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Editorials

Radio Interference from Luminous Gas Tubes

IT is well known that luminous gas tubes such as the neon signs now so widely used are a frequent source of interference. In the course of some experiments* undertaken in order to find the cause of the frequent breakdown of the high-tension leads used to connect the transformer to the gas tube an oscillographic record was made of the current taken by the tube in a normal installation. The result which is reproduced in Fig. 1 is very striking; it is sufficient in itself to explain the offensive character of such installations as interference producers. The installation is shown diagrammatically in Fig. 2, from which it can be seen that there are three oscillatory circuits, the capacity of which is provided by that between the conductor and the earthed sheathing of the leads. From the oscillogram it appears that as soon as the arc strikes the voltage falls so low that the arc is extinguished and the current interrupted; it then restrikes and is again extinguished and so it goes on until the voltage fails to reach the striking voltage. In the case illustrated there is a want of symmetry between the two half-waves; in one direction there are always four pulses, whereas in the other they vary between two and three. Un-

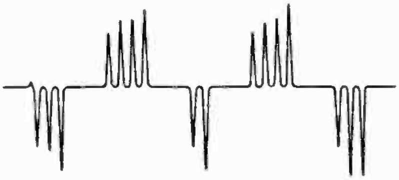


Fig. 1.

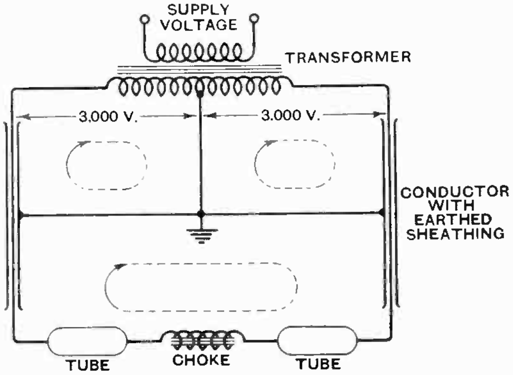


Fig. 2.

* *E.T.Z.*, p. 362, 12th April, 1934.

fortunately the article in which the experiment is described says very little about the possibility of adjusting the circuit constants with a view to obtaining more satisfactory operation, but accepts this as the normal condition. The suddenness of the striking and extinction even 100 times per second will, unless protective measures are taken, act as a fruitful source of disturbance, but the multiple striking and extinction shown in the oscillogram will have a frequency of much greater nuisance-value since it will give rise to a note of about 600 to 800 cycles per second, to which the ear is extremely sensitive, although, on account of its irregularity, it will probably be more of a noise than a note.

It is, however, pointed out that nearly all the troubles experienced by and caused by such installations can be avoided by using a rectifier and supplying the luminous tubes with steady high-voltage direct-current.

Interference with Broadcast Reception

A CONFERENCE presided over by Mr. C. C. Paterson has recently been held in Paris which was attended by official representatives of the various interests concerned in the protection of broadcast reception against the interference due to the operation of electrical apparatus, including representatives of seven of the National Committees of the International Electrotechnical Commission, of the International Broadcasting Union, of railway and tramway interests and of the World Power Conference.

The work has been shared between two sub-committees, one under Mr. Braillard to formulate recommendations for the numerical specification of the desirable limits to the interference with reception, and the other under Dr. van der Pol to study methods of measuring interference. A sub-committee of experts is to meet in Berlin in October to make experiments on the subject and it is hoped in this way to reach international agreement on the method of measurement to be recommended for use in all countries.

An Interesting Experiment in the Removal of Interference

A RECENT number of the *E.T.Z.** contains an account of an organised attempt to free a town from interference by fitting protective devices to nearly every piece of electrical apparatus which could possibly cause interference. The article is contributed by the German Post Office and commences with a statement of the importance of broadcasting for National-Socialist propaganda and as a link between Hitler and the people. The town chosen for the experiment was Baden-Baden, which has a 160 volt D.C. supply and a very large number of electro-medical installations and other apparatus likely to cause excessive interference. A conference was held there last August, attended by representatives of the Post Office and the Broadcasting Co., the local civic and police authorities, the supply companies, Siemens and Halske, the local contractors, etc. The Post Office and Siemens and Halske both seconded an engineer for the job; the latter firm offered to supply the necessary apparatus at 45 per cent. discount and the local contractors reduced the hourly rate by 25 per cent. A

	Total number.	Number made non-interfering.	Percentage.
Vacuum cleaners . .	1,468	1,284	87.5
Sewing machines . .	891	703	78.5
Motors under 0.5 kW	821	746	91.0
Motors over 0.5 kW	1,220	988	81.0
Hot cushions . .	1,220	945	77.5

census of electrical apparatus was taken and a publicity campaign was launched in order to persuade all owners of apparatus to have it fitted with protective devices and to pay a third of the cost, the Post Office paying the remainder. The incentive was the possibility of compulsion by law with no financial assistance. That the plan succeeded fairly well will be seen from

* *E.T.Z.*, p. 509, 24th May, 1934.

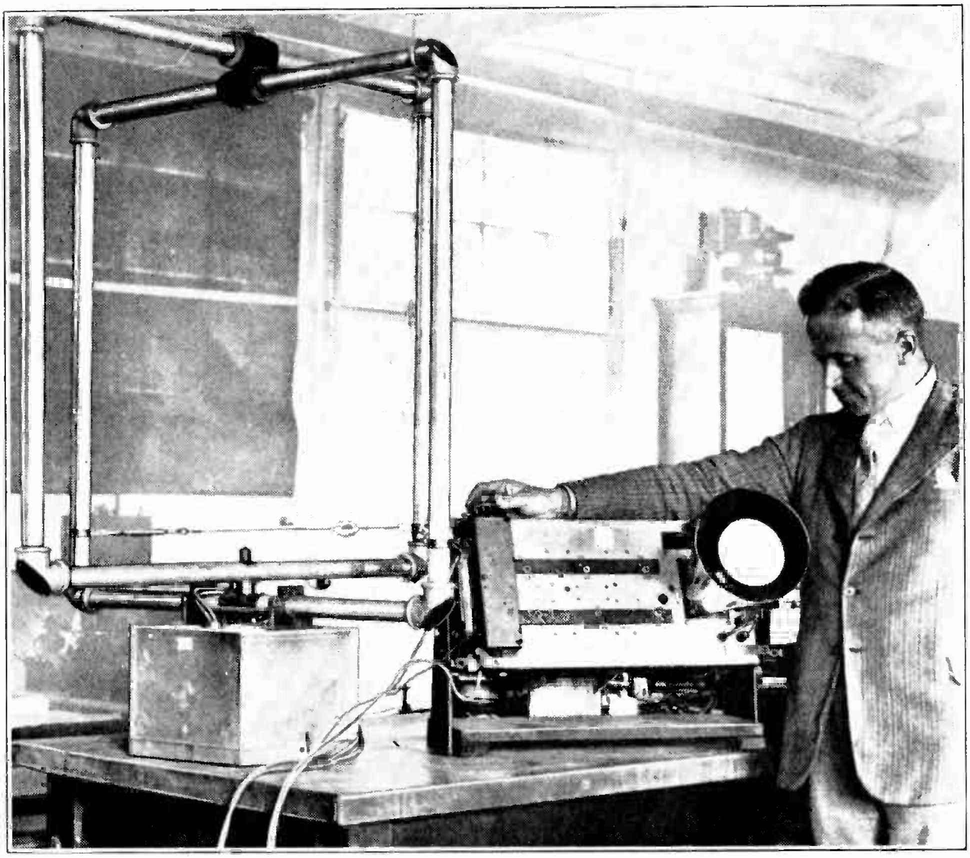
the table which gives some of the larger items.

Out of a total of 6,466 items 5,345 were made non-interfering, thus removing 82.5 per cent. of the sources of interference previously existing in the town. In most cases, the simplest devices were effective e.g., earthing the casing and fitting condensers between terminals and earth. This is shown by the fact that 7,727 condensers were employed and only 300 chokes and combinations of chokes and condensers. It was found very effective in the case of motors with series or interpole field windings to arrange them symmetrically between the brushes and the external circuit.

Of the many other points dealt with in the article we will refer only to one. It was found that with hoar-frost, the tramways, although fitted with Fischer bow-collectors, made it impossible to receive the local high-power transmitter, even when specially screened aerials were employed. The only successful way of overcoming this interference is at the source, by fitting condensers to the overhead wire as has been done successfully at Nordhausen.

G. W. O. H.

A New Radio Aid to Navigation



A photograph of the apparatus comprising the special direction-finder for foggy conditions which was demonstrated recently at the National Physical Laboratory. The actual apparatus was developed at the Radio Research Station at Slough. Signal voltages set up in two frames set at right angles are applied to the deflecting plates of a cathode ray oscillograph and the direction of the signal is then indicated by the position taken up by the spot of light on the tube screen.

The Design of A.V.C. Systems*

A Practical Review of the Chief Methods

By W. T. Cocking

AUTOMATIC volume control is a feature which is rapidly becoming universal in the more sensitive class of broadcast receiver because it can largely compensate for variations in volume due to fading and because it can prevent the output valve of the set from being seriously overloaded through the mal-adjustment of the controls. The systems are accurately known as methods of automatic gain or amplification control, since the aim is to make the amplification vary in a manner inversely proportional to the strength of the received signal in order that the output may be constant irrespective of the magnitude of the input. The term automatic volume control, however, is now so deeply embedded in every-day technical language that there is little point in making a change.

Although the precise details of the different A.V.C. systems may vary greatly, they all operate on the same fundamental principles. Variable-mu valves are normally used in the H.F. or I.F. amplifying stages, and their amplification is controlled by varying the grid bias. The bias is derived from the output of the detector, and matters are arranged so that the larger the detector input, the greater is the bias applied to the amplifying valves, and hence the lower their amplification. It will thus be obvious that as the input from the aerial increases so the detector input also rises, but not proportionately. As the L.F. amplification remains constant in nearly all systems, the output of the complete receiver must also rise with increasing signal strength, and the aim of A.V.C.—a uniform output whatever the signal input—can never be achieved. Fortunately, the ear is remarkably accommodating in the matter of variations in the volume level, and quite large differences are hardly detectable. An A.V.C. system, therefore, can in practice be said to be perfect if the output does not vary beyond the easily detectable range for any normal variations in signal input.

With a large signal input, such as that from a local station, the efficacy of A.V.C. in preventing a noticeable increase in volume depends very largely upon the design of the A.V.C. system itself and the number and type of valves which it controls. As regards its ability to make the volume variations of fading negligible, however, it depends far more upon the maximum sensitivity of the receiver. A.V.C. can only reduce the sensitivity of a set below its maximum level, and with a correctly designed system it will maintain the output volume substantially constant for any signal input between definite limits. One limit is set by the maximum sensitivity of the receiver, and the other by the overload point of the amplifier, detector, or A.V.C. valves. Before the volume rises appreciably at the latter limit, however, serious distortion usually appears, so that it may be said that the upper limit to input is set by the appearance of distortion.

Simple Diode A.V.C.

The connections of an ordinary diode detector as applied to the I.F. circuits of a superheterodyne are shown in Fig. 1, and it

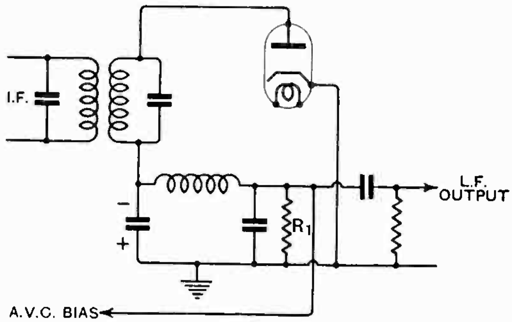


Fig. 1.—*A diode detector providing A.V.C.*

is well known that as a result of the rectification of a carrier a steady potential appears across R_1 as well as L.F. potentials due to the modulation of that carrier. The polarity of this voltage is such as to make the

* MS. accepted by the Editor May, 1934.

anode of the diode negative with respect to the cathode, but normally no deliberate use is made of it. It is, however, in the right sense for A.V.C. purposes, and one of the simplest methods of obtaining automatic volume control is to use this voltage for biasing the early stages. The usual connections are shown in Fig. 2, and any number of valves may be controlled.

Provided that the input exceeds a certain value, the diode is a linear rectifier, so that the bias voltage available is strictly proportional to the detector input, and for large inputs is about 90 per cent. of the peak carrier input. In the absence of a signal there is no current flow through R_1 and consequently no voltage drop across it. The grid of the controlled valve is returned to the earth line through R_2 and R_1, and is at the same potential as the earth line. The cathode of this valve, however, is positive with respect to the earth line by the voltage drop across its initial bias resistance R_3, so that the grid is negative with respect to the cathode. When a signal is tuned in a potential appears across R_1 and so makes the grid of the controlled valve negative with respect to the earth line, and hence more negative than formerly with respect to its cathode. If the current through R_3 remains substantially constant the whole of the potential across R_1 appears as additional bias on the controlled valve. If the current through R_3 is only the screen and anode current of the controlled valve, however, the effective grid bias for a given detector input will be less, for the application of a given A.V.C. bias reduces the anode and screen currents and so the voltage drop across R_3. In practice the difference is not very important, but the best operation of A.V.C. is obtained by making the voltage drop across R_3 substantially independent of the anode and screen currents, by connecting it so that a steady current flows through it which is large in relation to the valve current.

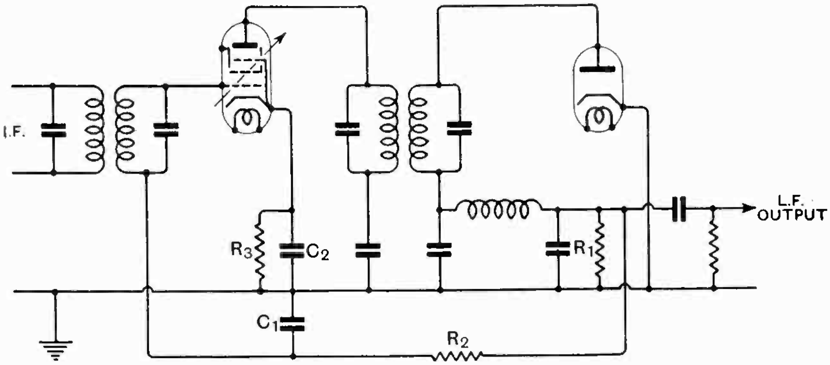


Fig. 2.—*Simple A.V.C. showing the connections to a controlled stage.*

The resistance R_2 and condenser C_1 are important and fulfil several functions. In the first place, C_1 completes the I.F. grid-cathode input path of the controlled valve; secondly, R_2 and C_1 form a filter to prevent any appreciable proportion of the I.F. potentials which appear across R_1 from being applied to the grid circuit of the controlled valve; thirdly, these components act as a filter to prevent the L.F. potentials across R_1 from affecting the input of the controlled valve; and fourthly, they control the speed of operation of A.V.C. The first function is simple and it is only necessary that the reactance of C_1 at the intermediate frequency should be low in comparison with the grid-cathode impedance of the valve, provided, of course, that the reactance of C_2 is negligibly small, as it should be. A value of 0.1 μF. satisfies most practical requirements. The second function of the filter can usually be ignored, for if it fulfils the third its efficiency as an I.F. filter will usually be high enough; this will not be the case, however, if the stray capacities across R_2 are appreciable. The third and fourth functions are closely interrelated, and will repay a detailed consideration.

Suppose R_2 and C_1 are of low value, so that there is little filtering effect at low frequencies. During modulation at low frequencies the bias voltage on the controlled valve will vary during the cycle of modulation, and the amplification of this stage will vary also. As the bias voltage increases during one half-cycle of modulation, the amplification and consequently the detector input and L.F. output decrease, and as it decreases during the subsequent half-cycle, so the amplification increases. The result is to reduce the L.F. output of the detector to an extent which increases as the modulation frequency is reduced. If the values of R_2 and C_1 are not sufficiently large, therefore, there will be a partial loss of bass, and the quality of reproduction will be unsatisfactory.

The speed of operation of A.V.C. is the next point to be considered. The A.V.C. bias is obviously the potential which appears across C_1, and in the steady state this is equal to the potential across R_1. When the voltage across R_1 is varying, however, as is the case when the receiver is being tuned from one station to another, the potential across C_1 is less or greater than that across R_1 for, in effect, the condenser C_1 is being charged or discharged through the resistance R_2. If C_1 and R_2 are both large, therefore, the time constant will be high, and it will take an appreciable time for C_1 to become charged fully, or to lose its charge if the potential across R_1 decreases. This makes the receiver unpleasant to handle, for on tuning to a strong station the volume is excessive, and is only reduced gradually by A.V.C. as C_1 acquires its full charge; moreover, on tuning away from a strong station C_1 loses its charge only slowly, so that the sensitivity of the set rises slowly, and weak stations may easily be missed.

Obviously the speed of operation should be as slow as possible consistent with pleasant operation in order to avoid a reduction in the low-frequency response. The highest time constant which may be used satisfactorily, therefore, will depend upon how rapidly tuning can be carried out, and so upon the band of frequencies covered by a given movement of the tuning control. The requirement is that the potential across C_1 should always be nearly equal to that across R_1 when the latter is varying owing to the rotation of the tuning control. Experience is the best guide to the choice of a time constant, and 0.1 second is usually chosen, corresponding to values of 0.1 μF. and 1 megohm for C_1 and R_2 respectively.

It can readily be seen that this particular method of control is far from ideal, for no matter how small the detector input may be there will always be some voltage developed across R_1 when the set is tuned to a signal, and hence some A.V.C. bias impressed on the controlled valve. The sensitivity of the set, therefore, will always be less than it would be in the absence of A.V.C. This, of course, is desirable in the case of strong signals, and is the proper function of A.V.C. It is definitely undesirable, however, for the reception of those stations the aerial input from which is less than that necessary to give the desired volume with the set working at full sensitivity. It is partly for this reason, and partly because the range of control is not as great as with other methods, that simple diode A.V.C. is now rarely used.

Before turning to a consideration of better methods, however, it will be as well to show how the efficacy of this system may be calculated, for the calculations used in other arrangements are similar, if more complicated. It is first necessary to prepare a curve showing the variation of amplification in decibels of the controlled stages with A.V.C. bias. This may be done by measuring the amplification of the amplifier at different bias voltages, expressing the amplification as a ratio of that at zero A.V.C. bias, and converting to decibels.

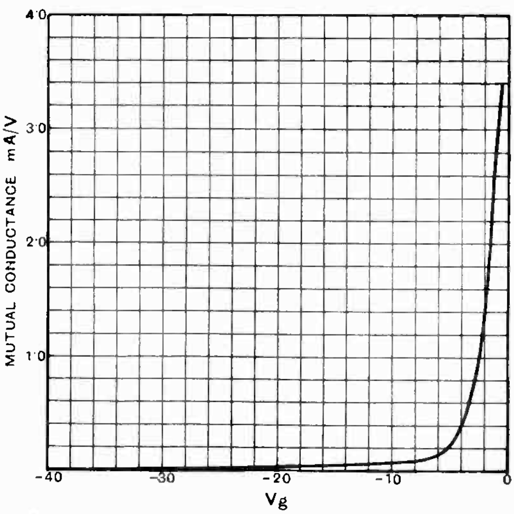


Fig. 3.—*Mutual Conductance/Grid Bias curve of an H.F. pentode.*

More often the amplification will have to be computed, for the number of controlled stages may not be known until the A.V.C. system is designed. In this case it is useful to remember that when the load impedance is low compared with the valve A.C. resistance, the stage gain is equal to gZ, where g

is the mutual conductance in mA/V. and Z is the load impedance in thousands of ohms. Since figures for actual amplification are not required, however, it is sufficient merely to remember that the amplification per stage is proportional to the mutual conductance. Most valve makers publish curves showing the variation in mutual conductance with grid bias, and a typical example is given in Fig. 3 for a modern H.F. pentode.

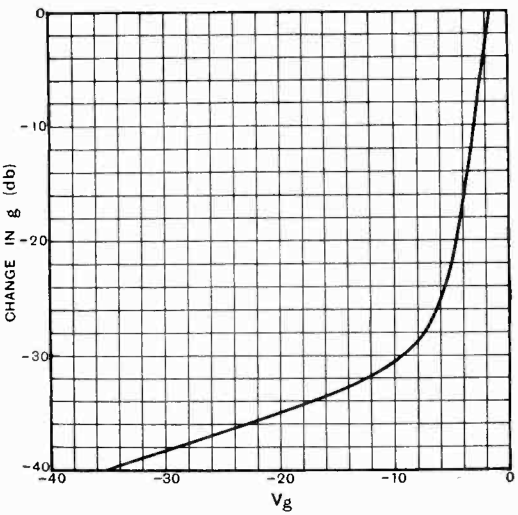


Fig. 4.—*The change in amplification plotted against grid bias for an H.F. pentode.*

Assuming that the initial bias is -1.5 volts, the mutual conductance at other bias voltages can be expressed as a ratio of the figure for -1.5 volts, and then converted to decibels, thus giving the curve of Fig. 4. By deducting 1.5 volts from the bias figures, this curve gives the change in amplification for one controlled stage for any A.V.C. bias. Thus, if the A.V.C. bias is 1.5 volts, the total bias on the valve is the A.V.C. bias plus the initial bias, or 3 volts, and the amplification falls about 10 db. per stage below its maximum value. If all the controlled valves in the receiver are alike, and have the same A.V.C. and initial biases, the total change in amplification can be obtained merely by multiplying the vertical scale by the number of controlled stages. If different valves be used, or one or more is only partially controlled, it is necessary to plot a curve similar to Fig. 4 for each stage, and then combine them by adding the vertical scales.

Now to compute the action of A.V.C. with the simple diode system it is necessary to assume a normal value of detector input, and we will define it as the input required to load the output stage fully with the amount of L.F. amplification it is intended to use, and with an 80 per cent. modulated carrier. Let us assume that it is 5 volts R.M.S., and further that we are using three controlled stages of amplification with identical valves in each, so that we can multiply the vertical scale of Fig. 4 by three. The curve of Fig. 5 shows the bias voltage obtainable from a typical modern diode at various inputs, and at 5 volts R.M.S., we see that it is 5.5 volts; the total bias on the early valves is 7 volts, therefore, and their amplification is 82.5 db. below their maximum. We cannot easily calculate the detector input for a change in the aerial input, but if we assume a change in detector input we can easily calculate the change in aerial input necessary to produce it. A rise of 6 db. in the detector input would provide an A.V.C. bias of 11 volts, or a total bias of 12.5 volts, with which the amplification would be 96 db. below maximum. A rise of 6 db. in the detector input thus implies that the amplification changes by $96 - 82.5 = 13.5$ db., so that the aerial input rises by $13.5 + 6 = 19.5$ db.

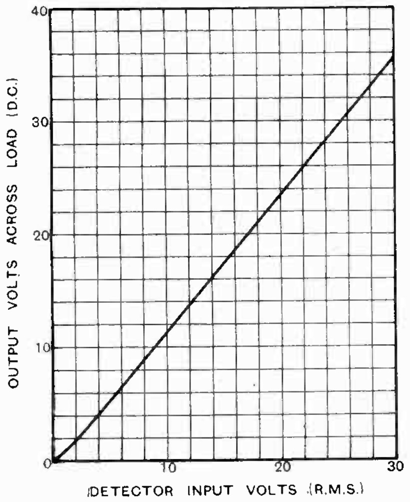


Fig. 5.—*Typical diode characteristics.*

By assuming other variations in the detector input, we can find from Fig. 5 the A.V.C. bias produced by other larger and smaller inputs, and hence from Fig. 4 the change in amplification. The change in detector input in decibels from the initial assumed value plotted against the difference between the amplification at the initial detector input and that at other detector inputs plus the change in detector input shows the action of A.V.C., and is given in Fig. 6 for the case discussed. It will be seen that this is hardly satisfactory, for if we assume that the zero db. level of detector input is to occur on the weakest worth-while signal, the change in aerial input between this and a strong local station will be much more than the 19.5 db. which is all that can be permitted if the output is not to change by more than 6 db.—and this is probably the largest change in output which is aurally undetectable.

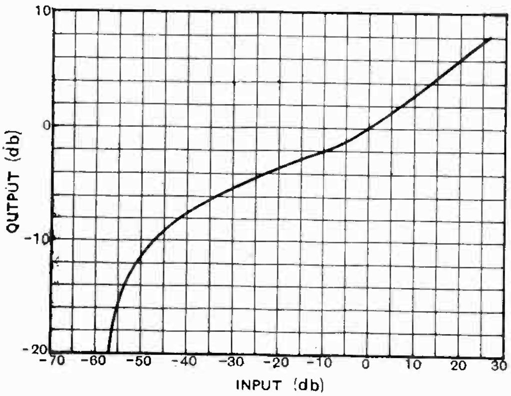


Fig. 6.—*The A.V.C. curve with a detector input of 5 volts R.M.S.*

Now for very small inputs, the output rises nearly proportionately to the input, because of the very small A.V.C. bias which is developed. As the input rises, the curve begins to tail over, indicating that A.V.C. is functioning in the manner expected. In this particular instance, however, the curve takes an unexpected upward trend at about the zero decibel level, and this is caused by the characteristics of the controlled valves, the particular type selected giving less change of mutual conductance with grid bias at high bias voltages than at low.

Matters are greatly improved if we decide to operate the detector at a lower input, as shown in Fig. 7 which is for a zero decibel level of 1 volt R.M.S. to the detector. A.V.C. is just starting to have a definite effect at this input with the result that the range of greatest control appears for an increase of input. When this is more than 65 db. above the normal level the upward trend again appears. The control is not greatly altered, however, and for a 6 db. rise in detector input, the signal input must still increase by only 19 db. as compared with 19.5 db. for the previous case.

It appears that for the best results with simple diode A.V.C. the detector must be operated at only a moderate input on the weakest worth-while signal, in order that much stronger signals shall fall on the flattening top of the input/output curve and that the detector input shall not be excessive on a very strong signal. The weakest worth-while signal is rather a vague indication and obviously varies in different districts. It is intended to mean a station the strength of which is just sufficiently greater than the mush level for its programme to be musically enjoyable. Under average conditions of reception with an outdoor aerial, it might represent an input to the first valve of some 25 micro-volts.

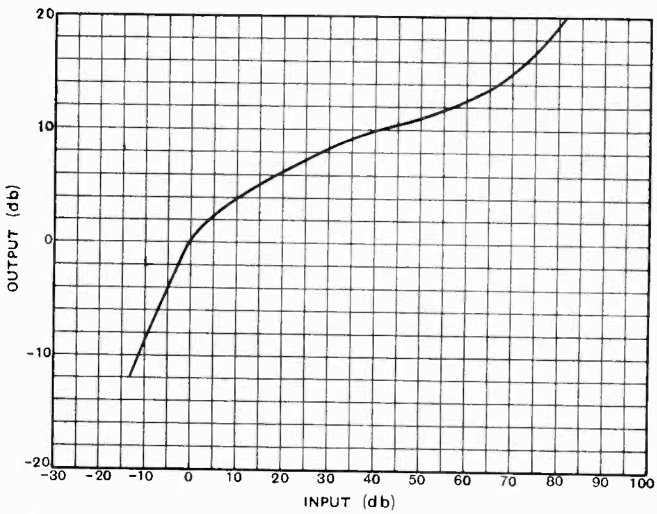


Fig. 7.—*The A.V.C. curve with a detector input of 1 volt R.M.S.*

Now at a short distance from a modern high power broadcasting station, as much as 5 volts input to the first valve may be obtained with an average outdoor aerial, so that the ratio between the weakest worth-while signal and the local station will be something like 200,000–1—a change of input of 106 db. The ideal receiver, therefore, would give a change of output of no more than 6 db. for a change of input of this order. How much simple A.V.C. falls short of the ideal can be seen when it is remembered that even with three controlled stages, the output varies some 35 db. for an input change of 106 db.

Delayed Diode A.V.C.

Partly because of this and partly because it reduces the initial sensitivity of the receiver, simple diode A.V.C. has fallen into disrepute, perhaps more so than it deserves, for there is no doubt that it can be very satisfactory for reducing fading. An auxiliary volume control, such as a local-distance switch, to prevent overloading on strong stations is essential, however. The next step in development, therefore, was the introduction of delayed diode A.V.C., and this removes most of the disadvantages of the simple system, and is very popular in commercially-built receivers at the present time.

The essential feature of the system is that the A.V.C. bias is not obtained from the detector, but from a separate diode which is so biased that it is non-operative until the signal exceeds a certain strength—hence the term, delayed. The connections are shown in Fig. 8, and it is usual to employ a duo-diode valve which is often combined with a triode, and so falls into the duo-diode-triode class. So far as the detector is concerned, the connections follow normal practice and the diode load resistance R_1 is returned to the diode cathode. The cathode, however, is not at the same potential as the earth line to which the grids of the controlled valves are returned through the usual resistances R_3 and R_4, it is maintained at a positive potential by the voltage drop along R_2, the current through this resistance being either the anode current of the triode section in the case of a duo-diode-triode or provided by a resistance R_5 connected to the H.T. supply with a simple duo-diode valve.

The second diode acts to provide the A.V.C. bias, and it is fed with the I.F. input through a small condenser C_1, its load resistance R_3 being returned to the earth line. In the absence of a signal, the A.V.C. diode anode is negative with respect to its cathode by the voltage drop along R_2, or the delay voltage. There is consequently no current flow through R_3 and the grid of the controlled valve is at the same potential as the earth line, and its only bias is that provided by its own fixed initial bias circuit which follows standard practice. The same conditions are maintained even when a signal is applied as long as the peak voltage developed between the A.V.C. diode anode and cathode is less than the delay voltage. Until the peak voltage exceeds this value, therefore, the receiver behaves just as if A.V.C. were not fitted. When the diode peak input exceeds the delay voltage, however, rectification occurs and a steady potential appears across R_3 which is applied through the filter R_4 and C_2 to the grids of the controlled valves.

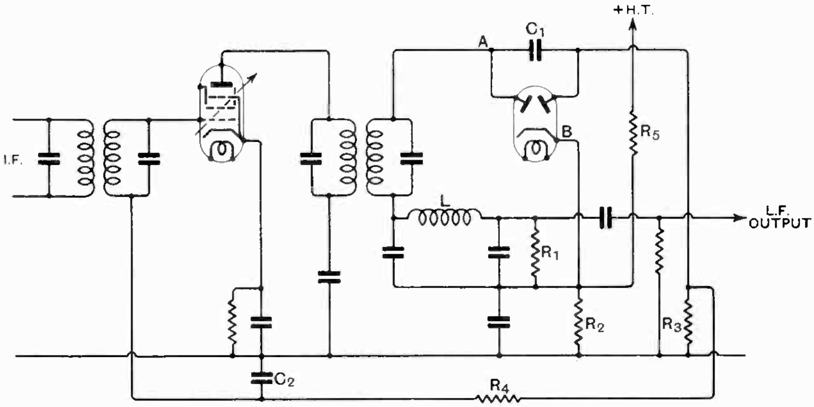


Fig. 8.—*The connections for Delayed Diode A.V.C.*

It is thus clear that the drawback of simple A.V.C. of reducing the initial sensitivity of the receiver is completely avoided; it is not so obvious, however, that the control obtainable is greatly improved. This is brought about by the fact that the A.V.C. bias increases more rapidly than the detector input as a result of the application of the delay voltage.

For the moment, let us assume that the diodes are perfect so that in the absence of a delay bias the D.C. voltage developed across the load is equal to the peak input. Further, let us assume that the result of applying a delay voltage is merely to reduce the output by the amount of the delay voltage. Lastly, assume that there are no losses in couplings, so that the A.V.C. diode input is the same as that of the detector proper. Under these conditions it can be shown that the delay voltage should be equal to the maximum A.V.C. bias required by the controlled stages when a 6 db. rise in detector input from the threshold condition is permitted.

Assuming this simple law to be realised in practice, we have a very easy means of determining the delay voltage required, and the normal detector input, for any given conditions. Thus if the aerial input varies over a range of 106 db. and we permit a rise of 6 db. in the detector input, the A.V.C. bias must change the amplification of the controlled stages by 100 db. With three fully controlled stages, this is a change of 33.3 db. per stage, and the change of bias required for its realisation can be read off from the valve grid-volts/mutual-conductance curves. Fig. 4 shows it to be from − 1.5 to − 15 volts in our case, so that we need a maximum A.V.C. bias of − 13.5 volts. The delay voltage, therefore, should be 13.5 volts, and at the threshold of A.V.C. the detector will operate with an input of 13.5 volts peak; when the input to the set has risen 106 db. the detector input will be 27 volts peak.

Such an A.V.C. system seems practically perfect; unfortunately, however, the calculations are not quite so simple in practice, nor is its performance so good. The three chief assumptions upon which the above rule for the determination of the delay voltage were based are not quite accurate, although they serve for a rough estimation. The output of a rectifier is less than the input voltage, there is an appreciable loss in couplings, and the delay voltage reduces the output by more than its own value.

The actual rectification characteristics of one diode of an MHD4 type duo-diode-triode valve, therefore, are shown in Fig. 9 for the case of a superheterodyne with an intermediate frequency of 110 kc/s. The connections were arranged as in Fig. 8, the important components being given the usual values of 0.0001 μF. for C_1, 0.1 μF. for C_2, and 1 megohm for R_3 and R_4. With zero delay voltage it can be seen that for inputs greater than some 2 volts R.M.S. the rectifier is strictly linear. These curves include the losses in the coupling condenser C_1, so that they are directly applicable to the usual practical case, and it is these losses which are

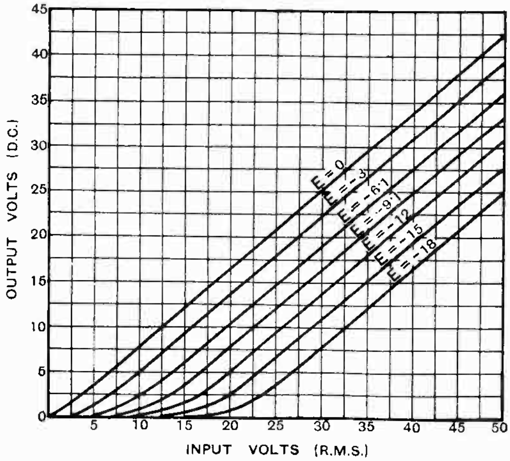


Fig. 9.—*Diode characteristics for various delay voltages.*

partly responsible for the curvature at inputs only slightly exceeding the delay voltage. When the detector input is only slightly greater than the delay voltage, the voltage drop across C_1 is smaller than with a large input owing to the higher internal resistance of the rectifier itself.

Our task, therefore, resolves itself into selecting the necessary delay voltage from this series of curves. The curve for zero delay shows that we can obtain 13.5 volts bias for an input of 16.5 volts R.M.S., but we shall not have zero bias until the input falls to zero. With 18 volts delay an input of 36.5 volts is needed for a maximum bias of 13.5 volts and zero bias is obtained with an input of about 12.5 volts; with this delay we can meet the required conditions if the detector input is allowed to vary in the ratio of 1—36.5/12.5; that is, a change of 9.3 db. instead of the 6 db. initially laid down. For the latter condition a higher delay voltage is required. For reasons which will be given later there are practical restrictions to the delay voltage which can be used with a system of this nature and this usually occurs for voltages of less than 18 volts, so that little purpose would be served by showing the curves for higher delay voltages, which would be necessary in order to select the correct one for a 6 db. rise only in detector input. For the moment, therefore, let us concentrate upon the 18 volts delay, and plot the curve showing the connection between the input from the aerial and the input to the detector.

For inputs below the threshold of A.V.C., the detector input will obviously rise in proportion to the aerial input as in an uncontrolled receiver, so that we have to concentrate only on that range of voltages over which A.V.C. is in action. Taking the threshold of A.V.C. as the zero level, we can re-plot the curve of Fig. 9 for a delay of 18 volts to show bias against input in decibels above the threshold input. Three times the vertical scale of Fig. 4 gives us the drop in amplification in decibels for three controlled stages plotted against grid bias (we must deduct the initial bias of 1.5 volts to obtain the curve plotted against A.V.C. bias). The drop in amplification is equivalent to a rise in aerial input for constant output, hence the sum of the rise in aerial input for constant output and the rise in detector input gives the rise in aerial input which actually takes place. The result is the curve of Fig. 10, and it is instructive to compare this with Fig. 6 for the simple diode system of A.V.C. Although the initial conditions have not been completely fulfilled the enormous improvement in control is readily apparent.

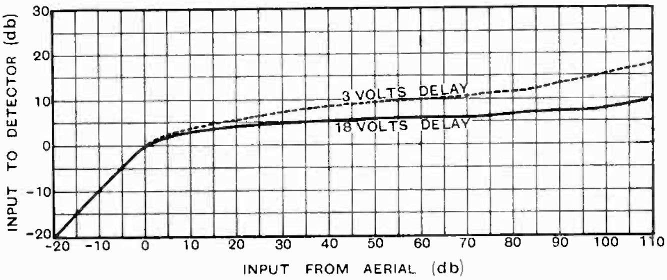


Fig. 10.—*The performance of Delayed Diode A.V.C. systems.*

We have yet to see, however, whether other considerations will permit us to realise this curve in practice. At the threshold of A.V.C. the detector input is 12.7 volts R.M.S. and we laid down that this condition must be obtained with an input to the first valve of 25 micro-volts. The amplification, therefore, must be 507,000 times which means a stage gain of about 80 times for three stages ; this is probably quite possible.

Now when the input has risen by 106 db., the detector input has risen by 8.5 db. or to 2.66 times its previous value, that is to 33.8 volts R.M.S. This is really the voltage applied to the diode, the input voltage to the detector diode will be slightly greater on account of the drop in the detector load by-pass condenser. For the same reason, the amplification required at A.V.C. threshold will be slightly greater than quoted above. Ignoring this discrepancy, however, it will be seen that the detector input required is very large, and it will be larger still during modulation. An input of 33.8 volts R.M.S. corresponds to 47.8 volts peak unmodulated carrier, but during 80 per cent. modulation the maximum value will reach 86 volts. The valve preceding the detector, therefore, must be capable of giving this output without introducing distortion.

The curve of Fig. 11 shows the maximum undistorted output of the same valve represented by Fig. 4. Although the valve will give an output of the required order when used with a bias of only a few volts, it will only give an output of some 20 volts peak with 15 volts grid bias. In other words, if we attempt to put the A.V.C. system which we have designed into practice, we shall meet with failure because the I.F. valve will be grossly overloaded on a strong signal. At first thought, the remedy would appear to lie in controlling only the two early stages of amplification and operating the last I.F. valve with a small fixed bias. This does not necessarily meet the case, however, for the range of control with two stages will be much less, so that to obtain good results a higher delay voltage will be needed. The detector must then be operated with a larger input, and more amplification will be necessary at threshold ; moreover, the detector input may become so large on a strong signal that even the fixed bias I.F. valve may fail to give the required output.

The true solution lies in the addition of an extra controlled stage, for this leads to a greater range of control for a given A.V.C.

bias. As a result, for the same control the A.V.C. bias required is reduced and also the delay voltage and the detector input. The amplification per stage at threshold is also lessened. By using a sufficient number of controlled stages, practically all conditions of signal input and perfection of control can be met. Usually, however, the number of controlled stages is limited by the very important factor of cost. In this case, the only way out of the difficulty is to design the set for a less perfect range of control and to fit a local-distance switch to reduce the sensitivity for the reception of strong signals which would otherwise cause overloading of the I.F. valve.

Thus, although delayed diode A.V.C. is very attractive at first on account of its simplicity, a closer investigation shows that there are serious difficulties. In cases where an endeavour is made to obtain a large range of control by using a high delay voltage, the detector input is also large and the usual duo-diode-triode valve becomes unsuitable for the reason that the triode portion of the valve will not handle the detector output.

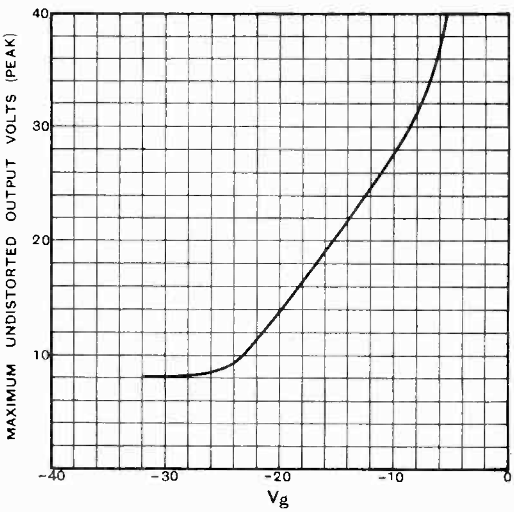


Fig. 11.—*The maximum output of an H.F. pentode at various bias voltages.*

The detector output will usually be of the order required for loading quite a large output valve directly. It is not uncommon, therefore, to find the system used with a simple duo-diode valve preceding the output stage, while in other cases metal rectifiers are used.

It is possible to use the delayed A.V.C. system, however, rather on the lines of the simple diode arrangement, making the delay voltage only enough to avoid an initial loss of sensitivity. This is probably the usual course adopted by designers, and the delay voltage is often fixed at about 3 volts. The results obtainable with three controlled stages are shown by the dotted curve of Fig. 10, and it will be seen that even this small delay is a great improvement on the non-delayed system. It is, however, considerably inferior to the higher delay as regards range of control, since for a 6 db. rise in detector input, the aerial input can only rise by 25 db., whereas with 18 volts delay it can rise by some 65 db.

Although A.V.C. is not so perfect, it is sufficient in practice to counteract the volume variations of most fading, and the lower delay voltage greatly relieves the position as regards overloading in the valve preceding the detector. When the input rises by 106 db., as for a local station, the detector input rises by about 18 db., and it is about 23.7 volts peak. During deep modulation the maximum peak voltage will be about 42.7 volts, roughly one-half of that in the previous case. A local-distance switch is still necessary, of course.

It will be seen, therefore, that the higher the delay voltage employed the better is the action of A.V.C. A high delay voltage, however, means a large detector input, and this in turn necessitates a high degree of H.F. or I.F. amplification and a minimum of L.F. amplification; it usually means, in fact, feeding the output stage directly from the detector. The high pre-detector amplification may lead to difficulties from instability, but on the other hand, the low amount of L.F. amplification makes it possible greatly to reduce smoothing equipment. Whatever delay voltage be used, a local-distance switch operating to reduce the amplification of the early stages is necessary for the reception of a nearby transmitter in order to avoid distortion due to overloading. In this connection, it may be as well to point out that in the case of local reception it is not always the I.F. valve which is most seriously overloaded. If a receiver be designed so that the I.F. gain is small, then at a high bias the I.F. valve may be attenuating, and overloading may occur in an earlier stage. The usual remedy for this is to control the last amplifier valve only partially.

(*To be continued.*)

Wide Range Variable Condenser for Special "Laws"*

A New Instrument Especially Suitable for the Frequency Adjustment of Heterodyne Oscillators

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

VARIABLE condensers designed to have any law connecting capacity with angular rotation other than linear, usually have moving systems consisting of a number of specially and similarly shaped plates. If the ratio of maximum to minimum capacity of such a condenser is great, the moving plates will be exaggerated in shape as, for example, that shown in Fig. 2. The eccentricity of these plates is a source of weakness of the moving plate system, the extreme overhanging portions of the plates being insufficiently supported to maintain constant dielectric gap distances for a considerable period. If the radial dimensions of the plate are reduced in order to overcome this source of inaccuracy, the active portions of the radial dimensions of the plates at low capacities are often, as in that shown in Fig. 2, so small, and vary so little, that the accuracy of conformity to law is inevitably low.

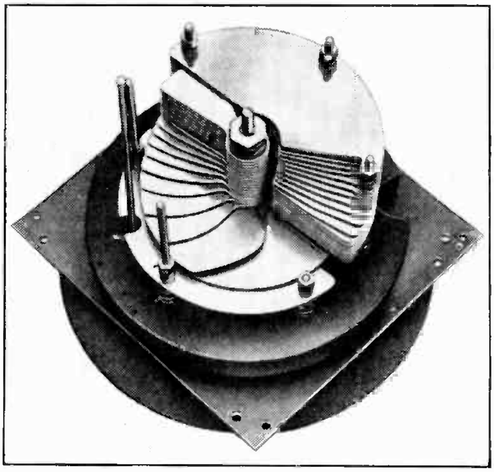


Fig. 1.

In order to overcome these sources of inaccuracy and law imperfection the author has departed from the conventional "similar plate" design by constructing a variable condenser, Fig. 1, in which the capacity is varied by continually varying the number of moving and fixed plates which are interleaved as well as by shaping them. In this way, without impairing the conformity to law, the radius of the moving plate system is limited to a reasonable dimension and a greater and more uniform geometrical stability is obtained in consequence. The resulting condenser is much more compact—a great saving of space being effected by reducing the eccentricity of the moving plates.

The frequency adjustment of a heterodyne oscillator in particular requires a variable condenser of greatly varying rate of change of capacity, $dC/d\theta$, and so, although the method of design applies equally to all other laws, a logarithmic capacity law has been used as an example for the illustration and for the drawings.

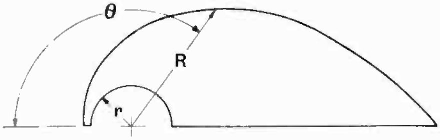


Fig. 2.

The formula for the design of plate shape for the moving system of the beat frequency adjusting condenser of a heterodyne oscillator has been given by the author in a previous article in this journal.[1] The radial

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

[1] "Precision Heterodyne Oscillators," *The Wireless Engineer*, May, 1934.

dimension of moving plate, Fig. 2, in a system of similarly shaped plates is given by

$$R = [114.6\{ka_1 b\epsilon^{b\theta} + K\}]^{\frac{1}{2}} \quad .. \quad (1)$$

where $K = r^2/114.6$

$$a_1 = C_{\text{min.}}$$

$$b = \frac{\log C_{\text{max.}} - \log C_{\text{min.}}}{78.174}$$

and $k = \dfrac{\text{Total plate area} - 180K}{C_{\text{max.}} - C_{\text{min.}}}$

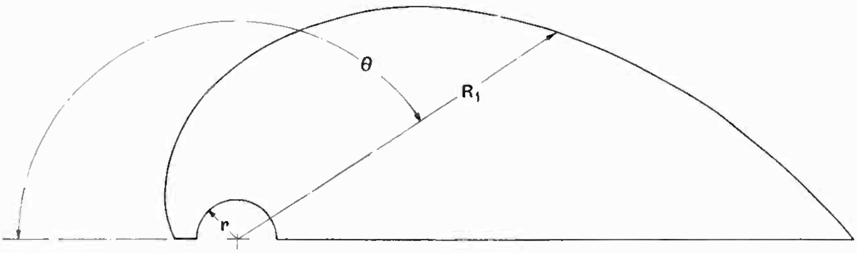


Fig. 3.

alternatively, the constant k may be determined by fixing R at $\theta = 180°$ when k becomes the only unknown in the formula.

If it is found that the resulting plate shape is too exaggerated, as that of Fig. 2 certainly is, the following procedure is adopted.

From considerations of stability and space a limiting radius ρ of moving system is fixed and another much larger plate-shape is designed—sufficiently large, in fact, to give, in a single plate, the required capacity change of the condenser. This plate is shown in Fig. 3, its shape being found from the formula (1) given above, making the total plate area minus $180K$ equal the area necessary to give the required capacity *change* with a single plate and with a predetermined dielectric air gap distance[2].

It is now necessary to replace any sector (of angle $\delta\ \theta$) of the plate R_1 by a number "n" of sectors of the same angle but of smaller and constant radius ρ (that of the limiting semi-circular plate, see Fig. 5), and so,

$$R_1^2 - r^2 = n(\rho^2 - r^2)$$

Therefore $n = \dfrac{R_1^2 - r^2}{\rho^2 - r^2}$ at any angle θ .. (3)

[2] Or a simpler method which is explained later may be employed.

A curve, as in Fig. 4, is plotted showing n for any angle θ and from this curve are read the angles θ_1, θ_2, θ_3, etc., at which 1, 2, 3, etc., plates must be engaged *completely* in order to be the area equivalent of the single large plate of Fig. 3. The multiplate system can now be constructed as in Fig. 5.

It is obvious that in order to preserve the smooth continuity of law, the leading edge of each moving plate must be introduced gradually into the pair of fixed plates between which it interleaves. The leading edge of each plate must, therefore, be shaped for this reason and cannot be radial as shown in Fig. 5.

It is obvious also that this shaping on plate 1 will be identical with that of the large equivalent single plate of Fig. 3, and as a fairly large number of radii are required in order to trace out this shape, the following method may be employed to find many values of R_1 from calculated and interpolated values of R.

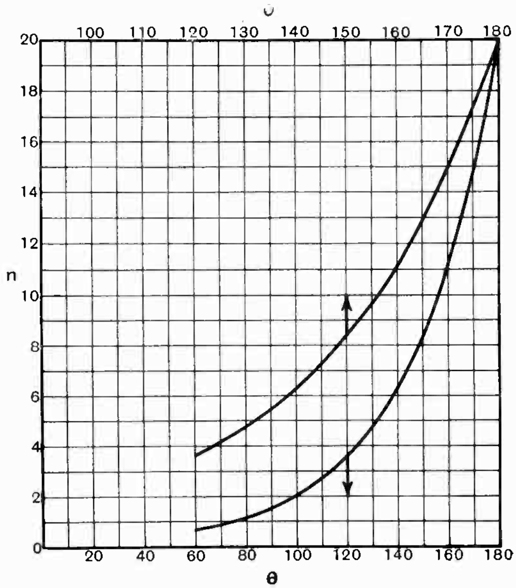


Fig. 4.

Decide upon the total number N of moving plates

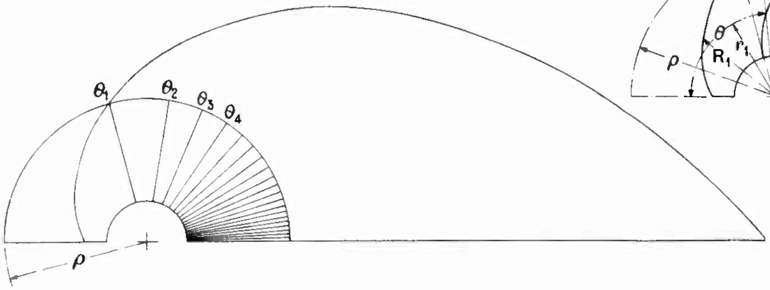
Then at $\theta = 180$

$$n = N$$

and from (3) $N = \dfrac{R_1^2 - r^2}{\rho^2 - r^2}$

$$R_1^2 - r^2 = N\rho^2 - Nr^2$$

Therefore $R_1 = \{N\rho^2 - (N - 1)r^2\}^{\frac{1}{2}}$ at $\theta = 180°$ .. (4)



(*Left*) Fig. 5.

Let x = ratio of $\dfrac{\delta A}{\delta\theta}$ of the new R_1 plate to the original R plate at any angle θ.

This ratio is

$$x = \frac{R_1^2 - r^2}{R^2 - r^2} \quad .. \quad .. \quad (5)$$

the value of which is known from (4) and a knowledge of the previously designed plate shape.

The radius of the new plate (Fig. 3) at any angle θ is given by

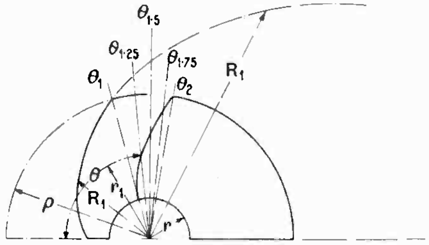
$$R_1 = \{x(R^2 - r^2) + r^2\}^{\frac{1}{2}} \quad .. \quad .. \quad (6)$$

where x and r are constants.

The shapes of the leading edges of the other plates are determined in the following manner. In order to obtain the shape of the leading edge of plate number 2, for example, it is obvious that the curve of Fig. 4 must be interpolated between $n = 1$ and $n = 2$. At an angle $\theta_{1\cdot25}$ where $n = 1.25$ the value of $\dfrac{\delta A}{\delta\theta}$ must be 1.25 times that of a single plate, and if y = the fractional part of n, then for the sector of the incomplete portion of the next entering moving plate to be y $(\delta A/\delta\theta$ of the complete plate)

$$y(\rho^2 - r^2) = (r_1^2 - r^2)$$

Therefore $r_1 = \{(\rho^2 - r^2)y + r^2\}^{\frac{1}{2}}$ .. (7)



(*Above*) Fig. 6.

where r_1 is the radial dimension of the leading edge being shaped, as shown in the constructional diagram of Fig. 6. From the curve of Fig. 4 the angles $\theta_{1\cdot25}$, $\theta_{1\cdot5}$ $\theta_{1\cdot75}$ are read corresponding to $n = 1.25$, $n = 1.5$ and $n = 1.75$ respectively. At these angles values of r_1 are found from (7) when $y = 0.25$ $y = 0.5$ and $y = 0.75$ respectively.

These same three values of r_1 may be used to shape the leading edge of the third plate at angles $\theta_{2\cdot25}$ $\theta_{2\cdot5}$ and $\theta_{2\cdot75}$ read from the curve of Fig. 4 corresponding with $n = 2.25$, $n = 2.5$ and $n = 2.75$ respectively. For the leading edges of all other moving plates the same values of r_1 are used at appropriate interpolated values of θ.

The method is made clear in the constructional diagram of Fig. 6 and the resulting moving plate system is shown in Fig. 7.

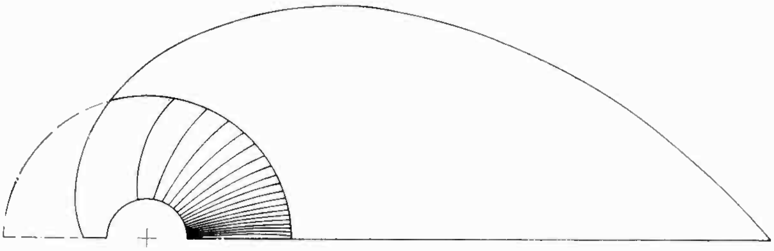


Fig. 7.

It is impracticable to employ moving plates shaped down to narrow sectors of a few degrees only, and so a certain angular limit is decided upon. All moving plates beyond this limit numerically are made to

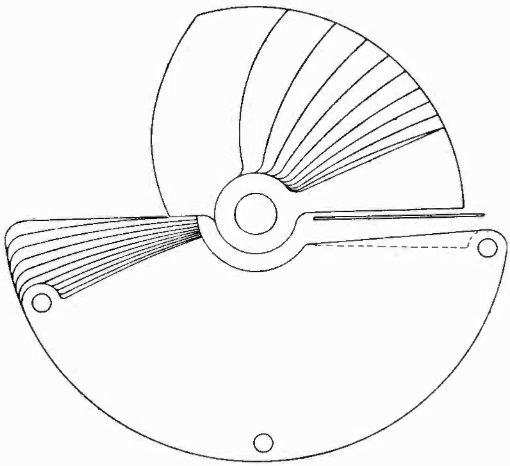


Fig. 8.

a constant angular dimension and the graduation of $dc/d\theta$ obtained by cutting away and shaping the radial edges of the fixed plates into which the leading edges of the moving plates commence to interleave. This purely mechanical modification is clearly depicted in the drawing of the complete plate system of Fig. 8.

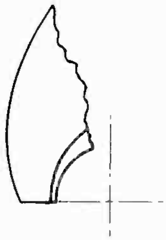


Fig. 9.

A comparison of this system and the equivalent single plate shape system will show that the former is much more compact, and its conformity to law much better at the lower capacities where a single moving plate only is operative and a much better shaping is obtained in consequence.

This feature is illustrated in Fig. 9, in which are shown the active area of the low capacity portion of the plates of this and the conventional " similar-plate " condenser. In the plate of the latter type it will be seen that a slight relative eccentricity of mounting of the fixed and moving plate systems together with " edge effects " is sufficient to change the law completely.

Book Reviews

Television : Theory and Practice

By J. H. Reyner, B.Sc., A.C.G.I., A.M.I.E.E., M.Inst.R.E., pp. 196, with 88 diagrams and 12 plates. Published by Chapman and Hall, Ltd., 11, Henrietta Street, London, W.C.2. Price 12s. 6d.

In a technique that is either developing or changing rapidly it is difficult to have an exposition that is not out of date by the time it is published. This new book on television is a good attempt to bring the subject closely up to the date of writing. While not a profound treatise, the new book gives a clear account of the basic principles of television, *e.g.*, general processes, optical systems, photo cells, etc., thence to cathode-ray methods, including the velocity-modulation system and other special cathode-ray systems Continental (European) and American practices are also reviewed. A useful chapter discusses the general features and essential detents of a television receiver, while a penultimate chapter deals with short-wave (*e.g.*, 7 metre) reception. A pleasing feature of the book is its obvious lack of influence from or allegiance to any particular system. The book is general in character and gives no great detail of any particular system. In some respects greater detail of certain modern practices might have been welcome. It is to be realised, however, that these details may not be readily available to the author of an independent book, and with such limitations the new book is a welcome addition to the literature of television.

Theory of Radio Communication

Post Office Engineering Department, Technical Instructions, pp. 153; with 173 diagrams. Published by *H.M. Stationery Office*, Adastral House, Kingsway, London, W.C.2. Price 7s.

Although this book is a reprint of sixteen pamphlets prepared primarily in connection with workmen's correspondence classes in the P.O. Engineering Department, it serves a useful general purpose as a source of information on modern communication engineering practice. The first section gives a good outline of a.c. theory with simple but sound mathematics ; succeeding sections follow on in more or less conventional text book order to cover the general field of radio theory and practice. As is to be expected from its source the book is more liberal than most independent text books can be regarding details of the practice of commercial communication channels. The information given on aerial arrays and transmission lines, radio-telephony circuits (and their linking up to land-lines) and other points of specialised Post Office technique is of a most useful character to those for whom it is intended and for others in the more general field of radio who may desire information on this technique. The value of the volume as a general text book would have been considerably enhanced by compilation in a less " pamphletted " style. J. F. H.

Analysis of Waveforms*

Half Period Contact in Waveforms Containing Even Harmonics

By L. G. A. Sims, Ph.D., M.I.E.E.

BY an extension of the Joubert contact principle, the harmonic content of distorted waveforms may be measured. The extension consists in the provision upon a Joubert disc of extra tracks containing as many contacts per cycle as the order of the harmonic to be measured. This principle of measurement is associated with the names of various investigators, notably Gall, Gates, Lombardi and Wedmore.

If the contact segments be very short, as in the original Joubert disc, the measurement of any harmonic will be vitiated rather seriously by all the harmonics of higher orders.

This error may be greatly reduced by the use of longer segments. For example, analysers are manufactured with segment length equal to one-third of the period of the desired harmonic. The mathematics of this disc (which fulfils admirably the requirements of symmetrically distorted waveforms) have been given by B. G. Gates,† and the following note is based upon his excellent treatment.

But little attention appears to have been paid to the analysis by this method of waveforms having unsymmetrical distortion. Such waveforms contain even harmonics and they are typical, for example, of the incremental magnetisation of iron which occurs in acoustic frequency transformers and chokes where D.C. and A.C. are superimposed.

Analysis of waveforms containing even harmonics appears to demand the use of segments covering a half period of the harmonic concerned.

Taking a disc of this nature, running at fundamental frequency (for example, 3,000 r.p.m. for 50-cycle excitation) the segment length on a harmonic track containing m segments will be $\frac{\pi}{m}$. The contact brush will make contact at the point $\left(p\frac{2\pi}{m} - \frac{\pi}{2m}\right)$ and break contact at $\left(p\frac{2\pi}{m} + \frac{\pi}{2m}\right)$ where p is any integer contained within m and phase is measured from the centre of a segment.

Assuming that the mean voltage at the brush is balanced against a D.C. potentiometer (to avoid imposing any appreciable load upon the analyser, such as might occur with a voltmeter) then, considering the nth harmonic

$$e = \left[\frac{1}{m}\cdot\frac{m}{\pi}e_n'\sum_{p=0}^{p=m-1}\int_{\frac{(4p-1)\pi}{2m}}^{\frac{(4p+1)\pi}{2m}}\cos n(\theta+\alpha_n)d\theta\right] \quad (1)\ ‡$$

where e = mean voltage as given by potentiometer.

e_n' = peak value of nth harmonic.

$$e = \frac{e_n'}{n\pi}\sum_{p=0}^{p=m-1}\left[\sin n\left\{\frac{(4p+1)\pi}{2m}+\alpha_n\right\} - \sin n\left\{\frac{(4p-1)\pi}{2m}+\alpha_n\right\}\right] \quad .. \quad (2)$$

or

$$e = \frac{e_n'}{n\pi}\sum_{p=0}^{p=m-1} 2\cos n\left\{\frac{2p\pi}{m}+\alpha_n\right\}\sin\frac{n\pi}{2m} \quad .. \quad (3)$$

Examination of the terms of the summation in (2) shows that the summation becomes zero in $2m$ terms, that is, within the limits stated, so long as n is less than m, or, if greater, is not a multiple of m.

The value of e is therefore not affected by

* MS. accepted by the Editor May, 1934.

† See *Journal of Scientific Instruments*, Vol. ix, No. 12.

‡ In accordance with the recommendations of the London Mathematical Society, peak values of harmonic quantities are indicated by dashes throughout the paper.

harmonics of lower order than m, where m represents the number of segments on any given track: it is also not affected by certain higher order harmonics.

Further, by examination of (3) it can be seen that e is zero *when n is a multiple of $2m$. Thus certain higher harmonics also disappear from this cause.*

For values of n greater than m which are multiples of m but not multiples of $2m$, equation (3) may be written

$$e = \left[\frac{2me_n'}{n\pi} \cdot \cos n\alpha_n \cdot \sin\frac{n\pi}{2m}\right] \quad \ldots \quad (4)$$

Examples of the application of this expression may be of interest.

Measurement of Fundamental Component $(m = 1)$.

All even harmonics disappear because they are multiples of 2. All odd harmonics remain because they are multiples of 1.

$$e_1 = \frac{2}{\pi}\left[e_1' \cos \alpha_1 \sin\frac{\pi}{2} + \frac{e_3'}{3}\cos 3\alpha_3 \cdot \sin\frac{3\pi}{2} + \frac{e_5'}{5}\cos 5\alpha_5 \sin\frac{5\pi}{2} + \ldots\right]$$

or

$$e_1 = \frac{2}{\pi}\left[e_1' \cos \alpha_1 - \frac{e_3'}{3}\cos 3\alpha_3 + \frac{e_5'}{5}\cos 5\alpha_5 + \ldots\right] \quad \ldots \quad (5)$$

where e_1 is the mean voltage read by the potentiometer connected to the analyser.

In practice it is usually desired to know only the peak value and phase of the harmonic under measurement. Generally this will occur when the contact brush is moved through the characteristic phase angle of this particular harmonic, that is, in the case above, through α_1. Upon this assumption we may re-state (5) for a maximum by writing

$$e_1 = \frac{2}{\pi}\left[e_1' - \frac{e_3'}{3}\cos 3(\alpha_3 - \alpha_1) + \frac{e_5'}{5}\cos 5(\alpha_5 - \alpha_1) + \ldots\right]$$

It is very important to notice that the second harmonic, which is usually the most prominent harmonic in unsymmetrically distorted quantities, does not vitiate the measurement of the fundamental.

Measurement of 2nd Harmonic $(m = 2)$

All odd harmonics disappear because they are not multiples of 2 and the 4th, 8th, 12th, etc., disappear because they are multiples of 4. At its maximum

$$e_2 = \frac{2}{\pi}\left[e_2' - \frac{e_6'}{3}\cos 6(\alpha_6 - \alpha_2) + \frac{e_{10}'}{5}\cos 10(\alpha_{10} - \alpha_2) - \ldots\right]$$

Measurement of 3rd Harmonic $(m = 3)$

The 1st, 2nd, 4th, 5th, 7th, 8th, 10th, 11th, 13th, 14th, etc., harmonics are eliminated because they are not multiples of 3 and the 6th, 12th, 18th, etc., are eliminated because they are multiples of 6.

At its maximum

$$e_3 = \frac{2}{\pi}\left[e_3' - \frac{e_9'}{3}\cos 9(\alpha_9 - \alpha_3) + \frac{e_{15}'}{5}\cos 15(\alpha_{15} - \alpha_3) - \ldots\right]$$

The application of equation (4) to other cases should be clear.

It is to be recalled that the foregoing analysis applies to analyser discs having a proposed harmonic length of $\frac{\pi}{m}$ radians: and it is particularly to be noted that, in each case, this disc when measuring a harmonic of order m eliminates the harmonic of order $(m + 1)$. In most waveforms this harmonic would otherwise prove the greatest source of error, at any rate in the lowest range of harmonic frequencies, which is usually the most important. That is, the second harmonic is eliminated during a measurement of the fundamental, and so on.

But so far as the writer is aware, discs having this characteristic are not yet manufactured. This is because the application of harmonic analysers of this type to unsymmetrically distorted waveforms, such as occur in iron-cored and other devices used in acoustic frequency technique has received less attention than their application to waveforms having symmetrical distortion, which are much more common, for example, in supply frequency work. The absence of even harmonics in these symmetrical waveforms has led to the use of discs designed to eliminate the *neighbouring odd harmonic* of higher order.

As such discs, though not ideal, may be used in work upon unsymmetrical waves, it is of interest to examine their characteristics in this work.

Gates has shown* that the disc for use with symmetrical† waveforms should have contact segments of length $\left(\frac{2\pi}{3m}\right)$. This disc eliminates harmonics which are multiples of $3m$: also those which are not multiples of m. Then on any harmonic track, due to the nth harmonic the mean voltage read by a potentiometer will be (subject to the above exceptions)

$$e = \left[\frac{3me_n'}{n\pi} \cdot \cos n\alpha_n \cdot \sin \frac{n\pi}{3m}\right] \quad \ldots \quad (6)$$

In a measurement of the fundamental maximum the reading will therefore be

$$e_1 = \frac{3\sqrt{3}}{2\pi}\left[e_1' + \frac{e_2'}{2}\cos 2(\alpha_2 - \alpha_1) - \frac{e_4'}{4}\cos 4(\alpha_4 - \alpha_1) - \frac{e_5'}{5}\cos 5(\alpha_5 - \alpha_1) + \ldots\right]$$

The 3rd harmonic is completely eliminated, but the 2nd harmonic vitiates the reading, to an extent which, if it is in phase, amounts to half the harmonic peak.

In a measurement of the 2nd harmonic we have, at maximum brush setting,

$$e_2 = \frac{3\sqrt{3}}{2\pi}\left[e_2' + \frac{e_4'}{2}\cos 4(\alpha_4 - \alpha_2) - \frac{e_8'}{4}\cos 8(\alpha_8 - \alpha_2) - \frac{e_{10}'}{5}\cos 10(\alpha_{10} - \alpha_2) + \ldots\right]$$

Here conditions are somewhat more favourable due to the elimination of the 3rd harmonic because it is not a multiple of 2.

For the 3rd harmonic peak we obtain

$$e_3 = \frac{3\sqrt{3}}{2\pi}\left[e_3' + \frac{e_6'}{2}\cos 6(\alpha_6 - \alpha_3) - \frac{e_{12}'}{4}\cos 12(\alpha_{12} - \alpha_3) - \frac{e_{15}'}{5}\cos 15(\alpha_{15} - \alpha_3) + \ldots\right]$$

Here also the disc eliminates neighbouring harmonics of which one is even, namely, the 4th: this disappears because 4 is not a multiple of 3.

The comparison of the two discs can be most readily made from a table of results, such as that given in Table I, compiled for the measurement of the fundamental, 2nd and 3rd harmonics. If desired the table can readily be extended to include harmonics of higher orders. It assumes that the harmonic peaks are in phase with that of the fundamental. This may not be generally true, though measurements show that it is a reasonable first approximation in the case of distorted current waveforms in incremental magnetisation.

The table indicates that, upon the above assumption regarding phase (and presupposing a harmonic series of odd and even terms with decreasing coefficients), the disc with $\frac{\pi}{m}$ segments is more accurate than that with $\frac{2\pi}{3m}$ segments.

But it would be unfair to dismiss the matter without reference to a fully practical case.

In an incremental magnetisation measurement upon a Stalloy sample the direct current in the exciting winding was adjusted to yield about $H = 10$, and the superimposed A.C. was adjusted to reduce H approximately to zero on the negative half wave. The applied A.C. pressure was nearly sinusoidal. Under these conditions the resultant exciting current wave was heavily distorted. A Fourier analysis of this wave taken with 36 ordinates per cycle gave the result

$$\begin{aligned} i = 111{,}5 &+ 42{,}3 \cos\theta + 22.83\cos 2\theta \\ &+ 12.2\cos 3\theta + 4.52\cos 4\theta \\ &+ 0.92\cos 5\theta + 0.33\cos 6\theta \\ &- 1.13\cos 7\theta - 1.43\cos 8\theta \\ &- 0.25\cos 9\theta + 0.43\cos(10\theta - 90) \\ &+ 0.28\cos 11\theta + 0.53\cos 12\theta \\ &+ \ldots + 0.43\cos(15\theta - 90) + \ldots \end{aligned}$$

(The higher harmonics and their phases included in the series are doubtless to some degree inaccurate on account of the fact that even 36 ordinates per cycle are inadequate for their exact determination. But apart from the last 2 or 3 terms the series is reliable.)

Rewriting the series for a peak value and

* *Loc. cit.*

† That is, waves in which $f(t) = -f(\pi + t)$—only odd harmonics present.

omitting the constant 111,5 we have

$$i' = 42.3 + 22.83 + 12.2 + 4.52 + 0.92 + 0.33 - 1.13 - 1.43 - 0.25 + 0 + 0.28 + 0.53 + \ldots + 0 + \ldots$$

The results in Table I and equations (4) and (6) may now be applied to this practical series for the two types of analyser discs, in order to examine the errors which each would yield in an experimental analysis.

TABLE I.

ANALYSER ERRORS, DUE TO HARMONICS UP TO 15TH.

Error due to ↓	Measurement of Fundamental.		Measurement of 2nd Harmonic.		Measurement of 3rd Harmonic.	
	Disc with $\frac{\pi}{m}$ Segments.	Disc with $\frac{2\pi}{3m}$ Segments.	Disc with $\frac{\pi}{m}$ Segments.	Disc with $\frac{2\pi}{3m}$ Segments.	Disc with $\frac{\pi}{m}$ Segments.	Disc with $\frac{2\pi}{3m}$ Segments.
Fundamental	—	—	—	—	—	—
2nd harmonic ..	—	$\frac{1}{2} e_2'$	—	—	—	—
3rd ,, ..	$\frac{1}{3} e_3'$	—	—	—	—	—
4th ,, ..	—	$\frac{1}{4} e_4'$	—	$\frac{1}{2} e_4'$	—	—
5th ,, ..	$\frac{1}{5} e_5'$	$\frac{1}{5} e_6'$	—	—	—	—
6th ,, ..	—	—	$\frac{1}{3} e_6'$	—	—	$\frac{1}{2} e_6'$
7th ,, ..	$\frac{1}{7} e_7'$	$\frac{1}{7} e_7'$	—	—	—	—
8th ,, ..	—	$\frac{1}{8} e_8'$	—	$\frac{1}{4} e_8'$	—	—
9th ,, ..	$\frac{1}{9} e_9'$	—	—	—	$\frac{1}{3} e_9'$	—
10th ,, ..	—	$\frac{1}{10} e_{10}'$	$\frac{1}{5} e_{10}'$	$\frac{1}{5} e_{10}'$	—	—
11th ,, ..	$\frac{1}{11} e_{11}'$	$\frac{1}{11} e_{11}'$	—	—	—	—
12th ,, ..	—	—	—	—	—	$\frac{1}{4} e_{12}'$
13th ,, ..	$\frac{1}{13} e_{13}'$	$\frac{1}{13} e_{13}'$	—	—	—	—
14th ,, ..	—	$\frac{1}{14} e_{15}'$	$\frac{1}{7} e_{14}'$	$\frac{1}{7} e_{14}'$	—	—
15th ,, ..	$\frac{1}{15} e_{15}'$	—	—	—	$\frac{1}{5} e_{15}'$	$\frac{1}{5} e_{15}'$

Measurement of Fundamental

Errors due to harmonics up to the 8th.

Disc with $\frac{\pi}{m}$ contacts.

$$i_1 = \frac{2}{\pi}\left[42.3 - \frac{12.2}{3} + \frac{0.92}{5} + \frac{1.13}{7} - \frac{0.25}{9}\right]$$

$$= \frac{2}{\pi}\,[38.51]$$

True peak = 42.3, so disc gives error of − 8.4 per cent.

Disc with $\frac{2\pi}{3m}$ contacts.

$$i_1 = \frac{3\sqrt{3}}{2\pi}\left[42{,}3 + \frac{22.83}{2} - \frac{4.52}{4} - \frac{0{,}92}{5} - \frac{1.13}{7} - \frac{1.43}{8}\right]$$

$$= \frac{3\sqrt{3}}{2\pi}\,[53.07]$$

Error = + 25.4 per cent.

(The factors $\frac{2}{\pi}$ and $\frac{3\sqrt{3}}{2\pi}$ are of course, known characteristics of the analysers and do not rank as errors.)

In this case the disc with $\left(\frac{\pi}{m}\right)$ segments is much superior.

Measurement of 2nd Harmonic

Errors due to harmonics up to the 10th.

Disc with $\frac{\pi}{m}$ segments.

$$i_2 = \frac{2}{\pi}\left[22.83 - \frac{0.33}{3} + \frac{0}{5}\right]$$

$$= \frac{2}{\pi}\,[22.72]$$

True peak = 22.83 so
Error = − 0.48 per cent.

Disc with $\frac{2\pi}{3m}$ segments.

$$i_2 = \frac{3\sqrt{3}}{2\pi}\left[22.83 + \frac{4.52}{2} + \frac{1.43}{4} - \frac{0}{5}\right]$$

$$= \frac{3\sqrt{3}}{2\pi}\,[25.45]$$

Error = 11,45 per cent.

Again the $\frac{\pi}{m}$ segments offer a decided advantage.

Measurement of 3rd Harmonic

Errors due to harmonics up to the 15th.

Disc with $\frac{\pi}{m}$ segments.

$$i_3 = \frac{2}{\pi}\left[12.2 + \frac{0.25}{3} + \frac{0}{5}\right]$$

$$= \frac{2}{\pi}\,[12.28]$$

True peak = 12.2 so

Error = + 0.66 per cent.

Disc with $\frac{2\pi}{3m}$ segments.

$$i_3 = \frac{3\sqrt{3}}{2\pi}\left[12.2 + \frac{0.33}{2} - \frac{0.53}{4} - \frac{0}{5}\right]$$

$$= \frac{3\sqrt{3}}{2\pi}\,[12.237]$$

Error = + 0.3 per cent.

In this case the harmonic phasing favours the $\frac{2\pi}{3m}$ disc, but in both cases the accuracy is now very high.

The comparison cannot reasonably be taken further due to the probable inaccuracy of the Fourier analysis in the higher order terms.

Finally, it will be clear that harmonic phasing cannot be entirely ignored in comparing the two types of segment. But the Fourier analysis shows that, in a typical wave of incremental magnetising current the large amplitude harmonic peaks are mainly in phase with that of the fundamental. In these circumstances the suggested $\frac{\pi}{m}$ segments are superior to those of length $\left(\frac{2\pi}{3m}\right)$. It should also be clear that this does not prejudice the use of the latter with waveforms containing only odd harmonics.

In conclusion, the writer is glad to thank D. L. Clay, B.Sc., for evaluating the Fourier series used in the latter part of the text.

Correspondence

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

Low-frequency Distortion in Horn Speakers Due to the Medium

To the Editor, The Wireless Engineer

SIR,—In the *Bell Technical Journal*, p. 259, April, 1934, an account is given of the horn type speakers designed by Messrs. Wente & Thuras for the Washington-Philadelphia Auditory Perspective demonstration. The low-frequency speakers were designed to cope with an output of 30 watts at 200 ~. To avoid the creation of alien frequencies, due to non-linearity of the medium when high throat pressures are used, it is essential to have a throat of much larger diameter than the customary 1 inch or so. The throat diameter, to give a second harmonic 30 db. below the fundamental, was calculated from a formula published by M. Y. Rocard in *Comptes Rendus*, Jan. 16th, 1933. In a footnote on p. 265 of the *B.T.J.*, it is stated that Messrs. Thuras, Jenkins and O'Neill find Rocard's formula to give a second harmonic 6 db. (4/1 in power) higher than that obtained experimentally.

In April, 1933, we solved the problem of sound waves of large amplitude in an exponential horn, although the analysis has not been published. M. Rocard's analysis was not given, so we are unable to say precisely where the difference between his and our own arises. The equation from which he starts differs from ours in several respects, one of which is a confusion between Lagrangian and Eulerian methods. The correct equations are given in *Loudspeakers*,* Chap. XI. An approximate solution of equation (11) therein shows that M. Rocard's formula for the second harmonic is *four* times too large, *i.e.*, 6 db., as reported in the *B.T.J.*, so our analysis has experimental confirmation. We regret that our results were not published sooner, but we were unaware of M. Rocard's work until the arrival of a reprint from the *B.T.J.* quite recently. We find that the ratio of the power in the second harmonic to that in the fundamental is

$$\phi_h = \frac{\xi_0^2 l}{8\alpha}\left\{\frac{k^4}{\beta^2}(\gamma + 1)^2 - k^2(5\gamma - 4) + \beta^2(\gamma - 1)\right\}, \quad (1)$$

where ξ_0 = particle amplitude at throat, β = flaring index, $\gamma = 1.4$, $k = \omega/c$, $l = \sqrt{(4k^2 - \frac{1}{4}\beta^2)}$, $\alpha = \sqrt{(k^2 - \frac{1}{4}\beta^2)}$, $\phi_h \ll 1$, $e^{-\frac{1}{2}\beta x} \ll 1$, and x is the distance from the throat, at which the ratio is taken. If P_1 the power in the fundamental, is never less than 30 db. above the second harmonic, the throat area

$$A_0 \geqslant 5.08 \times 10^{-2}\,\frac{P_1 l}{\alpha^2 k}\left\{\frac{k^4}{\beta^2}(\gamma + 1)^2 - k^2(5\gamma - 4) + \beta^2(\gamma - 1)\right\} \quad .. \quad (2)$$

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* McLachlan (Clarendon Press, Oxford, 1934).

Using the data from the *B.T.J.* and taking $\beta \doteq 0.012$ (cut-off 32 ∼), this formula can be written, with adequate accuracy,

$$A_0 \geqslant 10.16 \times 10^{-2} P_1 \frac{k^2}{\beta^2} (\gamma + 1)^2 \quad .. \quad (3)$$

which gives a throat diameter of about $5\frac{7}{8}$ inches for 30 watts at 200 ∼.

Having solved the equation for propagation in a tube expanding according to the law $A = A_0 e^{\beta x}$, the formulae for a long tube devoid of reflection were obtained when $\beta \rightarrow 0$. In the tube at 200 ∼ when $x > 200$ cm. but $\leqslant 500$ cm. the ratio

$$\phi_t = \xi_0^2 k^4 (\gamma + 1)^2 x^2 / 16 \quad .. \quad .. \quad (4)$$

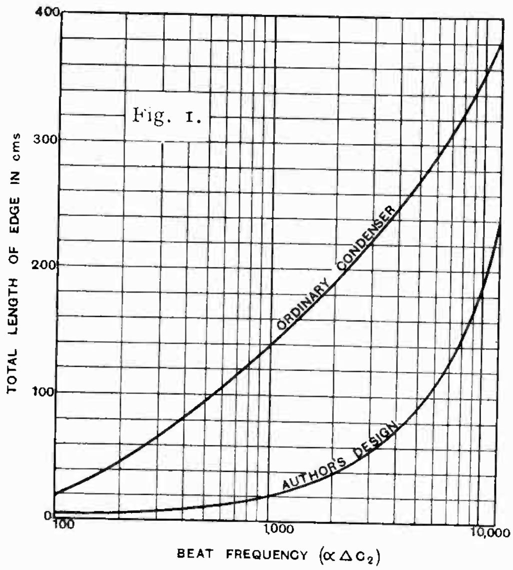
By taking $10 \log \phi_h / \phi_t$ at $x = 500$ cm. from the throat, we find the second harmonic in the horn to be about 9.5 db. below that in the tube, for equal input. This shows very clearly the reduction in distortion of the sound waves due to expansion in an exponential horn. The reduction would have been even greater if the cut-off point had been higher.

S. Goldstein.
London, 4th July, 1934. N. W. McLachlan.

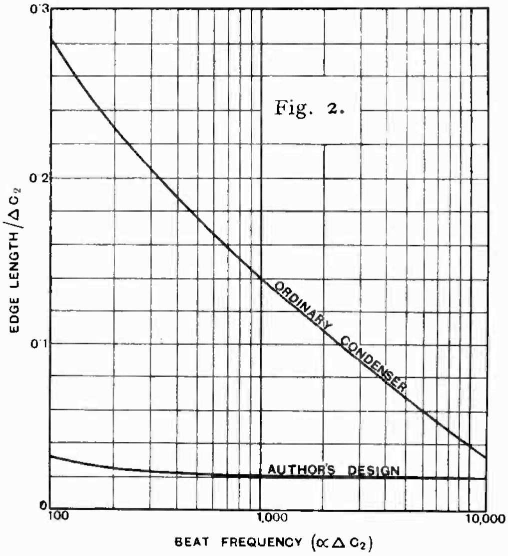
"Precision Heterodyne Oscillators"

To the Editor, The Wireless Engineer

Sir,—May I be permitted to thank Mr. W. W. Lindsay, Jr., for correcting my impression that several commercial heterodyne oscillators of American origin employed crystal-controlled fixed-frequency oscillators. I have committed a grave error in not preserving my information on these oscillators, and regret that I cannot now trace the literature from which these impressions were gleaned. My criticism was naturally levelled at commercial designs only, since I know that many American research laboratories design excellent apparatus for their own use. I am glad to learn, however, that the practice has not been adopted generally in that country.



The other matter to which Mr. Lindsay refers is that of obtaining a smooth law of capacity change in the special variable condenser incorporated in the oscillator described in my recent article in the "*W.E.*"



There is no discontinuity of "law" due to the entering of each additional sector into the fixed-plate system, because the leading edges of these sectors are shaped so as to enter gradually, as will be seen in an article on the condenser in this issue.* Moreover, a very small portion (theoretically a point) of *one* edge only is entering at any angular position.

In the design of this condenser no allowance is necessary for capacity augmentation due to edge effects. It will be seen that these effects are much less serious in this design of condenser than in the more conventional design, in which a number of similarly shaped plates are employed. This is because the number of plates interleaved (and, therefore, the number of edges operative) is proportional to the capacity at any setting of the condenser. The total length of "edge" is always, therefore, very roughly proportional to the capacity —much more nearly so than is the case with the more conventional type—and its effect upon the capacity law of the condenser is, therefore, negligible.

In Fig. 1 is shown the total length of edge operative in the author's condenser compared with that of an ordinary condenser of conventional design. It will be seen that there is always considerably less edge in the former design. The example taken is that of a 20-plate variable condenser designed for a beat frequency of 85–12,000 c.p.s., the maximum plate radius being the same for both types.

Moreover, the edge length in the author's design, in addition to being much less, is in practically constant ratio to the capacity at any setting. In Fig. 2 this is shown compared with the greatly changing ratio of edge/capacity which occurs in the ordinary design.

W. H. J. Griffiths.
Mottingham, S.E.9.

* See page 415 of this issue.—Ed.

Heterodyne Capacity Measuring Set*

An Instrument with a Visual Beat Indicator

By W. C. Lister

(Muirhead & Co., Ltd.)

FOR many years a simple and accurate method of measuring capacity has been provided by the substitution in the tuned circuit of a radio frequency oscillator of an unknown in place of a known capacity. Generally the oscillator is adjusted to a definite frequency by beating it against a second oscillator of fixed frequency. By listening to these beats with telephones one oscillator may be adjusted approximately to zero beat with the other, the accuracy of this adjustment depending on the frequency of the oscillator and the type of standard condenser used.

Where the accuracy obtainable in this way is insufficient, either the frequency must be increased or else the accuracy of setting. The former course is not always possible where capacities of the order 1,000$\mu\mu$F. have to be measured. The accuracy of setting may be increased by adjusting the heterodyne beat note to synchronism with a fixed audio note, from a tuning fork or another oscillator, by means of a second beat process. This method is capable of very

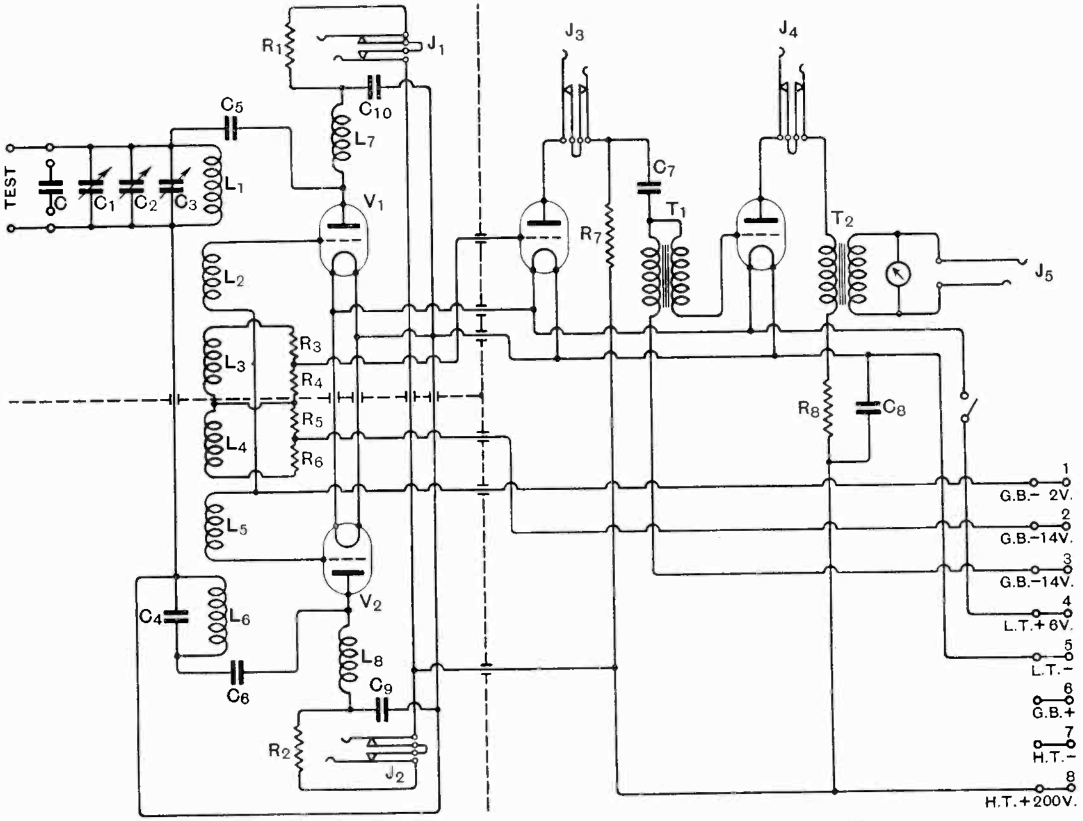


Fig. 1.—*The circuit which is based on the N.P.L. Beat Tone Oscillator.*

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

great accuracy but requires a certain amount of skill in operation and is not suitable for use in the workshop.

It was felt that a visual type of beat indicator, with a sensitivity comparable with that of the double beat method, would be useful for many purposes. Various possibilities were considered, amongst others the use of a tuned reed operated by the audio frequency beat note. Such an indicator is not easy to see, however, and there is no ready means of determining whether the frequency of the variable oscillator is above or below that of the fixed. Finally it was decided to take advantage of the falling off of the output of an audio frequency amplifier at the lower frequencies and adjust the oscillator frequency until a meter measuring output always registered the same figure.

The circuit arrangement is shown in Fig. 1, and is largely that of the N.P.L. Beat Tone Oscillator. The two radio frequency oscillators have a common nominal frequency of 100 kc/s., and their outputs feed on to a potentiometer across the input to a detector. This is followed by an amplifying valve working into a step-down transformer which supplies a rectifier pattern meter. A full scale deflection is obtained for any beat frequency above 15 to 20 c.p.s. Below this frequency the reading falls steadily to zero. The mid-point of the scale is chosen as a reference line, and the variable air condenser across one oscillator is always set until the pointer is at this point. In order to ensure that the frequency of the variable oscillator is always adjusted to be on the same side of zero beat it is only necessary to observe the convention that the meter reading should increase with a clockwise movement of the condenser handle.

The actual instrument is illustrated in Fig. 2. The component parts are assembled behind a panel suitable for mounting on a standard 19in. rack. The variable standard is a Muirhead Type 11 worm driven air condenser of 750$\mu\mu$F. capacity. One division on the worm drum represents one five-thousandth of the total capacity and it is easy to estimate to one-fifth of one division. This represents about 0.03$\mu\mu$F. and the null indicator provides ample discrimination. Equally important is the fact that the back-lash in the condenser is considerably less than this figure. This capacity change corresponds to a movement of the pointer of about 2 mm. The condenser scale is only engraved over the range where it is linear, actually about 650$\mu\mu$F. The scale reads zero for the maximum capacity setting, the figures increasing as the capacity decreases. This allows of the actual scale reading being proportional to the value of the capacity under test. A trimming condenser is provided for balancing the oscillators before making a measurement. The frequency drift is small and it is seldom necessary to re-adjust this trimmer once the oscillators have warmed up.

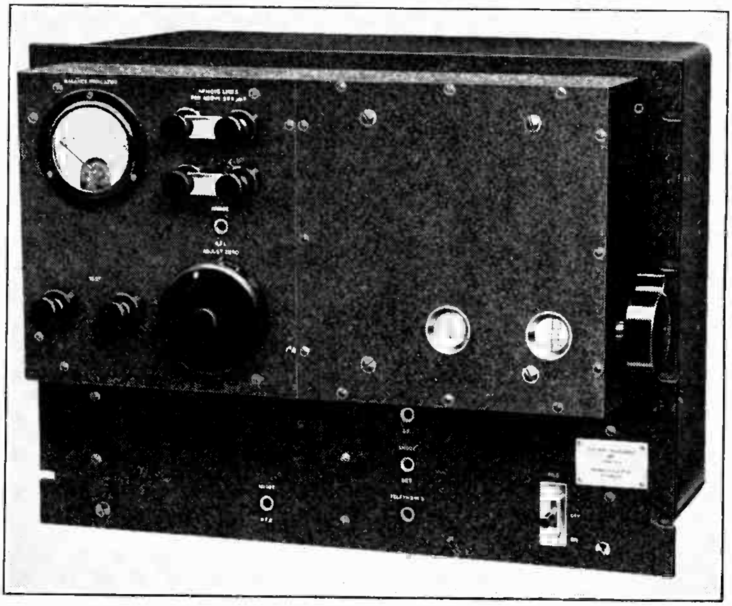


Fig. 2.—*Photograph of the instrument described.*

The actual procedure during a measurement is, therefore, this. With the condenser under test disconnected and the variable air condenser set at zero, the trimming condenser is adjusted until the pointer is over the datum line and the sign convention given above is satisfied. The condenser under test is then connected and the variable air condenser re-adjusted until the pointer is again at the same position and satisfying the sign convention. The reading on the air condenser is then a direct measure of the capacity under test.

The range may be extended beyond the limit of the variable condenser by means of a parallel fixed air condenser of 500$\mu\mu$F. capacity. It is thus possible to measure any capacity up to 1,100$\mu\mu$F. to an accuracy of 0.03$\mu\mu$F.

N.P.L. Annual Visit

THE Annual Summer visitation to the National Physical Laboratory took place on 26th June, 1934, when visitors had an opportunity of inspecting the various Departments of the Laboratory.

Matters of wireless and allied interest were to be found in several sections, particularly in the Radio Department, in which is included the Radio Research Station, Slough, several exhibits from Slough being temporarily housed in the Teddington headquarters for the occasion of the visitation. Amongst these were two cathode-ray exhibits, one a small-sized cathode-ray direction finder for use as a collision preventer intended for use on shipboard during foggy weather. The other was somewhat of a by-product of radio research, in the form of a cathode-ray compass, the electron jet being influenced by the earth's magnetic field so that it divides equally between "collector" electrodes when following a desired course. Deviation from the course then throws the beam more into one electrode or the other, actuating indicating devices which give indications of the departure or can be used to operate correcting gear.

In this department was also shown work on measurement in the laboratory of the electrical constants of soil, from which its properties in radio transmission may be determined. A further demonstration carried the measurements to one metre wavelength by determining the change of wavelength in a Lecher-wire system (as compared with air) when the system is immersed in the soil or other dielectric. An ultra-short wave exhibit was an "inverted diode" oscillator, in which the anode lies along the axis of a cathode consisting of six thoriated filaments. Oscillations of 300 megacycles frequency can be obtained.

Exhibits relating to transmission comprised the new transmitter for various forms of experimental and standard-frequency emissions, and a potentiometer type of feed for replacement of the normal type of inductively-coupled goniometer for supplying a rotating-beacon transmitter, *e.g.*, on the spaced-aerial or Adcock system. Another exhibit in this category was apparatus for investigating the temperature variations of condensers and inductance coils, as, for example, in the master-oscillator circuits of small transmitters or in other cases where high frequency-stability is required. Exhibits relating to measurement work comprised (*a*) a simple high-frequency bridge which was shown in operation making the somewhat unusual measurement of the negative resistance in retroactive circuits, and demonstrating that the amount of retroaction which reduces the resistance to zero is that required to make the circuit oscillate; (*b*) a method of increasing the sensitivity of a galvanometer by retroaction from photoelectric devices, the e.m.f. from the photo-cell being used to react on the galvanometer so as to increase the original deflection.

A final exhibit was one from the Radio Research Station, Slough, showing various automatic records made in the course of investigations of the ionosphere. The records included samples from (*a*) apparatus which explores the range of 2.5 to 5 megacycles, the transmitter and receiver automatically keeping in tune with each other, (*b*) apparatus where the transmitter varies automatically in tune over the range of 1.5 to 6 megacycles while the receiver is followed manually, (*c*) apparatus recording ionospheric echoes on fixed frequencies, *e.g.*, 3 and 6 megacycles over the 24 hours. The interpretation of the records was explained by a demonstrator on duty during the visitation.

The Electricity Department, which is responsible for all electrical standards and measurements, contained a number of exhibits of wireless interest, particularly those relating to the measurement of frequency. These included the Laboratory standard apparatus for precision measurement of radio frequencies, and the standard 1,000-cycle fork apparatus, working a chronograph so as to record the hourly rate of frequency standards with an accuracy of 2 parts in 10^7. A recent international comparison, made simultaneously on a standard broadcast wave by the Laboratory and several Continental laboratories, gave agreement to one part in 10^7. Other radio-frequency apparatus included a demonstration of luminous quartz crystals, a radio-frequency bridge of high accuracy, and apparatus for the measurement of the inter-electrode capacity of valves. Amongst primary standards was shown new equipment for absolute resistance measurements as well as the standard Lorenz apparatus for determination of the absolute unit of resistance, primary standards of inductance, etc.

The Physics Department supplied a series of exhibits relating to audio-frequency technique. Chief amongst these was the new Acoustics Laboratory, available for inspection for the first time. This consists of a series of rooms acoustically and electrically isolated, walls, floors and ceilings being massive and everywhere double, the inner shell resting on independent insulated piers.

Other demonstrations of allied interest were concerned with the absolute calibration of microphones, open-air acoustic measurements of loud speakers and the study, by cathode ray oscillograph, of the analysis and suppression of noise.

Connecting Several Receivers to One Aerial*

A Note on the Problems Involved

By M. Reed, M.Sc., A.M.I.E.E.

In some cases, particularly in flats or in large houses, it may be necessary to connect more than one receiver to the same aerial. To operate a number of receivers satisfactorily in this way, it is necessary to enable any one of the receivers to be tuned to the required station (say X) without causing an appreciable change in

(*a*) the tuning of the other receivers, and (*b*) the input to the other receivers.

If any of the other receivers are also tuned to X, then the only satisfactory method of satisfying the above requirements seems to be to fit a screen-grid valve as an isolating valve in front of each receiver, and to resistance-couple the aerial to this valve. Such an arrangement is used in Naval Ships and was described by Dr. Rawlinson in a paper read before the Wireless Section of the I.E.E. on the 7th March.

If the other receivers are not tuned in the immediate neighbourhood of X then a simpler solution can be obtained by coupling each receiver to the aerial by means of a small condenser. Since such a condenser is usually included in the standard type of receiver, no modifications are necessary. The method of determining a suitable value for this condenser, and also the conditions under which satisfactory results can be obtained, are given below.

Suppose, in the first place, that we have a tuned circuit $L_1 C_1$ which is connected to an aerial by means of a condenser C as in Fig. 1 (*a*). Fig. 1 (*b*) shows Fig. 1 (*a*) redrawn on the assumption that the aerial can be replaced by a condenser C_0, its inductance and resistance being neglected. To determine the resonance frequency of this system we can convert it into Fig. 1 (*c*) by making use of a theorem, proved by Moullin,† that the resonance condition of a system remains unchanged when the input terminals are short-circuited and the source is placed in any series or shunt member.

In the above case we have introduced the source e in series with L_1 and have short-circuited the terminals AB. From Fig. 1 (*c*)

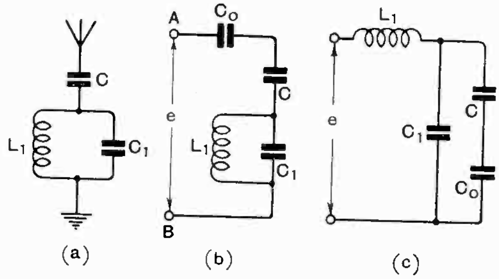


Fig. 1.

it is seen that the inductance L_1 is tuned by a capacity whose value is given by

$$C_t = C_1 + \frac{CC_0}{C + C_0},$$

and that the natural frequency f of the system is given by

$$f = \frac{1}{2\pi\sqrt{L_1 C_t}}.$$

If we put $f = 1{,}000$ kc/s/sec. (300 metres)

$L_1 = 100$ microhenrys

$C_0 = 250\ \mu\mu$F.

$C = 100\ \mu\mu$F.

then $C_t = 250\ \mu\mu$F.

and $$C_1 = C_t - \frac{CC_0}{C + C_0} = 178.6\ \mu\mu\text{F}. \quad (1)$$

Suppose now that we have more than one receiver connected to the same aerial (for simplicity it will be assumed that only two receivers are connected, but the method can be easily extended to any number of receivers) in the way shown in Fig. 2 (*a*), where $L_1 C_1$ and $L_2 C_2$ represent, respectively, the first tuned circuit of each receiver coupled to the aerial by means of the condensers C.

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

† *Proc. Camb. Phil. Soc.*, page 391, 1926.

Fig. 2 (*b*) shows Fig. 2 (*a*) redrawn after replacing the aerial by the condenser C_0. To estimate the effect of varying $L_2 C_2$ on the first receiver, when it is tuned to receive signals of frequency $\omega/2\pi$, we can convert Fig. 2 (*b*) into Fig. 2 (*c*) by using the theorem given above. From Fig. 2 (*c*) it can easily be shown that the effective capacity which tuned L_1 is given by :

$$C_{eff} = C_1 + \cfrac{C}{1 + \cfrac{C}{C_0 + \cfrac{C}{1 + \cfrac{C}{\left(C_2 - \cfrac{1}{\omega^2 L_2}\right)}}}} \quad .. \quad (2)$$

If the first receiver is tuned to a station whose frequency is much less than that of the station to which the second receiver is tuned, then C_2 will be much smaller than $1/\omega^2 L_2$, with the result that equation (2) reduces to

$$C_{eff} = C_1 + \cfrac{C}{1 + \cfrac{C}{C_0 + \cfrac{C}{1 - \omega^2 L_2 C}}}$$

which is independent of C_2. This shows that, in these circumstances, the second receiver can be tuned to any station without appreciably influencing the first receiver. In practice, this means that, if the first receiver is tuned to a station in the long-wave band above about 1,000 metres, the second receiver, provided its tuning inductance does not exceed about 200μH, can search for any station in the medium-wave band without affecting the first receiver. This condition holds for all values of C not exceeding about 100$\mu\mu$F.

If, on the other hand, the first receiver is tuned to a station whose frequency is much higher than that to which the second receiver is tuned, C_2 will be much larger than $1/\omega^2 L_2$. In this case equation (2) reduces to :

$$C_{eff} = C_1 + \cfrac{C}{1 + \cfrac{C}{C_0 + \cfrac{C}{1 + \cfrac{C}{C_2}}}} \quad .. \quad (3)$$

which shows that, for a given value of C_1, the variation produced by changing C_2 depends on the value of C. Consideration of a worked example will perhaps be the best way to see what the variations produced in C_{eff} are likely to be.

Suppose that C_2 can be varied from 50 to 500$\mu\mu$F. and that the other values are assumed to be the same as those given on page 1.

Then for the lower value of C_2 we have from equation (3) that

$$C_{eff} = C_1 + 74\mu\mu F.$$

Since the total capacity required to tune L_1 to 300 metres is, as before, $C_t = 250\mu\mu$F., the value of C_1 required in this case is given by $C_1 + 74 = 250$, *i.e.*, $C_1 = 176\mu\mu$F. For the higher value of C_2, we obtain

$$C_{eff} = C_1 + 77\mu\mu F.,$$

from which the corresponding value of $C_1 = 173\mu\mu$F.

In the absence of the second receiver, we have from equation (1) that $C_1 = 178.6\mu\mu$F.,

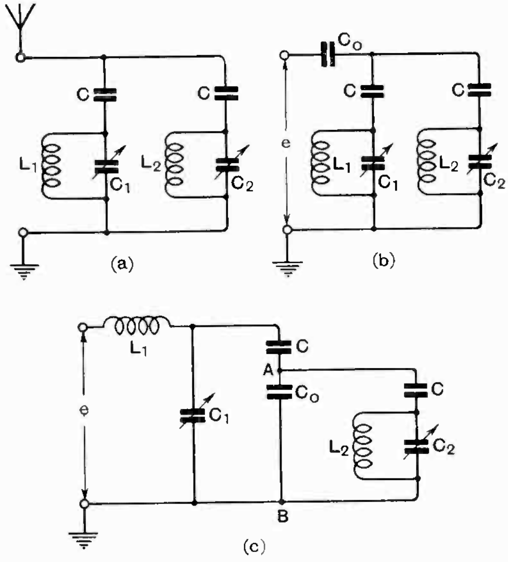


Fig. 2.

therefore the greatest variation produced by the second receiver is about 3 per cent. This change can, of course, be reduced by lowering the value of C. The above example shows that, if the first receiver is tuned to a station in the medium-wave band, it may be necessary to re-trim its first tuned circuit by a small amount when the second receiver is searching for a station in the long-wave band. In the above analysis it is assumed that when the second receiver is switched to "long-wave" the tuning inductance will be of the order of 2,000μH.

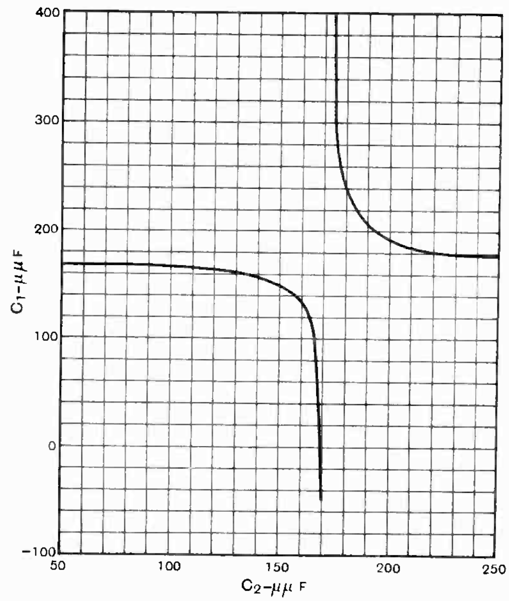


Fig 3.

From the foregoing we can conclude that, if it is desired to operate two receivers from the same aerial, one receiver being tuned to the long-wave band and the other to the medium-wave band, it is best to set the former receiver first and then to adjust the latter.

When both receivers are tuned to stations whose frequencies are not very different, considerable complications may be introduced in the way shown in Fig. 3. To obtain this curve it is assumed that $L_2 = L_1 = 100$ microhenrys, and that for each value of C_2 condenser C_1 is reset to maintain the first receiver in tune with the given station. From Fig. 3 it is seen that, as C_2 is varied, considerable changes in the tuning of the first receiver are introduced, particularly in the neighbourhood of 170 to 180$\mu\mu$F. For values of C_2 greater than 250$\mu\mu$F. the value of C_1 returns to its normal value, and satisfactory reception can be obtained with both receivers.

So far as the input requirement is concerned, we see from Fig. 2 (*b*) that an impedance Z_2, consisting of the second tuned circuit in series with the condenser C, shunts the first tuned system. The input to the latter therefore depends on the magnitude of Z_2. The reactive portion of this magnitude (it is assumed that the resistive portion can be neglected) is given by

$$\frac{1}{Z_2} = \frac{\omega C}{1 - \dfrac{C}{C_2 - \dfrac{1}{\omega^2 L_2}}}$$

If the second receiver is not tuned in the neighbourhood of the first $(C_2 - 1/\omega^2 L_2) \gg C$, which makes $\dfrac{1}{Z_2} = \omega C$.

In this case Z_2, and therefore the input to the first receiver, will be independent of the value of C_2. This means that, provided the tuning condition examined above is satisfied, the input condition will also be satisfied.

Books Received

Modern Acoustics

By A. H. Davis, D.Sc.

An account of modern developments in acoustics due principally to the development of electrical apparatus and methods. Pp. 345+xi, with 102 diagrams. Published by G. Bell & Sons, Ltd., York House, Portugal Street, London, W.C.2. Price 26s. net.

Report of the Radio Research Board for the Period 1st January, 1932, to 30th September, 1933.

Published by H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2. Price 2/6 net.

Abstracts and References

Compiled by the Radio Research Board and reproduced by arrangement with the Department of Scientific and Industrial Research.

PROPAGATION OF WAVES

On the Rotation of the Plane of Polarisation of Long Radio Waves.—A. L. Green and G. Builder. (*Proc. Roy. Soc.*, 2nd June, 1934, Vol. 145, No. A 854, pp. 145–158.)

This paper is a discussion of experimental observations on the propagation of long waves at non-vertical incidence, and in particular of the rotation of the plane of polarisation of the waves, which were made by Hollingworth (Abstracts, 1928, p. 460). Reference is also made to observations by Naismith (1931, p. 491) and Namba (1932, p. 87). The present paper applies the technique of the magneto-ionic ray theory (see, *e.g.*, Appleton, 1933, p. 30) to these observations, using the methods advocated by Baker and Green (1933, p. 614) who obtained *inter alia* a formula for the ratios of axes of the ellipses of polarisation in the ordinary and extraordinary downcoming waves. The present writers calculate the limiting polarisations of both ordinary and extraordinary downcoming waves and combine them, with suitable relative phases and amplitudes, into a single space wave; they also form estimates of the differential absorption experienced by the two components, when the electronic density is small. They derive " three working rules for long-wave propagation, namely :—

(*a*) for propagation approximately longitudinal to the earth's magnetic field, the ordinary and extraordinary downcoming rays are receivable with comparable intensities ; (*b*) for propagation approximating to the transverse type, the extraordinary ray reaches the ground with much the greater intensity ; (*c*) however, if the collision frequency is very great, for example if the absorption occurs comparatively near to the earth's surface and not entirely where the wave is bent over in the Kennelly-Heaviside layer, then, whatever the direction of transmission, both waves are equally attenuated."

From their analysis they obtain values of the amount of rotation of the plane of polarisation for night conditions and for the steady post-sunrise value which agree very well with Hollingworth's experimental values. They also infer that " differential absorption takes place in the post-sunrise period in a region between 47 and 70 km above the earth's surface." Qualitative explanations are given of other long-wave anomalies associated with asymmetrical propagation.

Phase Variations of Reflected Radio Waves, and a Possible Connection with the Earth's Magnetic Field in the Ionosphere.—I. Ranzi. (*Nature*, 16th June, 1934, Vol. 133, p. 908.)

The writer has observed, on the apparatus which has already been described (Abstracts, 1933, p. 559 and back reference : *see* also 1932, p. 632 ; 1933, p. 384 ; and March, p. 142—two), that the two echoes produced by magneto-ionic double refraction sometimes show phase variations of opposite sense. " This can be explained . . . only by admitting a variation of separation of the two echoes, possibly following a change of intensity of the earth's magnetic field in the ionosphere." Further investigations on this point are in progress.

Interaction of Radio Waves [and Its Possibility in the Case of Atmospherics].—Bailey. (*See* under " Atmospherics and Atmospheric Electricity.")

Interaction of Radio Waves [and Its Effect on Broadcast Channel Separation].—van der Pol. (*See* under " Reception.")

Radio Exploration of the Ionosphere [and the Magnetic Field There].—S. Chapman : Appleton. (*Nature*, 16th June, 1934, Vol. 133, p. 908.)

A letter emphasising the importance of Appleton's recent letter (July Abstracts, p. 373) on the measurement of the magnetic intensity in the ionosphere. If this measurement becomes possible to within 1%, the results may afford a check on the magnetic theory, if we know the height to which the measures refer ; and conversely, assuming the truth of the magnetic theory, an independent estimate of the height of reflection of the waves may be obtained.

Measurement of the Angle of Incidence at the Ground of Downcoming Short Waves from the Ionosphere [from C-R Oscillograph Traces of Signals from Two Horizontal Parallel Aerials in Broadside Position : Slough Results on Transmissions from Lawrenceville on Waves around 20 Metres].—A. F. Wilkins. (*Journ. I.E.E.*, June, 1934, Vol. 74, No. 450, pp. 582–588.)

The average angle of the Lawrenceville main ray, over the period Jan./April, 1933, was 72°, fairly constant throughout the day; but from about the end of April, in addition to a reduction of mean field strength, there developed a definite increase in angle during the day, from about the "winter" value at 12.00 up to 80° to 85° towards sunset. The smallness of the variation observed during the winter may be explained by the smaller diurnal variation of ionisation density. "The deduction (based on the prevalence of ellipses whose major axes are inclined at 45° to the oscillograph axes and whose eccentricity is constant) that there is one downcoming ray whose amplitude is great in comparison with other rays was confirmed by the preliminary results of some short-duration pulse transmissions from Lawrenceville on a wavelength of 20.73 metres."

MAXIMUM OPTICAL PATHS.—T. Smith. (*Nature*, 2nd June, 1934, Vol. 133, pp. 830–831.)

A letter emphasising that, in an optical path, the time is "a minimum when the path does not include an image of an end point of the range considered, but that if the path includes such an image, the time is neither a maximum nor a minimum—it is simply stationary . . . no given optical path is ever a maximum." The optical paths may be referred to as *stationary* paths.

IONOSPHERIC HEIGHT MEASUREMENT IN THE UNITED PROVINCES OF AGRA AND OUDH (India).—G. R. Toshniwal and B. D. Pant. (*Nature*, 23rd June, 1934, Vol. 133, pp. 947–948.)

A preliminary letter on measurements made by the pulse method at Allahabad on May 13th and 14th, 1934. Echoes were visually observed on a cathode-ray oscillograph. On May 13th, between 18.30 and 20.00 I.S.T., the E-layer height was found to be 135 km; there were many multiple reflections. Echoes of abnormally high intensity were occasionally observed. In the early morning hours (5.30—6.30) of May 14th the height of F layer was found to be 270 km, decreasing to 250 km; multiple reflections up to order 4 were present.

DIRECTION OF ARRIVAL OF [Short] WAVES.—C. B. Feldman. (*Rad. Engineering*, May, 1934, Vol. 14, No. 5, pp. 14–16.) On the work described in the long joint paper dealt with in March Abstracts, p. 142 (where the page reference should read "pp. 47–78").

PROPAGATION OF RADIO WAVES [and the Validity of the "1/500th part of Distance" Rule for Optimum Wavelength, and of the Multiple-Reflection and Long-Step Assumptions for Long and Short Waves respectively: Penetration of Ionosphere by Ultra-Short Waves at All Angles: etc.].—B. C. Sil: Mitra. (*Current Science*, Bangalore, May, 1934, Vol. 2, No. 11, pp. 437–438.) A letter prompted by a review, in the January issue, of Mitra's recent address: the reviewer replies.

A FUNDAMENTAL PROBLEM REQUIRING INTENSIVE RESEARCH: THE POSSIBILITY OF OVERCOMING THE "OPTICAL DISTANCE" LIMITATION OF ULTRA-SHORT WAVES.—(*QST*, June, 1934, Vol. 18, No. 6, pp. 7–8.)

PRELIMINARY TESTS WITH ULTRA-SHORT [Micro-] WAVES.—Sokolcow and others. (*See* under "Stations, Design and Operation.")

EFFECT OF THUNDERSTORMS UPON THE IONOSPHERE [Observations of certain Broadcasting Stations Audible only after Thunderstorms].—R. C. Colwell. (*Nature*, 23rd June, 1934, Vol. 133, p. 948.)

The Appalachian mountains shield Morgantown, West Virginia, U.S.A., from the radiation from broadcasting stations along the Atlantic coast. A short-wave station (frequency 7 or 14 Mc/s) operated at Morgantown by A. W. Friend is inaudible in the S.E. section of the United States except after a thunderstorm, though amateur short-wave stations in the Southern States can be received at Morgantown. The observations strongly support C. T. R. Wilson's theory that some of the ionisation in the ionosphere is due to thunderstorms, but not all of the abnormal ionisation arises from thunderstorms; increased ionisation in E layer after sunset during the winter months has often been observed when there were no thunderstorms within 1 000 miles.

SUR LA LUMIÈRE DES ÉTOILES FILANTES (The Light of Meteors [Opposition to Burgatti's Theory involving Heaviside Layer]).—J. Mascart: Burgatti. (*Comptes Rendus*, 5th Feb. 1934, Vol. 198, No. 6, 1934, pp. 544–546.) For a criticism by Fabry see *ibid.*, pp. 546–549.

ILLUMINATION INTENSITY BY THE FULL MOON.—K. Hisano. (*Japanese Journ. of Eng., Abstracts*, Vol. 11, 1934, p. 47.)

ONDE STAZIONARIE SUI FILI DI LECHER TRAVERSANTI UNO STRATO DIELETTRICO (Stationary Waves on Lecher Wires passing through a Dielectric Stratum [Theoretical and Experimental Determination of Connection between Wavelength and the Thickness and Position of Paraffin Plate, using Waves of 88 cm in Air]).—O. Fagioli. (*Physik. Ber.*, 1st May, 1934, Vol. 15, No. 9, p. 703.)

THE INFLUENCE OF CERTAIN TRANSMISSION-LINE ASSOCIATED APPARATUS ON TRAVELLING WAVES [Mathematical Treatment and Oscillographic Confirmation].—J. L. Miller. (*Journ. I.E.E.*, June, 1934, Vol. 74, No. 450, pp. 473–510: Discussion pp. 519–535.)

NOMOGRAMS OF THE PROPAGATION CONSTANTS ON THE TELEPHONE LINE.—T. Kamo. (*Japanese Journ. of Eng., Abstracts*, Vol. 11, 1934, p. 41.)

A GENERAL DERIVATION OF THE FORMULA FOR THE DIFFRACTION OF A PERFECT GRATING.—Eckart. (*See* under "Aerials and Aerial Systems.")

AN OPTICAL EXAMINATION OF THIN FILMS. I: THE OPTICAL CONSTANTS OF MERCURY.—L. Tronstad and C. G. P. Feachem. (*Proc. Roy. Soc.*, 2nd June, 1934, Vol. 145, No. A 854, pp. 115–126.)

The method adopted for determining the refractive index and index of attenuation from the metallic surface was to reflect a parallel beam of elliptically polarised light of known properties from the surface at a known angle, and to vary the ellipticity of the incident beam until the reflected light was plane polarised. Part II, on the behaviour of thin films of fatty acids on mercury, follows on pp. 127–135.

ANOMALOUS DISPERSION BY DIFFRACTION.—A. H. Pfund. (*Journ. Opt. Soc. Am.*, May, 1934, Vol. 24, No. 5, pp. 121–124.)

OPTICAL CONSTANTS OF ALKALI METALS [Calculation of Indices of Refraction and Attenuation from Sommerfeld's Theory, and Comparison with Measured Values].—J. Hurgin and N. Pisarenko. (*Nature*, 5th May, 1934, Vol. 133, p. 690.)

ON THE SOLUTION OF BOUNDARY PROBLEMS IN MATHEMATICAL PHYSICS [application to Partial Differential Equations of Elliptic Type, *e.g.* in Skin Effect].—J. Neufeld. (*Phil. Mag.*, May, 1934, Series 7, Vol. 17, No. 115, pp. 987–992.)

THE START OF LOVE WAVES [Pseudo-Period continuously Decreasing, Amplitude continuously Increasing: Alternative to Jeffrey's "Sudden Rotation" Hypothesis].—J. Coulomb. (*Comptes Rendus*, 23rd April, 1934, Vol. 198, No. 17, pp. 1525–1527.)

PHOTO-RECORD OF THE SPEED OF AN EXPLOSION WAVE IN AN ELECTRIC FIELD; *and* THE EFFECT OF THE ELECTRIC FIELD ON COMBUSTION PROCESSES AT LOW PRESSURES.—Malinowski and others. (*Physik. Zeitschr. der Sowietunion*, No. 3, Vol. 5, 1934, pp. 446–452: 452–463.)

TOTAL REFLECTION IN ACOUSTICS AND OPTICS (on the Basis of Experimental Seismological Results).—O. von Schmidt. (*Ann. der Physik*, 1934, Series 5, Vol. 19, No. 8, pp. 891–912.)

This paper lays stress on the fact that, even when total reflection from a surface takes place, there is a disturbance in the [optically speaking] less dense medium which may be regarded as travelling along the surface and which may possibly shower back the energy into the denser medium, giving rise to "wandering reflection." The writer discusses reflection in seismological phenomena and applies his ideas also to optics and radiotelegraphy; long distance propagation may be explained by this "wandering reflection." *See* next abstract.

POSTSCRIPT TO O. VON SCHMIDT'S PAPER [see above Abstract].—J. Picht. (*Ibid.*, pp. 913–920.)

These remarks indicate that the helpfulness of von Schmidt's paper for other workers lies in his account of seismic phenomena; the writer disagrees with some of his remarks on optical theory and refers to papers by himself (*Ann. der Physik*, 1929, Series 5, Vol. 3, p. 433, and Abstracts, 1930, p. 153, r-h col.) and Noether (1932, p. 217) for a true account of the subject; he also includes a theoretical investigation of reflection of a cylindrical wave, polarised perpendicularly to the plane of incidence.

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

INTERACTION OF RADIO WAVES [and the Possibility of Two Types of "Atmospheric"].—V. A. Bailey. (*Nature*, 9th June, 1934, Vol. 133, p. 869.)

This letter points out another interesting consequence of the effect of interaction of radio waves observed by Tellegen and others (Abstracts, 1933, p. 558; March, p. 144; and May, p. 260) and explained by the writer and Martyn (April, p. 199) "by taking account of the changes, in the mean velocity of agitations of electrons in the ionosphere, produced by a strong electric wave." This letter points out that atmospheric electric pulses may similarly superpose their wave-form on a carrier wave and thus produce "atmospherics" in a radio receiver.

It thus appears possible "that observed 'atmospherics' are of two types, one associated with and proportional to the intensity of the carrier wave and the other completely independent of the carrier wave."

NOTE ON AUDIO-FREQUENCY ATMOSPHERICS [Observations in August, 1933, during Considerable Sunspot Activity: Comparison with Preece's 1894 Results].—E. T. Burton. (*Proc. Inst. Rad. Eng.*, May, 1934, Vol. 22, No. 5, pp. 670–671.)

For previous papers *see* June Abstracts, p. 316, l-h col. "It appears that if the trains of descending tones are produced by multiple reflection attended by dispersion, the path followed by the later tones is probably considerably different from that of the first tone. This might indicate that the disturbance passes first through a medium of comparatively high dispersive properties; thereafter it may enter a region of lower dispersion and low attenuation which is bounded at least partially by regions of good reflecting properties for frequencies of the audio range." Preece's observation of some tones of duration as long as 20 secs., compared with the longest durations of about 5 secs. now noted, may be due to the fact that he was working in a period of high sunspot activity.

DAS ELEKTRISCHE FELD DER GEWITTERWOLKE (The Electric Field of a Thunder Cloud [Theoretical Investigation]).—J. Fischer. (*Physik. Zeitschr.*, 15th May, 1934, Vol. 35, No. 10, pp. 398–403.)

The writer of this paper is of the opinion that the model of a thundercloud devised by Ollendorff (1932 Abstracts, p. 220) is unnecessarily complicated and in insufficient agreement with present meteorological ideas as to the nature of such a cloud. He prefers to regard the cloud, for the purposes of theoretical investigation, as a simply charged circular disc with natural charge distribution; the field of such a disc can be represented by a combination of elementary functions. Curves are given showing the numerical field strength (or charge) on the earth's surface as a function of the height of the cloud regarded as (1) one charged disc, (2) two charged discs with different amounts of separation in height, and (3) two charged discs a fixed distance apart but at varying heights above the earth. The writer finds simple expressions for the position and magnitude of the maximum value of the field strength on the earth's surface as a function of the ratio of the height of the cloud above the surface to its radius.

IONISATION MEASUREMENTS NEAR THE GROUND DURING THE TIME OF THUNDERSTORMS.—G. R. Wait and A. G. McNish. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 750: abstract only.)

"A large definite diurnal-variation in the rate of ionisation was found. In addition, the ionisation was found to increase several fold at the time of thunderstorms. The increase in ionisation usually has an abrupt beginning, coinciding with the beginning of the rain. The total amount of increase is roughly proportional to the total amount of rainfall. The ionisation begins to decrease as soon as the rain ceases, the decrease with time being of such a character as to be explainable by assuming that decay-products of radium, principally RaB and RaC in equilibrium with it, are carried to the earth's surface by the rain."

DIE MESSUNG VON BLITZSTROMSTÄRKEN AN BLITZABLEITERN UND FREILEITUNGSMASTEN (The Measurement of Lightning Currents at Protectors and Overhead Line Poles [Values up to 60 000 Amperes]).—H. Grünewald. (*E.T.Z.*, 24th and 31st May, 1934, Vol. 55, Nos. 21 and 22, pp. 505–508 and 536–539.)

PRACTICAL EXPERIENCES OF LIGHTNING DISCHARGES TO AEROPLANES.—H. Koppe. (*Physik. Ber.*, 15th May, 1934, Vol. 15, No. 10, pp. 815–816.)

UNUSUAL STROKES OF LIGHTNING [Two Strokes to Same (Dead) Tree within about one Second].—E. P. Wightman. (*Science*, 8th June, 1934, Vol. 79, No. 2058, p. 524.)

THE PROTECTION OF LOW-TENSION POWER LINES AGAINST SURGES [due to Lightning Strokes and Inductive Discharges, etc.].—L. Lagron. (*Rev. Gén. de l'Élec.*, 9th June, 1934, Vol. 35, No. 23, pp. 787–797.)

INSTRUCTIONS FOR THE PROTECTION OF BUILDINGS AGAINST LIGHTNING.—ASE. (*Bull. Assoc. suisse des Élec.*, No. 13, Vol. 25, 1934, pp. 358–364.)

THE INITIAL STAGES IN SPARK GAP DISCHARGE [Ion Distribution during Dark Current Portion of Discharge obtained by Cloud Chamber Expansion].—L. B. Snoddy and C. D. Bradley. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 751: abstract only.)

ATMOSPHERIC ELECTRIC OBSERVATIONS [near Canberra].—A. R. Hogg. (*Physik. Ber.*, 15th May, 1934, Vol. 15, No. 10, p. 814.)

SOME OBSERVATIONS OF THE AVERAGE LIFE OF SMALL IONS AND ATMOSPHERIC IONISATION EQUILIBRIA.—A. R. Hogg. (*Ibid.*, p. 815.)

MICRO-CLIMATOLOGY [and the Investigation of Phenomena in the Air Layers within a Few Metres of the Ground].—L. A. Ramdas. (*Current Science*, Bangalore, May, 1934, Vol. 2, No. 11, pp. 445–447.)

WORLD CONFERENCE OF AUTHORITIES ON THE STRATOSPHERE, LENINGRAD, 1936. (*Science*, 8th June, 1934, Vol. 79, No. 2058, p. 521: no details.)

THE COMPOSITION OF THE AIR IN THE STRATOSPHERE [from Samples taken on Prokofiev's Ascent: Composition at 19 km practically Same as at Earth's Surface].—A. Kapustinskij. (*Physik. Ber.*, 15th May, 1934, Vol. 15, No. 10, p. 824.) *See* also Wangenheim, May Abstracts, p. 260, r-h column.

RUSSIAN STUDIES OF THE STRATOSPHERE [including Measurements of Cosmic Rays at High Altitudes].—(*Nature*, 16th June, 1934, Vol. 133, pp. 918–919.)

A short note on the results of the ascent made on 30th September, 1933, by Prokofiev, Godunov and Birnbaum. Measurements of cosmic ray intensity agree fairly well with Piccard's observations but show a discrepancy of more than 30% with Regener's results.

COINCIDENCE COUNTER STUDIES OF THE CORPUSCULAR COMPONENT OF THE COSMIC RADIATION [Latitude Variation: Presence of Positive Corpuscular Component].—T. H. Johnson. (*Phys. Review*, 1st May, 1934, Series 2, Vol. 45, No. 9, pp. 569–585.)

This paper summarises much recent work on the latitude variation of cosmic radiation; preliminary reports on the survey undertaken during the spring and summer of 1933 have already appeared. Other recent literature on the subject, the apparatus and experimental procedure, and the reduction of data are also discussed and it is definitely concluded that a part of cosmic radiation consists of positively charged particles, and that this part is sufficient to account for the entire variation of intensity with latitude. It is also found to be the principal source of showers.

WHAT FRACTION OF THE PRIMARY COSMIC RADIATION IS POSITIVE? [Positive Rays associated with Intense Soft Band containing more than 90% of Total Radiation at Top of Atmosphere].—T. H. Johnson. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 758: abstract only.)

THE EFFECT OF LATITUDE ON COSMIC-RAY INTENSITIES BOTH AT SEA-LEVEL AND AT VERY HIGH ALTITUDES.—R. A. Millikan and V. Neher. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, pp. 757–758: abstract only.)

ON THE EFFECT OF THE EARTH'S MAGNETIC FIELD ON THE CORPUSCULES OF THE PENETRATING RADIATION IN THE LATITUDE OF FLORENCE.—G. Bernardini and D. Bocciarelli. (*La Ricerca Scient.*, 30th April, 1934, 5th Year, Vol. 1, No. 8, pp. 451–452.)

COSMIC RAYS FROM SUPER-NOVAE [Mass may be annihilated in Bulk: Satisfactory Agreement with Some Major Observations: No Satisfactory Explanation at present of East/West Effect].—W. Baade and F. Zwicky. (*Proc. Nat. Acad. Sci.*, May, 1934, Vol. 20, No. 5, pp. 259–263.)

NATURE OF THE HIGH-ENERGY PARTICLES OF PENETRATING RADIATION AND STATUS OF IONISATION AND RADIATION FORMULAE [Evidence that High-Energy Particles have Protonic Mass and that Negative Protons exist].—E. J. Williams. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, pp. 729–730.) *See* also Gamow, under "General Physical Articles."

REPORT ON THE MEASUREMENTS OF COSMIC RADIATION DURING THE ASCENT OF THE BALLOON "DEUTSCHLAND" ON 24TH MARCH, 1933.—G. A. Suckstorff. (*Physik. Zeitschr.*, 1st May, 1934, Vol. 35, No. 9, pp. 368–372.)

Differences from former measurements by Kolhörster (*Physik. Zeitschr.*, 1913, Vol. 14, p. 1153) and observed fluctuations are explained by the assumption of increased atmospheric radiation [and ionisation] at heights of the order of 9 000 m, connected with the presence of attenuating layers in the atmosphere.

THE PRODUCTION OF SHOWERS BY COSMIC RADIATION.—C. W. Gilbert. (*Proc. Roy. Soc.*, 1st May, 1934, Vol. 144, No. A 853, pp. 559–573.)

The writer finds from experiments with triple coincidence counters that the frequency of showers in lead produced by cosmic radiation is proportional to the general cosmic radiation. The energy of the shower particles is greater at 3 500 m than at sea level. A primary radiation, a shower-producing radiation and the shower particles are needed to explain the curves obtained. The nature and properties of these radiations are tabulated.

BAROMETER EFFECT OF SHOWER-PRODUCING AND OF VERTICAL COSMIC RAYS.—E. C. Stevenson and T. H. Johnson. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 758: abstract only.)

COLLISIONS OF NEUTRONS WITH ATOMIC NUCLEI [Possible Application to Cosmic-Ray Bursts].—T. W. Bonner. (*Phys. Review*, 1st May, 1934, Series 2, Vol. 45, No. 9, pp. 601–607.)

IONISATION SPURTS RESULTING FROM COSMIC-RAY ENTITIES.—W. F. G. Swann and W. E. Ramsey. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 758: abstract only.)

A PRECISION RECORDING COSMIC-RAY METER [recording Changes in Cosmic-Rays].—A. H. Compton and others. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 758: abstract only.)

ON THE ORIGIN AND MAINTENANCE OF THE SUN'S ELECTRIC FIELD.—R. Gunn. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 750: abstract only.)

A METHOD DESIGNED FOR OBSERVING THE SOLAR CORONA WITHOUT AN ECLIPSE [Application of Television Scanning and Amplification of Corona Components only].—A. M. Skellett. (*Phys. Review*, 1st May, 1934, Series 2, Vol. 45, No. 9, p. 649.)

PROPERTIES OF CIRCUITS

DOPPELFILTER ("Double-Filters" [a New Type of Filter with Characteristics as Good as Zobel and Bridge Types]).—S. Matsumae and A. Matsumoto. (*E.N.T.*, May, 1934, Vol. 11, No. 5, pp. 172–178.)

The fundamental principle on which this new type is based is that two filters of the same type, one in the T and the other in the Π connection, can have the same cut-off frequencies, the same attenuation and phase characteristics, but reciprocal characteristic-impedance/frequency curves. The characteristic impedance is real in the pass region and imaginary in the attenuating region. If these two filters are connected in parallel or series (Figs. 2a and 2b respectively) to form a "double-filter," the characteristic impedance in the pass region becomes practically independent of frequency. This effect is increased still further if two Zobel "m-type" filters, mutually reciprocal, are employed. Fig. 4 shows a low-pass one-stage "parallel double-filter" of T and Π elements, whose indicial resistance R_o is derived from those of its elements by the "sum of reciprocals" relation: its characteristic impedance Z_p is given by equation 18, and its Z_p/R_o frequency curves by Fig. 5. If the filter is connected as in Fig. 4 between equal resistances R_o, the working attenuation T (in db) and the working phase value a are given by equations 21, and their frequency characteristics by Figs. 6 and 7. The entrance resistance of the filter closed by R_o is given by equation 22, and its frequency curve by Fig. 8. A corresponding "series double-filter" is shown in Fig. 9, together with its Z_s/R_o frequency curve corresponding to Fig. 5 for the "parallel" type: equation 23 shows that Z_s/R_o is the reciprocal of Z_p/R_o (equation 18): working attenuation and phase values are the same as for the "parallel" type (equations 21).

In these equations for the low-pass filter the x is defined by the relation

$$-x^2 = Z_1/4Z_2 = -(f/f_o)^2.$$

For high-pass, band-pass and band-stop filters x^2 again represents $-Z_1/4Z_2$, the three corresponding relations between x^2 and the various frequencies being given by equation 25: the same equations as those derived for the low-pass filter are then obtainable. As an example of multi-stage double-filters of T and Π elements the two-stage filters of Fig. 10 are taken: for the "parallel" type the working attenuation in db is given by equation 26.

The double-filter from the Zobel "derived m-type" circuits is then dealt with. Figs. 11a and b show the "shunt-derived m-type" and "series-derived m-type" elements: although they cannot be considered exactly as complementary T and Π elements, they have the same propagation constant and thus can be combined to form a double-filter (Fig. 12) in which the fundamental equations of the parallel double-filter (10, 11) take the form of equations 27, 28. For a numerical example of such a (low-pass) filter, with a cut-off frequency of 1 593 c/s, the attenuation curve is shown in Fig. 12, while Fig. 13 shows the constancy of characteristic impedance obtainable.

Finally, the paper deals with certain derived modifications. The parallel and series double-filters of Figs. 14a and b are simple generalisations of the two shown in Figs. 4 and 9. By re-arranging, equivalent circuits a′ and b′ are obtained, and by using only half of each of these the circuits a″ and b″ are arrived at, with characteristic impedances given by equations 30, which show the same reciprocal relation as that of equations 18 and 23 (see above). Thus by carrying to a further stage, filters corresponding to the Zobel " MM type " can be obtained.

ÜBER DIE FREIEN SCHWINGUNGEN IN KONDENSATORKREISEN MIT PERIODISCH VERÄNDERLICHER KAPAZITÄT (The Free Oscillations in Condenser Circuits with Periodically Variable Capacity [Theoretical Investigation]).—A. Erdélyi. (*Ann. der Physik*, April, 1934, Series 5, Vol. 19, No. 6, pp. 585–622.)

The frequency of the capacity fluctuations considered in this paper is small compared with the natural frequency of the circuit. The differential equation of the oscillations is a Hill's equation, which is integrated asymptotically to give the frequency of free oscillations in its regions of stability ; the breadth of the regions of instability is calculated. The solution of the equation in the regions of instability is found and an example of the behaviour there is worked out.

It is found that the " mean frequency " of oscillations in the regions of stability is *not* that found by Carson (*Proc. I.R.E.*, 1922, Vol. 10, p. 57) and Emersleben (*Physik. Zeitschr.*, 1921, Vol. 22, p. 393). The amplitude of the oscillations fluctuates, following the capacity fluctuations but with distortion. In the regions of instability there is a " pulling into tune " (ziehen) effect ; the mean frequency of the circuit oscillations adjusts itself exactly to the corresponding harmonic in the capacity fluctuations. The amplitude is even more distorted than in the case of stability.

THE VARIATION OF FREQUENCY OF OSCILLATING CIRCUITS WITH VARIATION OF CAPACITY [and Its Departure from the Calculated Values].—J. Groszkowski and Z. Jelonek. (*Wiadomości i Prace Inst. Radjotech., Warsaw*, No. 4, Vol. 5, 1933, pp. 33–35 : in Polish.)

Theoretical and experimental proof that the frequency variations may differ, even by some tens per cent, from those calculated by the usual formula $\Delta f/f = -\frac{1}{2} . \Delta C/C$.

LONG-PERIOD PULSATION OF THE OSCILLATION CURRENT IN THE PARALLEL RESONANCE CIRCUIT INCLUDING AN IRON-CORE INDUCTANCE [" Beat Phenomenon " as a Relaxation Oscillation].—Y. Watanabe and M. Kamaya. (*Japanese Journ. of Eng., Abstracts*, Vol. 11, 1934, p. 47.)

" TRANSIENTS IN TRANSFORMER-COUPLED AMPLIFIERS : PART II." CORRECTION.—W. Nowotny. (*Archiv f. Elektrot.*, 18th May, 1934, Vol. 28, No. 5, p. 328.) Correction of a printers' error in the paper dealt with in March Abstracts, pp. 147–148.

GOOD SHORT-WAVE CIRCUITS [Receiver, Wavemeter, Suppressed-Carrier Telephony Transmitter, etc.].—H. Schall. (*Radio, B., F. für Alle*, June, 1934, No. 6, pp. 84–86 : part of a series.)

ELECTRICAL EQUIVALENT CIRCUITS OF MECHANICAL TORSIONAL SYSTEMS, TAKING INTO ACCOUNT THE AXLE MASS.—Kettenacker. (*See* under " Miscellaneous.")

TRANSMISSION

EIN EINFACHES MODULATIONSVERFAHREN FÜR SEHR SCHNELLE ELEKTRISCHE SCHWINGUNGEN (A Simple Modulation Method for Micro-Wave Oscillations [using a Glow-Discharge Tube]).—O. Pfetscher and E. Haass. (*Zeitschr. f. tech. Phys.*, No. 6, Vol. 15, 1934, pp. 227–231.)

The satisfactory working of a micro-wave generator, whether of positive-grid or magnetron type, demands stable conditions of voltage, emission current, magnetic field, etc. ; even slight variations of these factors are liable to produce sudden fluctuations of output energy or of wavelength. It is therefore very desirable to find some method of modulation which affects the radio frequencies quite outside the valve itself—as in the Pungs-Gerth " choke " method for long-wave transmitters—by influencing the resistance of some external oscillatory circuit. Moreover, all direct modulation processes introduce frequency modulation, and this can be avoided if the resistance control is not applied to the primary circuit but to a secondary or tertiary circuit connected between generator and aerial.

Since the only known closed oscillatory circuits tunable to these frequencies around 10^9 c/s are of the transmission line form (either Lecher wires or concentric tubes), the problem is to find a suitable method of modulating the ohmic or inductive resistance (or the ohmic or inductive leakage) of such a circuit. After preliminary experiments in which the Lecher wire system was bridged near a potential antinode first by a carbon microphone arrangement and later by a form of condenser microphone, the writers turned to the use of a glow-discharge tube as the modulated shunt. A commercial " Indicator " lamp (June Abstracts, p. 322, Pohle and Straehler) of tubular form, giving a rod-shaped discharge, was de-socketed and provided with two external strip electrodes, the capacity between which was found to increase practically linearly from 1.7 cms to over 3 cms as the glow-discharge current was increased from zero to about 4 mA. It seemed likely that the total capacity change would be too small to provide satisfactory modulation, and a quantitative test was therefore made on the effect of such a device on the resonance curve of a Lecher pair loosely coupled to a magnetron generator. The tube was kept at a definite point and the tuning bridge moved along the wires : Fig. 4 shows four resonance curves, taken with a bolometer at the end of the Lecher pair, for four different values of glow-discharge current. It is obvious that the positions of the resonance points were practically unchanged by the varying glow discharge, but that the resonance peaks were greatly decreased in height as the discharge was increased: *the tube acted as a condenser of varying leakage, affecting the damping of the system, rather than as a detuning capacity.* The greatest action was obtained when the tube was so placed that its internal positive ring electrode was at a potential antinode: Fig. 5 shows how the magnitude of the effect varied with the position of this electrode along the wires, the glow discharge being kept constant.

After this test had shown the practicability of the method, the final modulation system of Fig. 7 was developed. The magnetron generator (20 cm waves) was provided with a secondary circuit consisting of a Lecher pair closed at both ends, coupled by galvanic-inductive coupling to a half-wave dipole, and shunted by the glow-discharge tube with its external electrodes. The modulating signals were amplified so as to control a screen-grid valve whose anode was connected in series with the glow-discharge tube: by means of the screen grid the mean anode current was regulated (independently of the control grid) so as to adjust the working point to the optimum position on the glow-discharge characteristic. Reception tests showed that the modulation was flowless and undistorted, provided the auxiliary d.c. potential across the tube was so adjusted that the discharge never became extinguished during pauses in the modulation. The formation of a secondary, radio-frequency discharge (light blue, as contrasted with the red low-frequency discharge), appearing when the generator energy was sufficiently great, also caused no trouble provided it was kept going continuously, as could always be arranged.

The paper ends by suggesting further development of the system by the use of special tubes, the parallel connection of several tubes, or the substitution of electronic valves (at present, however, sufficiently low-capacity valves are not available: unless, indeed, the plan adopted by Mouromtseff and Noble in their 3-m generator, of introducing the electrodes as distributed capacity in the Lecher pair, is imitated—*see* 1932 Abstracts, p. 636). Finally, it is mentioned that the long feeders so often needed between generator and aerial in micro-wave working should present favourable opportunities for the use of this system of modulation, and that an obvious field of application is the interlocking-signal type of radio-beacon when used on such waves.

MODULATION SYSTEM FOR MAGNETRON MICRO-WAVE OSCILLATORS.—M. Ponte. (Italian Pat. 311 766, pub. 10.10.1933: long summary in *Alta Frequenza*, April, 1934, Vol. 3, No. 2, pp. 233–234.) *See* also 1933 Abstracts, p. 444, r-h column.

SUR LES DOMAINES D'OSCILLATIONS DES TRIODES GÉNÉRATRICES D'ONDES ULTRACOURTES (The Oscillation Regions of Triodes generating Ultra-Short [Micro-] Waves).—E. Pierret. (*Rev. Gén. de l'Élec.*, 9th June, 1934, Vol. 35, No. 23, p. 784: summary only.)

The regions are the B-K (conforming to Barkhausen formula), the G-M (Scheibe formula) and the "higher order" regions (wavelengths shorter than given by either formula). The various regions are closed; their extent is smaller the shorter the wavelength—hence the difficulty of finding some of the "higher order" regions. Inside each region there is a point of maximum intensity. In general, the intensity of oscillation is smaller the higher the order of the region: certain valves which have not been highly exhausted, or whose electrodes give out occluded gas, form exceptions to this rule. Within each region the wavelength varies (except that in the "higher order" regions the wavelength is almost constant except at the ends of the region, where it undergoes a slight change: it is near a sub-multiple of the wavelength calculated by the Scheibe formula for the conditions corresponding to an intensity maximum). The number of regions, and their extent, varies with different valves even of the same type.

ÜBER DAS STIMMGABELGESTEUERTE MAGNETRON (The Magnetron controlled by a Tuning-Fork).—B. Pavlík. (*Physik. Zeitschr.*, 1st June, 1934, Vol. 35, No. 11, pp. 452–453.)

This note gives a magnetron circuit for production of oscillations stabilised by a tuning-fork. Magnetron characteristics are completely analogous to the grid characteristics of triodes, and the theory of control by a tuning fork of oscillations produced by a triode may be extended to explain the action of a magnetron. The only difference is that magnetic control involves energy absorption and an auxiliary valve must be used to lessen the influence of damping on the frequency of the tuning fork.

IMPROVED MAGNETRON OSCILLATOR FOR THE GENERATION OF MICRO-WAVES.—E. G. Linder. (*Phys. Review*, 1st May, 1934, Series 2, Vol. 45, No. 9, p. 656.)

Inclination of the axis of the anode by 3° or 6° with respect to the direction of the magnetic field is known to give maximum output from magnetron oscillators. This letter suggests as an alternative the use of electrostatic methods, *e.g.*, end plates placed near the ends of the cylindrical anode and maintained at a potential such that electrons are drawn towards them. The electron paths are spirals in this case also, and the efficiency is from two to three times greater. "Outputs of about 2.5 watts at a wavelength of 9 cm have been obtained." Statical and dynamical characteristics of a magnetron in this condition are shown.

ON THE ABNORMAL INCREASE OF SPACE CHARGE IN TRIODES [and the Ratio of Grid-Passing Electrons to Total Emission, and Its Effect on Production of B-K and G-M Oscillations]. —K. Okabe. (*Japanese Journ. of Eng., Abstracts*, Vol. 10, 1934, pp. 21–22.)

A MEDIUM-POWER 56-Mc [Ultra-Short-Wave] TRANSCEIVER.—F. Jacobs. (*QST*, June, 1934, Vol. 18, No. 6, pp. 21–22 and 86.)

FLEA POWER IN THE ARCTIC [Improvised 40 m-Band 2 Watt Cigar-Box Transmitter on 210 Volts in Alaska gives R5 in Hawaii, etc.].—P. L. Ennis. (*QST*, June, 1934, Vol. 18, No. 6, pp. 29–30.)

ELECTRON-COUPLED OSCILLATORY CIRCUITS IN TRANSMITTERS WITH SCREEN-GRID VALVES. —W. Möller. (*Radio, B., F. für Alle*, June, 1934, No. 6, pp. 89–92.)

ON THE OSCILLATION AMPLITUDE OF VACUUM-TUBE OSCILLATORS—A NEW METHOD OF AMPLITUDE DETERMINATION FOR THE OSCILLATION IN THE SO-CALLED "NEGATIVE RESISTANCE" CIRCUIT [using an Alignment Chart].—K. Morita. (*Japanese Journ. of Eng., Abstracts*, Vol. 10, 1934, p. 20.)

ON THE OSCILLATION AMPLITUDE OF VACUUM-TUBE OSCILLATORS—THE SO-CALLED "RELAXATION OSCILLATION."—K. Morita. (*Ibid.*, p. 20.)

THE BEHAVIOUR OF THE SELF-EXCITING OSCILLATOR MODULATED IN ITS GRID CIRCUIT [Pliodynatron and Meissner Circuits].—J. Groszkowski and Z. Jelonek. (*Wiamodości i Prace Inst. Radjotech., Warsaw*, No. 6, Vol. 5, 1933, pp. 62–66: in Polish.)

Authors' summary:—When the oscillation amplitude in an oscillator is varied, the inertia of the circuit, given by $L/2R$, opposes the variation. In a self-exciting oscillator there is, besides the real positive resistance of the oscillatory circuit, a negative resistance introduced by the valve. Being connected in parallel with the oscillatory circuit it suppresses the positive resistance of the latter in such a way that the total resistance is equal to zero. When the factor varying the oscillation amplitude is introduced, this resistance becomes positive or negative, but remains always near to zero. It is for this reason that the inertia of the system, during modulation, is high, and exerts a distinct effect on the result of the modulation.

In the present work, the pliodynatron circuit, grid modulated, is analysed. It is found that the working of the system differs from the static characteristic the less, (1) the smaller the degree of modulation, (2) the lower the modulation frequency, (3) the smaller the circuit capacity, and (4) the further the régime is from the critical point. The frequency of oscillation has no direct influence here. The grid-modulated Meissner circuit, corresponding in several respects to the above system, is also examined. Fig. 6 shows oscillograms of the modulation, while Fig. 7 gives the comparison of the dynamic characteristics with the static characteristic. The agreement between the analysis and the experimental results is evident.

CONSTANT-FREQUENCY OSCILLATORS: THE BINODE AS DYNATRON WITH AUTOMATIC REGULATION.—J. Groszkowski. (*Wiadomości i Prace Inst. Radjotech., Warsaw*, No. 6, Vol. 5, 1933, p. 61: in Polish.) *See* April Abstracts, p. 205, l-h column.

DESCRIPTION OF THE QUARTZ CONTROL OF A TRANSMITTER AT 1 785 KILOCYCLES PER SECOND [for N.P.L. Standard Frequency Transmissions: Short-Period Stability of 1 in 10^7 and Day-to-Day Stability of 1 in 10^6].—L. Essen. (*Journ. I.E.E.*, June, 1934, Vol. 74, No. 450, pp. 595–597.)

LOW-COST CRYSTAL CONTROL FOR HIGH POWER: APPLYING THE CRYSTAL-LOCK SYSTEM IN A 250-WATT OUTFIT.—D. J. Tucker. (*QST*, June, 1934, Vol. 18, No. 6, pp. 19–20 and 78.)

PRACTICAL TRANSMITTING CIRCUITS FOR SUPPRESSOR-TYPE SCREEN-GRID TUBES.—J. J. Lamb. (*QST*, June, 1934, Vol. 18, No. 6, pp. 14–16 and 72.)

SIMPLIFYING SPLIT-STATOR FINAL AMPLIFIERS.—B. Goodman. (*QST*, June, 1934, Vol. 18, No. 6, pp. 39–40.)

A STUDY OF MODULATION IN WIRELESS TELEPHONY [and the Appearance of Frequency Modulation].—S. Chiba and S. Hasebe. (*Japanese Journ. of Eng., Abstracts*, Vol. 11, 1934, p. 39.)

THE DEGREE OF AMPLITUDE MODULATION: SOME NOTES ON PRACTICAL MEASUREMENT [and Discussion of Definition of Percentage of Modulation and the Inadequacy of any "Effective" Method of Measurement: Review of Existing Methods: a Direct-Reading Modulation-Meter and a "Ripple-Meter."]—L. F. Gaudernack. (*Wireless Engineer*, June, 1934, Vol. 11, No. 129, pp. 293–301: to be concluded.)

A DIRECT-READING THERMAL MODULATION METER [Stable and Portable].—F. R. W. Strafford. (*Ibid.*, pp. 302–304.)

HIGH-FIDELITY BROADCAST TRANSMITTER PERFORMANCE.—E. A. Laport. (*Electronics*, May, 1934, pp. 144–145.)

BROADCAST TRANSMISSION PROGRESS AT CBS [Columbia Broadcasting System: M.C. and Velocity Microphones: Directional Aerials: etc.].—A. B. Chamberlain. (*Electronics*, May, 1934, pp. 138–140.)

PROGETTO DI MASSIMA DEGLI AMPLIFICATORI DI POTENZA PER TRASMETTITORI RADIOTELEGRAFICI (Design Considerations for Power Amplifiers for Radiotelegraph Transmitters).—V. Gori. (*Alta Frequenza*, April, 1934, Vol. 3, No. 2, pp. 149–167.)

After general considerations of modern technique, the writer shows how to evaluate, for a given power in a given aerial, the power of the amplifier stages and the elements of the associated circuits, the working characteristics of the amplifiers, and the successive ratios of the amplifications of the various stages. The method is illustrated by reference to a transmitter of 50 kw aerial power built by the Società Italo Radio.

RECEPTION

INTERACTION OF RADIO WAVES: RADIO TUNING MAY BE INSUFFICIENT TO PREVENT INTERFERENCE IF BROADCASTING POWERS INCREASE.—van der Pol. (*Science*, 8th June, 1934, Vol. 79, No. 2058, Supp. p. 11.)

EXPERIMENTS ON THE ELIMINATION OF INTERFERENCE BY SCREENED AERIAL LEADS, COMPENSATING AERIALS, ETC.—T. Sturm. (*Alta Frequenza*, April, 1934, Vol. 3, No. 2, pp. 198–201: summary only.)

DER RUNDFUNK-ENSTÖRUNGSVERSUCH IN BADEN-BADEN (The Campaign against Broadcast Interference in Baden-Baden).—Eppen and Sontag. (*E.T.Z.*, 24th May, 1934, Vol. 55, No. 21, pp. 509–512.)

To obtain the bases for a suitable law, a large-scale attempt was made in Baden-Baden to free the whole town from interference. Considering that no compulsory powers were used, the attempt may be considered to have succeeded, since more than 80% of the appliances traced as interfering, both household and commercial, were silenced by the addition of anti-interference devices. A table gives the numbers of the various types of interference-producing appliances ascertained (by means of a special census) to be in use in the town, together with the number actually silenced and the approximate cost of silencing. These costs varied from 3.35 RM, for such things as sewing-machine motors, to about 30 RM or more for hair-cutting machines and motors over ½ kw (these latter, together with electric ovens, forming the most numerous classes next to the vacuum cleaners, of which 1 284 were silenced). Hire-purchase complications in the case of vacuum cleaners were overcome by the co-operation of the chief firm producing these.

The experiment showed that in the vast majority of cases the use of condensers alone was sufficient. 7 727 condensers of various sizes were employed, but only 300 other devices such as chokes or condenser/choke combinations.

DIE BESCHALTUNG GEERDETER WECHSELSTROMMOTOREN ZUR RUNDFUNKENSTÖRUNG (The Treatment of Earthed A.C. Motors for the Prevention of Interference with Broadcast Reception).—(*Siemens-Zeitschr.*, No. 2, Vol. 14, 1934, pp. 67–70.)

MINISTERIAL DECREE OF 20TH APRIL, 1934, FIXING THE CHARACTERISTICS OF INTERFERENCE-INVESTIGATING EQUIPMENT AND THE METHODS OF TESTING IT.—(*Rev. Gén. de l'Élec.*, 2nd June, 1934, Vol. 35, No. 22, p. 768.)

EFFECT OF SPARK SUPPRESSORS ON AUTO PERFORMANCE [Negative Results of Series of Accurate Quantitative Tests].—A. L. Albert. (*Electronics*, May, 1934, p. 158.) For previous communications on the subject *see* May Abstracts, p. 268, r-h column.

RADIO-INFLUENCE INSULATOR CHARACTERISTICS [and the Prevention of Interference-Producing Arcs on H.T. Power Lines: Copper-Oxide Glaze, etc.].—G. I. Gilchrest. (*Elec. Engineering*, June, 1934, Vol. 53, No. 6, pp. 899–903.) *See* also Barrow, Abstracts, 1933, p. 325; Herweg and Ulbricht, 1932, p. 166; and McMillan, 1932, p. 224.

A NEW PORCELAIN POST INSULATOR [free from Radio Interference Action].—G. W. Lapp. (*Ibid.*, pp. 922–925.)

HIGH-VOLTAGE INSULATORS [and Their Testing, including for Radio Interference Characteristics].—W. A. Smith and J. T. Lusignan, Jr. (*Ibid.*, pp. 969–973.)

ELIMINATION OF MAINS NOISES BY USE OF SCREEN-GRID VALVE WITH ADJUSTABLE TAPPING FROM ANODE-SUPPLY SERIES RESISTANCE TO SCREEN GRID, THROUGH PHASE-ADJUSTING CONDENSER.—Radiohaus Horny. (Austrian Pat. 133 739: *Funktech. Monatshefte*, April, 1934, No. 4, p. 168.)

BAND-PASS FILTERS OF ECONOMICAL DESIGN.—H. F. Dalpayrat. (American Pat. 1 897 633: *Funktech. Monatshefte*, April, 1934, No. 4, p. 166.)

"An important disadvantage of the much-employed band-pass filter is the great expenditure of tuning elements involved. The diagrams show two arrangements each requiring only a single variable condenser. The coil of the receiving circuit 2, 3 [3 is the variable condenser] is prolonged at one or both ends by a small amount 4 (and 4'). The far ends of these extensions are connected to each other through a small fixed condenser 5. If the circuit 2, 3 is tuned to the signal wave, the circuit 2, 4, 4', 5, in whose tuning the condenser 3 takes part, shows tuning to a neighbouring wavelength. In this way a band-pass filter action is obtained on all the received wavelengths. Fig. 3 shows a circuit with *three* component circuits 2, 3 and 2, 4, 5 and 2, 4', 5'."

SINGLE-KNOB TUNING OF MULTI-STAGE R.F. AMPLIFIERS, USING CIRCUIT WITH ONLY ONE VARIABLE CONDENSER.—J. F. Lindberg. (American Pat. 1 898 635: *Funktech. Monatshefte*, April, 1934, No. 4, p. 168.)

HIGHLY SELECTIVE RECEIVERS: SHORTENING THE DECAY TIME BY PERIODIC PHASE REVERSAL.—J. Robinson. (Swiss Pat. 153 333: *Funktech. Monatshefte*, May, 1934, No. 5, p. 214.)

CRYSTAL-CONTROLLED RECEIVERS: THE BAND-FILTER ACTION OF A CRYSTAL WITH SLANTING SURFACE.—Guerbilsky and Ménard. (French Pat. 748 910: *Funktech. Monatshefte*, May, 1934, No. 5, p. 216.) *See* also 1933 Abstracts, pp. 508 and 580.

A SIMPLE TWO-VALVE RECEIVER USING AN IMPROVED BAND-SPREAD SYSTEM [1 450 to 41 000 kc/s with Complete Band-Spread over 5 Amateur Bands].—G. Grammer. (*QST*, June, 1934, Vol. 18, No. 6, pp. 9–13 and 82.)

RECEPTION OF SIGNALS WHOSE CARRIER FREQUENCY FLUCTUATES [by Heterodyning with Local Oscillations of Higher and Lower Frequencies and Combining and Rectifying the Two Beat Frequencies: for Telegraphy or Telephony].—Purrington: Hays Hammond. (American Pat. 1 876 746: *Funktech. Monatshefte*, April, 1934, No. 4, p. 166.)

DETECTION BY VALVES: SURVEY OF METHODS AND THEIR USE IN MODERN RECEIVERS.—K. Lewinski. (*Wiadomości i Prace Inst. Radjotech., Warsaw*, No. 4, Vol. 5, 1933, pp. 43–46: in Polish.)

IMPROVEMENT OF THE AUDION [Leaky-Grid Detector] BRINGS GREATER POWER TO THE RECEIVER.—E. Wölfel. (*Die Sendung*, 8th June, 1934, Vol. 11, No. 24, pp. 470–471.)

On the Design Procedure for the Ampli-Filter as a Detector, *and* On the Ampli-Filter.—H. Nukiyama and Z. Kamayachi. (*Japanese Journ. of Eng., Abstracts*, Vol. 11, 1934, pp. 39 and 47.) *See* also under "Acoustics and Audio-Frequencies"—two.

Two-Valve Detector Circuit with Grids in Push-Pull and Anodes in Parallel: Compensation for Anode Retroaction.—L. M. Ericsson Company. (German Pat. 585 809: *Funktech. Monatshefte*, April, 1934, No. 4, p. 168.)

Valve-less Receiving Detectors [the Use of Contact Rectifiers as Detectors: Advantages and Home Construction: Half- and Full-Wave Circuits].—K. Nentwig. (*Radio, B., F. für Alle*, June, 1934, No. 6, pp. 81–84.) Prompted by the exhibits at the 1933 "Radiolympia."

Detection of Damped Hertzian Waves by a Dry Cell with Solid Radioactive Electrolyte and Ionised Air.—L. Bouchet. (*Comptes Rendus*, 4th June, 1934, Vol. 198, pp. 1982–1983.) Experiments on the action of the writer's cell referred to in April Abstracts, p. 222, l-h column.

Acoustics and High Fidelity.—Massa. (*See* under "Acoustics and Audio-frequencies.")

Keep Faith with "High Fidelity" [and the RMA Engineering Division's Tentative Definition].—(*Electronics*, May, 1934, p. 135.)

"A receiver rated as a high-fidelity receiver must have an audio frequency range of at least 50 to 7 500 c/s, with total variations in acoustical output not exceeding 10 db and with at least 10 w of electrical power output, with total distortion not exceeding 5%."

Super-Regeneration Receiver for Short and Ultra-Short Waves [Single Three-Grid Valve Circuit].—R. Elsner. (German Pat. 585 673: *Funktech. Monatshefte*, April, 1934, No. 4, pp. 167–168.)

First Iron-Core-Coil Receiver Stromberg-Carlson Model 68 [and the Advantages of Universal-Wound Coils on Tubular Iron Cores for Inductances or Transformers: Adjustment of Coupling: Use at Intermediate Frequencies: etc.]—(*Electronics*, May, 1934, pp. 158–159.)

"The new . . . all-wave receiver is the first commercial set to use iron-core i.f. transformers. This receiver employs an i.f. of 370 kc/s, and the iron-core coils have a Q of about 175 at this frequency, which is substantially higher than that of commonly-used types of air-core coils. . . . Electrostatic coupling at the low-potential ends of the coils is used."

The Battery Single-Span Receiver.—W. T. Cocking. (*Wireless World*, 1st and 8th June, 1934, Vol. 34, pp. 370–373 and 388–392.) A battery-operated model of the receiver dealt with in June Abstracts, p. 322.

The Midget Superheterodyne.—J. H. O. Harries. (*Wireless World*, 25th May, 1934, Vol. 34, pp. 356–358.)

Same Variable Resistance used as Radio Tone Control and as Volume Control for Gramophone Reproduction.—L. Neumann. (Austrian Pat. 132 867: *Funktech. Monatshefte*, April, 1934, No. 4, p. 167.)

Wurlitzer Channel Control System [on 13-Valve Superheterodyne].—(*Rad. Engineering*, May, 1934, Vol. 14, No. 5, pp. 20–21.)

"The automatic gain control circuits function to maintain a constant voltage across the plate load of the second i.f. If this voltage is made up of only the i.f. signal, a certain voltage will be transferred to the grid of tube C [channel control tube]. If, however, this voltage is made up of equal parts of signal and noise, and is the same value as in the first case, only half as much voltage will be impressed on the grid of tube C. If this voltage is comprised wholly of noise, the automatic gain control circuits function to maintain this voltage at almost the same value as though it were at i.f., but the channel control coupling circuit transfers none of this voltage to the grid of tube C, and the audio channel remains quiet."

Automatic Gain Control with Diode Detection using the Type B7 [Diode-Pentode] Tube as a Combined I.F. Stage and Second Detector in the Short-Wave Superhet.—W. M. Smith. (*QST*, June, 1934, Vol. 18, No. 6, pp. 23–28 and 74, 76.)

Automatic Volume Control without Loss of Maximum Sensitivity [English and American Methods with Two Diodes, One with Negatively Biased Anode: the Writer's Method using Binode with Negative Bias on Anode of Its Diode System, or (for Battery-Driven Receivers) Two Directly-Heated Triodes].—H. Pitsch. (*Funktech. Monatshefte*, May, 1934, No. 5, pp. 182–183.)

New System of Automatic Volume Control.—(*Wireless World*, 4th and 11th May, 1934, Vol. 34, pp. 307–308 and 328–329.)

A system of delayed AVC is described in which the difficulties of the various "delayed" methods is overcome by the use of an additional valve operating as an anode-bend detector.

Methods of Automatic Volume Control.—Wired Radio Corporation. (Amer. Pats. 1 884 681 and 1 896 171, Hentschel and Olson: *Funktech. Monatshefte*, May, 1934, No. 5, pp. 215 and 214.)

Experiments on Short-Wave Fading [and Its Reduction by Successive Connection of Single Receiver to Three Simple Aerials of Different Receiving Characteristics].—D. Hiraga. (*Japanese Journ. of Eng., Abstracts*, Vol. 10, 1934, p. 37.)

An Electrolytic Fading Compensator [Loud-speaker Input passed through Transformer: Secondary Current passed through Dry-Plate Rectifier and M.C. Movement with Pointer dipping in Liquid "Frittöl" Resistance shunting Aerial to Earth].—W. Goy and Company. (*E.T.Z.*, 24th May, 1934, Vol. 55, No. 21, p. 520: summary only.)

The device is said to have the advantage of being easily applied to any multi-valve set, and it is claimed that in spite of the hitherto rejected l.f./r.f. method of control it introduces no appreciable distortion (provided the receiver is fairly well screened and reasonably selective): further, that owing to the aperiodic coupling to the aerial the noise level falls linearly with the signal energy.

INTERPHONE SYSTEM USING ELECTRIC LIGHT WIRING, AND THE BLATTERMAN SYSTEM OF REMOTE TUNING AND VOLUME CONTROL OF SUPERHETERODYNE RECEIVER BY MOBILE OSCILLATOR TRANSMITTING TO ELECTRIC LIGHT WIRING.—(*Electronics*, May, 1934, p. 159.)

SIMULTANEOUS USE OF VARIOMETER AS TUNING INDUCTANCE AND COUPLING ELEMENT: SPLIT WINDING GIVING GREATEST INDUCTANCE AT SAME TIME AS GREATER COUPLING COEFFICIENT.—Siemens & Halske. (Austrian Pat. 129 941: *Funktech. Monatshefte*, April, 1934, No. 4, p. 165.)

THE EFFECT OF C-ELIMINATOR ON THE FREQUENCY CHARACTERISTIC OF AN AUDIO-FREQUENCY AMPLIFIER.—H. Wada. (*Japanese Journ. of Eng., Abstracts*, Vol. 11, 1934, p. 40.)

THE CORRECT PRESENTATION OF RECEIVING CIRCUITS [Method reducing Number of Intersecting Lines: to be adopted by German Journal].—F. W. Gundlach. (*Electronics*, April, 1934, p. 127.) Summary of paper referred to in May Abstracts, p. 284, l-h column.

AERIALS AND AERIAL SYSTEMS

AN INVESTIGATION INTO THE FACTORS CONTROLLING THE ECONOMIC DESIGN OF BEAM ARRAYS [relating to Angle of Elevation of Main Lobe, Structures to support the Array, and Feeders and Transmission Lines].—T. Walmsley. (*Journ. I.E.E.*, June, 1934, Vol. 74, No. 450, pp. 543–574: Discussion pp. 574–581.)

MEASUREMENT OF THE ATTENUATION CONSTANT OF RADIO-FREQUENCY FEEDER LINES.—H. Iinuma. (*Japanese Journ. of Eng., Abstracts*, Vol. 11, 1934, p. 42.)

THE EFFECTIVE HEIGHT OF A BROADCAST RECEIVING AERIAL [and Its Dependence on Ratio of Capacities of Horizontal and Vertical Portions].—W. Kautter. (*Funktech. Monatshefte*, May, 1934, No. 5, pp. 196–197.)

"The aerial constant which determines the aerial e.m.f. [between aerial terminal and earth, in the un-loaded condition] for a given strength of field [in mv/m] is called the effective height." For the aerials in question, which are always small compared with a quarter-wavelength, the writer finds $h_{eff} = l.(\frac{1}{2} + C_2/C_1)/(1 + C_2/C_1)$, where C_1 and C_2 are the capacities of the vertical and horizontal parts respectively. Thus for a simple vertical aerial where C_2 is zero, $h_{eff} = l/2$, while for an infinitely large top capacity $h_{eff} = l$. If the two capacities are equal, the effective height is 75% of the attainable maximum. With screened aerials the horizontal part is in many cases dispensed with, for reasons discussed in a previous paper (January Abstracts, p. 39). Such a horizontal part may, however, have a good effect in increasing the aerial e.m.f. although contributing nothing by direct reception: it merely improves the capacitive potential-distribution between the various points of the vertical part and the earth.

The writer points out that the formula is for a uniform field and that with aerials in towns the effective height is smaller, owing to the greatly diminished field strengths at the lower parts of the aerial, due to the screening by house walls.

SOME NOTES ON THE INFLUENCE OF STRAY CAPACITANCE [due to Insulators, Tuning Elements, etc.] UPON THE ACCURACY OF ANTENNA RESISTANCE MEASUREMENTS.—E. A. Laport. (*Proc. Inst. Rad. Eng.*, May, 1934, Vol. 22, No. 5, pp. 657–669.)

The analysis shows that stray capacitance at the base of a capacitive aerial decreases the apparent resistance, while with an inductive aerial it increases it. The precautions to be taken to reduce errors in aerial measurements are discussed, and a reasonably accurate method, applicable when unavoidable stray capacitance exists at the base of the aerial, is described. In this, a series of resistance measurements is made, known steps of capacitance being added in parallel with the unknown stray capacitance. A curve is thus obtained which becomes asymptotic with the true aerial resistance as the stray capacitance approaches zero: semilogarithmic co-ordinate paper is best for the purpose. "This method may also be useful in measuring the resistance of coils with distributed capacitance."

THEORIES OF TRANSMISSION LINES AND MATCHING CIRCUITS FOR SHORT-WAVE ANTENNAS.—Y. Kato. (*Japanese Journ. of Eng., Abstracts*, Vol. 11, 1934, p. 37.)

A GENERAL DERIVATION OF THE FORMULA FOR THE DIFFRACTION BY A PERFECT GRATING [Theoretical Investigation of Possibility of Systematic Deviations from Simple Formula for Diffraction by Perfect Grating].—C. Eckart. (*Phys. Review*, 1st July, 1933, Series 2, Vol. 44, No. 1, pp. 12–14.) This paper is quoted by Kikuchi in his work on "Multi-Hertzian" oscillators dealt with in July Abstracts, p. 383.

WEBC's WOOD-STEEL TOWER [Total Height 357 ft: Steel Lattice Radiator on 125-ft Wooden Pedestal: Increased Signal Strength reported].—(*Electronics*, April, 1934, p. 123.)

THE IMPREGNATION OF WOODEN MASTS.—Scheidegger & Company. (*Bull. Assoc. suisse des Élec.*, No. 13, Vol. 25, 1934, pp. 347–348.)

AN INVESTIGATION ON EARTHING RESISTANCES [Theoretical and Experimental Investigation of Buried Earths for Protective Purposes].—N. Kimura. (*Japanese Journ. of Eng., Abstracts*, Vol. 11, 1934, p. 40.)

VALVES AND THERMIONICS

IMPROVED MAGNETRON OSCILLATOR [using Electrostatic Methods] FOR THE GENERATION OF MICRO-WAVES.—Linder. (*See* under "Transmission.")

TUBE CLASSIFICATION CHART: CHARACTERISTICS OF 1934 TUBES [Application of the Gundlach/Zilitinkewitsch Diagram, including Barkhausen "Figure of Merit," to American Valves].—H. R. Mimno: Gundlach. (*Electronics*, May, 1934, pp. 158 and 151.) For papers on this type of diagram *see* 1933 Abstracts, p. 161.

TELEFUNKEN/VALVO AGREEMENT ON VALVE DESIGNATIONS FOR FUTURE TYPES.—(*Funktech. Monatshefte*, May, 1934, No. 5, p. 210.)

CONVERTING PENTODE CHARACTERISTICS [to apply to Other Operating Conditions: with Curves].—(*Rad. Engineering*, May, 1934, Vol. 14, No. 5, p. 20.)

ON THE AMPLIFICATION CONSTANT OF MULTI-ELECTRODE VACUUM TUBES.—S. Koizumi. (*Japanese Journ. of Eng., Abstracts*, Vol. 10, 1934, p. 18.)

THE MEASUREMENT OF THE GRID/ANODE CAPACITANCE OF SCREEN-GRID VALVES.—Iorwerth Jones. (*See* under "Measurements and Standards.")

SOME CHARACTERISTICS OF TWO FOUR-ELECTRODE VACUUM TUBES COUPLED DIRECTLY WITH EACH OTHER, AND THEIR APPLICATIONS.—T. Amishima. (*Japanese Journ. of Eng., Abstracts*, Vol. 11, 1934, p. 40.)

See also 1932 Abstracts, p. 409, r-h column. Three-, four-, and five-electrode valves were used, with the plate of the first valve connected directly to the filament of the second, the high tension being applied between the filament of the first and the screen grid of the second.

MULTIPLE VALVES WITH PUSH-PULL SYSTEMS: NEUTRALISATION OF CAPACITIES BY AUXILIARY ELECTRODES NEAR THE ANODES, CONNECTED TO GRIDS OF THE OTHER SYSTEM.—M. von Ardenne and W. Stoff. (German Pat. 586 433: *Funktech. Monatshefte*, April, 1934, No. 4, p. 167.)

LOW-NOISE AMPLIFIERS [Tests on Western Electric Low-Noise Valves].—G. L. Pearson. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 740: abstract only.)

AUTOMATIC GAIN CONTROL WITH DIODE DETECTION: THE TYPE B 7 DIODE-PENTODES.—Smith. (*See* reference under "Reception.")

TUBE METAL CHARACTERISTICS [Svea Metal: Oxidation and Carbonisation; the Enormous Difference from Swedish Iron].—H. C. Todd. (*Rad. Engineering*, May, 1934, Vol. 14, No. 5, pp. 9 and 19.) For previous papers *see* Abstracts, 1933, p. 102, and February, p. 95.

CATECHISM ON IRON FOR RADIO TUBES [Svea Metal *versus* Various Alloys].—Weiller. (*Electronics*, April, 1934, pp. 124–125.)

THE AMPLIFICATION OF OSCILLATIONS OF MORE THAN 2 Mc/s FREQUENCY: PREVENTION OF DIELECTRIC LOSSES IN CATHODE EMITTING LAYER BY AUXILIARY POSITIVE GRID.—Telefunken. (German Pat. 581 342: *Funktech. Monatshefte*, May, 1934, No. 5, p. 215.)

THORIATED TUNGSTEN FILAMENTS [Diffusion Coefficients of Th through W Crystals, along Grain Boundaries and over Filament Surface].—I. Langmuir. (*Journ. Franklin Inst.*, May, 1934, Vol. 217, No. 5, pp. 543–569.)

This paper opens with a discussion of work already published on the subject of the electron emission from tungsten filaments containing approximately one per cent. of ThO_2. Particular reference is made to a paper by Brattain and Becker (1933 Abstracts, p. 330). The data obtained by the writer from numerous experiments in 1921–1923 are then recalculated, using a new relation (agreeing with Brattain and Becker's measurements) between ν_e, the rate of evaporation of electrons from a thoriated tungsten filament at temperature T, and θ, the fraction of the surface covered by thorium atoms. Data on ν_a (atom evaporation rate) are thus found in terms of T and θ, and agree with values of ν_a calculated from ν_e.

"The diffusion coefficients of Th through tungsten crystals, along grain boundaries and over the free filament surface, are calculated. A theory is given for the cause of the variation in the surface diffusion coefficient with σ [the number of thorium atoms per cc.]. The probable mechanism of the production of the metallic thorium within the filament is discussed. At 2 400° [K] the thorium which arrives at the surface along grain boundaries, for some unknown reason, does not spread out over the surface as it does at lower temperatures (1 900–2 100°)."

THE EFFECT OF TEMPERATURE ON ELECTRON FIELD CURRENTS FROM THORIATED TUNGSTEN.—A. J. Ahearn. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, pp. 764–765: abstract only.)

The measurements were similar to those already made on clean surfaces (February Abstracts, p. 95). Different amounts of thorium on the surface were used. "The observed currents at high fields (from 4×10^5 to 9×10^5 volts/cm) were independent of temperature to about 5% from 300°K to about 1 100°K, when the thermionic activity was only slightly greater than that for clean tungsten. When the thermionic activity was increased to approximately that of fully thoriated tungsten this independence of measured current extended only to about 900°K. Above these temperatures current values obtained by subtracting the room temperature current from those at higher temperatures satisfied the Richardson thermionic emission law as well as direct measurements thereof. All the data have now shown that there is no evidence of any temperature effect on field currents from clean molybdenum and tungsten surfaces and from tungsten contaminated with thorium. The measurements are consistent with the assumption that the field currents are constant and independent of temperature and that the thermionic emission accounts for all of the observed variations with temperature."

Electron Emission from Thoriated Tungsten [as Function of Temperature and Electric Field].—W. B. Nottingham. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 765: abstract only).

The surface coverage varied from zero to approximately a single layer. The principal results were: "(1) High velocity electrons have a Maxwellian distribution; (2) a selective transmission at the surface barrier results in a deficiency in the number of electrons with energy less than 0.5 volt; (3) the transmission properties of the surface are independent of the amount of thorium on the surface. This effect with pure tungsten has escaped detection since it is clearly observable only at temperatures less than 1 400°K. (4) Unless the partial pressure of gas which may react with the filament is less than approximately 10^{-14} mm, a double-layer composite surface is formed which has a lower work function and a lower transmission efficiency for low-velocity electrons (1933 Abstracts, p. 47). (5) The observed lack of 'saturation' for *partially* activated surfaces results from surface fields set up between covered and non-covered areas. At 1 160°K the enlargement of patches due to thorium migration is observable, thus indicating that the long-range forces between thorium atoms are repulsive while the short-range forces are attractive."

Thermionic Work Function of Thoriated Tungsten at Zero Field.—N. B. Reynolds and W. B. Nottingham. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 765: abstract only.)

The Atomic Work Function of Tungsten for Potassium.—R. C. Evans. (*Proc. Roy. Soc.*, 2nd June, 1934, Vol. 145, No. A 854, pp. 135–144.)

A paper on the rate of evaporation of positive *ions* of the alkali metals from a hot tungsten surface (1933 Abstracts, p. 330) was the predecessor of this paper, which deals with the evaporation of potassium *atoms* and finds that the atomic work function has the valne 2.80 electron volts.

The Apparent Thermionic Constant A of Clean Metals.—A. L. Reimann. (*Nature*, 2nd June, 1934, Vol. 133, p. 833.)

The apparent thermionic A (the A derived from a Richardson line) of some clean metals is less than A_0, the upper theoretical limit for this quantity. There will be a difference if the work function χ varies with temperature. It is found that, if C is the product of the inner potential and the electronic charge, the experimental data on the amount by which A falls short of A_0 may be accounted for "by assuming that C is sufficiently nearly constant for the temperature variation of χ to be determined in direction and order of magnitude by that of n alone," where n is the number of effectively free electrons per unit volume of the metal.

The Thermionic Work Function and the Slope and Intercept of Richardson Plots [of the Relation between Electron Emission Current and Absolute Temperature].—J. A. Becker and W. H. Brattain. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, pp. 694–705.)

From the authors' summary:—"This article is a critical correlation of the slope and intercept of experimental Richardson lines with the quantities appearing in *theoretical* equations based on thermodynamic and statistical reasoning [Fermi-Dirac distribution of electron velocities in the metal]. . . . From experimental and theoretical arguments it is deduced that the reflection coefficient is probably negligibly small. Hence we conclude that *for most surfaces the work function varies with the temperature*. . . . The data from photoelectric and Volta potential measurements support the conclusion that the work function depends on temperature."

Some Observations on the Radiation Characteristics of Oxide Cathodes [Oxide Layers of Various Thicknesses: Linear Relation between Radiance and Coating Thickness: Radiance from Folded or Slotted Surfaces].—W. T. Mills and E. F. Lowry. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 764: abstract only.)

The Emission of Electricity from Columbium [Values of Electron and Positive Ion Work Functions].—H. B. Wahlin and L. O. Sordahl. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 764: abstract only.)

The Effect of a Current through the Emitter upon the Energy Distribution of Field Current Electrons.—J. E. Henderson and R. K. Dahlstrom. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 764: abstract only.)

Molecular Ions from Heated Salts of Some of the Alkali Metals.—L. L. Barnes. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 751: abstract only.)

DIRECTIONAL WIRELESS

Ein Impulsanzeige-Verfahren für Funkbaken (An Impulse-Indicating Method for Radio Beacons [for Simultaneous Visual and Aural Indication of Equi-Signal Beacons: Superiority of Dot-Dash over A-N Signals]).—E. Kramar. (*E.N.T.*, April, 1934, Vol. 11, No. 4, pp. 152–154.)

Various visual methods described in a previous paper (Abstracts, 1932, pp. 642–643) are unsuitable for simultaneous aural reception on account of the quick alternation of the interlocking signals. The dot-dash signals "have been found by long series of tests to be superior to the usual interlocking A-N signals provided the dot/dash time ratio is at least 1 : 8 (contrary to the usual Morse rhythm) and the dash lasts about 1 second. This type of signalling is clear, and easily distinguished by the untrained ear": moreover, if the dots are associated with the short word "port" ("backbord") and the dashes with the longer word "starboard" ("steuerbord") this forms a valuable aid to the memory.

In order to obtain an arrangement giving a deflection to one side for a dot and to the other for a dash, the signals are first rectified and then passed to a transformer, on the secondary side of which only the start and stop processes are in evidence (Fig. 1c, where the left-hand trace shows the dot and the right-hand the dash). Thus an ordinary d.c. instrument in this circuit would deflect to the left at the beginning of a dot and to the right at its finish, while at the end of a dash it would deflect to the right and at the start of a new dash (after a dot interval) to the left. Now if the d.c. meter is modified in such a way that it is strongly damped and that its sensitivity decreases with increasing angle of deflection, it will respond to the first impulse and hardly at all to the quickly following reverse impulse. A dot, therefore, will produce a deflection to the left and a dash a deflection to the right. By suitably biasing the rectifier valve, and by the use of a high-ratio transformer, a high sensitivity is obtainable, so that the visual indicator gives a beam-breadth equal to that given by aural reception. The necessary damping is obtained by an ordinary method, and the required sensitivity curve by a special design of the magnet pole-pieces.

A Glow-Discharge-Tube Method of Modulating Interlocking-Signal Radio Beacons on Ultra-Short Waves.—Pfetscher and Haass. (*See* end of abstract under "Transmission.")

The Antenna Effect: a Simple Method for its Elimination [The Use of an Electrostatic Screen between Aerial Winding and Secondary connected to Input Grid, instead of Usual Transformers].—S. R. Khastgir and D. Chowdhuri. (*Indian Journ. of Phys.*, No. 3, Vol. 8, 1933, pp. 189–195.)

The Compensation of [German] Naval Radiogoniometers.—(*Alta Frequenza*, April, 1934, Vol. 3, No. 2, pp. 207–208: summary of German article.)

ACOUSTICS AND AUDIO-FREQUENCIES

Über die Güte von Sprachübertragungen mit besonderer Berücksichtigung des Gemeinschaftsempfangs (The Quality of Speech Transmission, with Special Attention to Public Address Working).—H. J. von Braunmühl. (*Funktech. Monatshefte*, May, 1934, No. 5, pp. 171–174.)

Based partly on Knudsen's work. Syllable-intelligibility tests have shown that under the best conditions the attainable optimum is 96%; a value of 85% is very good, 75% is adequate but requires attentive listeners, 65% is just practical but very exhausting, while under 65% is inadequate. The writer examines in detail the various influences affecting the results, as regards a broadcast transmission with loudspeaker reception. The intelligibility V is given by $V = 0.96 . k_s . k_e$, where k_s and k_e are the deterioration factors of transmission and reception respectively. Both k_s and k_e are products of a number of deterioration factors: thus $k_s = k_f' . k_f'' . k_n . k_g$, representing frequency-band cutting (low and high), reverberation effect, and noise, respectively. k_e has an additional factor k_l involving the absolute loudness: this does not come into k_s because in transmission the suitable value can always be obtained by amplification. All these various factors are considered separately with the aid of curves, and the results are applied to the quantitative treatment of specified cases I (a and b) and II (a and b). Ia, in which the intelligibility works out to $V = 0.85$ (*i.e.*, very good), is the case of transmission from an acoustically good lecture room with high-quality apparatus (no low-frequency cutting, no high-frequency cutting below 7 000 c/s, reverberation time < 0.5 sec., etc.) and reception with a high-quality receiver and distortionless loudspeaker in a noise-free, acoustically good room. In IIa which gives $V = 0.73$ (adequate), reception conditions are as above [there is a misprint here in the calculation table: "ungünstigen" should read "günstigen"] but transmission is from a large hall with a large audience and an imperfect connection to the transmitter, giving a cutting of frequencies above 4 500 c/s. In Ib and IIb the transmissions are as in Ia and IIa, but reception is in a meeting hall with a combined noise level of 30 phons: for Ib the intelligibility works out at 0.60 (below the satisfactory value) and for IIb at only 0.52 (quite useless).

Acoustics and High Fidelity [Frequency Range: Volume Range: Amplitude Distortion: Resonances in the System: Studio and Reproducing Room Characteristics: Ratio of Volume Levels: Binaural Effect].—F. Massa. (*Rad. Engineering*, May, 1934, Vol. 14, No. 5, pp. 10–13 and 19). Based on papers by the writer, Snow, Sivian, Macnair and others.

Über die Hörsamkeit kleiner Musikräume (The Acoustics of Small Music-Rooms).—G. von Békésy. (*Ann. der Physik*, 1934, Series 5, Vol. 19, No. 6, pp. 665, 679.)

An arrangement is described which generates slow exponentially increasing and decreasing sounds; it is used to determine the ratio of the building-up time and the echo time of various noises and musical sounds in small music-rooms. Curves are given for the most suitable echo times for different sounds in rooms of different sizes

Symposium on Wire Transmission of Symphonic Music and Its Reproduction in Auditory Perspective [Philadelphia/Washington Demonstration].—Fletcher and others. (*Bell S. Tech. Journ.*, April, 1934, Vol. 13, No. 2, pp. 239–308.) *See* Abstracts, March, p. 155: other papers, June, p. 328 (three).

Contribution to the Theory of the Design of Low-Disturbance Telephone Cable [Freedom from Crosstalk, Power-Line Interference, etc., by Tuned Length of Twist].—K. Sieber and K. Schlump. (*E.N.T.*, April, 1934, Vol. 11, No. 4, pp. 119–140.)

On the Electrodynamics of Iron-Jacketed Round Wire (Krarup Conductor).—J. Fischer. (*E.N.T.*, April, 1934, Vol. 11, No. 4, pp. 140–152.)

On the Units of Transmission Technique: Neper, Decibel, Phon (Decibel-Phon) and "Klirr" Factor [with a Table of Common Noises and Their Value in Decibel-Phons and Approximate Equivalents in Musical Scale of Loudness].—H. Reppisch. (*Funktech. Monatshefte*, May, 1934, No. 5, pp. 175–176.)

RETROACTION IN LOW-FREQUENCY AMPLIFIERS [and Its Importance in Increasing Amplification, especially in Telegraphy Reception].—W. Egerland: Fehse. (*Funktech. Monatshefte*, May, 1934, No. 5, p. 209.)

THE EFFECT OF C-ELIMINATOR ON THE FREQUENCY CHARACTERISTIC OF AN AUDIO-FREQUENCY AMPLIFIER.—H. Wada. (*Japanese Journ. of Eng., Abstracts*, Vol. 11, 1934, p. 40.)

HIGH QUALITY AMPLIFICATION [Discussion of Chief Sources of Distortion and Their Avoidance].—W. T. Cocking. (*Wireless World*, 4th May, 1934, Vol. 34, pp. 302–304.)

PUSH-PULL QUALITY AMPLIFIER.—W. T. Cocking. (*Wireless World*, 11th and 18th May, 1934 Vol. 34, pp. 320–323 and 336–339.)

An a.f. amplifier for the amateur constructor in which two output valves connected in push-pull are coupled to two similarly connected valves in the preceding stage, by the resistance-capacity method. A special single-valve feeder unit is described for use when it is required to use the amplifier in conjunction with a gramophone pick-up.

A METHOD OF IMPROVING THE FREQUENCY CHARACTERISTICS OF TRANSFORMER-COUPLED AUDIO-FREQUENCY AMPLIFIERS [by Addition of Regenerative Circuit of Opposed Characteristic].—N. Ueno and H. Kobayashi. (*Japanese Journ. of Eng., Abstracts*, Vol. 11, 1934, p. 42.)

WINDING CAPACITY OF AUDIO-FREQUENCY TRANSFORMER.—C. Okawa. (*Japanese Journ. of Eng., Abstracts*, Vol. 11, 1934, pp. 8–9.)

RECTIFYING ACTION OF THE "AMPLI-FILTER."—S. Matsumae and others: Nukiyama. (*Japanese Journ. of Eng., Abstracts*, Vol. 10, 1934, pp. 36–37.) On Nukiyama's device: *see* also below, and under "Reception."

ON THE DESIGN PROCEDURE FOR THE AMPLI-FILTER AS A DETECTOR.—H. Nukiyama and Z. Kamayachi. (*Japanese Journ. of Eng., Abstracts*, Vol. 11, 1934, p. 39.) *See* also Kajii and Matsumae, 1933 Abstracts, p. 116.

KLANGANALYSE MIT DER MISCHHEXODE (Sound Analysis with the Mixing Hexode [Its Use as a Distortionless Modulator for the Exploring Note Method of Analysis]).—M. Kluge. (*Zeitschr. f. tech. Phys.*, No. 6, Vol. 15, 1934, pp. 223–227.)

The writer begins by outlining and criticising various previous methods on the exploring note principle, and points out that the success of the mixing hexode in producing distortionless modulation, by pure product-formation, in superheterodyne receivers (*cf.* Steimel, April Abstracts, p. 211) suggests its usefulness for this other purpose. He then investigates the action of the valve and gives the circuit (Fig. 4) of the hexode analyser, together with experimental results confirming the theoretical conclusions. "It is seen that with decreasing modulation the amplitude of the desired difference-note decreases, but that the ratio of unwanted note to difference-note decreases proportionally with the modulation—even, for some unwanted notes, quadratically. It is in this property that the great superiority of the hexode as a modulator lies, compared with modulators with bent characteristics, with which—apart from push-pull rectifiers—even with exactly square-law curves and very small modulations the octave of the exploring and partial frequency is of the same order of magnitude as the desired difference-note." Another advantage is the sensitivity of the hexode.

THE MEASUREMENT OF SMALL ALTERNATING VOLTAGES AT AUDIO-FREQUENCIES [and the Causes and Reduction of Amplifier Background Noise].—E. A. Johnson and C. Neitzert. (*Review Scient. Instr.*, May, 1934, Vol. 5, No. 5, pp. 196–200.)

"A type 38 tube operated below ionising voltages of the gas in the tube is found to have a low noise level. 10^{-8} volt can be measured in the audio-frequency range. . . . Further progress in the measurement of small l.f. voltages seems to depend upon the reduction of resistance noise by artificial cooling, the reduction of tube noise by the use of special low-noise tubes, and the improvement of methods of frequency selection."

THE MEASUREMENT OF NOISES.—W. Zeller: Baron: Bakos and Kagan. (*Zeitschr. V.D.I.*, 2nd June, 1934, Vol. 78, No. 22, pp. 669–670.) Based on a *Revue Acoustique* (Vol. 2, 1934, p. 441) paper by Baron and the work of Bakos and Kagan (June Abstracts, p. 328, l-h column).

MESSGERÄT FÜR OBJEKTIVE GERÄUSCHMESSUNGEN (Measuring Instrument for Objective Noise Measurements [New Siemens Direct-Reading Noise-Meter]).—Siemens & Halske. (*E.T.Z.*, 24th May, 1934, Vol. 55, No. 21, p. 517.)

A special carbon microphone (of numerous units in parallel) provides high sensitivity and a practical independence of frequency between 50 and 8 000 c/s. The amplified currents are rectified by a dry-plate rectifier and led to a moving-coil instrument with a response time of 0.2 sec., corresponding to the time required by the ear to record the full strength of a sound. Since the sensitivity of the ear varies so much with frequency, and the variation is different at different noise levels, the apparatus is constructed so as to have six frequency characteristics, the suitable one coming into play automatically when one of the volume-ranges is selected.

ELECTRIC "EAR" SOLVES TYRE-DESIGN PROBLEM.—Goodrich Company. (*See* under "Miscellaneous.")

EINE METHODE ZUM VERGLEICH AKUSTISCHER IMPEDANZEN (A Method of [Experimental] Comparison of Acoustic Impedances [with Acoustic Bridge]).—K. Schuster. (*Physik. Zeitschr.*, 15th May, 1934, Vol. 35, No. 10, pp. 408–409.)

THE MEASUREMENT OF TEMPERATURE OF SOUND FIELDS [by Thermocouple: Construction Described].—E. A. Johnson. (*Phys. Review*, 1st May, 1934, Series 2, Vol. 45, No. 9, pp. 641–645.)

IS THE SOUND ABSORPTION COEFFICIENT OF A MATERIAL A CONSTANT OR A VARIABLE? [Variation with Area of Sample of Material].—V. L. Chrisler. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 749: abstract only.)

THE MAINTENANCE OF AN INDEPENDENT REED [and of Rayleigh's "Tuning Fork Syren."]—A. T. Jones. (*Review Scient. Instr.*, May, 1934, Vol. 5, No. 5, pp. 192–193.)

TOTAL REFLECTION IN ACOUSTICS AND OPTICS [on the Basis of Experimental Seismological Results].—von Schmidt: Picht. (*See* under "Propagation of Waves.")

ECHO-FREE "MUSHROOM" LOUDSPEAKERS [as used on the Tempelhofer Field: the Use of the New "Nawi" Diaphragm].—(*Funktech. Monatshefte*, May, 1934, No. 5, pp. 197–198.) *Cf.* July Abstracts, p. 386. In the present note it is mentioned that the special "Nawi" diaphragm is used—*see* May Abstracts, p. 271, r-h column.

DIELECTRIC PROPERTIES OF ROCHELLE SALT.—J. E. Forbes and H. Müller. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, pp. 736–737: abstract only.)

"LOUD SPEAKERS: THEORY, PERFORMANCE, TESTING AND DESIGN" [Book Review].—N. W. McLachlan. (*Wireless Engineer*, June, 1934, Vol. 11, No. 129, p. 304.)

THE VIBRATIONS OF A TELEPHONE DIAPHRAGM [investigated by an Electro-Optical Method using an Oscillograph].—H. E. Heinecke. (*E.T.Z.*, 3rd May, 1934, Vol. 55, No. 18, p. 452: short summary only.)

MICROPHONE SWITCHING SYSTEMS FOR BROADCAST STATIONS.—L. W. Barnett. (*Electronics*, May, 1934, pp. 152–153 and 170.)

INTERPHONE SYSTEM USING ELECTRIC LIGHT WIRING.—(*See* under "Reception.")

RECORDING AND REPRODUCING SOUND [Survey of Disc, Sound-on-Film, and Magnetic Processes].—H. A. Frederick. (*Review Scient. Instr.*, May, 1934, Vol. 5, No. 5, pp. 177–182.)

Among the points mentioned are the following: with vertical cut the lighter vibratory system in the reproducer, the accurately shaped reproducing stylus and the closer groove spacing make possible a 12" record with a playing time of 10 to 20 mins. for music; if the frequency range is reduced the playing time may be 30 to 45 mins. Hickman (1933 Abstracts, p. 628, r.-h col.) has reported a magnetic tape recorder having a tape speed of only 12 inches per second, compared with the usual 5–10 feet per second, the tape used being both narrower and thinner than that of the Blattnerphone. "He has demonstrated less background noise and increased frequency and loudness range."

SOUND FILM PRINTING. II: DATA REGARDING THE EFFECT OF FILM PITCH ON PRINTING LOSS AND IRREGULARITIES.—J. Crabtree. (*Bell Tel. System Tech. Pub.*, Monograph B-774, 17 pp.) For Part I *see* March Abstracts, p. 156, r-h column.

NOISELESS RECORDING WITH DOUBLE-TRIANGLE SLIT AND DOUBLE-CATHODE PHOTOCELL.—G. L. Dimmick and H. Belar. (*Electronics*, May, 1934, p. 142–143.)

MODERN SOUND FILM TECHNIQUE ["British Acoustic" Full-Range System].—A. L. M. Douglas. (*Wireless World*, 1st June, 1934, Vol. 34, pp. 374–375.)

WCAU'S PHOTOCELL ORGAN, WITH WIDE-FILM "PITCH" AND "TONE-QUALITY" SOUND TRACKS.—Eremeeff. (*Electronics*, May, 1934, p. 157.)

X-RAY STUDIES OF THE WOOD USED IN VIOLINS.—K. Lark-Horovitz and W. I. Caldwell. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, pp. 749–750: abstract only.)

TONE ANALYSIS AND PHYSICAL CHARACTERISTICS OF VIOLINS. II.—R. B. Abbott and T. H. Stevens. (*Phys. Review*, 15th April, 1934, Series 2, Vol. 45, No. 8, p. 562: abstract only.) For Part I *see* February Abstracts, p. 99, r-h column: the present results indicate that the relative musical values of violins can be determined by physical measurements, for which standard units can be established. *See* next abstract.

TONE ANALYSIS AND PHYSICAL CHARACTERISTICS OF VIOLINS. III. [Characteristic Resonance Frequency used to classify Violins].—R. B. Abbott and T. H. Stevens. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 750: abstract only.)

NEUERE UNTERSUCHUNGEN ÜBER DIE SCHWINGUNGSFORMEN VON GEIGENKÖRPERN [New Investigations of the Oscillation Forms of Violin Bodies [Preliminary Letter on Influence of Thickness of Wood on Oscillation Form]).—H. Backhaus. (*Naturwiss.*, 1st June, 1934, Vol. 22, No. 22/24, p. 420.)

GIBT ES EIN ABSOLUTES LAUTSTÄRKEBEWUSSTSEIN? (Is there an Absolute Loudness Perception? [Faculty corresponding to Absolute Pitch Perception: Curves of Observers' Judgments]).—P. R. Arendt and H. E. Kallmann: Lorenz Company. (*Funktech. Monatshefte*, April, 1934, No. 4, pp. 135–136.)

A NEW PROPERTY OF THE EAR?—R. T. Beatty: G. von Békésy: Vrijdaghs. (*Wireless Engineer*, May, 1934, Vol. 11, No. 128, p. 254.) Correspondence on the letter referred to in June Abstracts, p. 329, l-h column.

UNTERSUCHUNGEN ÜBER AKUSTISCHE SCHWELLENWERTE. III. ÜBER DIE BESTIMMUNG DER REIZSCHWELLE DER HÖREMPFINDUNG AUS SCHWELLENDRUCK UND TROMMELFELLIMPEDANZ (Investigations of Acoustic Threshold Values. III. Determination of the Excitation Threshold of Hearing from Threshold Pressure and Ear-Drum Impedance).—W. Geffcken. (*Ann. der Physik*, 1934, Series 5, Vol. 19, No. 8, pp. 829–848.)

For former papers on this subject *see* 1933 Abstracts, pp. 276 (Geffcken and Keibs, and back ref.) and 333 (Waetzmann and Geffcken). The sensitivities of the ears here investigated were found to be of the order of 10^9–10^{10} cm² sec/erg in the frequency range 500–2 200 c/s.

SULLA LOCALIZZAZIONE DELLE SORGENTI SONORE [On the Localisation of Sound Sources).—G. Giotti: Ronchi. (*La Ricerca Scient.*, 30th April, 1934, 5th Year, Vol. 1, No. 8, pp. 447–449.) On Ronchi's letter (March Abstracts, p. 157) and subsequent correspondence.

AN APPARATUS FOR OBTAINING HIGH PRECISION SUPERSONIC DATA.—H. L. Yeagley. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 749: abstract only.)

PROPAGATION OF SOUND AND SUPERSONIC WAVES IN GASES [Theoretical Derivation of Expressions for Phase Velocity and Absorption Constant per Wavelength].—H. L. Saxton. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 749: abstract only.)

GLI ULTRASUONI E IL LORO IMPIEGO PER L'ESPLORAZIONE SUBACQUEA (Supersonic Waves and Their Use in Submarine Exploration [Vertical, for Sounding, and Horizontal]).—S. Rosani. (*Alta Frequenza*, April, 1934, Vol. 3, No. 2, pp. 168–195.) Survey, with particular attention to the Marti recorder and S.C.A.M. (Turin) equipment.

ACOUSTIC ALTIMETER INDICATING BY RED FLASHES ON DIAL.—Delsasso. (*Sci. News Letter*, 26th May, 1934, Vol. 25, No. 685, pp. 326–327.) For previous references to Delsasso's work *see* Abstracts, 1929, p. 637; 1930, p. 117; 1933, p. 46; and June, p. 327.

PHOTOTELEGRAPHY AND TELEVISION

TELEVISION [Short Survey: Future depends on Ultra-Short-Wave Development and production of Simple, Cheap Receiver, probably Cathode-Ray].—H. Meyer. (*Bull. Assoc. suisse d. Élec.*, No. 11, Vol. 25, pp. 283–286.)

THE FREQUENCY BAND PROBLEM IN TELEVISION [and the Two "Schools of Thought": I. Reduction of Band Width by Improved Scanning Methods].—E. L. Gardiner. (*Television*, July, 1934, Vol. 7, No. 77, pp. 297–298 and 326: to be continued.)

THE PRESENT POSITION OF TELEVISION TECHNIQUE [and the Desire for Increase of Framing Frequency to 40 p.s.].—(*Radio, B., F. für Alle*, June, 1934, No. 6, p. 98.)

THE TELEVISION POLICY THAT THE PUBLIC WANTS [General Summary of First Results of the "Television" Questionnaire].—(*Television*, June, 1934, Vol. 7, No. 76, pp. 236–237.) Followed by "Facts and Figures of Public Opinion" in the July issue, p. 284.

PUTTING VISION ON THE RADIO PROGRAMMES [Technique of Presentation].—E. Robb. (*Television*, June, 1934, Vol. 7, No. 76, pp. 242–245 and 280.)

PUBLIC-ADDRESS TELEVISION: A SHORT-RANGE SYSTEM WITH SCREEN PROJECTION FOR PUBLIC-ADDRESS PURPOSES.—L. Baily: Marconi Company. (*Television*, June, 1934, Vol. 7, No. 76, p. 240.)

TRICHROMATIC REPRODUCTION IN TELEVISION.—J. C. Wilson. (*Nature*, 2nd June, 1934, Vol. 133, p. 840.) Note on the paper dealt with in July Abstracts, p. 390.

THE SUPERIORITY OF VERTICAL OVER HORIZONTAL SCANNING.—de Forest. (*Television*, June, 1934, Vol. 7, No. 76, p. 241.)

Quotations from a letter on European television. Regarding the 9 000-cycle side band restriction, the writer says: "Imagine getting a good picture out of that. Yet Baird does it—by the use of 30-line pictures and 12½ pictures a second. Considering the handicaps, the results are amazing. *Vertical scanning is the answer—incomparably superior to horizontal scanning when less than 120 lines are employed.*"

SCANNING METHOD, FOR TRANSMISSION OR RECEPTION, USING COMBINATION OF SLOTTED DISC FOR RAPID TRAVERSE AND SLOTTED CYLINDER FOR SLOW TRAVERSE.—R. Barthélémy. (French Pat. 761 181, pub. 13.3.34: *Rev. Gén. de l'Élec.*, 26th May, 1934, Vol. 35, No. 21, p. 169 D.)

LOOKING IN WITH A STATIONARY MIRROR DRUM: A TEST OF THE MIHALY APPARATUS.—von Mihaly. (*Television*, July, 1934, Vol. 7, No. 77, pp. 289–290.) For a paper on this mirror drum *see* February Abstracts, p. 101, l-h column.

ON THE SCANNING METHOD FOR TELEVISION.—H. Kono. (*Japanese Journ. of Eng., Abstracts*, Vol. 10, 1934, p. 37.)

A "NON-SCANNING" SYSTEM [Subject projected on to Photoelectric Plate forming Cathode of Barkhausen-Kurz Oscillator with Electrode Distances varying from Point to Point over Cathode Surface, giving Different Micro-Wavelengths at Different Points].—H. M. Dowsett and R. Cadzow. (British Pat. 406 368: *Television*, June, 1934, Vol. 7, No. 76, p. 251.)

THE LOW FREQUENCIES IN TELEVISION.—F. Kirschstein. (*Alta Frequenza*, April, 1934, Vol. 3, No. 2, pp. 209–212.) Long summary of the German papers referred to in 1933 Abstracts, p. 631, l-h column.

A NEW SYNCHRONISING SYSTEM OF TELEVISION [using Eddy-Current Brake].—T. Sone. (*Japanese Journ. of Eng., Abstracts*, Vol. 11, 1934, pp. 42–43.) English summary of paper referred to in 1932 Abstracts, p. 353, r-h column.

"TELEVISION—THEORY AND PRACTICE" [Book Review].—J. H. Reyner. (*Television*, July, 1934, Vol. 7, No. 77, p. 290.)

MAGNETIC REFOCUSING OF ELECTRON PATHS.—Stephens. (*See* July Abstracts, p. 394.)

USING MERCURY-VAPOUR TUBES [for Television Reception; Characteristics and Use of Tubes intended for Sound-on-Film Recording].—(*Television*, June, 1934, Vol. 7, No. 76, pp. 265–267.)

"TRANSIENTS IN TRANSFORMER-COUPLED AMPLIFIERS: PART II." CORRECTION.—Nowotny. (*See* under "Properties of Circuits.")

FAILURE OF TALBOT'S LAW FOR BARRIER-LAYER PHOTO-CELLS [Investigation of Cell Response to Interrupted Light].—P. R. Gleason. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 745: abstract only.)

The response of various cells to interrupted light was measured on a d.c. instrument. "With flash frequencies up to 2 000 per sec. none of the cells integrated the flashes in agreement with the average light reaching them; and the same cell gave different results when light intensity, area of illumination, circuit resistance, or frequency of light interruption was changed. The percentage increase in the average current as the flash frequency was raised from 16 to 2 000 per sec. ranged from 1% or less for the Photox cell to more than 25% under extreme conditions from the Visitron F2, Tungsram type S, and photronic cells. This deviation with frequency remained 2% or less for all cells when the circuit and galvanometer resistance was small compared with the effective cell resistance. The larger deviations appeared when larger circuit resistances were introduced and also when the spacing between the openings in the [interrupting] disc was increased. No complete explanation is offered."

ÜBER DAS VERHALTEN VON SPERRSCHICHTEN IN ELEKTRISCHEN WECHSELFELDERN [The Behaviour of Barrier Layers in Alternating Electric Fields).—H. Bomke and E. Hasché. (*Physik. Zeitschr.*, 15th May, 1934, Vol. 35, No. 10, p. 414.)

The barrier-layer photocells under investigation were placed in the condenser of a short-wave emitter, in a position where the field was homogeneously distributed. A sensitive galvanometer was connected to the cell and showed that the h.f. field caused a direct current to flow in the current-circuit of the cell; this current was opposed in direction to the photocurrent obtained on irradiation of the cell with light or X-rays. The effect did not occur until a critical field strength was reached and then increased exponentially with the field; various combinations of conductors and semi-conductors showed qualitatively the same phenomenon. A curve is given showing the characteristic behaviour for a wavelength of 16.4 m. This effect may give a possible method of measuring the energy of h.f. oscillations.

ZUR FRAGE DER KONSTANZ DER SELENSPERRSCHICHT-PHOTOZELLEN (The Constancy of Selenium Barrier-Layer Photocells).—L. Bergmann. (*Physik. Zeitschr.*, 1st June, 1934, Vol. 35, No. 11, pp. 450–452.)

This note contains a discussion of results obtained by Grundmann and Kassner (April Abstracts, p. 216) and a comparison of them with the writer's own measurements. He finds that the cells are quite constant up to certain illumination intensities, but must not be subjected to a stronger illumination for any length of time. To measure large intensities the cells must be protected by grey filters or stops.

INFLUENCE OF POLARISATION ON THE ACTION OF ELECTROLYTIC SELENIUM PHOTOCELLS.—R. Audubert and J. Roulleau. (*Comptes Rendus*, 28th May, 1934, Vol. 198, No. 22, pp. 1907–1909.) Further development of the work dealt with in July Abstracts, p. 392.

THE PHOTOELECTRIC PROPERTIES OF THE (100) AND (111) FACES OF A SINGLE COPPER CRYSTAL.—N. Underwood. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 745: abstract only.)

NEW RESEARCHES ON "METALLIC PHOTORESISTANCE" [of Thin Metal Films].—Q. Majorana. (*Physik. Ber.*, 15th May, 1934, Vol. 15, No. 10, pp. 780–781: see also p. 781.) For previous papers *see* March Abstracts, p. 160.

THE PROPORTIONALITY OF PHOTOELECTRIC CELLS.—H. Schneller: H. Janssen. (*Physik. Ber.*, 15th May, 1934, Vol. 15, No. 10, p. 806.)

THEORY OF PHOTOCELL AND STATIC CHARACTERISTIC OF THREE-ELECTRODE PHOTOCELL.—N. Kadokura and S. Nakajima: Asada. (*Japanese Journ. of Eng., Abstracts*, Vol. 11, 1934, p. 25.) For papers on the "grid-photoelectric cell" of Asada and Hagita *see* 1931 Abstracts, p. 391.

ENERGY DISTRIBUTION OF PHOTOELECTRONS FROM POTASSIUM FILMS ON SILVER.—J. J. Brady. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 745: abstract only.)

THE PHOTOELECTRIC EFFECT FOR HIGH ENERGY QUANTA [Calculation using Relativistic Quantum Electrodynamics].—H. Hall. (*Phys. Review*, 1st May, 1934, Series 2, Vol. 45, No. 9, pp. 620–627.)

AREA AND BRIGHTNESS OF STIMULUS RELATED TO THE PUPILLARY LIGHT REFLEX.—M. Luckiesh and F. K. Moss. (*Journ. Opt. Soc. Am.*, May, 1934, Vol. 24, No. 5, pp. 130–134.)

MEASUREMENTS AND STANDARDS

DAS EINFADENELEKTROMETER ALS FREQUENZSCHWANKUNGSANZEIGER (The Single-Thread Electrometer as a Frequency Fluctuation Indicator).—C. Hagen. (*Zeitschr. f tech. Phys.*, No. 6, Vol. 15, 1934, pp. 231–236.)

In the measurement of oscillations, mechanical, acoustical, or electrical, the percentage frequency fluctuations are often required to be known, and oscillographs or vibrating-reed frequency meters are employed—or an instrument such as the AEG meter, in which the charging current of a fixed condenser operates a m.c. galvanometer giving a direct reading in cycles/second. The present paper describes an arrangement using comparatively simple components, giving continuous and rapid indication of frequency fluctuations, and applicable over a large range of frequencies. It is based on the fact that if an alternating voltage is applied to a condenser C in series with a resistance R, the effective component voltages V_C and V_R across C and R are equal when, for a given frequency ω_0, $R = 1/\omega C$. If, however, the working frequency alters (the amplitude remaining constant), V_C becomes greater or less than V_R according to whether the frequency is decreased or increased. These relative voltage changes serve as a measure of the departure of the frequency from the prescribed value, and by the use of a suitable circuit can be indicated by a single-thread electrometer.

This circuit is shown diagrammatically in Fig. 2. The alternating potential is applied to the grid of an amplifier valve, and the amplified voltage taken to the grid of an amplitude-limiting valve which prevents any fluctuation in amplitude which would deprive the results of their value. The anode circuit of this second valve contains a high resistance R_2, across whose ends lie the capacity C and resistance R in series. The component voltages V_C and V_R are taken to the right- and left-hand plates of the single-thread electrometer, the tension of whose Wollaston-wire thread can be finely adjusted within certain limits. The condenser C is made up of a fixed condenser in parallel with an adjustable one, to allow the required relation between ω, C and L to be obtained (zero adjustment). The electrometer reading can be observed under a microscope, or better by projection on to a ground glass screen.

Section IV establishes the relation between electrometer deflection a and frequency fluctuation δf, equation 7 showing its linear nature so long as δf is very small compared with f_0, the nominal frequency. A lower limit is set to this frequency by a fluttering of the electrometer thread at frequencies below 50 c/s, and an upper limit by the electrometer beginning to act as a capacitive shunt. Sections V and VI describe the experimental confirmation of the theoretical results, the apparatus used being based on the principle of Schäfer's extensometer (used for measurements on bridge structures, etc.) in which a stretched steel wire is kept in undamped vibration by magnetic retroaction.

Supplementary 10 Mc/s Standard Frequency Transmissions from WWV.—Nat. Bureau of Standards. (*Bur. of Stds. Tech. News Bull.*, May, 1934, No. 205, p. 49: *Journ. Franklin Inst.*, June, 1934, Vol. 217, No. 6, p. 760.)

Constant-Frequency Oscillators: the Binode as Dynatron with Automatic Regulation.—J. Groszkowski. (*Wiadomości i Prace Inst. Radjotech., Warsaw*, No. 6, Vol. 5, 1933, p. 61: in Polish.) *See* April Abstracts, p. 205, l-h column.

N.P.L. Standard Frequency Transmissions: the Quartz Control of the 1 785 kc/s Transmitter.—Essen. (*See* reference under "Transmission.")

On the Frequency Variation of Quartz Oscillators with Gapless Holders [due to Displacement of Plates in the Holders].—K. Hatakeyama. (*Japanese Journ. of Eng., Abstracts*, Vol. 11, 1934, p. 40.) *See* also Matsumara and Hatakeyama, 1931 Abstracts, p. 335.

Space-Charge Effects in Piezoelectric Resonators [Theoretical Explanation of Variation of Resonant Frequency with Gap].—W. G. Cady. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, pp. 740–741: abstract only.)

The Relation of Wave Constants with Dimensions of X-Cut Rectangular Quartz Plates.—S. Matsuma and K. Hatakeyama. (*Japanese Journ. of Eng., Abstracts*, Vol. 11, 1934, p. 39.)

A Refracting Interferometer for examining Modes of Vibration in Quartz Plates [particularly Lateral Vibrations of Too Weak Amplitude to be observed by Previous Methods: Quartz and Tourmalin Results].—H. Osterberg. (*Review Scient. Instr.*, May, 1934, Vol. 5, No. 5, pp. 183–186.)

Towards the end of his paper the writer says: "The above observations suggest that in the case of tourmalin, as well as in the case of quartz, those longitudinal modes do not exist in which the wave trains are propagated only along the thickness of a plate whose length and width are considerably greater than its thickness. This conclusion is contrary to concepts held by the most recent contributors to this literature. It emphasises the uncertainty in determining the mode of vibration merely from the coincidence of the observed and computed frequencies. An explanation of the absence of these so-called 'thickness modes' is not simple. . . ." For previous papers by the writer *see* Abstracts, 1930, p. 223; 1932, p. 235; and 1933, pp. 223 and 457.

Interferometer Method for Measuring the Amplitude of Vibration of Quartz Bar Crystals.—S. H. Cortez. (*Journ. Opt. Soc. Am.*, May, 1934, Vol. 24, No. 5, pp. 127–129.)

The Perfection of Quartz Crystals [investigated with X-Ray Double Crystal Spectrometer].—F. E. Haworth and R. M. Bozorth. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 762: abstract only.)

Dielectric Properties of Rochelle Salt.—J. E. Forbes and H. Müller. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, pp. 736–737: abstract only.)

Die Zeitwaage, ein Gerät zum Messen des Gangunterschiedes von Uhren (The "Time Balance," an Apparatus for measuring the Time-Keeping of Clocks [Rapid Regulation of Clock by comparing Rate of Ticking with that of Standard Clock]).—R. Tamm. (*Zeitschr. V.D.I.*, 5th May, 1934, Vol. 78, No. 18, pp. 556–558.)

Based on the principle of making the "tick" signals from one clock turn a current through an integrating d.c. meter "on," and the signals from the other clock turn it "off," so that the time-differences between the two sets of ticks can be read directly in milliseconds. The limit of accuracy depends on the irregularity of the ticks themselves, but a day's recording of these irregularities give useful information as to the working of the movements.

SULLA MISURA DELLA RESISTENZA EQUIVALENTE DEI CIRCUITI OSCILLATORI (The Measurement of the Equivalent Resistance of Oscillatory Circuits [Negative Resistance Valve Method]).—M. Boella: Pinciroli. (*Alta Frequenza*, April, 1934, Vol. 3, No. 2, pp. 196–197.)

A letter prompted by Pinciroli's work (July Abstracts, p. 393, l-h column). The writer points out that the chief causes of inaccuracy in the measurement of equivalent (dynamic) resistances by valve negative resistance methods are (as Pinciroli's work makes additionally clear) the difficulty of determining the point of setting-in of the oscillations and the disturbing influence of the external couplings between the circuits, by reason of which the setting-in does not occur exactly when the equivalent resistance of the circuit is equal to the absolute negative resistance of the valve. Both these difficulties are briefly discussed, together with possible lines on which they might be overcome.

THE MEASUREMENT OF THE GRID/ANODE CAPACITANCE OF SCREEN-GRID VALVES [Method for Working Conditions and Method with Cold Filament—applicable to Routine Test of R.F. Insulation: No Special Apparatus required].—T. Iorwerth Jones. (*Journ. I.E.E.*, June, 1934, Vol. 74, No. 450, pp. 589–594.)

VERGLEICH VON KONDENSATOREN (The Comparison of Condensers [Simple Bridge Procedure for measuring Capacities and Dielectric Losses of Condensers without use of Schering Bridge]).—H. Kind. (*Elektrot. u. Masch:bau*, 24th June, 1934, Vol. 52, No. 25, p. 292.)

SOME NOTES ON THE INFLUENCE OF STRAY CAPACITANCE UPON THE ACCURACY OF ANTENNA RESISTANCE MEASUREMENTS [and a Method of approaching the True Value: applicable also to Coils with Distributed Capacitance].—Laport. (*See* under "Aerials and Aerial Systems.")

A STUDY OF RADIO-FREQUENCY CHOKE COILS [Question of Validity of Representation as Inductance shunted by Lumped Capacity, etc.: Experimental Investigation].—R. Lee. (*Electronics*, April, 1934, pp. 120–121 and 129.)

INDUCTANCE FOR RADIO FREQUENCIES: A NEW COMPACT STANDARD [with Temperature Coefficient of order of 5 Parts in a Million per Degree Centigrade].—W. H. F. Griffiths. (*Wireless Engineer*, June, 1934, Vol. 11, No. 129, pp. 305–307.) Further development of the work dealt with in 1930 Abstracts, pp. 52–53.

THE CARRYING CAPACITY OF STANDARD RESISTANCES IN PETROLEUM AND IN AIR.—H. von Steinwehr. (*Physik. Ber.*, 1st May, 1934, Vol. 15, No. 9, p. 690.)

AUTOMATIC RECORDING OF FIELD STRENGTH [for Study of Service Areas of Broadcasting Stations].—C. M. Jansky, Jr. (*Electronics*, May, 1934, p. 148.)

THE SCREENING CAGE AT THE HEINRICH-HERTZ INSTITUTE [for Receiver and Other High-Frequency Measurements].—O. Schütte and G. Weiss. (*Funktech. Monatshefte*, May, 1934, No. 5, pp. 169–170.)

A DEVICE FOR THE MEASUREMENT OF THE INTENSITY OF MAGNETIC FIELDS.—H. S. Jones. (*Review Scient. Instr.*, June, 1934, Vol. 5, No. 6, pp. 211–214.)

A POSSIBLE METHOD OF MEASURING THE ENERGY OF R.F. OSCILLATIONS [based on Behaviour of Barrier-Layer Photocells in A.C. Fields].—Bomke and Hasché. (*See* abstract under "Phototelegraphy and Television.")

EINE ABSOLUTMETHODE ZUR MESSUNG DER DIELEKTRIZITÄTSKONSTANTEN VON ELEKTROLYTLÖSUNGEN BEI HOCHFREQUENZ (An Absolute Method for Measuring the Dielectric Constants of Electrolytic Solutions at High Frequencies).—H. Hellmann. (*Ann. der Physik*, 1934, Series 5, Vol. 19, No. 6, pp. 623–636.)

This paper discusses the various absolute and relative methods of measuring the dielectric constants of solutions at high frequencies and gives a detailed account of the theory of the method of measuring the intensity of the standing wave in a system of Lecher wires, with one end in a trough of the liquid under investigation. Particular attention is paid to the boundary conditions of the experiment, and the possible sources of error.

THE MEASUREMENT OF SMALL ALTERNATING VOLTAGES AT AUDIO-FREQUENCIES [and the Causes and Reduction of Amplifier Background Noise].—Johnson and Neitzert. (*See* under "Acoustics and Audio-Frequencies.")

A COMPENSATED THERMIONIC ELECTROMETER [Description of a Single-Valve Instrument and Discussion of Principles of Operation].—K. G. Compton and H. E. Haring. (*Bell Tel. System Tech. Pub.*, Monograph B-780, 12 pp.)

"This apparatus has been found to compare favourably with 'balanced tube' circuits both as regards stability and sensitivity, and to be superior in many respects to the quadrant electrometers which usually have been used for the measurement of small currents . . . etc."

TRUE VOLTAGE MEASUREMENTS: PROPERTIES OF THE ELECTROSTATIC VOLTMETER.—E. H. W. Banner. (*Wireless World*, 4th May, 1934, Vol. 34, p. 313.)

MEASUREMENT OF THE A.C. COMPONENT OF SUPERPOSED D.C. VOLTAGE OR CURRENT [Compensation Method where Ripple is Small and Usual Two-Meter Procedure fails].—H. Kind. (*E.T.Z.*, 31st May, 1934, Vol. 55, No. 22, pp. 541–542.)

VACUUM TUBE PHASOMETER [for Measurement of Phase Difference and Power Factor].—Y. Watanabe. (*Japanese Journ. of Eng., Abstracts*, Vol. 11, 1934, p. 46.)

THERMIONIC VOLTMETER WITH AUTOMATIC COMPENSATION [Various Methods, and the Design of a Voltmeter in which the Amplifying Valve also acts as Compensating Valve].—S. Dierewianko. (*Wiadomości i Prace Inst. Radjotech., Warsaw*, No. 4, Vol. 5, 1933, pp. 35–38: in Polish.)

DIE ANPASSUNG VON QUOTIENTEN-MESSGERÄTEN (The Matching of Quotient Meters [showing the Ratio of Two Currents]).—H. Dallmann. (*Archiv f. Elektrot.*, 18th May, 1934, Vol. 28, No. 5, pp. 265–269.)

CONTROL APPARATUS FOR A DOUBLE-STRING EINTHOVEN GALVANOMETER [giving Rapid and Safe Handling and Increased Utility].—W. H. H. Gibson. (*Journ. Scient. Instr.*, June, 1934, Vol. 11, No. 6, pp. 187–193.)

ALTERNATING CURRENT "STANDARD CELL" [Thermocouple Adjusting Device giving 1.5 Volts A.C. Voltage which has been compared with D.C. Standard Cell].—(*Journ. Scient. Instr.*, June, 1934, Vol. 11, No. 6, pp. 193–194.)

STORES SPECIFICATIONS AND ACCEPTANCE TESTING.—J. Legg. (*Inst. P.O. Elec. Eng.*, Printed Paper No. 148, 45 pp.)

SUBSIDIARY APPARATUS AND MATERIALS

"DOUBLE-FILTERS" [a New Type of Filter with Characteristics as Good as Zobel or Bridge Types].—Matsumae and Matsumoto. (*See* under "Properties of Circuits.")

A MAGNETIC OBJECTIVE FOR THE ELECTRON MICROSCOPE.—E. Ruska. (*Zeitschr. f. Physik*, 1934, Vol. 89, No. 1/2, pp. 90–128.)

The purpose of the new work described in the present paper was first the design of a magnetic coil to give the shortest possible focal length and have as many applications as possible. The work follows the lines of that referred to in May Abstracts, p. 280, l-h column, where the object was the production of very high magnification. Importance was attached to the flexibility of the magnetic arrangement. Previous investigations have only discussed the electron-optics of magnetic coils of a few special shapes and of large focal length; the second purpose of the present paper was the development of quantitative, experimental investigations of the general electron-optics of short-focus coils.

To obtain short focal lengths it is necessary to construct very strong magnetic fields with sufficiently short axes; this can only be done in practice by enclosing the coil winding in a ferromagnetic screen, which is only split by a short ring-shaped slit inside the tube. The field concentration obtainable is thus limited by the saturation of the ferromagnetic material. The fundamental construction of the objective here considered was discussed earlier (Ruska and Knoll, Abstracts, 1931, p. 625). The form of the coil was described in the paper referred to above; the description is repeated in this paper. Measurements were made on a network of molybdenum wires of very fine mesh, on which a small piece of aluminium foil was placed. The latter lay entirely within the circular stop. The image was formed on a fluorescent metallic screen with millimetre divisions. High-voltage electron beams were used (10 to 100 kilovolts). The measuring procedure is described.

A short recapitulation is given of the theoretical principles underlying the magnetic objective; measurements on a coil free from iron as well as on the iron-cased one are described. Characteristic minimum focal lengths are observed for every type of magnetic pole piece employed with the iron-cased coil; these minima are functions of the voltage. It is found that, so long as the current in the pole pieces is less than is needed to produce the maximum permeability in the poles, concentration of the axial field is produced; with larger currents, deconcentration takes place. Thus a limiting focal length can be defined and was determined quantitatively for a number of pole piece designs. Focal lengths down to 0.4 cm for 60 kilovolt beams and 0.3 cm for 40 kilovolt beams were obtained. Final magnifications of 10^4 with only two image stages could be obtained with no great length of microscope.

Experimental curves are also given showing the errors introduced by stops of varying diameter. For earlier papers on magnetic objectives see H. Busch, *Arch. f. Elektrot.*, 1927, Vol. 18, p. 583; Wolf, *Ann. der Physik*, 1927, Vol. 83, p. 854; Knoll and Ruska, Abstracts, 1932, p. 418, and 1933, p. 51; Brüche and Johannson, 1932, p. 476; von Borries and Ruska, 1933, p. 517; Knoll, Knoblauch and von Borries, 1930, p. 520; and the papers referred to above.

FIELD COMBINATIONS FOR VELOCITY- AND MASS-SPECTROGRAPHY, II [Application in Electron Optics].—W. Henneberg. (*Ann. der Physik*, 1934, Series 5, Vol. 20, No. 1, pp. 1–12.)

For Part I *see* May Abstracts, p. 280. The purpose of this paper is to make available for spectroscopic purposes the large dispersion in the equatorial plane of the field of a magnetic doublet. The difficulty that the diverging electron beams of the same velocity are not well focussed is got over by placing a short electron lens in the beam and superposing other fields, *e.g.* a homogeneous magnetic field and a cylindrical electric field.

ELECTRON MICROSCOPE [Calculations for Two-Lens Electron Microscope casting Images of Ribbon Filaments on Fluorescent Screen].—C. J. Calbrick and C. J. Davisson. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 764: abstract only.)

ELECTRON MICROSCOPY OF BIOLOGICAL OBJECTS.—L. Marton. (*Nature*, 16th June, 1934, Vol. 133, p. 911.)

GAUGAIN-HELMHOLTZ (?) COILS FOR UNIFORM MAGNETIC FIELDS.—L. W. McKeehan. (*Nature*, 2nd June, 1934, Vol. 133, pp. 832–833.) Discussion of the appropriateness of this name for the coils used to produce uniform magnetic fields.

THE DESIGN AND OPERATION OF A HIGH-SPEED CATHODE-RAY OSCILLOGRAPH [for Internal Recording and External Light-Blackening Recording through Reinforced Thin Glass Window: Synchronisation with Short-Time Transients, etc.].—J. L. Miller and J. E. L. Robinson. (*Journ. I.E.E.*, June, 1934, Vol. 74, No. 450, pp. 511–519: Discussion pp. 519–535.)

On the Sharpness of Trace in External Contact Recording with the Cathode-Ray Oscillograph [and Its Dependence on the Thickness and Refractive Index of the Screen Carrier].—H. Graupner. (*Archiv f. Elektrot.*, 18th May, 1934, Vol. 28, No. 5, pp. 323–325.)

The trace thickness increases in proportion to the thickness of the foil window, and falls with increasing index of refraction of the foil material. But it is not advisable to use very thin foil, since this leads to more difficulty in ensuring good contact between the foil and the photographic emulsion, and a gap of 0.1 mm here causes as great a thickening of trace as an increase of 0.5 mm in foil thickness.

A Device for Adjusting the Position of the Spot in X-Ray or Cathode-Ray Tubes [Improvement on Seemann's Design by replacing Flexible Rubber Mounting by Short Seamless Metal "Bellows."]—J. Obrist. (*Zeitschr. f. tech. Phys.*, No. 6, Vol. 15, 1934, pp. 236–238.)

A Device for Showing the Direction of Motion of the [Cathode-Ray] Oscilloscope Spot [by Interruption by Neon-Lamp Discharge].—E. R. Mann. (*Review Scient. Instr.*, June, 1934, Vol. 5, No. 6, pp. 214–215.) Dispensing with the auxiliary oscillator used by Hollmann and Saraga in their stroboscopic method (1933 Abstracts, p. 282).

Photography of Transients with a Cathode-Ray Oscillograph [and the Experimental Determination of the Maximum Photographable Spot Velocity, by a Spiral Record].—Karplus. (*Electronics*, April, 1934, p. 125.)

On the Contact Conduction and Rectification [on Cold Electron Emission Theory].—G. Hara. (*Japanese Journ. of Eng., Abstracts*, Vol. 11, 1934, pp. 44–45.) English summary of paper referred to in 1932 Abstracts, p. 242, r-h column.

Specific Resistance of Cuprous Oxide [Exponential Variation in Direction of Growth of Oxide: Effect of Various Growth Conditions].—W. H. Brattain. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 745: abstract only.)

On the Choice of the Grid Resistance at the Input of a High-Sensitivity Amplifier, *and* On the Choice of the Coupling Elements in the Construction of an Amplifier with Small Time Constant.—G. Stetter: G. Ortner and G. Stetter. (*Physik. Ber.*, 1st May, 1934, Vol. 15, No. 9, pp. 689: 689–690.) *See* also June Abstracts, p. 335, r-h column.

Amplifiers for Alternating-Current Bridges [and the Consideration of the Stray Admittances introduced by Them].—W. A. Ford and H. W. Bousman. (*Gen. Elec. Review*, May, 1934, Vol. 37, No. 5, pp. 224–226.)

The Stability of D.C. Amplifiers [and the Design of a Bridge-Connected Amplifier with Two Double-Grid Valves: All Voltages taken from One 40-Volt Battery: Sensitivity of the Order of 10^{-14} Ampere].—Meunier and Andriot. (*Rev. Gén. de l'Élec.*, 16th June, 1934, Vol. 35, No. 24, pp. 813–814: summary only.)

Low-Noise Amplifiers [Tests on Western Electric Low-Noise Valves].—G. L. Pearson. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 740: abstract only.)

The Recording of Feeble Impulses [from Alpha Particles, Protons, etc.] with the help of Valve Amplifiers.—S. Dierewianko and M. Żyw. (*Wiadomości i Prace Inst. Radjotech., Warsaw*, No. 4, Vol. 5, 1933, pp. 38–43: in Polish.)

A Chopper utilising Contacts vibrating in a Vacuum [for amplifying D.C. Components of Voltage by an A.C. Amplifier: Device about Same Size as Receiving Valve].—F. G. Kelly. (*Proc. Inst. Rad. Eng.*, May, 1934, Vol. 22, No. 5, pp. 672–674.)

A Successful D.C. Transformer.—F. Noack. (*Wireless World*, 1st June, 1934, Vol. 34, pp. 383–84.)

Use is made of the old principle of charging condensers in parallel and discharging them in series. Recent research work into the practical application of the necessary switching system has enabled a German firm to commercialise the principle successfully.

Power Transformers for Automobile Radio Vibrators.—V. C. MacNabb. (*Electronics*, May, 1934, pp. 149–150.)

Magnetic Permeability of the Ferromagnetic Metals at Very High Frequencies [and the Differences between Values determined from "Internal Self-Induction" and Ohmic Resistance: Value of 6 for Iron at 12 cm Wavelength and Less than 5 for Cobalt at 120 cm].—G. Potapenko and R. Sänger. (*World Power*, June, 1934, Vol. 21, No. 126, p. 335.) Translation of the paper referred to in February Abstracts, p. 108, l-h column.

On the Theory and Measurement of the Magnetic Properties of Iron.—D. C. Gall and L. G. A. Sims. (*Journ. I.E.E.*, May, 1934, Vol. 74, No. 449, pp. 453–468.)

Standard Current Transformers with "Mixed" Cores [Composite Cores of Nickel-Iron and Ordinary Dynamo-Iron Stampings, to flatten out Error Curve].—E. Billig. (*Elektrot. u. Masch:bau*, 29th April, 1934, Vol. 52, No. 17, pp. 199–203.)

An Analytical Expression for the Hysteresis Loop.—G. Grobe. (*E.T.Z.*, 7th June, 1934, Vol. 55, No. 23, pp. 559–561.)

The Longitudinal and Transverse Magneto-Resistances and Magnetic Structure of Ferromagnetic Substances.—G. Alocco. (*Physik. Ber.*, 1st May, 1934, Vol. 15, No. 9, p. 702.)

AUTOMATIC STABILISATION OF TEST VOLTAGES [for Indicators and Recorders in Bridge or Differential Circuits, etc.] BY MEANS OF ORDINARY METAL-FILAMENT LAMPS.—W. Geyger. (*Archiv f. Elektrot.*, 18th May, 1934, Vol. 28, No. 5, pp. 270–273.)

After a short discussion of previous stabilising methods (iron-wire barretters, choke-coils and transformers with differently saturated cores, etc.) and their disadvantages, the writer shows that by the use of suitable circuits (differential, for a.c., and bridge, for d.c. or a.c.) commercial metal-filament lamps will give satisfactory stabilisation. Since such a lamp need be worked at only 50–90% of its rated voltage, its life is good and its characteristic satisfactorily constant, while in addition its thermal inertia and consequent time lag is decidedly less than is the case with iron-wire barretters.

STABILISED CURRENT SOURCES [Survey of the Use of Glow-Discharge Tubes].—L. Körös and R. Seidelbach. (*Physik. Ber.*, 15th May, 1934, Vol. 15, No. 10, p. 788.) For previous papers *see* 1933 Abstracts, p. 577 ("Stabilovolt") and back reference: *also* Colebrook, same column.

GLOW-DISCHARGE TUBES AS STABILISERS AND VOLTAGE DIVIDERS [Survey].—M. lo Piparo. (*Alta Frequenza*, April, 1934, Vol. 3, No. 2, pp. 241–250.)

ON THE MEASUREMENT OF THE CONCENTRATION OF THE CHARGE CARRIERS IN THE GLOW DISCHARGE.—E. F. Buchmann. (*Zeitschr. f. tech. Phys.*, No. 5, Vol. 15, 1934, pp. 180–186.)

THE HIGH-CURRENT GLOW DISCHARGE AT ATMOSPHERIC PRESSURE.—H. Thoma and L. Heer. (*Zeitschr. f. tech. Phys.*, No. 5, Vol. 15, 1934, p. 186.) Further development of the work dealt with in January Abstracts, p. 51, r-h column.

BETTER FILAMENT-CURRENT STABILISATION WITH SINGLE IRON-WIRE BARRETTER IN COMMON LEAD THAN WITH SEPARATE BARRETTER FOR EACH VALVE.—Dr. Nickel Laboratories. (German Pat. 592 346: *Funktech. Monatshefte*, May, 1934, No. 5, p. 216.)

ELECTRONIC REGULATOR FOR A.C. GENERATORS [giving Regulation within $\pm$ 1/10%].—F. H. Gulliksen. (*Elec. Engineering*, June, 1934, Vol. 53, No. 6, pp. 877–881.)

THE GRID-CONTROLLED GAS DISCHARGE [Thyratron] AS A.C. RESISTANCE WHICH CAN BE REGULATED.—A. J. Schmidek: Lenz. (*Archiv f. Elektrot.*, 18th May, 1934, Vol. 28, No. 5, pp. 325–327.) Remarks on Lenz's paper (1933 Abstracts, p. 516, l-h col.): the writer replies.

AN AUTOMATIC MAGNETIC FIELD STABILISER OF HIGH SENSITIVITY [using Photocell, Thyratron, and Auxiliary Relay Circuits].—C. E. Wynn-Williams. (*Proc. Roy. Soc.*, 2nd June, 1934, Vol. 145, No. A 854, pp. 250–257.)

THE EXTRACTION OF SMALL AMOUNTS OF ENERGY FROM HIGH-TENSION NETWORKS [by the Capacitive Potential-Divider or "Transforming Condenser"].—P. Hochhäusler. (*Archiv f. Elektrot.*, 18th May, 1934, Vol. 28, No. 5, pp. 302–310.)

VOLTAGE-DOUBLER TUBE IN NOVEL USE—A NEW LIGHT RELAY [One Half of 25Z5 Voltage Doubler supplies Plate Voltage, Other Half Grid Bias independent of Plate Current Variations, for Relay-Operating Valve controlled by Photocell].—Hitchcock. (*Electronics*, April, 1934, p. 124.)

DETECTION OF DAMPED HERTZIAN WAVES BY A DRY CELL WITH SOLID RADIOACTIVE ELECTROLYTE AND IONISED AIR.—L. Bouchet. (*Comptes Rendus*, 4th June, 1934, Vol. 198, pp. 1982–1983.) Experiments on the action of the writer's cell referred to in April Abstracts, p. 222, l-h column.

AN AMAZING ELECTRIC BATTERY ["Salora Hydrolux" Primary Battery: Inactive when Circuit is Broken: 1 000 Hours' Use, then Renewed by Filtering the Electrolyte].—(*Autocar*, 18th May, 1934, Vol. 72, No. 2011, p. 881.)

EXPERIMENTAL CONTRIBUTION TO THE THEORY OF LECLANCHÉ CELLS [with Some Little Known Phenomena].—R. Cordebas. (*Rev. Gén. de l'Élec.*, 26th May, 1934, Vol. 35, No. 21, pp. 709–719.)

ON THE POLARISER CIRCUIT OF ELECTROSTATIC INFLUENCE MACHINES WITH FIXED FIELDS [Wommersdorf Condenser Machine].—S. Takata and others. (*Japanese Journ. of Eng., Abstracts*, Vol. 11, 1934, p. 44.)

AN ELECTRICAL DEVICE FOR REMOTE INDICATING, RECORDING AND INTEGRATING THE INDICATIONS OF A FLOAT TYPE FLUID METER [or other Readings needing Remote Indication].—J. Razek. (*Phys. Review*, 15th April, 1934, Series 2, Vol. 45, No. 8, pp. 563–564: abstract only.)

The device consists essentially of a long induction unit in which a rod of magnetic material moves and induces a voltage varying with the indication to be measured. A diode enables indication and recording to be made on ordinary d.c. instruments.

A PROBLEM OF VIBRATIONS IN ELECTRICAL ENGINEERING: ELASTIC SUPPORTS FOR ELECTRICAL MACHINES.—C. Galmiche. (*Rev. Gén. de l'Élec.*, 2nd June, 1934, Vol. 35, No. 22, pp. 739–755.)

A SIMPLE CONSTANT-LEVEL SUSPENSION [for Quadrant Electrometers, High-Sensitivity Galvanometers, etc.: Single-Point Suspension protecting also from Small Vibrations].—R. P. Johnson and W. B. Nottingham. (*Review Scient. Instr.*, May, 1934, Vol. 5, No. 5, pp. 191–192.)

THE RUPTURING STRENGTH OF INSULATING OILS FOR DIFFERENT WIDTHS OF GAP.—R. Bredner. (*E.T.Z.*, 7th June, 1934, Vol. 55, No. 23, p. 556.)

A [Guard-Ring] Cell for Routine Electrical Measurements on Insulating Oils.—W. G. Horsch and L. J. Berberich. (*Review Scient. Instr.*, May, 1934, Vol. 5, No. 5, pp. 194–196.)

The Breakdown Field Strength of Compressed Gases and Their Use for High-Tension Insulation.—A. Palm. (*Archiv f. Elektrot.*, 18th May, 1934, Vol. 28, No. 5, pp. 296–302.)

Breakdown of Solid Insulators in Liquids under Pressure.—L. Inge and A. Walther. (*Elektrot. u. Masch:bau*, 27th May, 1934, Vol. 52, No. 21, pp. 243–244.)

A New Porcelain for Insulators.—E. Alessandri: Korach. (*L'Elettrotec.*, 15th June, 1934, Vol. 21, No. 17, pp. 384–386.) Correspondence on the paper referred to in May Abstracts, p. 282, l-h column.

Recent Developments in Insulating Materials.—G.W.O.H.: Handrek. (*Wireless Engineer*, June, 1934, Vol. 11, No. 129, pp. 291–292.) Editorial based partly on Handrek's article—*see* May Abstracts, p. 282, l-h column, where references to other papers on the subject are also given.

The Radio-Frequency Performance of Some Types of High Resistance used in Radio Receivers [in connection with Their Suitability for the Dielectric Loss Measurement of Condensers and Insulating Materials].—M. Boella. (*Alta Frequenza*, April, 1934, Vol. 3, No. 2, pp. 132–148.)

The resistances tested were the Loewe, Dralowid and Siemens (Karbowid) types, and the frequency range extended from about 10 kc/s to over 5 Mc/s. The method of measurement is described and a number of curves given. The method of dielectric loss measurement, for which the high resistances were required, is based on replacing the condenser under test by a pure capacity shunted by a pure resistance. The tests showed that such commercial resistances could be employed, within certain limits, for this purpose: they also led to certain hypotheses on the variation with frequency of the apparent resistance values, and suggested certain modifications in design to improve the performance at high frequencies

A Study of R.F. Choke Coils.—Lee. (*See* under "Measurements and Standards.")

The Measurement of Temperature of Sound Fields [by Thermocouple: Construction Described].—E. A. Johnson. (*Phys. Review*, 1st May, 1934, Series 2, Vol. 45, No. 9, pp. 641–645.)

Thermocouples for the Measurement of Small Intensities of Radiations [Design of Thermocouples for use with A.C. Amplification].—L. Harris. (*Phys. Review*, 1st May, 1934, Series 2, Vol. 45, No. 9, pp. 635–640.)

A Selenium Alloy with High Thermoelectric Force.—M. Levitskaja and V. Dlugač. (*Physik. Ber.*, 15th May, 1934, Vol. 15, No. 10, p. 776.)

Metallic Resistance Materials [especially for High Temperatures: Megapyr, Permatherm, Kanthal, etc.].—A. Schulze. (*Zeitschr. V.D.I.*, 19th May, 1934, Vol. 78, No. 20, p. 615.)

The Electrical Conductivity of Compressed Graphite Powder.—J. Brunner and H. Hammerschmid. (*Physik. Ber.*, 1st May, 1934, Vol. 15, No. 9, pp. 692–693.)

Selsyn Instruments for Position Systems.—T. M. Linville and J. S. Woodward. (*Elec. Engineering*, June, 1934, Vol. 53, No. 6, pp. 953–960.)

General Method of Harmonic Analysis of Periodic Curves [Curve reproduced by Positions of Sliders on Potentiometers along Surface of Rotating Cylinder, each Slider connected to Segment of Commutator: in combination with a Rotating Resistance varying Sinusoidally].—V. Vasilesco. (*Rev. Gén. de l'Élec.*, 9th June, 1934, Vol. 35, No. 23, pp. 773–778.)

STATIONS, DESIGN AND OPERATION

Interaction of Radio Waves: Radio Tuning may be Insufficient to prevent Interference if Broadcasting Powers increase.—van der Pol. (*Science*, 8th June, 1934, Vol. 79, No. 2058, Supp. p. 11.)

The Usefulness of the "Sound Prism" Analyser in connection with the Necessary Separation of Broadcasting Wavelengths.—McIlwain and Schuck. (*Science*, 8th June, 1934, Vol. 79, No. 2058, Supp. p. 11.) For this analyser *see* July Abstracts, p. 388, r-h column.

Microphone Switching Systems for Broadcast Stations.—L. W. Barnett. (*Electronics*, May, 1934, pp. 152–153 and 170.)

[Swiss] Regulations concerning the Design and Testing of Mains-Driven Telediffusion Apparatus receiving from the Telephone Network.—(*Bull. Assoc. suisse d. Élec.*, No. 11, Vol. 25, 1934, pp. 290–296.)

The "Compandor"—an Aid against Radio Static [on Long-Wave Transatlantic Radiotelephone Circuit].—R. C. Mathes and S. B. Wright. (*Elec. Engineering*, June, 1934, Vol. 53, No. 6, pp. 860–866.) For a previous reference to this device for improving the speech/noise ratio, *see* 1933 Abstracts, p. 230 (Faulkner).

Preliminary Tests with Ultra-Short Waves [60 and 80 cm Micro-Waves, with Barkhausen-Kurz Generator: Range Tests in Town and Country: Duplex Telephony over 400 Metres in Town].—D. Sokolcow, W. Majewski and S. Ryzko. (*Wiadomości i Prace Inst. Radjotech.*, *Warsaw*, No. 6, Vol. 5, 1933, pp. 67–74: in Polish.)

THE RADIOTELEPHONE EQUIPMENT OF THE ITALIAN LINER "CONTE-VERDE"—(*Rev. Gén. de l'Élec.*, 16th June, 1934, Vol. 35, No. 24, p. 196 D.)

GENERAL PHYSICAL ARTICLES

SIDELIGHTS ON ELECTROMAGNETIC THEORY [Derivation of Electromagnetic Equations from Variational Principle; Remarks on Born's New Electrodynamics].—H. Bateman. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, pp. 721–723.)

EVIDENCE THAT HIGH-ENERGY COSMIC RAY PARTICLES HAVE PROTONIC MASS AND THAT NEGATIVE PROTONS EXIST.—Williams. (*See* reference under "Atmospherics and Atmospheric Electricity"; also Gamow, below.)

NEGATIVE PROTONS AND NUCLEAR STRUCTURE [Theoretical Evidence for Existence of Negative Protons].—G. Gamow. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, pp. 728–729.) *See* also Williams, above.

METALLIC ATOMS DEPOSITED AS THIN LAYER AT VERY LOW TEMPERATURE CANNOT YIELD FREE ELECTRONS: FILM IS THEREFORE NON-CONDUCTING: CONDUCTIVITY SUDDENLY PRODUCED BY RISE OF TEMPERATURE OR MAGNETIC FIELD—(*Funktech. Monatshefte*, May, 1934, No. 5, p. 198.) Based on paper in *Ann. der Physik*, Vol. 19, Series 5, 1934 (not as quoted).

SECONDARY EMISSION OF ELECTRONS FROM GOLD AND ALUMINIUM [Showing Decline of Secondary Emission at Higher Primary Energies].—J. C. Turnbull and P. L. Copeland. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 763: abstract only.)

SECONDARY EMISSION OF ELECTRONS FROM COMPLEX TARGETS [formed by Evaporation of One Element on Another].—P. L. Copeland. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, pp. 763–764: abstract only.)

ON THE ELECTRON THEORY OF METALS [Theory considering also Polar States of Atoms].—S. Schubin and S. Wonsowsky. (*Proc. Roy. Soc.*, 2nd June, 1934, Vol. 145, No. A 854, pp. 159–180.)

ELIMINATION OF PECULIARITIES IN DIELECTRIC BEHAVIOUR OF WATER VAPOR.—J. D. Stranathan. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 741: abstract only.) Giving electric moment of 1.83×10^{-18} for water molecule and explaining peculiarities as due to local condensation.

INFRA-RED ABSORPTION BY ROCHELLE SALT CRYSTALS [High Dielectric Constant Not Due to Polarisation of Water Molecules].—J. Valasek. (*Phys. Review*, 1st May, 1934, Series 2, Vol. 45, No. 9, pp. 654–655.)

ELECTRIC ENERGY AND WAVES [Treating Magnetic Energy simply as Potential Energy of Moving Charges].—F. W. Warburton. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 765: abstract only.)

VISUAL MEASUREMENTS OF STATISTICAL PHOTON FLUCTUATIONS [Schrott Effect].—Brumberg and Wawilow. (*Physik. Ber.*, 15th May, 1934, Vol. 15, No. 10, p. 804.)

MISCELLANEOUS

AN ADDITION THEOREM FOR SPHERICAL HARMONIC FUNCTIONS AND ITS APPLICATION TO DIRECTIONAL QUANTISATION OF ATOMS.—H. Hönl. (*Zeitschr. f. Physik*, 1934, Vol. 89, No. 3/4, pp. 244–253.)

SOME IMPORTANT STATISTICAL RELATIONS.—W. E. Deming and R. T. Birge. (*Phys. Review*, 15th May, 1934, Series 2, Vol. 45, No. 10, p. 767: abstract only.)

ON THE EXPANSION OF MATHIEU FUNCTIONS IN A SERIES OF BESSEL'S FUNCTIONS [used in Solution of Wave Equation for Spaces with Elliptical Boundaries].—S. C. Dhar. (*Phil. Mag.*, May, 1934, Series 7, Vol. 17, No. 115, pp. 1031–1038.)

ON THE THEORETICAL DETERMINATION OF EARTH RESISTANCE FROM SURFACE POTENTIAL MEASUREMENTS [D.C. Problem: Use and Limitations of Method of Successive Approximations].—A. F. Stevenson. (*Physics*, April, 1934, Vol. 5, No. 4, pp. 114–124.)

ON THE SOLUTION OF BOUNDARY PROBLEMS IN MATHEMATICAL PHYSICS [Application to Partial Differential Equations of Elliptic Type, *e.g.* in Skin Effect].—J. Neufeld. (*Phil. Mag.*, May, 1934, Series 7, Vol. 17, No. 115, pp. 987–992.)

NEW ALGEBRAIC METHOD FOR THE VECTORIAL CALCULATION OF ALTERNATING CURRENTS.—A. Blondel. (*Rev. Gén. de l'Élec.*, 12th May, 1934, Vol. 35, No. 19, pp. 635–651.)

NUMERICAL SOLUTION OF EIGENVALUE PROBLEMS IN ANY NUMBER OF DIMENSIONS [Approximation to Differential Equations by Difference Equations].—G. E. Kimball and G. H. Shortley. (*Phys. Review*, 15th April, 1934, Series 2, Vol. 45, No. 8, p. 560: abstract only.)

CALCULATION OF THE INTERNAL FORCES DEVELOPED IN MECHANICAL SYSTEMS SUBMITTED TO ELECTRODYNAMICAL FORCES.—A. Eigermann. (*Rev. Gén. de l'Élec.*, 19th May, 1934, Vol. 35, No. 20, pp. 677–688.)

ON THE OPERATIONAL TREATMENT OF CERTAIN MECHANICAL AND ELECTRICAL PROBLEMS [Theoretical Paper including Discussion of Electrical Oscillations in Transmission Lines].—A. N. Lowan. (*Phil. Mag.*, June, 1934, Series 7, Vol. 17, No. 116, pp. 1134–1144.)

ELECTRICAL EQUIVALENT CIRCUITS OF MECHANICAL TORSIONAL SYSTEMS, TAKING INTO ACCOUNT THE AXLE MASS.—L. Kettenacker : Deutsch. (*Archiv f. Elektrot.*, 18th May, 1934, Vol. 28, No. 5, p. 328.) Correspondence on Kettenacker's papers referred to in February Abstracts, pp. 89 and 110, l-h columns.

ELECTRICAL RECORDING EXTENSOMETER [Sturdy and Fool-Proof Ultra-Micrometric Equipment using Moving-Iron Oscillograph : for Bridge Vibration Measurement, etc.].—F. de la C. Chard. (*Engineering*, 29th Dec. 1933, Vol. 136, No. 3546, pp. 699–700.)

SCHÄFER'S VIBRATING-STEEL-WIRE EXTENSOMETER FOR BRIDGE GIRDER INVESTIGATIONS ETC.—Schäfer. (*See* end of abstract of Hagen's paper, under "Measurements and Standards.")

THE "TIME BALANCE" [Electro-Acoustic Apparatus for Rapid Regulation of Clocks].—Tamm. (*See* under "Measurements and Standards.")

VOLTAGE-DOUBLER TUBE IN NOVEL USE—A NEW LIGHT RELAY.—Hitchcock. (*See* under "Subsidiary Apparatus and Materials.")

PHOTOCELL CONTROL IN PAPER BAG MANUFACTURE.—O. C. Cordes. (*Elec. World*, 17th Feb. 1934, Vol. 103, pp. 248–251.) *Cf.* Shoults, July Abstracts, p. 398, r-h column.

ELECTRIC "EAR" SOLVES TYRE-DESIGN PROBLEM [Tyre Noise Analysis with Acoustimeter].—Goodrich Company. (*Electronics*, April, 1934, p. 119.)

EMERGENCY "REACTION INTERVAL" OF CAR DRIVER MEASURED BY RADIO SIGNALS BETWEEN TEST CAR AND EMERGENCY-PRODUCING CAR.—(*Electronics*, April, 1934, p. 119.)

REGISTERING BROADCAST LISTENERS' OPINIONS [Listeners instructed to "Telegraph" Votes by Switching on a 60-Watt Lamp : Additional Load measured by Electric Light Company].—(*Electronics*, April, 1934, p. 118.)

APPLAUSE-METER IN AMATEUR THEATRICAL CONTEST.—(*Electronics*, May, 1934, p. 155.)

MOBILE PUBLIC-ADDRESS EQUIPMENTS FOR PARIS POLICE, FOR PERSUASION AND WARNING OF CROWDS.—(*Electronics*, May, 1934, p. 155.)

DENTAL DECAY BACTERIA KILLED BY ULTRA-SHORT WAVES [3.2 m : Irradiation Time between 5 and 60 Minutes).—Oartel and Wolf. (*Radio, B., F. für Alle*, June, 1934, No. 6, p. 97 : paragraph on American announcement.)

REPLY TO THE PAPER BY N. N. MALOV : "THE QUESTION OF THE SELECTIVE WARMING OF TISSUE BY ULTRA-SHORT WAVES."—H. Pätzold. REPLY TO H. PÄTZOLD'S REMARKS.—N. N. Malov (*Physik. Zeitschr.* 1st May, 1934, Vol. 35, No. 9, pp. 376–377.)

For reference to the paper in question *see* April Abstracts, p. 224, r-h col. A paper by H. Pätzold was also referred to in 1932 Abstracts, p. 541, l-h col. Pätzold here remarks that the values of the dielectric constant and conductivity of different parts of the human body, known only for long wavelengths, may be quite different for ultra-short wavelengths and the range of wavelengths producing a given effect may vary from one individual to another and in unhealthy conditions. Further research requires the use of apparatus with wavelengths adjustable down to at least 3 m. Malov replies that he has already stated that his paper, as well as Pätzold's former one (which he had criticised in the paper referred to above), is only to be considered as a preliminary investigation. His (Malov's) calculated curves show that the differences in the temperature reactions of different organs in the range of 2–4 m are not greater than for longer waves, *e.g.*, 6–10 m. The therapeutic effect of ultra-short waves is not only due to heat production but also to some yet unknown cause. There appears at present to be no reason why we should prefer waves in the range 2–4 m to those of slightly greater length.

ANOMALOUS DISPERSION AND ABSORPTION OF ELECTRIC WAVES [of Low and Ultra-High Frequency] BY GLUCOSE AND SUCROSE.—M. Kubo. (*Jap. Journ. of Phys.*, 28th Feb. 1934, Vol. 9, No. 1, Abstracts p. 30.)

HIGH-FREQUENCY SCALPEL SUPPLIED WITH RADIO WAVES [eliminating Cord Connection].—Breitwieser. (*Sci. News Letter*, 19th May, 1934, Vol. 25, No. 684, p. 312.) *Cf.* 1933 Abstracts, p. 231, r-h column.

THE RECORDING OF [Physiological] ACTION CURRENTS WITH THE CATHODE-RAY OSCILLOGRAPH.—W. Schmitz. (*E.T.Z.*, 3rd May, 1934, Vol. 55, No. 18, pp. 448–449 : summary only.)

MAGNETIC VISION [Flicker and Headaches produced by Alternating Magnetic Field due to Eddy Currents in Brain, not to Direct Magnetic Influence on Nervous System].—L. Fleischmann. (*Electrician*, 4th May, 1934, Vol. 112, No. 2918, p. 608.) Continuation of the correspondence referred to in June Abstracts, p. 340, r-h column. *See* also *ibid.*, 8th June, p. 793.

ROYAL SOCIETY EXHIBITS, 9TH MAY : AURORA IN A BOTTLE—NEW CATHODE-RAY COMPASS—LIGHTNING CAMERAS—AUTOMATIC RADIO DIRECTION FINDER, ETC.—(*Electrician*, 18th May, 1934, Vol. 112, No. 2920, p. 657.)

WORK OF THE NATIONAL PHYSICAL LABORATORY IN 1933 [Summary of Report].—(*Electrician*, 18th May, 1934, Vol. 112, No. 2920, pp. 661–662.)

PRESERVATION OF RECORDS IN LIBRARIES [Factors causing Decay, and Measures to be taken against Them.]—Nat. Bureau of Standards. (*Bur. of Stds. Tech. News Bull.*, March, 1934, No. 203, pp. 21–22.)

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.

PIEZO-ELECTRIC CRYSTALS

Convention date (Germany), 22nd July, 1932.
No. 406572

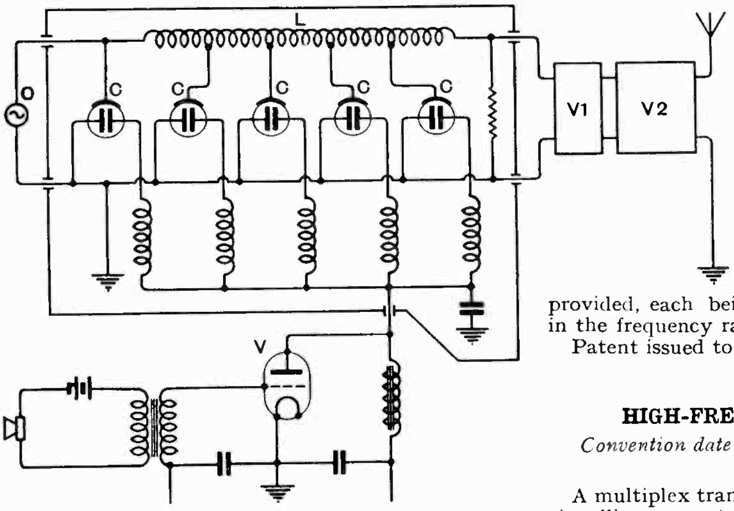
To stabilise the frequency of oscillation, the crystal is placed in an evacuated chamber fitted with a thermostat, and is so mounted that it is free to oscillate without either of its faces coming into contact with the electrodes. This is ensured by cutting in the middle plane of the crystal a circumferential groove with which projections on a ring-shaped holder engage to give a three-point support.

Patent issued to Telefunken Ges. Fur Drahtlose Telegraphie M.B.H.

MODULATING SYSTEMS

Convention date (U.S.A.) 19th September, 1931.
No. 406674

The carrier wave is phase-modulated by signal currents which vary the effective impedance of a loaded line along which the carrier is passing.



No. 406674.

As shown in the Figure, carrier-oscillations generated at *O* are fed into an artificial line comprising series inductance *L* and a number of neon tubes or similar glow-discharge devices *C* forming capacities in shunt. The effective capacities of the tubes vary according to the voltage applied to them by the modulating valve *V*. As the amplified microphone current from *V* increases or decreases the discharge across the tubes *C*, the impedance of the line changes, and by altering the velocity of the carrier wave imparts a phase modulation. The output is passed through a current-limiter *V1* and a combined power-amplifier and frequency multiplier *V2* to the transmitting aerial.

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

VARIABLE-MU VALVES

Application date 27th June, 1932. No. 406677

The valve is fitted with a two-part second grid comprising two series of windings, one of which may be enclosed by the other. The two windings are arranged so that, when one is used alone, the screening effect is sufficient to give the valve a constant mutual conductance. The second series of windings may then be switched in, from outside the valve, to change the effective mutual conductance to a desired value, or to impart to the valve a variable-mu characteristic.

Patent issued to J. H. O. Harries.

LOUD SPEAKERS

Application date, 8th September, 1932. No. 406749

To increase the note range, a single stretched diaphragm is driven simultaneously by two separate windings which are located in different concentric gaps in a common magnetic unit. One coil is arranged to respond to high and the other to low frequencies. The diaphragm is arranged to vibrate as a whole to low notes, whilst only the centre part responds to the higher frequencies. A number of such coils may be provided, each being responsive to selected bands in the frequency range.

Patent issued to A. H. Midgley.

HIGH-FREQUENCY CONDUCTORS

Convention date (U.S.A.), 31st December, 1931.
No. 406705

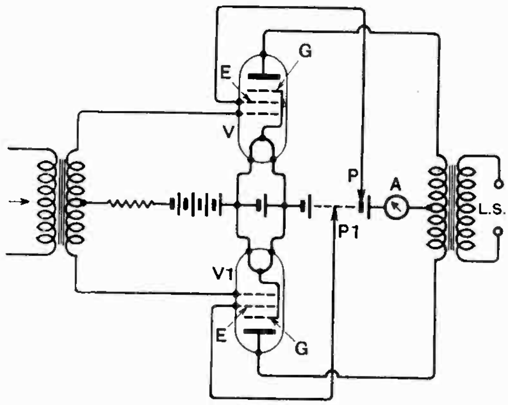
A multiplex transmission line, capable of carrying signalling currents of the order of a million cycles a second at a low energy level and without serious attenuation, consists of a tubular outer conductor, inductively loaded at intervals with strips of magnetic material. This encloses a second or return conductor which may also be loaded. The two conductors are air-spaced and are separated by insulating "spiders." The magnetic loading may take the form of a thin film electrolytically deposited on one or both of the conductors, or a number of loading wires may be arranged longitudinally between the two.

Patent issued to Standard Telephones and Cables, Ltd.

PUSH-PULL AMPLIFIERS

Application date, 8th July, 1932. No. 406744

To facilitate the accurate matching of a class *B* amplifier, each valve, *V*, *V*1 is of the pentode type, the electrode *E* being screened from secondary



No. 406744

anode emission by a suppressor grid *G*. Correct balance is obtained by adjusting the separate bias tappings *P*, *P*1 to the grids *E* until equal and opposite readings are shown on the ammeter *A*. The two electrode-systems may be enclosed in the same glass bulb.

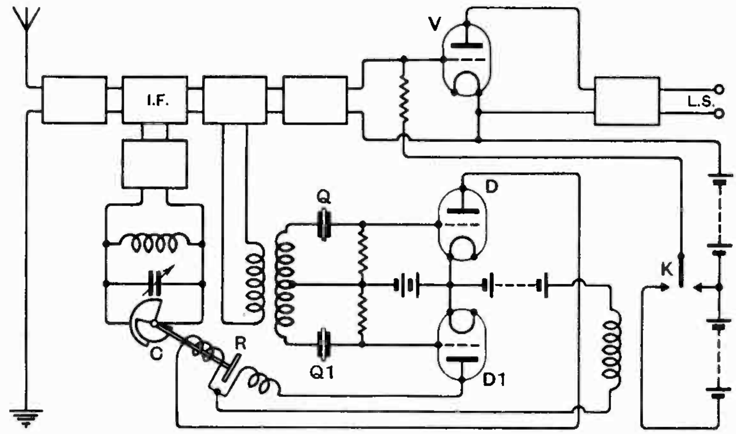
Patent issued to E. Y. Robinson, and Associated Electrical Industries, Ltd.

AUTOMATIC TUNING

Application date, 9th September, 1932. No. 407057

Receivers of high selectivity are provided with means for automatically keeping the tuned circuits in step with any slight variations or "drift" in the frequency of the incoming carrier wave. In the superhet receiver shown in the Figure, a part of the signal energy from the intermediate-frequency amplifier *IF* is fed to a pair of detectors *D*, *D*1 through piezo-crystals *Q*, *Q*1, one of which is tuned slightly above and the other slightly below the carrier frequency. Should the carrier wave "drift," one or other of the crystals will pass more energy, and the balance of the relay *R* will be upset. This rotates a compensating condenser *C* so as to bring the tuning back into step with the carrier and so prevent distortion. Another relay *K* places a heavy negative bias on the amplifier *V* so as to cut out from the loud speaker all signals below a predetermined level.

Patent issued to J. Robinson, and British Radiostat Corporation, Ltd.



No. 407057.

TELEVISION SYSTEMS

Convention date (U.S.A.), 16th January, 1932. No. 406845

Relates to systems in which the scanning of a motion-picture film is performed continuously as the film moves forward. According to the invention provision is made for "framing" the picture without altering the speed of travel. This is ensured by the use of an adjustable "impedance roller" mounted just below the gate and as close to it as possible. The roller is carried on a pivoted support so that it can be moved over a small arc in order to adjust the film in its frame position relatively to the gate.

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

WAVELENGTH SWITCHING

Convention date (Germany), 16th April, 1932. No. 406874

To reduce the number of control knobs on the panel of a receiver, the tuning handle is designed so that it can also be moved to and fro along its axis in order to operate the wave-change switch. A slotted sleeve engages a pin on the control shaft to allow the necessary axial movement, whilst a recess at the end of the sleeve throws the wave-change switch from one position to the other.

Patent issued to N. V. Philips Gloeilampen Fabrieken.

CATHODE-RAY TUBES

Convention date (Germany), 19th June, 1931. No. 407377

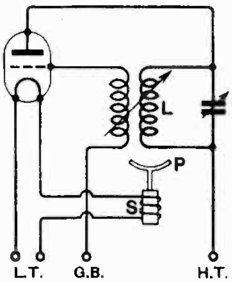
To prevent rapid disintegration of the cathode, due to ionic bombardment, the usual Wehnelt cylinder is provided on the outside with a metallic ring-shaped screen, which, owing to its relatively lower potential, attracts the free ions and so diverts them from the cathode.

Patent issued to M. von Ardenne.

STABILISING FREQUENCY

Application date, 12th September, 1932. No. 407079

The invention covers various means for automatically compensating for the effect of supply voltage fluctuations upon the frequency generated by a back-coupled valve oscillator. As shown in the Figure, a solenoid *S* is connected in the filament supply circuit and responds to any fluctuation in the supply by altering the position of a metal plate *P* relative to the tuning coils *L*. Alternatively the position of the "spade-tuning" element *P* is controlled by means of a bimetallic thermal strip, or similar current-actuated device.



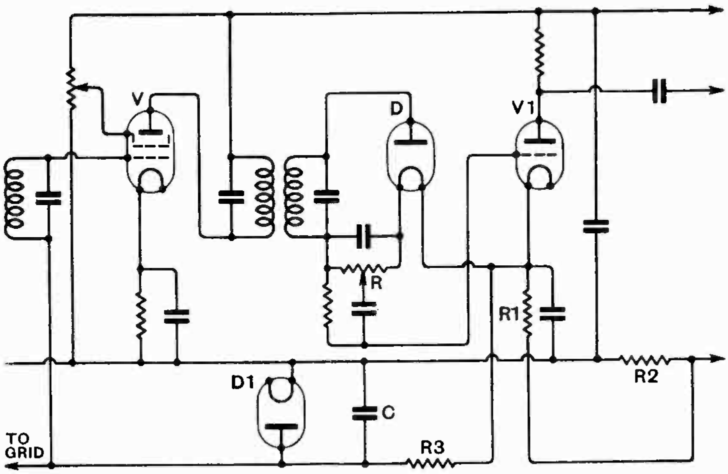
No. 407079.

Patent issued to G. B. Baker.

AUTOMATIC GAIN CONTROL

Application date, 13th August, 1932. No. 407317

The output from a high-frequency amplifier *V* is applied to the diode valve *D*, and the rectified D.C. and audio-frequency components are passed to the grid of the amplifier *V1* through a resistance *R*. One end of a resistance *R1* in the cathode circuit of the amplifier *V1* is connected to the negative end of a resistance *R2* (conveniently the loud-speaker field winding), whilst the other end of the resistance *R1* is connected through a filter network *R3*, *C* to the grids of the H.F. stages. The filter network is shunted by a diode valve *D1* or other rectifying device so that during "no signal" periods, when the applied bias tends to be positive, this positive bias is short-circuited or rendered ineffective so far as the H.F. valves are concerned. Incoming signals throw the cathode of the amplifier *V1* negative relatively to the cathodes of the H.F. valves, and this negative bias is passed on, unaffected by the diode *D1*, to give "delayed" gain control.



No. 407317.

Patent issued to E. Y. Robinson, and Associated Electrical Industries, Ltd.

THERMIONIC AMPLIFIERS

Application date, 19th September, 1932. No. 407398

The control grid consists of a large number of turns of fine wire coated with barium, thorium or other electron-emitting material. The cathode is thick or heavy, and the normal spacing between cathode grid and anode is increased. The amplifier is operated with a positive bias on the grid so that the rate of change in the number of electrons reaching the grid under the influence of an applied signal voltage is equal to the rate of change in the number of "secondary" electrons leaving the grid for the anode. Any power absorbed by the grid circuit is therefore supplied by the inherent grid emission, and is not taken from the signal energy. This allows the grid to be worked at a positive potential, giving the valve a high mutual conductance without introducing grid distortion.

Patent issued to F. B. Dehn.

TELEVISION SYSTEMS

Convention date (U.S.A.), 30th September, 1931.

No. 407409

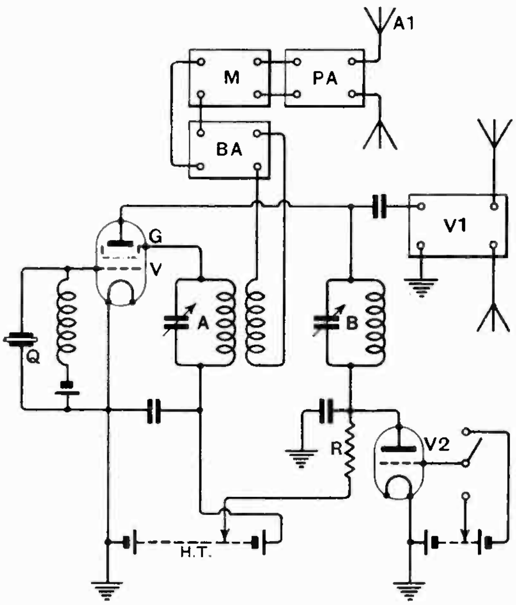
Both the vertical and horizontal scanning frequencies are superposed on the same carrier wave as the picture signals, the two synchronising impulses being separated out at the receiving end, and distinguished from the picture signals by amplitude selection, and from one another by the steepness of their respective wave fronts. A circular series of apertures, displaced from the spiral scanning-apertures of the usual rotating disc, generates the line-frequency impulses in a separate photo-electric cell. The picture-frequency impulses are produced by a single elongated slit in the scanning disc. The slit has an enlarged end portion which renders the cathode ray ineffective on the viewing-screen during the interval between one picture and the next.

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

TRANSMITTING SYSTEMS

Convention date (U.S.A.), 19th March, 1932.
No. 407529

The valve *V* generates by dynatron action, the grid *G* being tapped to a higher H.T. voltage than the anode. The circuit *A* is preferably tuned to the second harmonic of the fundamental frequency of the piezo-electric crystal *Q*, whilst the circuit *B*



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is tuned to the fourth harmonic, thus giving a simplified frequency-multiplication. Oscillations from the circuit *B* are fed to the aerial through a power amplifier *V*1. Signalling is effected by a valve *V*2 shunted across a resistance *R*. Oscillations from the circuit *A* may be fed separately through a " buffer " amplifier *BA*, modulator *M*, and power amplifier *PA* to a second transmitting aerial *A*1. The system generates considerable power at a stable frequency, and with substantially no reaction between the tuned circuits *A*, *B* and the master-control *Q*.

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

INDOOR AERIALS

Application date, 30th March, 1933. *No.* 407201

An aerial is built up from a number of rods connected together so as to form a semi-flexible assembly which can be pushed up the shaft of a chimney or ventilating flue. Insulating knobs are attached at the junctions of the rods, so as to prevent the line from making conductive contact with the walls. A bridge plate fitting over the arch of the fire place holds the aerial in position. The lead-in and earth terminals are taken to a wall contact at the side of the fireplace.

Patent issued to H. A. Ewen.

SIGNALLING VALVE FAILURE

Convention date (France), 14th November, 1932.
No. 407645

The filaments are arranged as arms in a Wheatstone bridge circuit, the diagonals of which contain signal lamps which indicate when a burn-out occurs. A relay coil and a rectifier are included in the diagonal to prevent the passage of any out-of-balance currents through the filaments of the remaining valves.

Patent issued to Lignes Telegraphiques et Telephoniques.

SHORT-WAVE RELAYS

Convention date (Germany), 22nd October, 1931.
No. 407739

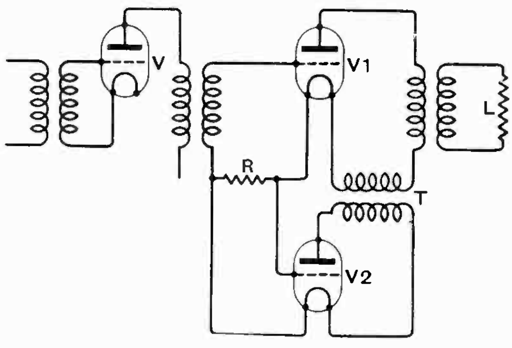
A studio, or an " outside " point of performance, is connected to the main broadcasting aerial by a link of ultra-short-wave radiation. In televising a sporting event, for instance, the local scanning apparatus modulates a 10-metre wave which is transmitted direct as a radiated beam. This is picked up at the main transmitter and re-radiated on a medium wavelength.

Patent issued to C. Lorenz, A.G.

THERMIONIC AMPLIFIERS

Convention date (Germany), 11th April, 1932.
No. 407542

When an amplifier is driven into grid current, distortion arises because (*a*) the normal anode current is " robbed " by the grid current and (*b*) the normal anode voltage is reduced owing to the extra load. The arrangement shown in the figure is designed to overcome both defects. The valves *V*, *V*1 are cascaded amplifiers feeding a load *L*. The input of an auxiliary " compensating " valve *V*2 consists of a resistance *R* inserted in the grid circuit of the amplifier *V*1. When grid current flows, the voltage drop across the resistance *R* automatically causes the valve *V*2 to feed energy,



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through the coupling *T*, into the output circuit of the amplifier *V*1, sufficient to offset the distortion which would otherwise be caused. When no grid current passes the effect of the resistance *R* is inappreciable.

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