Inst. Rad. Eng.*, July, 1934, Vol. 22, No. 7, pp. 878–885.)

ELECTRON-COUPLED TRANSMITTERS [Good 40 and 20 Metre Results from Federated Malay States to Japan, Australia and Europe, using Audio-Frequency Pentode].—J. MacIntosh. (*Wireless Engineer*, July, 1934, Vol. 11, No. 130, p. 371.)

SYMMETRICAL OSCILLATORS AND THE MULTIVIBRATOR.—Mercier. (*See* under "Properties of Circuits.")

THE PRODUCTION OF SINUSOIDAL OSCILLATIONS WITH A TIME PERIOD DETERMINED BY A RELAXATION TIME.—J. van der Mark and B. van der Pol. (*Physica*, April, 1934, Vol. 1, No. 6, pp. 437–448.) In English: *see* July Abstracts, p. 377.

APPLICATIONS OF THE DYNATRON.—G. F. Clarke: Groszkowski: Scroggie. (*Wireless Engineer*, June, 1934, Vol. 11, No. 129, p. 307.) *See* June Abstracts, p. 320, l-h column.

THEORIE D'UN OSCILLATEUR DONT LE COURANT DE SATURATION N'EST PAS ATTEINT (Theory of an Oscillator in which the Saturation Current is not reached [Triode in which a Supplementary Current occurs, due to Secondary Grid Emission or to Ionisation: requires Closer Grid/Plate Coupling: Oscillating Energy increases continuously with Plate Voltage: Economy in Heating Current].—A. Amweg. (*Helvet. Phys. Acta*, Fasc. 5, Vol. 7, 1934, pp. 466–468.)

THE PROSPECTS OF HIGH-FIDELITY TRANSMISSION.—(*Electronics*, July, 1934, pp. 206–208.)

SOME NOTES ON THE PRACTICAL MEASUREMENT OF THE DEGREE OF AMPLITUDE MODULATION.—Gaudernack. (*Proc. Inst. Rad. Eng.*, July, 1934, Vol. 22, No. 7, pp. 819–846.) *See* August Abstracts, p. 438, r-h column.

A "SHORT-CUT" METHOD FOR CALCULATION OF HARMONIC DISTORTION OF MODULATED RADIO WAVES [Graphical Method of great service in Class B Modulator Design].—I. E. Mouromtseff and H. N. Kozanowski. (*Proc. Inst. Rad. Eng.*, June, 1934, Vol. 22, No. 6, p. 684: short summary only.)

SCARCITY OF BROADCASTING WAVELENGTHS IN EUROPE: POSSIBILITY OF SUPPLY OF SUPPRESSED CARRIER AT RECEIVER: SINGLE SIDE-BAND TRANSMISSION: ETC.—Harbich: Koomans. (*See* abstract under "Stations, Design and Operation.")

DESIGN OF POWER AMPLIFIER OUTPUT CIRCUITS [with reference to Harmonic Content, Modulation, Distributed Capacity, etc.: by use of Charts and Simple Arithmetic].—R. Lee. (*Rad. Engineering*, July, 1934, Vol. 14, No. 7, pp. 10–12.)

TRANSFORMERS FOR CLASS B MODULATORS [Design and Characteristics of Input and Output Transformers: Insulation Requirements, etc.].—J. Kunz. (*Rad. Engineering*, July, 1934, Vol. 14, No. 7, pp. 13 and 19.)

KOMBINIERTES ÜBERBLEND-, MISCH- UND LAUTSTÄRKEREGELGERÄT (A Combined Fading-In and -Out, Mixing, and Loudness Control Apparatus [Control of any Item independent of the Loudness of the Others]).—P. E. Klein. (*Funktech. Monatshefte*, July, 1934, No. 7, pp. 264–265.)

A-C OPERATED HIGH-GAIN AMPLIFIERS [for Condenser, Moving Coil, or Ribbon Microphones, etc.: A.C. Feed to Heaters and Rectified A.C. to Anodes, without Introduction of Hum].—D. E. Noble. (*Electronics*, July, 1934, pp. 210–212.)

SIMPLIFIED VOICE-OPERATED TELEGRAPHY/TELEPHONY CHANGE-OVER FOR SEPARATELY-EXCITED TRANSMITTERS.—W. Runge. (German Pat. 577 872, pub. 14.5.1934: *Hochf: tech. u. Elek:akus.*, August, 1934, Vol. 44, No. 2, p. 71.)

ORIGIN OF THE HIGH-FREQUENCY OSCILLATIONS PRODUCED BY HIGH-TENSION MAGNETOS.—J. Jaffray: Finch and Sutton. (*Comptes Rendus*, 25th June, 1934, Vol. 198, No. 26, pp. 2244–2246.)

Continuation of the work dealt with in 1933 Abstracts, p. 271. The paper by Finch and Sutton (*Proc. Phys. Soc.*, not *Proc. Roy. Soc.* as given here: *see* 1933 Abstracts, p. 282) is referred to, "but the writers have not made a systematic study of this high frequency" (of the order of 10^7 c/s). The writer finds that these oscillations are due to the discharge in the external circuit (which has a low coefficient of self-inductance) of the capacity of the secondary circuit, practically localised in the winding. The "first phase" of the discharge can be made to disappear by introducing a sufficiently large resistance into the circuit: as this resistance is increased, the h.f. oscillations are progressively damped out. "For $R = 3\,500$ ohms, the disruptive spark becomes very feeble and hardly visible in the photographs: the first phase has practically vanished. At the same time the arc is changed to a flame or positive glow. This modification does not bring about a great change in the appearance of the photographs; but the light emitted by the discharge becomes red instead of remaining violet as in the arc, and direct observation under a lens or microscope has enabled me to observe very clearly four regions in the discharge: the blue cathode glow, the Faraday dark space, the red positive column, and the bright anode spot."

RECEPTION

GÜTEBESTIMMUNG VON STÖRSCHUTZANORDNUNGEN (Measuring the Effectiveness of Interference-Quenching Appliances [with Results on some Commercial Types, and a Special Design for Extending the Action to Short Wavelengths]) E. Müller. (*Hochf:tech. u. Elek:akus.*, August, 1934, Vol. 44, No. 2, pp. 60–67.)

The writer begins with a survey of our present knowledge of the origin and cure of industrial interference: about thirty literature references are given. He states that up to the present no objective method of measuring the effectiveness of condenser/choke combinations has been given, and goes on to describe his own method and equipment, which depends on the direct measurement of the output voltage/input voltage ratio. A sinusoidal wave is used to replace the interference wave, and the wavelength is varied over the range 25 to 250 metres, curves being drawn showing the "transmission" of the appliance (given in percentages by E_o/E_i) as a function of wavelength.

The generator is a push-pull one in the 3-point connection, of fairly high power (15–20 w) so that even with efficient appliances the output voltages are measurable. Coupled to this is a tuned circuit (*see* Fig. 1) in series with which is connected the input condenser C_1 of the appliance. The output terminals of the appliance are connected through a screened lead and two blocking condensers C_8 and C_9 to the lighting system, so as to represent practical conditions. The input voltage at C_1 is measured by the use of a valve voltmeter employing a low-capacity diode specially designed for h.f. measurements (Rohde, 1931 Abstracts, p. 393); the voltage range is 0.1–500 v. Errors at small voltages, due to the potential drop along the diode filament, are discussed in section IV on various sources of error. The output voltage reaching the lighting system is measured with an ordinary triode in an audion-voltmeter connection (range 10–90 mv), calibrated with h.f. by means of a capacitive potential divider. If higher voltages reach the mains, the triode is replaced by another special diode. Careful screening is provided throughout.

Section V deals with results. The first thing to do was to find out, by measurements with an actual receiver and actual interference, by how much the interfering voltage ought to be reduced by an appliance if the latter was to be regarded as satisfactory. It was concluded that an appliance should reduce the voltage ratio at least down to 5%. Curves 5 to 8 show the results with a number of commercial appliances. The best of these as regards broadcasting wavelengths (Fig. 5) shows a reduction to below 1% for all wavelengths down to about 100 m. Practically all the types give unsatisfactory results below this wavelength, an exception being Fig. 8, probably owing to its small dimensions (short leads and low-capacity coils, $L = 2 \,.\, 10^6$, $C = 8$ cm) This fact led the writer to experiment with special coils, with a view to improving performance at short wavelengths. Figs. 9–11, illustrating his results, are all deliberately taken without any earth on the appliance, since for one reason or another such appliances are frequently used without an earth. The curves must therefore be compared with those less satisfactory curves in the previous diagrams where it is indicated that no earth is used. The only really good results with a conventional circuit but special coils at wavelengths below 100 m are shown in Fig. 11, obtained with a cylindrical coil split up into spaced sections. The curve marked with circles represents a copper-wire coil of this type ($L = 6 \,.\, 10^5$, $C = 4$ cm), while the black-point curve represents an iron-wire coil. This latter curve is referred to in the text as Fig. 12, but is actually as here stated. Both these curves of Fig. 11 show, however, not too good results at wavelengths *above* 100 m, and it is therefore concluded that the demands of the short and medium waves are incompatible.

The solution thus appears to be a series connection of a "short-wave" coil such as has just been described and a medium-wave coil such as the ferrocart coil whose curves are shown (marked with triangles, for one condenser, and crosses, for two condensers) in Fig. 9. The excellent results throughout nearly the whole range of 25–250 m, obtained with such composite coils and three condensers, are shown in the curve (marked with circles) in the same Fig. 9. Its only flaw is a momentary rise to about 6% at about 125 m. It is not quite clear whether the short-wave coil here employed is the copper-wire or the iron-wire one: presumably the former. The paper ends with a discussion of the influence of earthing the input condenser on the performance of the various appliances, and also the effect of the addition of a second (output) condenser. *See* also Schütte and Weiss, July Abstracts, p. 380.

Über Messungen der Übertragung von Störungen aus dem Starkstromnetz auf Rundfunkantennen (Measurements of the Transference of Interference from the Public Supply Network to Broadcast Receiving Aerials).—F. Eppen and K. Müller. (*E.N.T.*, July, 1934, Vol. 11, No. 7, pp. 257–261.)

The writers enumerate 7 factors governing the strength of interference in the loudspeaker: (1) the h.f. interfering e.m.f. of the interference-producer and (2) the internal resistance of the latter; (3) the matching relation between this internal resistance and the resistance of the network; (4) the attenuation of the interference in its propagation along the power system, depending on local conditions; (5) the greatly varying coupling between the network and the aerial; (6) the matching relation between aerial and receiver; and finally (7) the receiver sensitivity. Of these, (1) and (2) can be measured by known methods (Wild, 1933 Abstracts, p. 272); (3) is without effect when condensers are used to suppress the interference, owing to the over-matched condition then existing; otherwise its value can be estimated, but only by further measurements; (6) and (7) apply equally to signals and can therefore be neglected, since the important point is the signal/noise ratio. The writers therefore concentrate on (4) and (5), which are best taken together, since they always act together and their separate values have only a theoretical importance. The tests refer only to inside aerials in apartment houses in Berlin: they were carried out by Siemens & Halske in conjunction with the German P.O. and the State Association for Electrical Supply.

An interference voltage may be divided into two components: the first, the symmetrical component, can be represented by a p.d. between the two conductors to a wall-plug, while the asymmetrical component is a p.d. between the mean potential of the two conductors and the neighbouring earth. The latter component has the greater effect on the receiving aerial (Fig. 1) since it produces a field between the lines and earth (usually represented by water or central-heating systems): in this intervening space the aerial lies, and thus receives a proportion of the interfering voltage depending on its capacity to the wiring system. The effect of the symmetrical component, on the other hand, is governed only by the *difference* of the capacities of the two lines with respect to the aerial. Nevertheless the various asymmetries due to switches, tappings, wall-plugs, etc., do produce strongly asymmetrical voltages which act as mentioned above. A measurement of the symmetrical component alone, in a truly symmetrical system, would lead to the obtaining of very weak couplings. Since the two components spread by different paths, it is clear that the "propagation" attenuation of the symmetrical component (propagating along copper conductors only) must be less than that of the asymmetrical, which has an earth-return. Thus while the asymmetrical component has a greater effect close to the interfering source, at greater distances the case is reversed and the symmetrical component is the more powerful: this is particularly marked for overhead-wire systems, in which the "propagation" attenuation for the symmetrical component is especially low.

The tests were carried out by the use of a signal generator (Fig. 3), covering all the broadcast frequencies from 160 to 1 100 kc/s, in combination with a measuring circuit (Fig. 4) giving the values of voltage and current delivered to the network and the apparent impedance of the latter. The received "interference" voltage was measured by a mains-driven superheterodyne receiver (in which the fading-compensator was replaced by a multi-contact potential divider) and a d.c. meter in the anode circuit of the detector valve, which was selected to be one with a square-law characteristic. Mains-voltage fluctuations were allowed for by the use of a regulating resistance and voltmeter. Mains-interference was blocked out by a condenser/choke combination.

The measured signal output could be applied to the wall-plug either symmetrically or asymmetrically, at will. Fig. 5 shows that in 60% of 330 tests of both types the "transfer" attenuation was less than 5.5 Nepers, while in only 20% was it less than 2.8 Nepers. Figs, 6, 7 and 8 show the attenuations of the symmetrical and asymmetrical components separately, for 160, 680 and 1 100 kc/s respectively, while Figs. 9 and 10 re-group these same curves so that the symmetrical components appear on the former diagram and the asymmetrical on the latter. The increase of "transfer" attenuation with increasing frequency is clearly seen, particularly striking being the very small value for the 160 kc/s asymmetrical component—an unfortunate fact since most interference sources are specially powerful on long waves. The small values of "transfer" attenuation, particularly at low frequencies, are partly due to the formation of standing waves on the lines, giving at certain distances from the source a potential higher than that at its own terminals. Fig. 8, for 1 100 kc/s, shows how at this high frequency the "transfer" attenuation of the asymmetrical component overtakes that of the symmetrical, so that for high attenuations (*i.e.*, at greater distances from the source) the former is more strongly attenuated than the latter.

In addition to these tests, measurements were made of the voltages produced in the same indoor aerials by three local stations whose field strengths at various points of Berlin were already known from P.O. measurements. By dividing the measured voltages by these field strengths the equivalent heights of the aerials were obtained (Fig. 11). The screening effect of steel-frame buildings, in reducing the equivalent heights in some cases to a few centimetres, is discussed: it accounts for the fact that interference is more troublesome in new buildings than in old. The justifiability of using a c.w. signal generator, for tests relating to the behaviour of what actually are highly modulated interference waves, is also discussed. A further part of the paper will be published in which the effect of the situation of such aerials on the signal/noise ratio will be examined, together with the question of how far they owe their useful voltage to the secondary-radiator action of the house wiring.

INSULATOR SURFACE AND RADIO [Interference] EFFECTS [and the Action of Hygroscopic Deposits].—W. A. Hillebrand and C. J. Miller, Jr. (*Elec. Engineering*, August, 1934, Vol. 53, No. 8, pp. 1213–1220.)

PAPERS ON THE H.F. OSCILLATIONS PRODUCED BY H.T. MAGNETOS.—Jaffray: Finch and Sutton (*See* abstract under "Transmission.")

ASE AND UCS COMMISSION FOR THE STUDY OF INDUSTRIAL INTERFERENCE.—(*Bull. Assoc. suisse des Élec.*, No. 15, Vol. 25, 1934, p. 428.)

PROPOSALS FOR REGULATIONS FOR THE PROTECTION OF BROADCAST RECEIVERS AGAINST INTERFERENCE DUE TO HIGH- and LOW-CURRENT INSTALLATIONS (including Definition of "Intolerable" Interference: Measures to be taken at the Receiving End and at the Origin: etc.].—ASE. (*Ibid.*, No. 16, Vol. 25, 1934, pp. 450–456.)

EINE DROSSELKETTE GEGEN NETZSTÖRUNGEN (A Filter [with Specially Wound Coils] for the Elimination of Interference from the Mains).—F. C. Saic. (*Radio, B., F. für Alle*, August, 1934, No. 150, pp. 132–135.)

DECOUPLING EFFICIENCY [and the Negative Efficiency of Decoupling Filters as regards Hum Suppression in Mains-Driven Receivers].—G. F. Clarke: Kinross. (*Wireless Engineer*, July, 1934, Vol. 11, No. 130, pp. 370–371.) Prompted by Kinross's letter on Barclay's paper (Abstracts, February, p. 91, and 1933, p. 504).

A METHOD OF MEASURING NOISE LEVELS ON SHORT-WAVE RADIOTELEGRAPH CIRCUITS [Percentage of Time during which Noise Level exceeds Predetermined Limit indicated by Biased Valve Circuit and Ballistic Meter].—H. O. Peterson. (*Proc. Inst. Rad. Eng.*, June, 1934, Vol. 22, No. 6, p. 682: short summary only.)

THE EFFECT OF BACKGROUND NOISE IN SHARED CHANNEL BROADCASTING.—C. B. Aiken. (*Bell S. Tech. Journ.*, July, 1934, Vol. 13, No. 3, pp. 333–350.)

For previous papers *see* Abstracts, September, pp. 498–499; *also* 1932, pp. 343; 1933, pp. 392 and 460–461; and January, p. 37. Author's abstract:—"The interference which occurs in shared channel broadcasting consists of several components of different types. Of these the programme interference is usually the most important in the absence of a noise background, while if a strong noise background is present another component, which may be called flutter interference, predominates.

"A simple theory of the flutter effect is developed and it is shown that its importance is dependent upon the type of detector employed. If manual gain control is used, flutter may be greatly reduced by the use of a linear rectifier. However, if automatic gain control is used, this superiority of the linear detector cannot be realised and flutter is bound to be troublesome.

"The results of experimental studies of the various types of interference are given and a comparison is made of the relative importance of flutter and programme interference. The effects of the type of detector used and of the width of the received frequency band are observed. It is evident from these studies that improvements in the size of the lower grade service areas of shared channel stations might be obtained by close synchronisation of the carrier frequencies, even though different programmes are transmitted."

INTERFERENCE TO WIRELESS COMMUNICATIONS OF THE MERCANTILE MARINE.—J. A. Slee. (*Wireless Engineer*, July, 1934, Vol. 11, No. 130, pp. 368–369.) Summary of I.E.E. paper.

DISCUSSION ON "AN OUTLINE OF THE ACTION OF A TONE-CORRECTED HIGHLY SELECTIVE RECEIVER."—C. B. Fisher: Moullin. (*Proc. Inst. Rad. Eng.*, July, 1934, Vol. 22, No. 7, pp. 926–928.) Discussion on Moullin's paper (January Abstracts, p. 35).

A SHORT-WAVE SUPERHETERODYNE RECEIVER FOR THE WAVE-RANGE 15–200 METRES, WITH INTERCHANGEABLE COILS.—W. Möller. (*Radio, B., F. für Alle*, August, 1934, No. 150, pp. 113–116.)

THREE-VALVE REFLEX SUPERHETERODYNE FOR DIRECT CURRENT MAINS.—F. H. Marz. (*Funktech. Monatshefte*, July, 1934, No. 7, pp. 271–276.)

TWO MODERN FOUR-VALVE "STRAIGHT" RECEIVERS [for D.C. Mains].—J. Lorch. (*Ibid.*, pp. 277–279.)

THREE-CIRCUIT, FOUR-VALVE RECEIVER WITH HEXODES [for A.C. Mains].—R. Wehler. (*Ibid.*, pp. 279–282.)

DEUTSCHE EMPFÄNGER DES AUSLANDSDEUTSCHEN (German Receivers for the Over-Seas German [Requirements for German Short-Wave Broadcast Reception, to replace American Receivers]).—W. Mehl. (*Funktech. Monatshefte*, July, 1934, No. 7, pp. 267–270.)

A VERY SMALL "POCKET" RECEIVER [weighing 410 Grammes, occupying under ¼ Litre: One Tetrode and Headphones].—W. Stockhusen. (*Funktech. Monatshefte*, July, 1934, No. 7, pp. 291–296.)

A MOBILE PRINTER FOR POLICE AND AIRCRAFT RADIO [12″ × 4″ × 4″, Operating from 6-Volt Battery: Prints 30–40 Words per Minute: Permanent Record: Secrecy].—W. H. G. Finch. (*Electronics*, July, 1934, p. 218.)

THE SIRUTOR, A NEW COPPER-OXIDE RECTIFIER FOR USE AS DETECTOR [Five Elements in Series].—Siemens Company. (*Radio, B., F. für Alle*, August, 1934, No. 150, pp. 135–136.)

The name represents "Siemens-Rundfunk-Detektor."

METHODEN ZUR KRACHBESEITIGUNG (Methods of "Crack-Killing," ["Silent Tuning," etc., in Receivers with AVC: and a New Method using the "Barometer" Luminous-Column Tuning Indicator with an added Contact Electrode]).—Th. Sturm. (*Funktech. Monatshefte*, July, 1934, No. 7, pp. 259–263.)

(1) The simplest method—limitation of sensitivity: this reduces but does not silence the noises. (2) Methods of silencing: (a) by relay: a somewhat expensive method, since the relay must respond to about 0.2 mA; (b) by arranging a setting-in of grid current in the r.f. valves so that the associated oscillatory circuits are heavily damped when the field strength sinks below a certain value; (c) the use of a half-wave rectifier (Fig. 6): unluckily the best selenium rectifier has a resistance of only 0.5 megohm in the blocking direction, so a rectifier valve must be used; (d) bridge circuit with auxiliary valve (Fig. 7).

Before coming to his last method (patented by Richter and Geffcken) the writer describes the "barometer" column method of tuning indication, one form of which is called the "orthoscope." He then shows how such a glow-discharge tube can be made, by the introduction of a contact electrode, to act also as a "crack-killer" or what he calls a "filter tube" (siebröhre). Such an arrangement is shown in Fig. 9, where S is the additional contact electrode, which is only reached by the luminous column when the signal field strength exceeds a certain value; below this value the contact is broken and the valve N in the l.f. stage receives a high bias (from $-G_2$ through the very large ohmic resistance R_3) which blocks the flow of its anode current. The valve N must not have too small a "durchgriff," since unfortunately the grid bias transmitted through S (when the column is making contact with this electrode) is not quite constant but varies a little with the strength of the glow; but this need not spoil the sharpness of the cut-out effect, since $-G_2$ may be made sufficiently great. The paper ends with a discussion, applicable to all methods depending on the blocking of a l.f. stage, of the desirable time constant.

DEVELOPMENTS IN AUTOMATIC SENSITIVITY CONTROL [Discussion of Recent Methods: All Desirable Features can be obtained with Standard Tetrode or Pentode].—G. E. Pray. (*Proc. Inst. Rad. Eng.*, June, 1934, Vol. 22, No. 6, p. 682: short summary only.)

RESONANT LINES IN RADIO CIRCUITS [particularly at Ultra-High Frequencies].—Terman. (*See* under "Properties of Circuits.")

GAS DISCHARGE TUBE AS INTERVALVE COUPLING: THE PRACTICAL APPLICATION FOR D.C. AMPLIFICATION.—H. Smith and E. G. Hill. (*Wireless Engineer*, July, 1934, Vol. 11, No. 130, pp. 359–361.) On the coupling referred to in January Abstracts, p. 36, l-h column.

NIEDERFREQUENTE RÜCKKOPPLUNG ZUR KOMPENSATION LINEARER VERZERRUNGEN (Low-Frequency Retroaction for the Compensation of Linear Distortion [a Suggestion]).—E. Grave. (*Funktech. Monatshefte*, July, 1934, No. 7, p. 270.)

Prompted by Egerland's paper referred to in August Abstracts, p. 445, l-h column. An editorial note suggests that the method is worthy of test: "usually one trusts to the leakage resonance of a l.f. transformer, at a frequency of about 6000 c/s, for the improvement of the characteristic."

BROADCAST LISTENERS: NUMBERS AND PERCENTAGES OF POPULATION, FOR EUROPEAN AND OTHER COUNTRIES, UP TO BEGINNING OF 1934.—(*Bull. Assoc. suisse des Élec.*, No. 14, Vol. 25, 1934, pp. 383–384.)

AERIALS AND AERIAL SYSTEMS

AMPLITUDEN-, ABSTANDS- UND PHASENBEDINGUNGEN BEI ANTENNENKOMBINATIONEN (Amplitude, Spacing and Phase Conditions in [Symmetrical] Antenna Combinations).—W. Berndt. (*Hochf:tech. u. Elek:akus.*, July, 1934, Vol. 44, No. 1, pp. 23–28.)

Author's summary:—"A general survey is made of the influence of spacing, phase and amplitude on the shape of the directive characteristic of symmetrically arranged aerials. The rules for the choice of amplitudes are given for the case of strongly suppressed subsidiary maxima. The individual amplitudes of the antennas appear here as the coefficients of certain periodic curves developed in Fourier series. For a small number of component antennas and for circular arrangements, the amplitudes are best obtained by a graphical method. The amplitudes thus found apply to all types of antenna combinations irrespective of spacing and phase.

"The conditions governing the choice of spacing and phasing, for an arbitrary number of component antennas, are then derived. At the same time general formulae are obtained for the sharpness of directivity of the various combinations. A method for the convenient graphical determination of directive characteristics is given." A simple example of this graphical method is given in Fig. 2, for a combination of two aerials whose field strength in the direction of the joining line depends on the spacing between the two components according to the equation $R(x) = 2a \cdot \cos(\pi x/\lambda + \phi/2)$. This function, represented graphically, gives a cosine curve displaced by $\phi/2$, with a peak value $2a$. Taking first the case of a spacing of 0.4λ and a phase difference of 90°, a horizontal bracket is drawn below the horizontal axis of the cosine curve, of a width to enclose a region of that curve corresponding to 0.4λ, and with its mid-point displaced sideways, relatively to the vertical axis, by a distance representing half the phase difference, namely $\phi/2 = 45°$. Vertically below the bracket a circle is drawn of diameter equal to the width of the bracket. The points where the diameters of this circle meet the circumference are projected on to the cosine curve, and the values of the function thus obtained are transferred to the appropriate diameters, giving a number of points whose joining line forms the directive characteristic. It is easy to see from this Fig. 2 how a change in spacing and phasing affects the characteristic: thus if the spacing were altered to $\lambda/4$ and the phasing kept unchanged, the bracket would cover just the first quarter period of the cosine curve and the characteristic would become a cardioid: for $\phi/2 = 0°$ or 90° the characteristic would be symmetrical in all four quadrants.

MAINTAINING THE DIRECTIVITY OF ANTENNA ARRAYS [Slight Detuning Effects, altering the Pattern of Directive Broadcasting Aerials, Radio Beacons, etc., counteracted by use of Constant Current Transmission Lines].—F. G. Kear. (*Proc. Inst. Rad. Eng.*, July, 1934, Vol. 22, No. 7, pp. 847–869.)

In a previous paper (1933 Abstracts, p. 625) the writer dealt with the application of this method to a radio range beacon. Several broadcasting stations have now adopted it, including WKRC (Ohio) and WORC (Massachusetts).

DIRECTIONAL ANTENNA AT WMC [Self-Excited Reflector Mast spaced a Quarter Wavelength from Vertical 5-Wire Cage Transmitting Aerial].—C. E. Baker. (*Rad. Engineering*, July, 1934, Vol. 14, No. 7, pp. 7–8.)

SCHWUNDVERMINDERNDE ANTENNEN (Fading-Reducing Aerials [for Broadcasting Stations]).—W. Strohschneider. (*Bull. Assoc. suisse des Élec.*, No. 16, Vol. 25, 1934, pp. 443–445.) Short survey based on papers by Eppen and Gothe and Böhm (Abstracts, 1933, p. 394, and 1932, p. 526).

A 14-MC ROTARY BEAM ANTENNA FOR TRANSMITTING AND RECEIVING [Rotatable System of Half-Wave Radiators, Wave Reflectors, and Wave Directors].—J. P. Shanklin: Yagi. (*QST*, July, 1934, Vol. 18, No. 7, pp. 32–34 and 68.)

VALVES AND THERMIONICS

GRID-CIRCUIT LOSSES IN VACUUM TUBES AT VERY HIGH FREQUENCIES [a Major Limitation to Use of Valves at Very High Frequencies].—B. J. Thompson and W. R. Ferris. (*Proc. Inst. Rad. Eng.*, June, 1934, Vol. 22, No. 6, p. 683: short summary only.)

INPUT IMPEDANCE OF VACUUM TUBE DETECTORS AT ULTRA-SHORT WAVES.—A. B. Crawford. (*Proc. Inst. Rad. Eng.*, June, 1934, Vol. 22, No. 6, pp. 685: short summary only.)

PHASE ANGLE OF VACUUM TUBE TRANSCONDUCTANCE AT VERY HIGH FREQUENCIES [Confirmation of Theoretically Predicted Phase Angle].—F. B. Llewellyn. (*Proc. Inst. Rad. Eng.*, June, 1934, Vol. 22, No. 6, p. 683: short summary only).

THE SPLIT-ANODE MAGNETRON WITH MAGNETIC FIELD ABOVE CRITICAL CUT-OFF VALUE.—Posthumus. (*See* abstract under "Transmission.")

DISPERSIONE ANOMALA NEL MAGNETRON ? ("Anomalous Dispersion" in the Magnetron ? [Readjustment of Circuit Tuning necessary after switching-on Filament Current: Sense of Adjustment depends on Magnetic Field being below or above a Critical Value: Dielectric Constant of Medium between Cathode and Anode decreased or increased by Electron Movements according to Magnetic Field Strength ? Resemblance to Anomalous Dispersion in Optics]).—A. Giacomini. (*La Ricerca Scient.*, 15/30 June, 1934, 5th Year, Vol. 1, No. 11/12, pp. 650–651.)

THE INFLUENCE OF THE MAXWELLIAN VELOCITY DISTRIBUTION ON THE PRODUCTION OF MICRO-WAVES.—von Ardenne. (*See* under "Transmission.")

EQUIPOTENTIAL CATHODES [Indirectly Heated Cathodes Not strictly Equipotential: Methods of Correction].—E. Alberti. (*Funktech. Monatshefte*, July, 1934, No. 7, pp. 253–254.)

The methods suggested are (1) decreasing the cathode resistance, at any rate near the end connected to the anode battery, *e.g.* by increasing its cross section at this end; (2) leading the emission current out from *both* ends of the cathode, thus reducing the maximum voltage drop to a quarter and also improving the temperature distribution; (3) partially compensating the voltage drop by an auxiliary current in the opposite direction to the emission current: the maximum drop can easily be reduced to a third or a quarter, although it cannot be eliminated completely because the drop due to the auxiliary current increases linearly along the cathode, while that due to the emission current increases almost quadratically.

A NEW METHOD OF DETERMINING THE OPERATING CHARACTERISTICS OF POWER OSCILLATORS [by Measurements with 60-Cycle Power Mains].—C. N. Kimball and E. L. Chaffee. (*Proc. Inst. Rad. Eng.*, June, 1934, Vol. 22, No. 6, p. 683: short summary only.)

FINE STRUCTURE OF TRIODE CHARACTERISTICS.—B. van der Pol and Th. J. Weijers. (*Physica*, April, 1934, Vol. 1, No. 6, pp. 481–496.)

Authors' summary:—The detailed structure of diode, triode and tetrode characteristics is experimentally investigated by measuring the amplitudes of the different harmonics (up to the tenth) in the anode current, as a function of the grid-bias potential when a sinusoidal e.m.f. of constant amplitude is applied to the grid. These curves show a great number of maxima and minima. The amplitude of every harmonic, considered as a function of the grid biasing potential, has (to a pronounced degree of accuracy) the form of the differential of the one preceding it. It is thus possible to determine the successive differentials of the characteristic in a wide domain. In some small domains, however, this appears not to be the case. The latter anomalies in the higher differentials of the characteristics are most likely due to critical potentials in the secondary electron emission from the electrodes.

A new analytical development of the characteristic in a series of Tchebycheff polynomials [June

Abstracts, p. 339, r-h col.] is given which has some advantages over the development in a Taylor series. Whereas the coefficients of the Tchebycheff series follow immediately from the measurements with a finite amplitude on the grid, the coefficients of the Taylor series can only be derived from the limit towards which these measurements converge for an infinitely small grid swing.

THE OCTODE, A NEW MIXING VALVE FOR SUPERHETERODYNE RECEIVERS [Oscillator, Mixer and AVC].—O. Stettler: Philips Company. (*Bull. Assoc. suisse des Élec.*, No. 16, Vol. 25, 1934, pp. 441–443.)

The 3rd and 5th grids are screen grids connected to each other inside the bulb, and the 6th (suppressor) grid is connected to the cathode. The valve may be regarded as a triode, with the 1st grid (led out at top of bulb) and 2nd grid as control grid and anode, with a superposed pentode system whose control grid is the 4th grid: the two systems use the same electron stream but are separated by the screen-grid 3. Grid 2 (anode of triode) consists of two little bars lying mostly outside the main electron path. The mutual conductance curve of the pentode system is influenced by the control grid of the triode system, and takes the form of Fig. 2. It is non-sinusoidal, and this is a great advantage as regards background noise; for in this way a steep "transposing" slope S_c is obtained with the smallest possible anode d.c., I_a, and the noise is proportional to $\sqrt{I_a}/S_c$. One advantage over the mixing hexode is that by adjusting the bias of grid 4 this "transposing" slope can be regulated, which was impossible with the hexode, since the oscillations broke off when the bias changed. With the octode the value of S_c varies from 600 to 2 μA/V as the 4th grid bias is changed from -1.5 to -20 V. Another advantage is the higher internal resistance, 1.5 megohm compared with 150 000 ohms for the mixing hexode and 300 000 for the pentagrid. Moreover, the octogrid oscillates faultlessly well under 15 m.

SPACE-CHARGE-GRID TUBE WITH VARIABLE-MU GRID [Theoretical Solutions of Generalised Equations: Graphical Determination of Distribution of Grid Pitches].—W. Dehlinger. (*Physics*, July, 1934, Vol. 5, No. 7, pp. 173–177.)

SIMPLIFYING DYNAMIC TUBE CURVES [with the Aid of an Additional Voltage Abscissa].—R. C. Hitchcock. (*Electronics*, July, 1934, pp. 220–221.)

SCHWINGENDE ELEKTRONENRÖHRE MIT STARK POSITIVEM GITTER UND DEREN ANWENDUNG ALS THYRATRONERSATZ (Oscillating Valve with Highly Positive Grid, and its Use as a Thyratron Substitute).—H. Alfvén and P. Ohlin. (*Zeitschr. f. Physik*, 1934, Vol. 89, No. 11/12, pp. 826–833.)

The valve, with grid potential of about 100 volts, is made to oscillate with coupled inductance coils in the grid and anode circuits, the wavelength obtained being about 150 m. The theory of the oscillation is discussed with the help of the valve characteristics. It is found that the valve has a property similar to that of a thyratron, with sudden onset of anode current when a critical value of the grid voltage is passed. It can be used to replace two thyratrons (*cf.* Wynn-Williams, 1932 Abstracts, p. 535) in automatic counters, and has the advantage of not being sensitive to temperature changes as are thyratrons, besides being considerably cheaper. A diagram of the circuit used is given. Impulses occurring at time intervals of 0.001 sec. have been counted, and circuits can be constructed for intervals even less than this value.

PROCESSES IN VACUUM TUBE MANUFACTURE [Filament Conversion: Oxidation and Lacquer-Solvent Troubles: Carbonisation: Ageing and Its Object: etc.].—E. R. Wagner. (*Electronics*, July, 1934, pp. 213 and 219.)

ELECTRON EMISSION [Short Survey].—S. Dushman. (*Elec. Engineering*, July, 1934, Vol. 53, No. 7, pp. 1054–1062.)

ADSORPTION OF ALKALI METALS ON METAL SURFACES. I.—FORMATION AND ADSORPTION OF IONS: POTENTIAL CURVES.—J. H. de Boer and C. F. Veenemans. (*Physica*, July, 1934, Vol. 1, No. 9, pp. 753–762.)

DIRECTIONAL WIRELESS

INTERFERENCE TO WIRELESS COMMUNICATIONS OF THE MERCANTILE MARINE.—J. A. Slee. (*Wireless Engineer*, July, 1934, Vol. 11, No. 130, pp. 368–369.) Summary of I.E.E. paper.

MAINTAINING THE DIRECTIVITY OF ANTENNA ARRAYS [including Radio Beacon Aerials].—Kear. (*See* under "Aerials and Aerial Systems.")

LOST FISHING DORIES LOCATED BY RADIO [Note-Modulated 20-lb transmitter in Dory for tracking by Mother Ship].—(*Electronics*, July, 1934, p. 217.)

TEACHING PILOTS "BLIND FLYING" IN RADIO BEAM [with Dummy Aeroplane, at Newark Airport].—(*Electronics*, July, 1934, p. 216.)

ACOUSTICS AND AUDIO-FREQUENCIES

EINIGE UNTERSUCHUNGEN ÜBER SEKUNDÄRSCHWINGUNGEN—"SON RAUQUE"—BEI LAUTSPRECHERMEMBRANEN (Some Investigations of Secondary Vibrations—"Hoarse Tone"—in Loudspeaker Diaphragms [Sub-Harmonic Parasitic Frequencies, their Cause and Elimination: the "Nawi" Diaphragm]).—F. von Schmoller. (*Telefunken-Zeit.*, June, 1934, Vol. 15, No. 67, pp. 47–54.)

For other workers' views on these sub-harmonic frequencies, not referred to here, *see* Abstracts, 1933, p. 509, r-h column: *also* March, p. 156 (Pedersen). For references to the Telefunken "Nawi" diaphragm *see* August, p. 446, l-h column.

The present writer's preliminary qualitative tests showed that for a continuous variation of frequency the "secondary" vibration only appeared when the electrical energy supplied to the loud speaker exceeded a certain value: moreover, that its appearance depended on the speed of change of frequency. Since a very rapid change gave rise to no, or very slight, secondary vibration, it was concluded that the latter must possess a certain building-up time. Further investigations showed that this building-up time decreases as the power increases. In the region of "critical power" τ may amount to 20 seconds; as the power is increased, τ drops remarkably quickly and for very high powers may reach values of the order of 0.1 sec.—practically as small as that of the primary frequency. In practice, therefore, the secondary vibration must occur even with quite short-time excitation of a frequency, such as takes place in speech- and music-transmission; it is liable to interfere seriously with the quality of reproduction.

The intensity/input-power curve for a constant "fundamental" frequency may vary in some ways according to the fundamental frequency chosen, but all such curves have two characteristics in common: they display a type of instability at the critical input (*i.e.* at the setting-in of the "hoarse tone") and then rise quite sharply, to tend later to saturation (Fig. 36). The absolute value of sound pressure in such a region of saturation may reach about 10–15% of the total radiated pressure, measured in the axial direction of the cone.

Tests in which the frequency was varied continuously in the upward direction, and the total sound pressure in the axial direction was measured, gave the total-pressure/frequency curve of Fig. 35 (top curve). By comparing this with the corresponding secondary-vibration curve showing the secondary-vibration pressures at the various "zones of instability" (bottom curve, which shows that in such a zone the intensity of the secondary vibration has a very marked maximum at the "fundamental" frequency and decreases more or less symmetrically on either side: at 1 800 c/s there are two maxima, representing two zones partly merged) it is seen that for each instability zone there is a corresponding deep crevasse in the total-pressure curve, representing a large decrease in total sound pressure; the crevasses in the frequency curve of the total radiated sound pressure are thus apparently due to the appearance of the "hoarse tone." A footnote adds that not *all* the sharp dips in the frequency curve can be explained in this way.

To examine this phenomenon more closely, the sound output as a function of exciting energy was plotted (Fig. 37) at the two border-frequencies one on each side of an instability zone. The two curves were, as expected, linear but of different slopes. The curve for ω_g, the "fundamental" frequency of the instability zone, was also linear up to the point of critical input, where it showed a point of discontinuity and thereafter became again linear but with a greatly reduced slope. Moreover, a similar curve was found for any frequency between the two border frequencies, so that in such a zone of instability there occurs not only the formation of the lower octave but also a non-linear distortion of the sound output. "The deep crevasses in the frequency curve, at the emergence of secondary vibrations, must be considered as indicating that in transverse vibration a large part of the energy supplied to the loud speaker is consumed in friction in the diaphragm material composed of paper fibres."

The writer remarks that the avoidance of secondary vibrations is obviously desirable in all speech- and music-reproduction. The straightforward way—increasing the diaphragm thickness—spoils the other properties of the loudspeaker: "a simple method, however, of avoiding the secondary vibrations may be deduced directly from our mechanical analogy shown in Fig. 33: a curved rod, whose one end is fixed while the other is submitted to a periodically acting force in the direction of the chord, undergoes in all cases a displacement in *one* definite direction [as contrasted with the *straight* rod shown in the diagram], so that the condition necessary for the production of secondary vibrations of half the primary frequency is absent. For diaphragms, therefore, the rule may be deduced that *only surfaces which contain no straight lines should be employed.*" Telefunken have therefore produced, in place of the usual cone diaphragm, their "Nawi" diaphragm (named from its "non-developable" surface) of moulded pasteboard. A section of this diaphragm is seen in Fig. 38 with its gently curving outline: it actually gives practically no secondary vibrations, as can be seen by comparing the negligible instability regions in Fig. 39 with those in Fig. 34 for an ordinary cone diaphragm. This fact, as has been shown above, brings with it the additional advantage of a smoother frequency characteristic. The paper ends with a short theoretical treatment of secondary vibrations (based on an unpublished paper by Benecke) using a Mathieu differential equation: the final section compares the experimental and theoretical results. A short appendix deals with the Telefunken "power" loud speakers Ela K11W and Ultra Kraft II (with maximum loads of 5 and 20 watts respectively) both embodying the new diaphragm.

Gerät zur Untersuchung und Demonstration von Schwingungsfiguren auf Membranen (An Apparatus for the Investigation and Demonstration of Vibration Figures on Diaphragms [using Sand or Glycerin]).—P. E. Schiller. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 15, 1934, pp. 294–296.)

Proof of the Existence of the Internal Electrical Field of Rochelle Salt, by the Use of X-Rays.—H. Staub. (*Helvet. Phys. Acta*, Fasc. 5, Vol. 7, 1934, pp. 480–482.) For previous work *see* Abstracts, 1933, p. 403, and May, p. 271.

Über die Schrägstellung des Wiedergabespaltes bei Lichttonfilmen in Vielzackenschrift ([The Distorting Effect of] the Slant of the Reproducing Slit in Sound-on-Film Working with the Multiple-Contour Process [Comparison of the Old Single Zig-Zag, the New Double- and Multiple-Contour (Amplitude) Systems and the "Ladder-Rung" (Intensity) System]).—A. Narath. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 15, 1934, pp. 307–312.)

See also next abstract. Among the conclusions arrived at are the following:—the multiple-contour method is on a level with the "rung" (sprossen) method as regards linear distortion; its non-linear distortion decreases with the number of tracks—for an infinite number of these it would be distortionless; with the amount of slit obliquity occurring in practice a multiple-contour system of at least 10 tracks is desirable.

EIN NEUER LICHTTONSCHREIBER (A New Sound-on-Film Recorder [for Single- and Multiple-Contour Amplitude or "Rung" (Intensity) Methods: suitable for "Noiseless" Recording: applicable to other Purposes]).—P. Glass and K. Schwarz. (*E.N.T.*, July, 1934, Vol. 11, No. 7, pp. 245–256.)

The recorder consists of two parts, the moving mirror with its drive (forming the "light tap") and the optical system of lamp, lenses, screens and slit. The light tap has an oblong armature of thin iron foil (faced with a mirror) at the middle point of a stretched spring-steel "cord" (in the diagram it appears to be a very narrow flat strip). "In the course of this paper it will be shown that an electro-magnetic system has a number of important advantages over an electro-dynamic system. . . . We have therefore chosen the electro-magnetic drive." The pole-pieces of the permanent magnet are so staggered, with respect to the armature edges, that a current in their modulating coils causes an attraction, or a repulsion, at both air-gaps simultaneously, so that a torsional vibration of armature and mirror is produced. A damping arrangement, not shown in the diagram, is provided (for a discussion of the temperature dependence of this, and of other parts, *see* p. 249). The practical advantages of the apparatus are so great that it should find application in fields other than sound-film recording.

Section I d deals with the method of displacing the working point of the light tap in order to give "noiseless" recording. Sections II b and c discuss how the optical system is arranged for the various systems of recording, and the corresponding illumination/mirror-deflection characteristic curves are given. Section III deals particularly with the new multiple-contour amplitude system (*see* also Narath, above) and includes a table which shows the various advantages and disadvantages of the three systems—single-contour amplitude, multiple-contour amplitude, and intensity recording.

VERWENDUNG VON METALL-EINKRISTALLEN FÜR SCHALLPLATTEN (The Use of Metal Single Crystals for Gramophone Records [Reduction of Surface Noise with Metal Records by use of Metal Discs with Crystals of Several Centimetres' Diameter]).—A. E. van Arkel and A. Th. van Urk. (*Physica*, April, 1934, Vol. 1, No. 6, pp. 425–426.)

ELECTRONIC MUSIC FROM VIBRATING REEDS.—R. G. Silbar. (*Electronics*, July, 1934, p. 226.)

AUDIO EQUALISERS [for Improvement of Loudspeaker and Pick-up Fidelity: Equalisation of Telephone and other Lines to Broadcasting Stations: Sound-on-Film Reproduction: etc.].—I. A. Mitchell. (*Rad. Engineering*, July, 1934, Vol. 14, No. 7, pp. 20–21.)

A number of circuits for the various purposes are illustrated with their characteristic curves. The need for a high Q value is emphasised: special nickel-iron dust core materials allow values of 50–100 to be obtained in place of the old laminated core values around 2 at the higher audio-frequencies. "A demonstration of unequalised and equalised sound sources would convince any man that equalisers will be the keynote of our audio progress in the future."

HIGH EFFICIENCY IN AUDIO-FREQUENCY AMPLIFIERS [illustrated by Measurements on a 250–450 Watt Amplifier for Audio-Frequency Rediffusion Systems].—E. K. Sandeman: Standard Telephones & Cables, Ltd. (*Wireless Engineer*, July, 1934, Vol. 11, No. 130, pp. 351–358.)

PRINCIPLES OF AUDIO-FREQUENCY WIRE BROADCASTING ["Audio-Frequency Rediffusion"].—P. P. Eckersley. (*Wireless Engineer*, June, 1934, Vol. 11, No. 129, pp. 312–313). Summary of I.E.E. paper.

WIDE-BAND OPEN WIRE PROGRAM SYSTEM.—H. S. Hamilton. (*Bell S. Tech. Journ.*, July, 1934, Vol. 13, No. 3, pp. 351-381.) *See* June Abstracts, p. 329, l-h column.

LINE FILTER FOR PROGRAM SYSTEM.—A. W. Clement. (*Bell S. Tech. Journ.*, July, 1934, Vol. 13, No. 3, pp. 382–390.) *See* June Abstracts, p. 329, l-h column.

BACKSTAGE SOUND EFFECTS FOR STAGE PRODUCTIONS. (*Electronics*, July, 1934, p. 217.)

BEAT-FREQUENCY OSCILLATOR [and the Great Frequency Stability with Air Condensers instead of Mica].—W. C. Lister: Cooper and Page. (*Wireless Engineer*, June, 1934, Vol. 11, No. 129, pp. 307–308.) *See* June Abstracts, p. 328, l-h column.

PRECISION HETERODYNE OSCILLATORS [and the Conditions of Heterodyne Stability].—D. A. Bell: Griffiths. (*Ibid.*, p. 308.) Prompted by Griffiths's paper (July Abstracts, p. 387). For a letter from Lindsay, *re* an alleged American practice of employing a crystal oscillator, *see* July issue, p. 370.

PRECISION HETERODYNE OSCILLATORS [and the Relation between Beat Note and Fixed Frequency].—H. Meyer: Griffiths. (*Bull. Assoc. suisse des Élec.*, No. 14, Vol. 25, 1934, p. 385.) Summary of Griffiths's paper (*see* last abstract) and a criticism of his formula $F = kf_1^3$ as "somewhat misleading."

UNTERSUCHUNGEN ÜBER OBERTÖNE VON STIMMGABELN UND U-FÖRMIGEN STÄBEN MIT HILFE DER ELEKTRONENRÖHRE (Investigations on the Overtones of Tuning Forks and U-Shaped Rods with the help of Thermionic Valves).—P. Hacquebord and H. C. Huizing. (*Passow-Schaefer Beiträge, Groningen*, Vol. 31, 1934, pp. 248–259.)

Authors' summary:—A method is described by which tuning forks may be kept in continuous vibration by triode valves. With the help of this method each anharmonic overtone can be excited separately [the most prominent being that of frequency $6.25\,n_0$]. This is found impossible for the harmonic overtones: these are not actual vibrations of the tuning fork but occur in the air. The anharmonic overtones are subdivided into Series A and B with an even and odd number of nodes respectively. The number of periods and the position of the nodes are examined and some vibration curves shown, the difference between the two series A and B being pointed out particularly. The photographic method used is described. The difference between the interference planes of the two series is also examined. It is found that the electrically excited tuning-fork vibrations have a very pure character.

A PORTABLE FREQUENCY ANALYSER [for Use with Noise Meter in investigating Noises of Machinery].—M. S. Mead, Jr. and T. M. Berry. (*Gen. Elec. Review*, August, 1934, Vol. 37, No. 8, pp. 378–383.)

SIMPLIFIED MEASUREMENTS OF SOUND ABSORPTION [Modified Form of "Tube" or "Reflected Wave" Method, for Reliable and Rapid Routine Tests, etc.].—A. L. Albert and T. B. Wagner. (*Elec. Engineering*, August, 1934, Vol. 53, No. 8, pp. 1160–1162.)

RESONANCE IN SOFT-WALLED CYLINDERS.—J. C. Cotton. (*Journ. Acoust. Soc. Am.*, January, 1934, Vol. 5, No. 3, pp. 208–212.)

AMPLIFICATION OF SMALL BELLS.—A. N. Curtiss and G. M. Giannini. (*Ibid.*, pp. 213–217.)

EXPERIMENTAL INVESTIGATIONS ON THE SOUND AND VIBRATION OF JAPANESE HANGING-BELL [Sound recorded by Condenser Microphone and Oscillograph: Vibration by Capacity-Change Ultra-Micrometric Method without Contact with Vibrating Body].—J. Obata and T. Tesima. (*Jap. Journ. of Phys.*, 15th June, 1934, Vol. 9, No. 2, pp. 49–73: in English.)

A NEW PROPERTY OF THE EAR? [Explanation based on Assumptions regarding both Damping and Efficiency of Aural Resonators].—G. F. Clarke: Vrijdaghs. (*Wireless Engineer*, July, 1934, Vol. 11, No. 130, pp. 371–372.)

For previous correspondence *see* August Abstracts, p. 446, r.-h column. The present writer uses the abbreviation "h" (generally denoting "hours" but here standing for "Hertz") in place of "c/s," presumably as a result of a recent international vote.

THE ATTRIBUTES OF TONES [Pitch, Loudness and a Third, "Tonal Volume": "Pitch Effect" reverses at High Frequencies, so that Pitch remains Constant for All Values of Energy at a certain Frequency (between 3 100 and 3 300 c/s for all three Observers)].—S. S. Stevens. (*Proc. Nat. Acad. Sci.*, July, 1934, Vol. 20, No. 7, pp. 457–459.)

EFFECTS OF PROTRACTED EXPOSURE TO A LOUD TONE [of Medium Pitch: Almost Horizontal Subsidence in Auditory Acuity from 200–5 000 c/s: Special Effectiveness of Interrupted Tones: etc.].—F. Finch and E. Culler. (*Science*, 13th July, 1934, Vol. 80, No. 2063, pp. 41–42.)

APPLICATIONS OF PITCH AND INTENSITY MEASUREMENTS OF CONNECTED SPEECH.—J. Tiffin. (*Journ. Acoust. Soc. Am.*, April, 1934, Vol. 5, No. 4, pp. 225–234.)

MOTIONAL IMPEDANCE DIAGRAMS [of a Telephone Receiver].—T. S. Littler. (*Ibid.*, pp. 235–241.)

PHONETIC DISTRIBUTION IN FORMAL AMERICAN PRONUNCIATION.—C. H. Voelker. (*Ibid.*, pp. 242–246.)

FIRST PRELIMINARY X-RAY CONSONANT STUDY.—G. O. Russell. (*Ibid.*, pp. 247–251.)

THE EFFECTS OF NOISE UPON HUMAN EFFICIENCY.—J. Obata and others. (*Ibid.*, pp. 255–261.)

AN INTERPRETATION OF VIBRO-TACTILE PHENOMENA.—R. H. Gault. (*Ibid.*, pp. 252–254.) For the "teletactor" *see* 1930 Abstracts, p. 471.

EXPERIMENTS ON THE SENSES OF TOUCH AND VIBRATION.—L. D. Goodfellow: Gault. (*Ibid.*, July, 1934, Vol. 6, No. 1, pp. 45–50.)

ÜBER EINE OPTISCHE METHODE ZUR MESSUNG STEHENDER ULTRASCHALLWELLEN IN FLÜSSIGKEITEN (An Optical Method of measuring Stationary Supersonic Waves in Liquids [by the Debye-Sears Effect]).—R. Wyss. (*Helvet. Phys. Acta*, Fasc. 4, Vol. 7, 1934, pp. 406–412.)

OPTICAL IMAGE OF THE STANDING COMPRESSIONAL WAVE IN AN OSCILLATING QUARTZ CRYSTAL. A NEW METHOD OF MEASURING THE COMPRESSIBILITY OF QUARTZ [Preliminary Note].—H. R. Asbach, E. Hiedemann and K. H. Hoesch. (*Naturwiss.*, 6th July, 1934, Vol. 22, No. 27, p. 465.)

THE MECHANICAL ACTION OF SUPERSONIC WAVES [Wavelengths measured by Spacing of Arcs marked on the Nickel Deposit on the Electrode of an Electrolytic Cell immersed in the Quartz-Excited Oil Bath].—C. Ballhausen. (*Funktech. Monatshefte*, July, 1934, No. 7, p. 296.)

[Lecture] DEMONSTRATIONS WITH VERY SHORT SOUND WAVES AND THE REACTION OF AN ACOUSTIC FIELD ON ITS SOURCE.—H. E. Meier. (*Physik. Zeitschr.*, 1st July, 1934, Vol. 35, No. 13, pp. 524–527.)

A NEW HYDRODYNAMICAL THEORY OF THE SOUND-SENSITIVE FLAME.—H. Zickendraht. (*Helvet. Phys. Acta*, Fasc. 5, Vol. 7, 1934, pp. 468–470.) For previous work *see* 1933 Abstracts, p. 167, l-h column.

PHOTOTELEGRAPHY AND TELEVISION

DER HEUTIGE STAND DER FERNSEH-ÜBERTRAGUNG (The Present Position of Television Transmission).—F. Schröter. (*Telefunken-Zeit.*, June, 1934, Vol. 15, No. 67, pp. 5–22.)

Part II of the survey dealt with in June Abstracts, pp. 330–331. The sections are as follows:—8. The transmission of the low picture frequencies: carrier-frequency amplification: introduction and filtering-out of the carrier. 9. Raster [number of elements in] and brightness [the alkali-metal-oxide layer photocell, with its sensitivity of 60–80 μA/lumen, has just come in time to allow the raster number to be doubled—to about 80 000]: storage [the help given by the intermediate film principle; the Zworykin iconoscope; the possibility of applying the "storage" principle to increase the brightness at the receiving end; etc.]: and the physiological factors of image quality [flicker; fatigue; the effect of deliberate light-control distortion on the sharpness of contrast; etc.]. 10. Synchronisation of the cathode-ray tube [Schriever's system of residual aerial current—Abstracts, 1933, p. 630 (*see* also von Ardenne, May, p. 274): the special accuracy of synchronisation demanded by various suggested ways of improving the image without increasing the band-width, such as the odd-and-even line alternation at 50 times per second, or the more complex 100 per second changes of line order—1, 5, 9 . . ., 2, 6, 10 . . ., 3, 7, 11 . . ., etc.]. Velocity and velocity-amplitude modulation methods are referred to at the end of the paper: "a discussion of the difficulties likely to arise, when these systems are applied to distant transmission instead of to 'short-circuit' tests, would be premature."

TELEVISION BY ELECTRONIC METHODS [Description of the Farnsworth "Image Dissector" Analyser (with Translucent Photoelectric Film), Cathode-Ray Reproducer, and Auxiliary Apparatus].—A. H. Brolly: Farnsworth. (*Elec. Engineering*, August, 1934, Vol. 53, No. 8, pp. 1153–1160.)

TRICHROMATIC REPRODUCTION IN TELEVISION.—J. C. Wilson. (*Journ. Roy. Soc. Arts*, 29th June, 1934, Vol. 82, No. 4258, pp. 841–863.) The full paper, summaries of which have already been dealt with (*see* August Abstracts, p. 447).

A THEORY OF SCANNING AND ITS RELATION TO THE CHARACTERISTICS OF THE TRANSMITTED SIGNAL IN TELEPHOTOGRAPHY AND TELEVISION.—P. Mertz and F. Gray. (*Bell S. Tech. Journ.*, July, 1934, Vol. 13, No. 3, pp. 464–515.)

Authors' abstract:—By the use of a two-dimensional Fourier analysis of the transmitted picture, a theory of scanning is developed and the scanning system related to the signal used for the transmission. On the basis of this theory a number of conclusions can be drawn:—

(1) The result of the complete process of transmission may be divided into two parts, (*a*) a reproduction of the original picture with a blurring similar to that caused in general by an optical system of only finite perfection, and (*b*) the superposition on it of an extraneous pattern not present in the original, but which is a function of both the original and the scanning system.

(2) Roughly half the frequency range occupied by the transmitted signal is idle. Its frequency spectrum consists of alternating strong bands and regions of weak energy. In the latter the signal energy reproducing the original is at its weakest, and gives rise to the strongest part of the extraneous pattern. In a television system these idle regions are several hundred to several thousand cycles wide and have actually been used experimentally as the transmission path for independent signalling channels, without any visible effect on the received picture.

(3) With respect to the blurring of the original, all reasonable shapes of aperture give about the same result when of equivalent size. The sizes (along a given dimension) are determined as equivalent when the apertures have the same radius of gyration (about a perpendicular axis in the plane of the aperture).

(4) With respect to extraneous patterns, certain shapes of aperture are better than others, but all apertures can be made to suppress them at the expense of blurring. An aperture arrangement is presented which almost completely eliminates extraneous pattern while about doubling the blurring across the direction of scanning as compared with the usual square aperture. From this and other examples the degradation caused by the extraneous patterns is estimated.

A NEW SOUND-ON-FILM RECORDER [applicable to Other Purposes].—Glass and Schwarz. (*See* under "Acoustics and Audio-frequencies.")

ERKLÄRUNGSVERSUCH DES DUNKELSTROMES DER ALKALIZELLEN ALS GLÜHELEKTRONENSTROM (Experiment to explain the Dark Current of Alkali Photocells as of Thermionic Origin [not Radioactive: Temperature Dependence of Current measured]).—R. Schulze. (*Zeitschr. f. Physik*, 1934, Vol. 90, Nos. 1/2, pp. 63–69.)

A METAL CONTACT PHOTOCELL [Photoelectrically Sensitive Alkali or Alkaline-Earth Metal separated from Another Metal by Thin Insulating Layer: a Caesium/Zirconium-Oxide/Zirconium Photocell].—J. H. de Boer and W. Ch. van Geel. (*Physica*, April, 1934, Vol. 1, No. 6, pp. 449–451.) Another cell experimented with was caesium/artificial-resin/nickel. *See* also a letter from Selényi, *ibid.*, July, 1934, pp. 781–782, on his Na/NaO/Na cell (1930 Abstracts, p. 165).

SUR LE RÔLE DE LA COUCHE DE BARRAGE DANS LE REDRESSEMENT ET DANS LES PHÉNOMÈNES PHOTOÉLECTRIQUES [The Rôle of the Barrier Layer in Rectification and in Photoelectric Phenomena.)—W. Ch. van Geel. (*Physica*, May, 1934, Vol. 1, No. 7, pp. 530–542.)

Recently developed theory of the constitution of semi-conductors and insulators is here applied to elucidate certain hitherto unexplained phenomena, namely (1) the fact that the barrier-layer photo-effect is greater than the internal photo-effect; (2) the difference between the red limit of the barrier-layer cell and the red limit of the internal photo-effect; (3) the metal/dielectric work function; (4) the barrier-layer photo-effect with applied auxiliary voltage; (5) the fact that the photo-electrons are only set free in the neighbourhood of the barrier layer; and (6) the alteration of the internal energy levels in a semi-conductor on illumination.

THE PHOTOELECTRIC EMISSION OF BARRIER LAYERS AND THE EINSTEIN EQUATION [Experimental Confirmation, taking Photoconductivity of Layer into account].—G. Liandrat. (*Comptes Rendus*, 9th July, 1934, Vol. 199, No. 2, pp. 130–131.) Following on the writer's previous work (May and July Abstracts, pp. 276 and 391).

THE VELOCITY DISTRIBUTION OF THE PHOTO-ELECTRONS IN THIN METALLIC [Platinum] FILMS.—E. Wasser. (*Physik. Zeitschr. der Sowietunion*, No. 5, Vol. 5, 1934, pp. 645–658.) In German.

INVESTIGATIONS ON PHOTO-EFFECTS IN CUPRITE CRYSTALS [Barrier-Layer Photo-Effect harder to obtain than with an Artificial Micro-crystalline Cu_2O Plate: the Effect of Crystal Thickness].—N. J. Barbaumow and others. (*Ibid.*, pp. 666–675.) In German.

MEASUREMENTS AND STANDARDS

A PRECISION WAVEMETER WITH 0.4% ACCURACY FOR THE WAVE-RANGE 270–3 000 METRES AND A.C. MAINS SUPPLY [with a Special Method of Outside Coupling].—G. Rösseler, H. Hoesch and H. R. Asbach. (*Hochf:tech. u. Elek:akus.*, August, 1934, Vol. 44, No. 2, pp. 67–68.)

The instrument comprises the actual wavemeter circuit (dynatron circuit), a quartz-controlled check oscillator circuit, and the mains unit. Mains fluctuations are dealt with by a glow-discharge potential divider, so that their effect is negligible compared with other sources of error, such as changes in the oscillatory circuit due to temperature and humidity variations. Such errors are corrected, against the check circuit, by means of a narrow-range short-circuited-turn damping adjustment (" korrektur " in the diagram). The dynatron oscillator derives its filament current from a dry-plate rectifier with an amply-designed smoothing filter getting rid of all a.c. hum, thus giving a flawless note and a high sharpness of resonance. The dynatron circuit was selected for two reasons: the absence of a special retroaction coil and the consequent convenience in switching to the various wave-ranges, and the ease with which the undesired harmonics can be suppressed. The quartz-controlled check oscillator does not require d.c. heating. Its crystal is of exactly 100 kc/s fundamental frequency, with a negligible temperature coefficient within a 15°–30°C range. The harmonics are strongly marked, so that they can easily be used up to the 45th for the calibration of the wavemeter; the only precaution to be taken, in each re-check of the calibration, is that the quartz-controlled oscillator anode current should be brought (by adjustment of the variable condenser) to the same value; the milliammeter for this purpose is the only meter used. While the wavemeter is in use the quartz oscillator can be disconnected: the consequent change in the current drawn from the mains is compensated by the glow-discharge potential divider.

Listening is accomplished with the aid of an external, leaky-grid detector circuit. This is very loosely coupled to the instrument: a small-diameter copper tube lies axially inside the oscillating coil of the quartz oscillator, and is connected through a small condenser to the aerial coil of the audion circuit. This arrangement has several advantages. It is practically impossible to withdraw energy from the two generators and thus to affect their frequencies; touching the aerial merely weakens the note by de-tuning the audion circuit, but does not alter its pitch. Moreover the quartz oscillations, especially the harmonics of high order, are comparatively strongly transmitted, while the dynatron fundamental comes through quite well in spite of the much looser coupling (between the copper tube and the 25-cm distant oscillating coil); in this way the dynatron harmonics are almost completely suppressed, so that the measurements are quite unambiguous. It is mentioned that the first writer has evolved an arrangement, based on the well-known double-beat principle, " for the measurement of dipole moments (very small capacity changes). This will be described in a paper to be published shortly."

ONDEMÈTRES-HÉTÉRODYNES (Heterodyne Wavemeters [Accumulator- or Mains-Driven: of Simple Design and High Frequency-Stability, based on David's Two-Grid Valve Circuit in Space-Charge-Grid Connection]).—E. Chatel. (*L'Onde Élec.*, May, 1934, Vol. 13, No. 149, pp. 231–236.)

After a short description of David's circuit (1931 Abstracts, p. 448) and a simplified form of it (Fig. 2) which gives rather less but still quite satisfactory stability and is very practical, the writer describes some types of wavemeter manufactured by " La Précision Électrique," employing the latter circuit. That shown in Fig. 4 is accurate to 1/1 000, for a range such as 15–2 500 m: it is not stated whether this type can be mains-driven. Figs. 5 and 6 show a mains- or battery-driven type accurate to better than 0.5%; the usual ranges are 15–500 m or 100–10000 m. Portable types are made, accurate to 1/1 000 and covering a narrow band such as 800–1 400 m.

THE PRIMARY FREQUENCY STANDARD AND MONITORING STATION OF THE CANADIAN RADIO BROADCASTING COMMISSION.—W. A. Steel. (*Proc. Inst. Rad. Eng.*, June, 1934, Vol. 22, No. 6, p. 681: summary only.) For an earlier paper *see* 1933 Abstracts, p. 457.

THE NEW ULYSSE NARDIN CHRONOMETERS RECORDING ELECTRICALLY 1/5th and 1/10th SECOND.—H. Rosat. (*Helvet. Phys. Acta*, Fasc. 5, Vol. 7, 1934, p. 493.)

" FINE GRAIN " PHENOMENON IN THE DIRECT STABILISATION OF A PULSE FREQUENCY BY A STANDARD SUBMULTIPLE FREQUENCY [with reference to Multivibrator Control].—Verman, Char and Mohammed. (*See* end of abstract under " Propagation of Waves.")

OSCILLATIONS WITH HOLLOW QUARTZ CYLINDERS CUT ALONG THE OPTICAL AXIS.—Ny Tsi-Zé and T. Ling-Chao. (*Nature*, 11th Aug. 1934, Vol. 134, pp. 214–215.)

Preliminary letter on the use of a hollow quartz cylinder, cut along the optical axis and with two electrodes applied to its inner and outer surfaces, as a piezoelectric oscillator.

OPTICAL IMAGE OF THE STANDING COMPRESSIONAL WAVE IN AN OSCILLATING QUARTZ CRYSTAL. A NEW METHOD OF MEASURING THE COMPRESSIBILITY OF QUARTZ [Preliminary Note].—H. R. Asbach, E. Hiedemann and K. H. Hoesch. (*Naturwiss.*, 6th July, 1934, Vol. 22, No. 27, p. 465.)

INTERFEROMETER METHOD FOR MEASURING THE AMPLITUDE OF VIBRATION OF QUARTZ BAR CRYSTALS: CORRECTION.—S. H. Cortez. (*Journ. Opt. Soc. Am.*, July, 1934, Vol. 24, No. 7, p. 194.) *See* August Abstracts, p. 449.

SOME IMPROVEMENTS IN QUARTZ CRYSTAL CIRCUIT ELEMENTS.—F. R. Lack, G. W. Willard and I. E. Fair. (*Bell S. Tech. Journ.*, July, 1934, Vol. 13, No. 3, pp. 453–463.)

Authors' abstract:—The characteristics of the Y-cut quartz crystal plate are discussed. It is shown that by rotating a plate about the X-axis special orientations are found for which the frequency spectrum is simplified, the temperature coefficient of frequency is reduced practically to zero, and the amount of power that can be controlled without fracture of the crystal is increased. These improvements are obtained without sacrificing the advantages of the Y-cut plate, *i.e.*, activity and the possibility of rigid clamping in the holder.

ELECTRICAL WAVE FILTERS EMPLOYING QUARTZ CRYSTALS AS ELEMENTS [and the Elimination of Some of the Crystal Compliances by Rotating the Angle of Cut, giving practically a Single Resonant Frequency over a Wide Range].—Mason. (*See* under "Subsidiary Apparatus and Materials.")

THE GRAPHICAL DETERMINATION OF RESULTANT AND INPUT RESISTANCES IN COMPLEX CIRCUITS.—H. Reppisch. (*Funktech. Monatshefte*, July, 1934, No. 7, pp. 255–259.)

DISTRIBUTED CAPACITY OF SINGLE-LAYER COILS [Reasons for Disagreement between Previous Theory and Experiment: Neglect of Two Important Parameters: a New Formula including Diameter of Bare Wire and Pitch of Winding: Experimental Verification].—A. J. Palermo. (*Proc. Inst. Rad. Eng.*, July, 1934, Vol. 22, No. 7, pp. 897–905.)

A METHOD OF MEASURING STATIC POTENTIALS, SUCH AS THE CHARGE POTENTIAL OF A CONDENSER [and the Percentage Modulation of a Radio Wave] FOR VOLTAGES EXCEEDING 0.1 VOLT, WITH A TRANSPORTABLE APPARATUS USING ONLY AN ELECTRO-MAGNETIC VOLTMETER AS THE MEASURING INSTRUMENT.—H. Subra. (*Comptes Rendus*, 9th July, 1934, Vol. 199, No. 2, pp. 124–126.)

DIE METHODEN DER KAPAZITÄTSMESSUNG (Capacity Measuring Methods [Survey with Literature References]).—T. Walcher. (*Elektrot. u. Masch:bau*, 5th Aug. 1934, Vol. 52, No. 31, pp. 360–366.)

THE ACTION OF A HIGH-FREQUENCY ALTERNATING FIELD ON SUSPENDED METALLIC RINGS AND DISCS [Experiments with Special Electrodynamometer: Verification and Extension of Pierce's Expression for Electro-Inductive Torque on a Ring: Application to Practical Method of measuring Intensity of H.F. Magnetic Fields].—P. K. Taylor. (*Proc. Inst. Rad. Eng.*, July, 1934, Vol. 22, No. 7, pp. 886–896.)

A NEW METHOD OF DETERMINING THE OPERATING CHARACTERISTICS OF POWER OSCILLATORS [by Measurements with 60-Cycle Power Mains].—C. N. Kimball and E. L. Chaffee. (*Proc. Inst. Rad. Eng.*, June, 1934, Vol. 22, No. 6, p. 683: short summary only.)

MEASURING THE EFFECTIVENESS OF INTERFERENCE-QUENCHING APPLIANCES.—Müller. (*See* under "Reception.")

SUBSIDIARY APPARATUS AND MATERIALS

A TWO-STAGE VACUUM IN A SEALED-OFF CATHODE-RAY OSCILLOGRAPH [giving a Ray Current of 4 mA for 14 kv in place of 40 μA for 36 kv with Single Vacuum].—K. Szeghö. (*Archiv f. Elektrot.*, 10th July, 1934, Vol. 28, No. 7, pp. 445–447.)

A NEW MASS SPECTROGRAPH [Combination of Electron-Optical Cylindrical Lenses].—J. Mattauch and R. Herzog. (*Zeitschr. f. Physik*, 1934, Vol. 89, No. 11/12, pp. 786–795.)

ION- AND ELECTRON-OPTICAL CYLINDER LENSES AND PRISMS. I.—R. Herzog. (*Zeitschr. f. Physik*, 1934, Vol. 89, No. 7/8, pp. 447–473.)

Author's summary:—It is shown that any combination of a radial electric field with a magnetic field perpendicular to it gives an electron-optical image which satisfies the same equations as optical images produced by the combination of a cylindrical lens and a prism. The position of the cardinal points is calculated and the theoretical results are applied to various special cases.

GRAPHITE FILMS FOR CATHODE-RAY TUBES [as Conducting-Layer "Second Anode": No Impairment of Image Brilliancy by Reflection, as with Metallic Layers: etc.].—(*Electronics*, June, 1934, p. 197.) *See* also June Abstracts, pp. 325–326.

THE HYDRAULIC COUNTER [Water-Jet Microphone] FOR ELEMENTARY RAYS: MEASUREMENT OF THE ELEMENTARY PHOTO-EFFECT IN WATER.—H. Greinacher. (*Helvet. Phys. Acta*, Fasc. 5, Vol. 7, 1934, pp. 514–519.) Further work on the instrument referred to in July Abstracts, p. 396.

OSCILLATING VALVE WITH HIGHLY POSITIVE GRID, AND ITS USE AS A THYRATRON SUBSTITUTE [in Automatic Counters, etc.].—Alfvén and Ohlin. (*See* under "Valves and Thermionics.")

AUTOMATIC SYNCHRONISING EQUIPMENT WITH GAS-FILLED GRID-CONTROLLED DISCHARGE TUBES.—V. Grosse. (*E.T.Z.*, 2nd Aug. 1934, Vol. 55, No. 31, pp. 761–763.)

THE USE OF KRYPTON AND XENON IN INCANDESCENT LAMPS.—G. Claude. (*Comptes Rendus*, 4th June, 1934, Vol. 198, No. 23, pp. 1959–1962.)

AN ALTERNATING CURRENT METHOD FOR COLLECTOR ANALYSIS OF DISCHARGE-TUBES.—R. H. Sloane and E. I. R. MacGregor. (*Phil. Mag.*, July, 1934, Series 7, Vol. 18, No. 117, pp. 193–207.)

The writers describe a method of finding the second derivative of discharge-tube probe characteristics directly, and of automatically determining the space potential. The second derivative is recorded as the difference between currents registered with and without an alternating e.m.f. superposed. Curves are shown illustrating the application of the method to actual cases.

VOLTAGE IMPULSES FOR THYRATRON GRID CONTROL.—M. M. Morack. (*Gen. Elec. Review*, June, 1934, Vol. 37, No. 6, pp. 288–295.)

GAS DISCHARGE TUBE AS INTERVALVE COUPLING: THE PRACTICAL APPLICATION FOR D.C. AMPLIFICATION.—H. Smith and E. G. Hill. (*See* under "Reception.")

A BALANCED ELECTROMETER TUBE AND AMPLIFYING CIRCUIT FOR SMALL DIRECT CURRENTS [Analysis and Two Modifications of Du Bridge Circuit, permitting Wider Range of Valve Characteristics].—G. P. Harnwell and S. N. Van Voorhis. (*Rev. Scient. Instr.*, July, 1934, Vol. 5, No. 7, pp. 244–247.)

THE RÔLE OF THE BARRIER LAYER IN RECTIFICATION AND IN PHOTOELECTRIC PHENOMENA.—van Geel. (*See* under "Phototelegraphy and Television.")

THE SIRUTOR, A NEW COPPER-OXIDE RECTIFIER FOR USE AS DETECTOR [Five Elements in Series].—Siemens Company. (*See* under "Reception.")

VIBRATOR POWER SUPPLY FROM DRY CELLS [with Formulae for Performance of an Idealised Supply System for (*e.g.*) a Portable Receiver with Loudspeaker, using 6 Dry Cells].—W. van B. Roberts. (*Electronics*, July, 1934, pp. 214–215.)

DIRECT CURRENT TRANSFORMERS.—F. Noack. (*Radio, B., F. für Alle*, August, 1934, No. 150, pp. 118–120.) *See* also August Abstracts, p. 452.

MEASUREMENTS ON MAINS TRANSFORMERS [for Broadcast Receivers].—K. Nentwig. (*Radio, B., F. für Alle*, August, 1934, No. 150, pp. 120–124.)

TURBO-ELECTRIC RADIO FOR TRAWLERS (Comparison with Battery-Driven Generators).—P. P. Eckersley: B. C. Holding. (*Electrician*, 15th and 22nd June, 1934, Vol. 112, Nos. 24 and 25, pp. 824 and 854.) Argument prompted by a recent article.

THE REGULATION OF VOLTAGE AND CURRENT IN D.C. CIRCUITS [by Regulator Lamps].—G. F. Partridge: Potter. (*Journ. Scient. Instr.*, July, 1934, Vol. 11, No. 7, pp. 233–234.) Prompted by Potter's paper (May Abstracts, p. 281, r-h column).

ELECTRON TUBE MOTOR CONTROL [A.C.-Operated Voltage-Controlled Rectifier for D.C. Motors of or under 3 H.P.].—F. H. Gulliksen. (*Electronics*, June, 1934, p. 179.)

TEMPERATURE CONTROL BY ELECTRON TUBES.—K. Henney. (*Electronics*, June, 1934, pp. 183–184 and 196.)

THERMIONIC TRIODE THERMOSTAT.—(*Journ. Scient. Instr.*, July, 1934, Vol. 11, No. 7, pp. 227–229.)

THEORETICAL CONSIDERATION ON THE SHEATH WIRE HEATING ELEMENT [Helical Coil of Nickel-Chromium Wire surrounded by Powdered Magnesium Oxide in Metal Tube].—R. Kawahara. (*Journ. I.E.E. Japan*, April, 1934, Vol. 54 [No. 4], No. 549, pp. 273–277: English summary pp. 37–38.)

A NEW PHOTOELECTRIC TEMPERATURE REGULATOR [giving Continuous Control within ± 0.17° at 1000° by Stretched-Ribbon Mirror Galvanometer and Selenium-Photocell/Thyratron Combination].—B. Lange and E. Voos. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 15, 1934, pp. 323–326.)

A CERAMIC INSULATING MATERIAL OF HIGH DIELECTRIC CONSTANT, FOR THE CONSTRUCTION OF CONDENSERS [Some Electrical and Mechanical Data on Kerafar].—E. Albers-Schönberg. (*Zeitschr. V.D.I.*, 21st July, 1934, Vol. 78, No. 29, p. 892: summary only.) *See* also Schwandt, Abstracts, June, p. 335, and G.W.O.H., August, p. 454, l-h columns.

PURE FUSED SILICA AND ITS USES IN ELECTROTECHNICS.—M. Mollet. (*L'Elettrotec.*, 15th July, 1934, Vol. 21, No. 20, pp. 449–457.)

INSULATOR ARCOVER IN AIR [Humidity Tests leading to a Theory of Arcover].—F. W. Maxstadt. (*Elec. Engineering*, July, 1934, Vol. 53, No. 7, pp. 1062–1068.)

INSULATOR SURFACE AND RADIO [Interference] EFFECTS [and the Action of Hygroscopic Deposits].—W. A. Hillebrand and C. J. Miller, Jr. (*Elec. Engineering*, August, 1934, Vol. 53, No. 8, pp. 1213–1220.)

ELECTROMAGNETIC SCREENING [The Effect of Screening Cans on the Effective Inductance and Resistance of Coils: a New Approximate Treatment].—G.W.O.H.: Kaden. (*Wireless Engineer*, July, 1934, Vol. 11, No. 130, pp. 347–350.)

Following on his Editorial on Kaden's work (June Abstracts, p. 334) the writer now gives a simpler treatment which makes assumptions not departing much further from the actual data than Kaden's "sphere and dipole" method. He replaces the can by a short-circuited solenoid. The results are compared with those obtained by the other method. A misprint in the former Editorial is corrected.

FOUCAULT CURRENTS IN CYLINDRICAL SHELLS AND RIBBONS [Theoretical Paper on Distribution of Alternating Currents in Strip Conductors].—F. W. Carter. (*Proc. Camb. Phil. Soc.*, 30th July, 1934, Vol. 30, Part 3, pp. 341–346.)

ON THE APPLICATION OF VECTOR DIAGRAMS TO THE STUDY [and Practical Calculation] OF ELECTRIC FILTERS.—A. Harkevitch. (*L'Onde Élec.*, June, 1934, Vol. 13, No. 150, pp. 245–260.)

ELECTRICAL WAVE FILTERS EMPLOYING QUARTZ CRYSTALS AS ELEMENTS.—W. P. Mason. (*Bell S. Tech. Journ.*, July, 1934, Vol. 13, No. 3, pp. 405–452.)

Author's abstract:—This paper discusses the use of piezoelectric crystals as elements in wave filters and shows that very sharp selectivities can be obtained by employing such elements. It is shown that by employing crystals and condensers only, very narrow band filters result. By using coils and transformers in conjunction with crystals and condensers, wide-band-pass and high- and low-pass filters can be constructed having very sharp selectivities. The circuit configurations employed are such that the coil dissipation has only the effect of adding a constant loss to the filter characteristic, this loss being independent of the frequency. Experimental curves are given showing the degree of selection possible.

In the appendix, a study is made of the modes of motion of a perpendicularly cut crystal, and it is shown that all the resonances measured can be derived from the elastic constants and the density of the crystal. The effect of one mode of motion on another mode is shown to be governed by the mutual elastic compliances of the crystal. By rotating the angle of cut of the crystal, it is shown that some of the compliances can be made to disappear and a crystal is obtained having practically a single resonant frequency over a wide range of frequencies. Such a crystal is very advantageous for filter purposes.

STATIONS, DESIGN AND OPERATION

GERMANY'S BROADCASTING SERVICE AS A TECHNICAL PROBLEM [Scarcity of Broadcasting Wavelengths in Europe: the Shared-Wave Principle: Anti-Fading Aerials: Directive Aerials (Lahti, Kaschau and Vienna): Common-Wave Transmission: Future Prospects].—H. Harbich. (*E.T.Z.*, 12th July, 1934, Vol. 55, No. 28, pp. 685–688.)

In the subsequent Discussion (pp. 705–707) Wagner asks the "receiver specialists" whether receivers could be made to be less sensitive to selective fading and the consequent distortion; mentioning that he has recently obtained better and more uniform reception with a receiver whose self-excited oscillation could be so finely adjusted as to allow zero-point tuning: this improvement he attributes to the supply of additional carrier wave. Runge and others discuss the possibilities of such local supply of carrier, and Schröter refers to the work of Koomans in Holland on carrier and single side-band transmission, and the attractions of such a plan.

THE BERLIN AND HAMBURG HIGH-POWER BROADCASTING STATIONS.—W. Meyer. (*Telefunken-Zeit.*, June, 1934, Vol. 15, No. 67, pp. 39–46.)

THE EFFECT OF BACKGROUND NOISE IN SHARED-CHANNEL BROADCASTING.—Aiken. (*See* under "Reception.")

A COMBINED FADING-IN AND -OUT, MIXING, AND LOUDNESS CONTROL APPARATUS.—Klein. (*See* under "Transmission.")

PRINCIPLES OF AUDIO-FREQUENCY WIRE BROADCASTING ["Audio-Frequency Rediffusion"].—P. P. Eckersley. (*Wireless Engineer*, June, 1934, Vol. 11, No. 129, pp. 312–313.) Summary of I.E.E. paper.

SHORT-WAVE COMMUNICATION OVER DISTANCES OF 100 TO 1 000 KILOMETRES [with Curves and Empirical Formulae for the Choice of Day and Night Waves].—V. Kolesnikov. (*L'Onde Élec.*, June, 1934, Vol. 13, No. 150, pp. 271–276.)

Assuming that in favourable conditions a field strength of 100 μv/m is sufficient, the power necessary for a 1 000 m station to work over 1 000 km is (by the Moscow formula) about 8 kw. Experience shows that a regular service on short waves can be assured with 1–1.5 kw (for the shorter ranges, 100–400 km, this may be reduced to 0.6–0.7 kw for telephony and 100–120 w for telegraphy). Curves for the optimum and limiting wavelengths, as a function of distance, are given for day and for night; these are derived from the results of Bureau, the Aerotechnical Research Institute of Warsaw, Ede's results in China, and service data. Empirical formulae for the optimum waves are also given: for day, $\lambda = 74.24 - 0.036\,l$, and for night $\lambda = 97 - 0.013\,l$, the distance l being in km and the wavelength in metres. Communication is possible within the band between $\lambda \pm 7$.

SHORT-WAVE RESULTS ON WIRELESS TRANSOCEANIC SERVICES IN 1926–1934.—Mögel. (*See* under "Propagation of Waves.")

THE DANGER OF MUTUAL BLOCKING BY ECHO SUPPRESSORS [and an Apparatus for measuring the Probability of such Blocking].—H. Decker. (*E.N.T.*, July, 1934, Vol. 11, No. 7, pp. 238–245.)

THE COMPANDOR—AN AID AGAINST STATIC IN RADIO TELEPHONY.—R. C. Mathes and S. B. Wright. (*Bell S. Tech. Journ.*, July, 1934, Vol. 13, No. 3, pp. 315–332.) *See* August Abstracts, p. 454, r-h column.

RADIO EQUIPMENTS FOR AERONAUTICS [Introduction: Aeroplane Sets: Ground Installations].—(*Bull. S.F.R.*, Jan./Feb./March, 1934, Vol. 8, No. 1, pp. 1–60.)

THE "TERRA-WAVE" POLICE TRANSMITTER-RECEIVER [8–10 Metre Wavelengths: Vertical Aerials giving Strong Ground Waves: Unmodulated Carrier Power 15 Watts].—RCA Victor. (*Rad. Engineering*, July, 1934, Vol. 14, No. 7, pp. 14–15 and 19.)

GENERAL PHYSICAL ARTICLES

THE STABILITY AND CHARGE OF AEROSOLS [Theoretical Paper].—N. Fuchs. (*Zeitschr. f. Physik*, 1934, Vol. 89, No. 11/12, pp. 736–743.)

THE HEAT OF ADSORPTION OF HYDROGEN ON TUNGSTEN [Value 2.8×10^4 calories per mol.]—J. K. Roberts and B. Whipp. (*Proc. Camb. Phil. Soc.*, 30th July, 1934, Vol. 30, Part 3, pp. 376–379.)

REMARK ON A SUPPOSED RELATION BETWEEN WORK FUNCTION AND ELECTRON POTENTIAL IN A METAL.—K. F. Niessen: Frenkel. (*Physica*, May, 1934, Vol. 1, No. 7, pp. 623–626.) Criticism of Frenkel's 1928 results ($\phi = W_a/6$).

[Marked] DEPENDENCE OF THE CONDUCTIVITY OF VERY THIN METALLIC FILMS ON THE ELECTROSTATIC FIELD.—R. Deaglio. (*Naturwiss.*, 3rd Aug. 1934, Vol. 22, No. 31, pp. 525–526.)

THE CATALYTIC PROPERTIES AND STRUCTURE OF METAL FILMS. PART II—THE ELECTRICAL CONDITION OF PLATINUM FILMS.—G. I. Finch and A. W. Ikin. (*Proc. Roy. Soc.*, 2nd July, 1934, Vol. 145, No. *A* 855, pp. 551–563.)

REIGNITION OF AN ARC AT LOW PRESSURES [Results consistent with Theory of Transition from Glow Discharge to Arc].—S. S. Mackeown, F. W. Bowden and J. D. Cobine. (*Elec. Engineering*, July, 1934, Vol. 53, No. 7, pp. 1081–1085.) With a bibliography of 33 items.

MISCELLANEOUS

RESEARCH [in Telecommunication, excluding Radio] IN THE BRITISH POST OFFICE.—B. S. Cohen. (*Journ. I.E.E.*, August, 1934, Vol. 75, No. 452, pp. 133–160.)

THE WORK OF THE INSTITUTE FOR THE APPLICATIONS OF THE CALCULUS, IN SCIENTIFIC AND TECHNICAL RESEARCH.—M. Picone. (*L'Elettrotec.*, 25th June, 1934, Vol. 21, No. 18, pp. 397–402.) For a previous paper on this Institute *see* 1933 Abstracts, p. 580, l-h column.

CHARACTERISTIC NUMBERS, FUNCTIONS, AND ORTHOGONAL PROPERTIES OF DIFFERENCE EQUATIONS.—H. Levy and E. A. Baggott. (*Phil. Mag.*, July, 1934, Series 7, Vol. 18, No. 117, pp. 177–187.)

THE NUMERICAL SOLUTION OF SCHRÖDINGER'S EQUATION [Practical Method of Successive Approximation by Difference Equation Solutions].—G. E. Kimball and G. H. Shortley. (*Phys. Review*, 1st June, 1934, Series 2, Vol. 45, No. 11, pp. 815–820.)

THE MID-COURSE METHOD OF FITTING A PARABOLIC FORMULA OF ANY ORDER TO A SET OF OBSERVATIONS.—T. Smith. (*Proc. Phys. Soc.*, 1st July, 1934, Vol. 46, Part 4, No. 255, pp. 560–569: Discussion pp. 569–573.)

THE VECTOR REPRESENTATION OF A SAMPLE [Theory of Statistics].—M. S. Bartlett. (*Proc. Camb. Phil. Soc.*, 30th July, 1934, Vol. 30, Part 3, pp. 327–340.)

PRACTICAL METHODS FOR THE ANALYSIS OF OSCILLATING CURVES [for the Recognition of Hidden Periodicities, the Interpretation of Graphs, etc.].—F. Vercelli. (*La Ricerca Scient.*, 15th April, 1934, 5th Year, Vol. 1, No. 7, pp. 364–383.)

SELECTIVE TRANSFORMATIONS. APPLICATION TO THE ANALYSIS OF MIXTURES OF SINUSOIDAL CURVES [by a Modification of the Recording Microphotometer].—M. Lévy: Labrouste. (*Comptes Rendus*, 25th June, 1934, Vol. 198, No. 26, pp. 2222–2225.)

POTENTIAL FUNCTIONS WITH PERIODICITY IN ONE CO-ORDINATE.—R. C. J. Howland. (*Proc. Camb. Phil. Soc.*, 30th July, 1934, Vol. 30, Part 3, pp. 315–326.)

POSITRON, NEUTRON—CAN WE PUT THEM TO WORK? [in Valves or Cathode-Ray Tubes].—(*Electronics*, April, 1934, p. 122.)

THE DE-ELECTRIFICATION OF PAPER, FIBRE, ETC. [Prevention of Static Charges by Ionisation of the Air by Brush-Discharge Equipment].—C. Lorenz Company. (*E.T.Z.*, 31st May, 1934, Vol. 55, No. 22, pp. 544–545.) To avoid the use of more expensive methods (radium preparations, etc.—*see* Abstracts, 1929, p. 346, and 1930, p. 471).

SLOW PULSATIONS: ELECTROMAGNETIC FLUCTUATIONS IN HARDNESS OF METALS [probably due to Periodic Changes in Electromagnetic Force of Cohesion between Crystal Slip Planes].—Herbert. (*Electrician*, 8th June, 1934, Vol. 112, No. 23, p. 784.) For Herbert's work on magnetic hardening *see* 1930 Abstracts, p. 526, r-h column.

THE MEASUREMENT OF PRESSURES IN STAMPING PROCESSES, USING AN ULTRA-MICROMETRIC DEVICE BASED ON THE PRESSURE/MAGNETIZABILITY EFFECT IN STEEL/NICKEL ALLOYS.—K. M. Dolezalek: Janovsky. (*Zeitschr. V.D.I.*, 21st July, 1934, Vol. 78, No. 29, pp. 871–874.) The method of investigation is based on Janovsky's work (March Abstracts, p. 168, l-h column).

THE ELASTOGRAPH OF THE UNIVERSITY OF BRISTOL [Capacity-Change Ultra-Micrometric Device using Matthews Electrocardiograph as Recorder].—F. de la C. Chard. (*Génie Civil*, 14th July, 1934, Vol. 105, No. 2, pp. 44–45.)

CAPACITY-CHANGE ULTRA-MICROMETRIC METHOD OF STUDYING THE VIBRATION OF LARGE BELLS.—Obata and Tesima. (*See* abstract under "Acoustics and Audio-frequencies.")

"INDUCTIVE" TEMPERATURE MEASUREMENT [Trial of Method of measuring Temperature of Roller in Rubber Manufacture, using A.C. Electromagnet in Bridge Circuit: Eddy Current Loss in Roller varies with Temperature].—G. Keinath. (*E.T.Z.*, 12th July, 1934, Vol. 55, No. 28, pp. 697–698.)

A GLOW-DISCHARGE ANEMOMETER [replacing the Hot-Wire Anemometer for Aerodynamical Research].—F. C. Lindvall. (*Elec. Engineering*, July, 1934, Vol. 53, No. 7, pp. 1068–1073.)

ELECTRONIC PHOTELOMETER [for Routine Analysis of Solution Samples by Colour: *e.g.* Haemoglobin in Blood].—Sheard and Sanford. (*Electronics*, July, 1934, p. 221.)

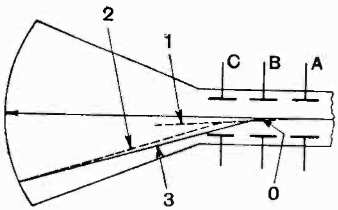
Some Recent Patents

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.

CATHODE-RAY RECEIVERS

Convention date (Germany), 26th October, 1932.
No. 409221

In general the two pairs of deflecting-electrodes used to traverse the beam over the fluorescent screen are situated at slightly different distances along the axis of the tube, so that the movement



No. 409221.

of the beam, say in the vertical direction, has a slightly different radius of curvature from that in the horizontal direction. The result is a loss of focus, particularly towards the edges of the screen, which gives rise to blurring. According to the invention, this loss of definition is made good by using three pairs of deflecting electrodes *A*, *B*, *C* instead of the usual two, the total vertical deflection being shared in equal parts by the electrodes *A* and *C*. The electrodes *A* deflect the beam from its normal axis to the line 1, whilst the plates *C* further deflect it from line 1 to line 2. The middle pair of plates B (shown in the same plane for the sake of clearness) then superpose a lateral swing in the direction 3 which starts from the common centre *O* of the other two.

Patent issued to Telefunken ges. für Drahtlose Telegraphie, M.b.h.

DIRECTION-FINDING SYSTEMS

Convention date (U.S.A.), 19th November, 1931.
No. 409298

The "Döppler" principle, by virtue of which the pitch of a note changes with any movement of the source relative to the receiver, is utilised as a means for determining the position of a moving aeroplane. Two fixed transmitters, spaced apart, radiate a continuous train of waves, both of which are received by the moving craft. This marks out a track in space which (*a*) if the transmitters radiate on the same frequency is indicated by zero reception; or (*b*) if they radiate waves of different frequencies is indicated by a beat note of constant pitch. If the craft "yaws" to one side or other of the track, the deviation is immediately indicated, (*a*) by the appearance of a note, or (*b*) by an alteration in the pitch of the existing beat note.

Patent issued to Electrical Research Products Inc.

TESTING LOUD SPEAKERS

Application date, 10th November, 1932.
No. 409415

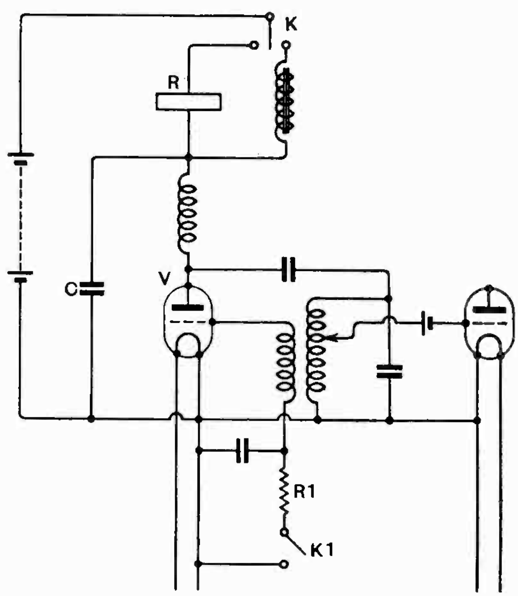
A single large baffle-board is wired so that a number of different loud-speaker models can be mounted on it and connected, either singly, or in selected pairs in series or parallel, so as to give a demonstration of performance. The arrangement allows a rapid and convenient comparison to be made, either for test purposes or when selling to a customer.

Patent issued to B. Freeman.

KEYING SYSTEMS

Application date, 4th November, 1932.
No. 409405

In an I.C.W. system in which the signal is sent by interrupting a carrier-wave at a constant frequency, the "breaks" are effected by disconnecting a resistance in the grid circuit of the oscillator valve. As shown in the figure, closure of the keying contact *K* causes a relay *R* to open



No. 409405.

the grid circuit of the oscillator valve *V* at a point *K*1 below the resistance *R*1. This causes the grid to accumulate a negative bias, so that the plate current falls off, and the relay *R* falls back, whereupon the cycle is repeated. The relay is "held" for a definite interval of time (depending upon the charging current of the condenser *C*) both at "make" and "break," thereby maintaining a constant frequency of interruption.

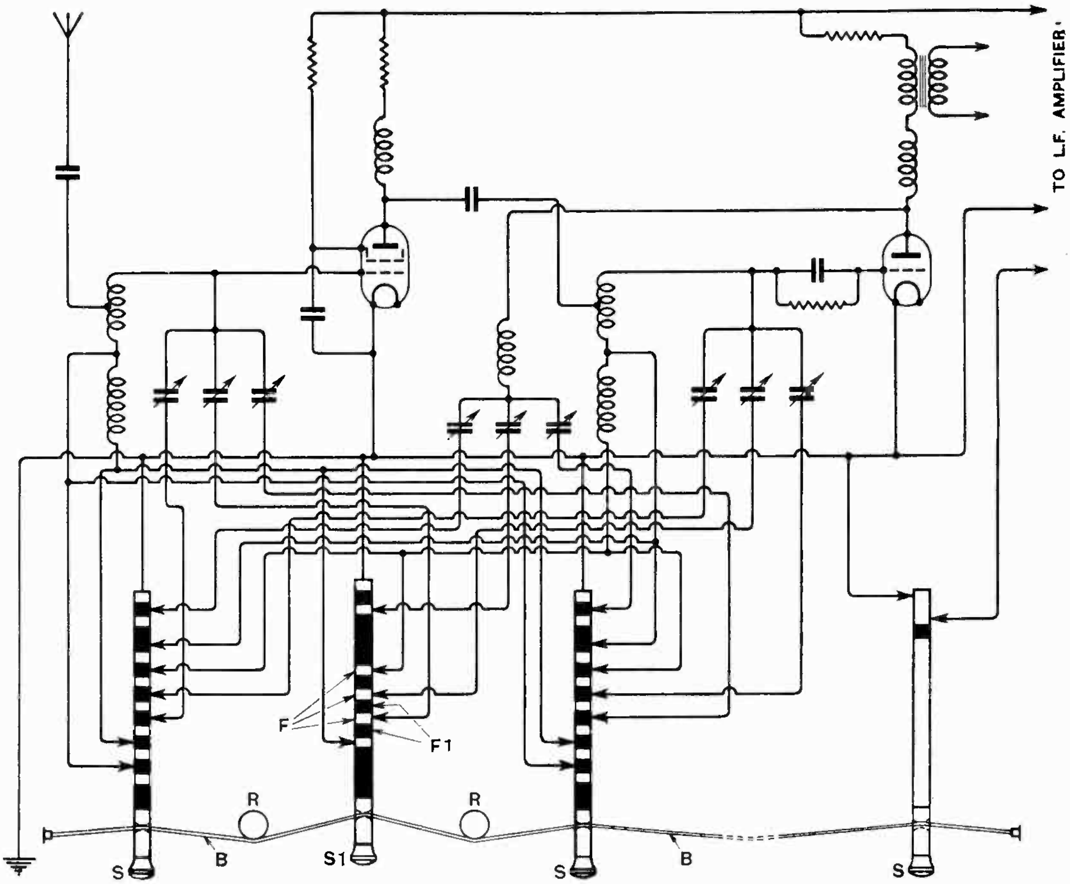
Patent issued to General Electric Co., Ltd., and D. W. Berry.

SWITCH TUNING

Application date, 18th November, 1932.
No. 409429

Tuning is effected by a system of interlinked switches which automatically open, close, or select certain tuned circuits corresponding to pre-determined transmitting stations. The arrangement is such that only one pre-tuned circuit can be operated at a time. As shown in the figure, each switch *S* consists of a rod formed with conducting sleeves *F* and intermediate insulating bands *F*1. The former engage contact to close the required circuits when a selected switch, such as *S*1, is pushed forward as shown. A non-elastic but flexible band *B* is threaded through each switch-rod, and passes over bearing-rollers *R*, so as to prevent the simultaneous operation of more than one switch.

Patent issued to W. M. Sherman.



No. 409429.

"FILM" TELEVISION

Convention date (Germany), 5th November, 1931.
No. 409400

Relates to television systems of the kind in which an outdoor event is first recorded by a kinematographic camera, and the scene is then televised by scanning the film. In order to speed-up transmission so that it occurs almost simultaneously with the event, the development of the film is arrested at a point where it would be too faint for ordinary reproduction, though the light and shade values are sufficiently defined for scanning purposes. For instance, a developing period of two seconds is sufficient, the final fixing, washing, and drying processes taking place after the film has been scanned. Preferably a "blue-sensitive" film is used in combination with a red scanning beam and a "red sensitive" photo-electric cell.

Patent issued to Fernseh Akt.

TELEVISION SYSTEMS

Convention date (U.S.A.), 7th January, 1932.
No. 409367

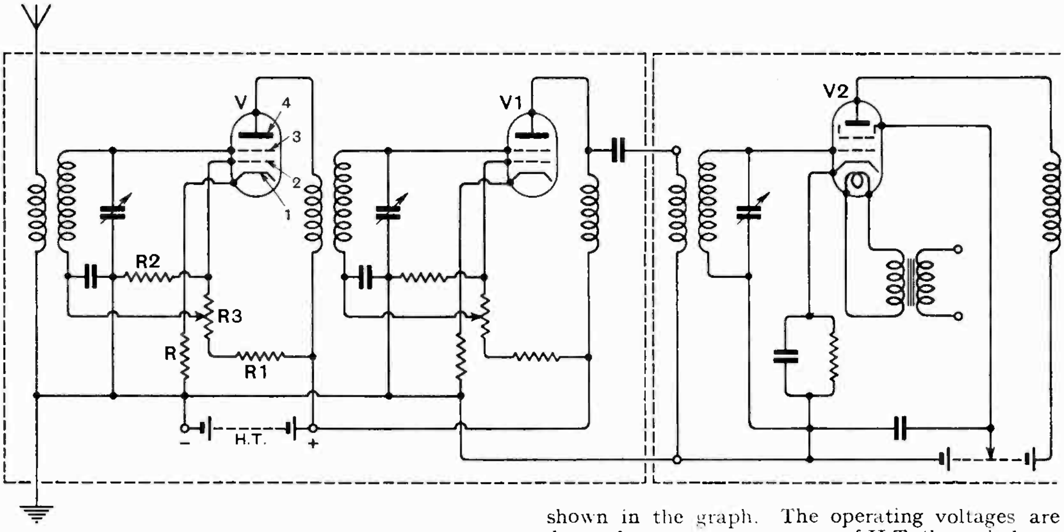
Relates to apparatus for televising out-of-door sporting events, or similar "extended" scenes such as a theatrical performance, where it is necessary to shift the general direction of the scanning beam rapidly from point to point. According to the invention, the projector for the light beam, and the receiver for directing the reflected light on to the photosensitive cell, are each mounted on separate pivotal supports, which are linked together for simultaneous adjustment, so that it is possible to follow a figure over a wide field of view without having to move the scanning-apparatus bodily. The projector and receiver are controlled by a pantograph arrangement which automatically rotates the latter through twice the angle of the former.

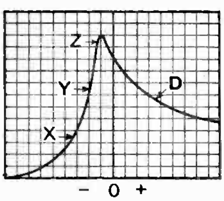
Patent issued to Electrical Research Products Inc.

STATIC-ELIMINATORS

Convention dates (U.S.A.), 14th April and 22nd June, 1932. *No.* 409460

The effect of static interference is reduced by making use of cold-cathode valves having a "peaked" characteristic curve, the operating point being controlled by the strength of the impacting disturbance so as to preserve automatically a high ratio of signal strength to disturbance. As shown in the circuit, the two input valves *V*, *V*1 are of the "cold-cathode" type, the discharge across the high-voltage electrode 2 and the electrode 1 forming the source of the electron stream in place of the normal heated filament. The discharge in combination with the electrodes 3 and 4 constitutes a triode amplifier having a grid-volt anode-current characteristic of the form





No. 409460.

shown in the graph. The operating voltages are drawn from a common source of H.T. through dropping resistances *R*, *R*1, *R*2, *R*3. The output circuit of the valve *V*1 feeds a high-frequency amplifier *V*2 of normal type. The effect of the stages *V*, *V*1 is to amplify all signals between *X* and *Z*, in the ordinary way, but to suppress all disturbances having an amplitude greater than *Z*.

Patent issued to Rapid Research Laboratories Inc.

AMPLIFYING VALVES

Convention date (U.S.A.), 15th June, 1932.
No. 409461

It is known that an amplifier operated with a positive bias on the grid is capable of giving high output, not only because it will take a large useful grid-swing, but also because it has a low output impedance. Also, with a positive grid bias, it is possible to secure a higher mutual conductance than otherwise. On the other hand, the power output is limited by overheating of the anode. According to the invention, an auxiliary grid is interposed between the control grid and the cathode, and is connected to the mid-point of the cathode heater, so that it is biased negatively with respect to the positive terminal of the cathode. It is then possible to give the control grid a positive bias, and at the same time to increase the input impedance, so as to give a high gain without distortion or overheating, particularly in the case of resistance-coupled L.F. amplifiers.

Patent issued to Radio Research Laboratories Inc.

VALVE ELECTRODES

Convention date (Germany), 17th November, 1932.
No. 409546

Relates to a method of making thin wire-wound grids of identical form by mass-production. One or more supporting wires are first laid on an iron core, and the fine grid structure is wound over both. The grid is next welded to the supports and annealed at a temperature of from 700° to 1,000° C. The iron core is then partly dissolved or destroyed by immerson in a bath of dilute hydrochloric acid, the remainder being detached if necessary by a mechanical operation. The core, by acting as a support, prevents any alteration of shape in the fine grid-structure during the welding and annealing processes.

Patent issued to N. V. Philips' Gloeilampenfabrieken.

Convention date (Holland), 22nd March, 1933.
No. 409613

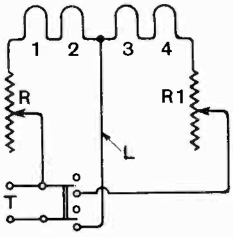
Grids for valves, zig-zag and coiled filaments, and similar electrode structures are made of wire gauze built up of different kinds of wire, such as iron and tungsten. After the gauze has been bent or otherwise manipulated into the desired form, the mere supporting wires (say of iron) are dissolved away by immersion in hydrochloric acid, leaving the required tungsten or molybdenum structure in fixed formation. The method is applicable, for instance, to the manufacture of the irregularly spaced grids commonly used in variable-mu valves.

Patent issued to N. V. Philips Gloeilampenfabrieken.

CATHODE-HEATING CIRCUITS

Convention date (Holland), 19th January, 1933.
No. 409574

To adapt a mains-driven set for operation on supply mains of different voltage, the heating circuit is provided with a switch *S* which, in the full-line position, connects the supply terminals *T* across the filaments 1 and 2, in parallel with the filaments 3 and 4, both branches containing series resistances *R*, *R*1. In the upper or dotted-line position, the switch places all the filaments and resistances in series. When a power-output valve of high rating is used in the last stage, the branch lead *L* is preferably connected between the filaments 3 and 4, instead of as shown. The arrangement reduces the energy lost in the voltage-dropping resistances to a minimum.



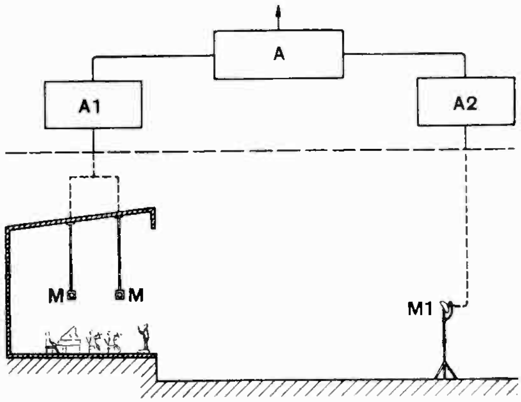
No. 409574.

Patent issued to N. V. Philips' Gloeilampenfabrieken.

"MONITORING" SYSTEMS

Convention date (U.S.A.), 26th August, 1932.
No. 409967

Automatic gain-control systems in practice are liable to a lag or inertia delay of the order of one-twentieth of a second. In order to overcome this, a suitable time delay is introduced between the arrival of the voltages used for A.V.C. and the arrival of the signal proper at the amplifier. As shown, the A.V.C. voltages are derived from two microphone pick-ups *M*, *M*, which are placed in close proximity to the orchestra in a broadcasting studio, and are connected to the main amplifier *A* through an intermediate amplifier *A*1. Meanwhile, the main signal is handled by a microphone *M*1, which is placed 50 feet away from the performers —so as to introduce the desired period of delay. The voltages produced at *M*1 are passed through an amplifier *A*2 to the main amplifier *A*.



No. 409967.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.

TUNING SYSTEMS

Convention date (Germany), 6th October, 1931.
No. 409737

The normal band from 200–600 metres and the long-wave band from 1,000–2,000 metres are each subdivided into a number of separate sections with associated tuning scales, the full swing of the tuning condenser being used over each. This is effected by inserting a fixed condenser in parallel with the ordinary tuning condenser, so as to reduce the ratio of maximum to minimum capacity, thereby producing a vernier effect. Each subsection is associated with a separate inductance, these being successively thrown into circuit by a switch which simultaneously brings a fresh portion of the full wave-range scale into view. The switch may be moved forward one step, automatically, at the end of each rotation of the tuning-condenser knob.

Patent issued to L. L. De Kramolin.

VALVE CONSTRUCTION

Application date, 2nd November, 1932.
No. 409693

The anode of the valve is formed in two flat sections, which face opposite sides of the control grid, and are screened from the latter by tubular structures which are perforated only on the side facing the grid. The screens may be connected at the top and bottom and serve to shield the connecting leads as well as the electrodes. The anode sections are supported inside the screening-members by insulating strips of mica, porcelain, or steatite.

Patent issued to P. Freedman.

COATED VALVES

Convention date (Austria), 3rd February, 1932.
No. 409851

Instead of the usual metal-paint coating, or the known metal cylinder, a wire-gauze net is drawn closely over the glass bulb of the valve. The net is connected to the cathode and serves to screen-off external fields. At the same time it radiates heat freely and so keeps the valve cool. The net can be made of fine-gauze wire, of comparatively large mesh, without impairing the screening effect.

Patent issued to B. Erber and A. Schwitzer.

DIRECTIVE AERIALS

Convention date (U.S.A.), 15th September, 1932. No. 409978

Two wires, each long in comparison to the working wavelength, are arranged to diverge horizontally from a common apex, to form an aerial giving maximum concentration along the line bisecting the angle. According to the invention several such units are mounted one above the other on the same mast-supports, and are fed in phase-quadrature to give a unidirectional field. The direction of maximum radiation can be reversed by making the current in one pair of wires "lead" instead of "lag" the next pair. The required phase-adjustments are applied by means of tuning-strips inserted in the feed wires.

Patent issued to Marconi's Wireless Telegraph Co., Ltd.

TELEVISION SYSTEMS

Convention date (Japan), 12th December, 1932.
No. 409970

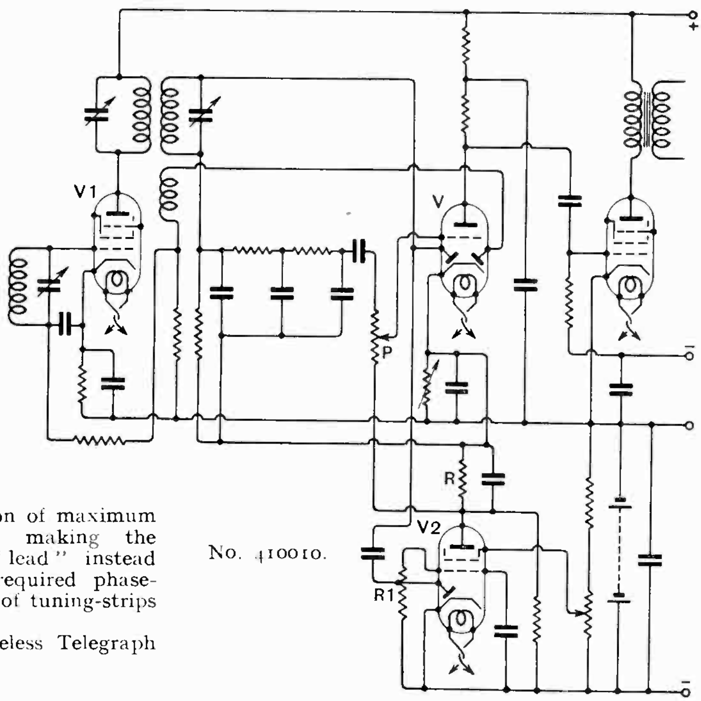
The picture is projected on to the screen of a cathode-ray tube as a series of dots, instead of lines, thus avoiding striation effects. To ensure this result the cathode-ray tube is provided with a separate pair of coils, in addition to the normal control electrodes. The extra coils are fed with saw-toothed current at a frequency which, when superposed in the line-scanning frequency, causes the cathode ray to "dwell" at regular intervals in its forward movement. This breaks up the normal to-and-fro traverse into a progressing series of "spots" separated by intermediate regions of less illumination.

Patent issued to T. Nakashima and K. Takayanagi.

"QUIET" A.V.C.

Application date, 23rd October, 1933. No. 410010

A quiet background is ensured, when tuning between stations of a predetermined carrier strength, by applying a paralyzing-bias from a resistance *R* to the control grid of the double-diode-triode *V*. The diode portion of the diode-tetrode control valve *V2* is fed from the output circuit or the H.F. valve *V1*, so that an incoming signal is rectified and applies a negative bias through a resistance *R1* to the grid of *V2*. The resulting increase in the internal resistance of that valve reduces the voltage across the resistance *R* until the point is reached at which the initial bias in the grid of the valve *V* is reduced to allow the received signal to pass through to the loudspeaker. Manual volume control may be applied through the tapping *P*.



No. 410010.

Patent issued to Cromwell (Southampton), Ltd.

VALVE CONSTRUCTION

Convention date (Germany), 23rd November, 1934.
No. 410019

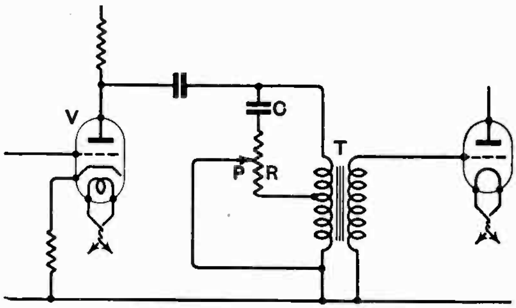
To reduce dielectric losses in short-wave working, the "pinch" of a valve is made of a densely burned mass of magnesium silicate, or of commercial steatite which consists of 90 per cent. soapstone. The connecting wires for the electrodes have the same coefficient of expansion as the silicate, whilst the glass bulb is either fused directly on to the cap or through the medium of an intermediate glass bead or rim.

Patent issued to Steatit-Magnesia A.G.

REGULATING TONE

Application date, 4th October, 1932. No. 410119

A tone control network is inserted between the L.F. valve *V* and a power amplifier. It consists



No. 410119.

of a resistance *R* in series with a condenser *C*, shunted across either the whole or part of the primary winding of the coupling transformer *T*. By varying the position of the tapping *P*, the response of the network can be varied progressively from a maximum at low frequencies to a maximum at high frequencies, the by-passing effect of the condenser *C* increasing as the resistance *R* is cut out.

Patent Issued to Electric and Musical Industries Ltd., and H. L. Oura.

IRON-CORED H.F. COILS

Convention date (Germany), 8th March, 1932.
No. 410327

The magnetic material used for "loading" H.F. coils is liable to vary from a uniform standard of permeability, so that it becomes necessary to make subsequent adjustments in order to secure a specified inductance, or to match a given impedance. In order to allow this to be effected in a simple manner, the coil windings are divided into two or more sections, each carried on a separate bobbin or former. The windings are then threaded over the same powdered-iron coil, in such a way that the magnetic gap or distance between them can be varied slightly, either to adjust the overall inductance to a definite value, or alternatively to vary it progressively over wide limits.

Patent issued to H. Vogt.

PHOTO-ELECTRIC CELLS

Application date, 11th November, 1932.
No. 410142

In order to increase the intensity of the current developed under the influence of light, a semi-cylindrical electrode which acts as a primary cathode is arranged on one side of the anode. On the opposite side of the anode is a similar, but smaller cathode, which emits secondary electrons when struck by the stream from the first cathode. The glass bulb is opaque except for a window to admit the incident light, which passes to each side of the back of the smaller cathode so as to reach the sensitized convex surface of the primary cathode.

Patent issued to Electric and Musical Industries Ltd., and W. F. Tedham.

WATER-COOLED VALVES

Application date, 9th November, 1932.
No. 410165

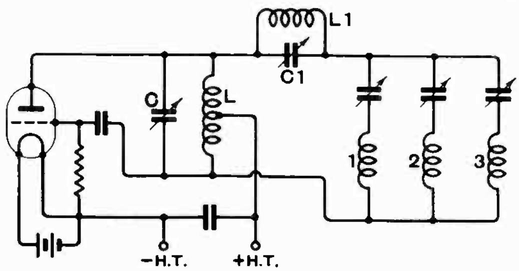
High-power amplifiers are usually cooled by immersing the anode in a stream of water or other liquid fed through a circulating system of pipes. High-frequency losses are, however, liable to occur either in the pipe system or in the supporting structure. In order to reduce such loss to a minimum, the H.F. end of the cooling pipe is enclosed by a metal structure, which is also connected to the source of H.F. potential so as to act as a "corona ring." This reduces the H.F. voltage gradient down the piping.

Patent issued to Marconi's Wireless Telegraph Co., Ltd., and C. S. Franklin.

VALVE GENERATORS

Application date, 12th November, 1932.
No. 410182

The frequency of a valve-oscillator is stabilised by taking steps to eliminate all harmonics of the fundamental. As shown in the figure, the main oscillatory circuit *L*, *C* (which serves to maintain the valve in oscillation) is shunted by a series of acceptor circuits 1, 2, 3. These are tuned to the principal harmonic frequencies and serve to by-pass or drain them away. A blocking circuit *L1*, *C1*,



No. 410182.

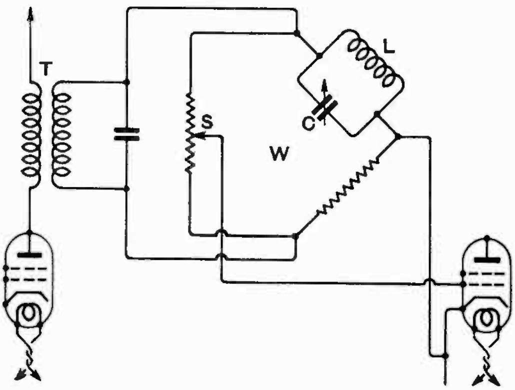
tuned to the fundamental frequency, is inserted in the common lead to the acceptor circuits in order to prevent the fundamental from entering them.

Patent issued to Marconi's Wireless Telegraph Co., Ltd., and W. A. Appleton.

SUPERHET RECEIVERS

Application dates 30th November, 1932 and 5th January, 1933. No. 410225

Heterodyne "whistle" is eliminated, without affecting the high-note reproduction of the desired signal, by inserting a variable filter-circuit in the intermediate-frequency stage. As shown in the



No. 410225.

Figure the tuned secondary of the I.F. transformer *T* is shunted by a Wheatstone-bridge arrangement *W*, including in one of the arms a circuit *L*, *C* which can be tuned to the unwanted frequency. The bridge is then balanced by the slider *S* so as to prevent that frequency from reaching the input of the next valve, which is branched across the other diagonal of the bridge. The condenser *C* is ganged to the slider *S* so as to enable the tuning and balancing to be effected in one operation.

Patent issued to W. Baggally.

AUTOMATIC VOLUME CONTROL

Convention date (Germany), 3rd September, 1932. No. 410374

Gain control is effected by applying the rectified signal voltage to the grid of a special six-electrode valve, so that it alters the internal resistance of the valve, instead of varying the mutual conductance or "slope" as usual. The change in resistance is utilised to vary the damping of the output circuit of the valve, which, in turn, controls the loud speaker volume. The valve comprises the usual control grid, followed by a positively biased grid and a perforated anode. Beyond the latter comes a negatively-biased "piling-up" grid; finally there is an outer anode which is anchored to a positive voltage of less value than that applied to the perforated output anode.

Patent issued to Telefunken Ges. fur drahtlose Telegraphie m.b.h.

CATHODE-RAY TUBES

Application date 15th November, 1932. No. 410478

Relates to tubes of the kind in which the beam passes through and is not appreciably intercepted by the auxiliary or focusing electrode. Under these circumstances it is possible to dispense with a separate source of biasing voltage, and to supply the operating potentials for the anode and auxiliary electrode from suitable tappings on a common potentiometer shunted across the supply. A condenser is connected between the auxiliary electrode and the cathode so as to maintain the former at a substantially steady voltage.

Patent issued to Electric and Musical Industries, and J. D. McGee.

PIEZO-ELECTRIC OSCILLATORS

Convention date (France) 3rd December, 1932. No. 410429

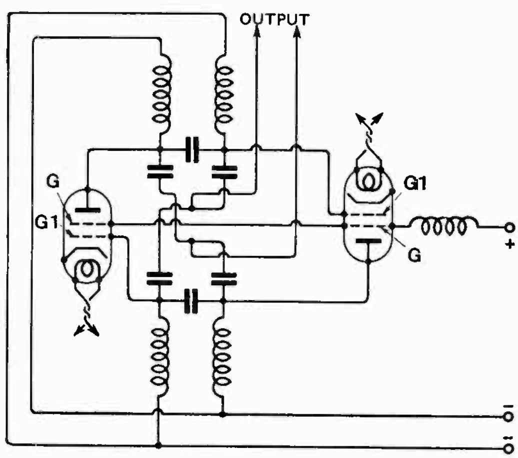
A quartz crystal for stabilising the frequency of a valve oscillator is cut as a rectangular parallelepiped. The electric axis and one of the other axes are equal, whilst the third axis is of different length, the object being to make the fundamental frequency of vibration along all three axes the same.

Patent issued to Cie Générale de T.S.F.

SHORT-WAVE GENERATORS

Convention date (Germany) 20th September, 1932. No. 410389

To increase the power and efficiency of valve-generators working on the Barkhausen-Kurz system, an auxiliary "trap" grid *G1* is inserted between the cathode and the positive grid *G*, the voltage of the former being kept substantially 180° out of phase with the anode voltage. The Figure shows a push-pull arrangement of two such valves, the anode of each being cross-coupled to the "trap" grid of the other, and kept in counter-phase by a quarter-wave Lecher-wire connection.



No. 410389.

The output is taken from the two terminals so marked.

Patent issued to Telefunken Ges. fur drahtlose Telegraphie m.b.h.