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AND

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## Editorial

### Recent Developments in Frequency-changing Valves

THERE seems to be no limit to the number of electrodes and to the resulting complexity of the thermionic valve. It is now thirty years since Sir Ambrose Fleming invented the diode as a detector of wireless waves, to be followed in 1908 by the triode of De Forest, surely one of the most far-reaching inventions ever made. The next twelve years were spent in the gradual evolution of the triode to a device of reliable precision. Then followed the introduction of the screening grid, largely based on the pioneer work of Schottky, and the tetrode replaced the triode for many purposes, but mainly for high-frequency amplification. The disadvantages due to the emission of secondary electrons from the anode were overcome in the pentode of Philips by the introduction of a third grid between the screen and the anode, connected to the cathode, and thus giving a strong field between it and the anode which prevented any secondary electrons produced at the anode from escaping from it. The separate heating of the cathode, which was then becoming general, necessitated three external connections, making six terminals in all, the last grid being connected to the cathode inside the valve. The function of the pentode is the same as that of the triode, the two additional grids merely modifying its characteristics.

In the earliest applications of the valve to the superheterodyne principle of reception a triode was employed as an oscillator and its output was added to the received high-frequency signal current and the mixture applied to the operating grid of a rectifying triode, the anode circuit of which contained a circuit tuned to the difference frequency. This arrangement is still largely employed except that a pentode is used as the rectifying or frequency-changing valve. In practice many difficulties are encountered; harmonics are produced by the oscillator and by the rectifier; the signal and oscillator tuned circuits are coupled and affect each other, and there is the danger of radiating from the aerial at the oscillator frequency. Many methods of using the same valve as oscillator and rectifier have been tried and the growing popularity of the superheterodyne receiver has led to intensive research in the development of suitable valves for this purpose. There have always been attempts to get as much as possible into one glass bulb, and a few years ago Loewe and Ardenne not only put two or three valves into a single bulb, but also much of the auxiliary apparatus of a multi-stage amplifier. The first attempt to control the electron stream in a valve by two grids each supplied with an alternating voltage was probably made by Schottky, who, however, supplied both grids with the same A.C. voltage, the electron stream passing through them in succession, with the object of obtaining a steeper characteristic, *i.e.*, a greater mutual conductance.

Even with a separate oscillator it is possible to avoid the coupling of the two tuned circuits, except for the very small amount due to the capacity between two grids. If the electron stream of the mixing valve is acted upon by two grids one after the other as mentioned above, one of the grids can be supplied from the signal and the other from the oscillator. Whereas if the two currents are first mixed and then supplied to the valve, it is essential that the latter should have a non-linear characteristic in order to obtain rectification and production of the difference frequency; this is not necessary in the double-grid valve, each grid of which may have a linear characteristic. A valve suitable for this purpose has two operating grids and two screen grids; it is thus like a pentode with an extra operating grid between the two screens, but with this important difference, that the screen next to the anode is not connected to the cathode but to the other screen grid. The valve has thus six electrodes, and we have therefore a hexode.

Instead of using a separate triode as an oscillator a triode can be incorporated in the same bulb as the hexode and utilise a part of the same cathode. Such valves are now on the market. In some cases the valve is made somewhat longer than usual and the lower part of the cathode is used for the triode and the upper and major portion for the hexode ; in other cases the two valves are side by side in the bulb. In all cases the grid of the triode is connected within the valve to the screened second operating grid of the hexode.

In modern medium-priced receivers it is usual for the automatic volume control to operate directly on the frequency-changing valve ; this is done by varying the bias of the first or signal-operated grid. It is essential that a wide variation of this grid bias should be possible without affecting the oscillator in any way, and this is the case in a properly designed triode-hexode. In Germany such a valve is called a Fading-Misch-Hexode—that is to say, an anti-fading frequency-mixing hexode.

Another line of development which has been followed simultaneously is the arrangement of the triode oscillator and pentode in series in one common electron stream, instead of side by side each with its own electron stream derived from different parts of the same cathode. In this case, starting from the cathode, there is the oscillator grid and a very open grid which acts as the oscillator anode. The electron stream then passes on through a high-voltage screen to the ordinary elements of a pentode, viz. : operating grid, high-voltage screen, cathode connected screen and anode. The two high-voltage screens are connected inside the valve and may be regarded as one, enclosing the signal-operated grid. This type of valve has been developed simultaneously in America—where it it is called a pentagrid converter—and in Europe by Philips, who refers to it as an Oktode. If this multiplication of electrodes continues one will be tempted to refer to valves in general as "multiplodes," or, as the purist will probably prefer, "polyodes."

With regard to the question of the relative merits of the parallel and series arrangements of oscillator and rectifier, it is interesting to note that the Telefunken Company has decided to market both forms because of the uncertainty in the present state of rapid development as to which type will prove the more successful. Finality in receiver design appears to-day to be further removed than ever.

G. W. O. H.

# Radio Wave Propagation*

## An Ultra Short Wave Demonstration Model

*By* E. C. S. *Megaw, B.Sc., D.I.C.*

*(Communication from the Research Staff of the M.O. Valve Company, Ltd., at Wembley)*

THE development, during the last few years, of efficient and stable oscillators for metre and centimetre wavelengths has provided radio engineers and physicists with a useful tool for various purposes apart from actual communication. The object of this article is to describe a simple and compact apparatus for demonstrating the principal phenomena of radio wave propagation using wavelengths of the order of 10 to 30 cm. This apparatus was first shown at the January, 1934, Exhibition of the Physical Society, using 25 cm. waves produced by an Osram CW.10 magnetron valve. It has since been used with an experimental valve operating at about 14 cm. wavelength with equally satisfactory results.

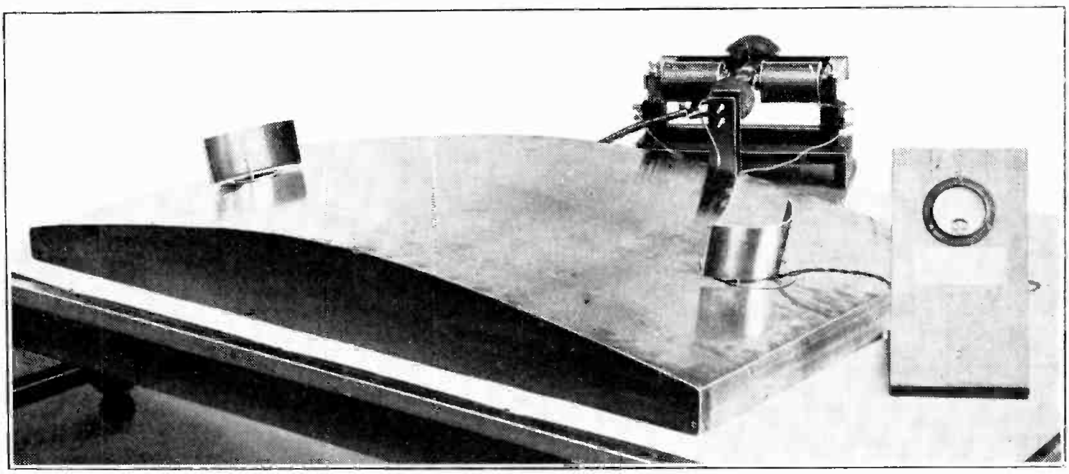

Fig. 1.—*Demonstration model with magnetron oscillator.*

Fig. 1 shows a photograph of the complete apparatus apart from power supplies. The separate parts will now be described in detail.

### The Transmitter

The transmitter uses a magnetron oscillator of the split-anode type, which has been discussed by the writer elsewhere.† The valve has a cylindrical anode, which is divided longitudinally into two segments separated by a small gap. The oscillatory circuit consists of an adjustable parallel wire system connected at one end to the two anode segments. The filament is of pure tungsten accurately centred in the anode. To reduce inter-electrode capacity, anode and filament leads are brought out at opposite ends of the bulb.

The valve is mounted between the poles of an electro-magnet, which is designed to give a very uniform magnetic field inside the anode. The object of the magnetic field is to deflect the electrons emitted from the filament so that they describe roughly circular paths inside the anode. The frequency at which the electrons travel round their orbits depends mainly on the magnetic field strength. To produce centimetre waves the field strength is adjusted so that the electron frequency corresponds to the desired wavelength. When the anode voltage is increased to a value which makes the

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

† *Journ. I.E.E.*, Vol. 72, p. 326, April, 1933.

electrons skim the inner surface of the anode, oscillations are set up in the external circuit. To obtain the maximum transfer of energy from the moving electrons to the circuit, the electrode axis must be tilted at an angle of a few degrees to the direction of the magnetic field. For this purpose the valve is mounted so that it can be rotated through a small angle between the magnet poles.

The relation between wavelength and magnetic field strength is given approximately by

$$\lambda = 12{,}000/H$$

where $\lambda$ is in cm. and $H$ in c.g.s. units. This relation is independent of the valve dimensions. The optimum anode voltage is given approximately by

$$E_a = 6.3 \times 10^5 \, . \, d_a^2/\lambda^2$$

$d_a$ being the anode diameter in cm. Thus, the shorter the wavelength required the larger the field strength and anode voltage must be. For a given valve the minimum wavelength is fixed by the highest anode voltage which can be safely used. For the shortest wavelengths the anode diameter must be kept small to avoid overloading. The efficiency of a properly adjusted oscillator of this kind is of the order of 10 per cent.

The circuit diagram of the transmitter is shown in Fig. 2. The oscillatory circuit is tuned by adjusting the position of the disc $D$ so as to make the length $l_1$ approximately equal to half a wavelength. The object of the disc is to reduce radiation from the circuit. Its radius, although not critical, should preferably be $\frac{1}{4}$ or $\frac{3}{4}$ of a wavelength. The transmitting aerial is fed through a concentric line which is connected to the oscillator by a short length $l_2$ (about half a wavelength) of parallel wire line, as shown in Fig. 2. The coupling is adjusted by means of sliding connectors so as to match the feeder impedance.

Rheostats for controlling the field current and filament emission (which must be kept within certain limits to obtain good efficiency) are shown in the diagram. An adjustable H.T. supply is also necessary if an appreciable wavelength range is to be covered. It will be seen that the circuit requires no H.F. chokes and there is only one oscillatory circuit to tune.

## Transmitter Power Supplies

When using an Osram CW.10 magnetron valve operating at about 25 cm. wavelength, the transmitter requires approximately the following supplies:

| | |
|---|---|
| L.T. .. .. | 3.0 V. 3.5 A. |
| H.T. .. .. | 1,000 V. 30 mA. |
| Field .. .. | 5.0 V. 1.0 A. |
| | (or 2.5 V. 2.0 A.) |

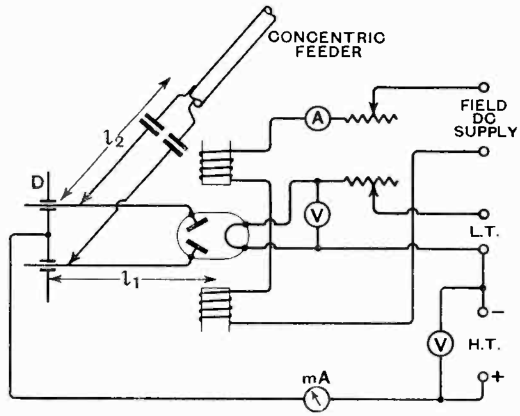


Fig. 2.—*Transmitter circuit diagram.*

For the demonstrations previously referred to an A.C. mains unit was used for all the supplies with A.C. filament heating and full-wave rectified supplies for H.T. and field. Alternatively, the filament and field can be supplied by a 4-volt accumulator and a small motor generator used for H.T. if A.C. supplies are not available. If the transmitter is also to be used for radio communication purposes D.C. filament heating is preferable for good frequency constancy.

The H.F. output of the transmitter under the above conditions is about 2 to 3 watts.

## The Earth Model

The surface over which the waves are transmitted consists of a copper sheet 8ft. by 2ft. mounted on a wooden frame so as to have a radius of curvature of about 8ft. along its length. Compared with the height of the aerials, this represents a great exaggeration of the curvature of the earth's surface, but the object in using a curved surface was only to give a qualitative demonstration of the diffraction of radio waves and to have a region of weak ground ray not too far from the transmitter for experiments with reflected rays.

It would be quite possible to arrange a model of this kind so that the surface had the proper scale values of conductivity and dielectric constant, but no such refinements were attempted in the present case.

### The Transmitting Aerial and Feeder

The arrangement of the transmitting aerial is shown diagrammatically in Fig. 3. The aerial itself consists of a vertical rod of adjustable length projecting from the surface of the model near one end. If the aerial is a plain rod its length is adjusted to a quarter wavelength. By attaching a small disc to the top of the aerial, as indicated in Fig. 3, the intensity of the horizontal radiation can be increased. This type of radiator has recently been adopted in some Continental broadcasting stations to reduce fading. In the model this disc is about one-twentieth wavelength in diameter and the optimum height is found to be about one-eighth wavelength. The aerial mounting is arranged so that a parabolic reflector can be fitted to it, the aerial lying along the focal line of the reflector. The reflector can be rotated round the aerial by means of a small motor outside the model to produce a rotating beam of radiation.

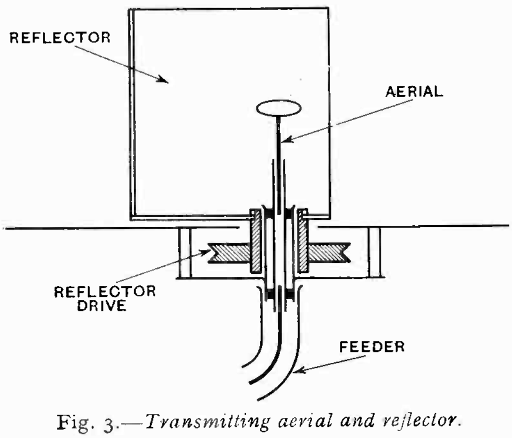


Fig. 3.—*Transmitting aerial and reflector.*

The feeder is connected directly to the lower end of the aerial. By making the characteristic impedance of the feeder sufficiently low, reflection loss at the junction between aerial and feeder can be reduced to a negligible value. The feeder used consists of flexible copper tubing of about 8 mm. internal diameter with a central conductor of 16 S.W.G. copper wire. Small ebonite spacers are used at 5 to 10 cm. intervals. This feeder has a characteristic impedance of about 100 ohms and shows no serious loss

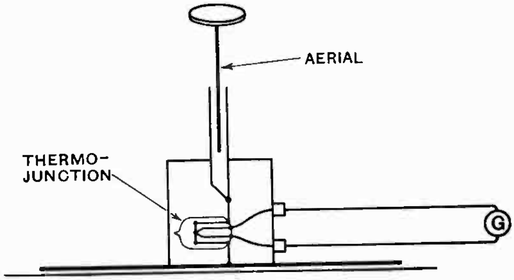


Fig. 4.—*Receiver.*

in sections several wavelengths long. On account of its mechanical flexibility, the relative positions of transmitter and earth model need not be definitely fixed.

### The Receiver

Fig. 4 shows the arrangement of the receiver. The aerial is of the same type as that used at the transmitter. To measure the received current, a vacuum thermo junction is connected between the lower end of the aerial and "earth." The junction is mounted in a small ebonite block which supports the aerial and which is fixed to a brass disc forming the earth connection. This disc is made half a wavelength in diameter so that it acts as an efficient "counterpoise" if it is desired to use the receiver apart from the earth model. The thermo-junction is connected by flexible leads to a suitable galvanometer so that the receiver can be placed anywhere on the model. It was found that a 5 mA. junction of about 100 ohms heater resistance gave satisfactory results in conjunction with a Weston student's galvanometer. The tuning of the receiving aerial is very flat, with a series resistance of the same order as the aerial impedance, which proved to be an advantage rather than otherwise. The junction does not, however, behave as a pure resistance at these frequencies. It was found that the optimum length of the aerial (without top disc) was considerably greater than one-quarter wavelength, indicating that the junction was behaving as a resistance shunted by a capacitance.

The receiver is arranged so that reflectors of various sizes can be clipped on at the proper distance from the aerial. An aperture of about 1.25 λ was found to give the best results at both transmitter and receiver when the focal distance of the parabola was made equal to $\frac{1}{4}\lambda$. The following gains were obtained at the receiver with reflectors of these dimensions and various heights :

| | | | |
|---|---|---|---|
| Reflector height .. | $\frac{1}{4}\lambda$ | $\frac{1}{2}\lambda$ | $\frac{3}{4}\lambda$ |
| Gain in db. .. | 3.4 | 4.9 | 6.0 |

It was observed that the same reflectors gave slightly more gain at the transmitter than at the receiver, presumably due to the different current distribution in the aerial.

### Results Obtained with the Model

With the transmitter and receiver described it was found that an adequate received signal for demonstration purposes could be obtained with the receiver anywhere on the surface of the model. With the receiver removed from the model to a distance of about 20ft. from the transmitter a perceptible signal was still obtained when reflectors giving a total gain of about 12 db. were used.

The following effects can be illustrated by means of the model :

(1) Attenuation of signal with increasing separation between transmitter and receiver.

(2) Persistence of a diffracted signal when the receiver is below the transmitter horizon. Care must be taken to see that no radiation is reaching the receiver direct from the oscillator. This can be ensured by raising the model so that the lowest part of its surface is above the highest part of the transmitter.

(3) Reflections, shadows and interference effects from any more or less conducting object placed on the model. (This type of effect is often more difficult to avoid than to demonstrate !)

(4) Polarisation of the waves, by rotating the receiving aerial in a plane normal to the direction of propagation.

(5) Interference effects between a weak " ground ray " and a reflected ray returned from any convenient reflector above the model. It can be shown that a standing interference pattern exists on the surface of the model and that any variation of reflector height produces " fading " at a fixed receiver.

A metal plate about 18in. square serves quite well as the reflector for this purpose, but a more faithful representation of the ionosphere has also been used with considerable success. This takes the form of a

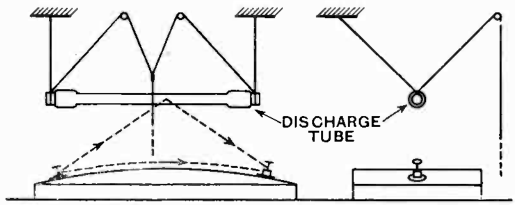


Fig. 5.—*Arrangement of discharge tube for ionosphere demonstration.*

discharge tube suspended on cords above the model so that its height can be varied, as indicated in Fig. 5. The electrical connections to the tube, which are not shown in Fig. 5, are carried along the two fixed cords. With this arrangement interference fading can be produced by varying the height of the discharge tube, and a complete " fade out " of the reflected ray occurs when the current in the discharge is reduced to the point at which " electron limitation " sets in. A rough estimate indicated that this occurred at approximately the ionisation density (about $10^{11}$ electrons per c.c. for 14 cm. waves) given by the formula used to determine the ionisation in the upper atmosphere by radio-telegraphic methods.

In addition to experiments of this kind, which can be extended *ad lib.* according to the ingenuity of the demonstrator, the model can easily be adapted to measurements of the horizontal polar diagrams of almost any kind of aerial system and, with a modified receiver, of the vertical diagrams also. The design of the model would naturally be somewhat different if quantitative work of this sort were the primary object. It seems probable, however, that scale models on these lines may prove of value in the future to the designer of complicated aerial systems.

The author desires to tender his acknowledgment to the General Electric Company and the Marconi Company on whose behalf the work was done which has led to this publication.

# Cambridge Versatile Galvanometer*

## With Some Attachments for Use in the Wireless Laboratory

*By C. R. Cosens, M.A.*

IN 1926 Drs. L. A. Sayce and James Taylor contributed a series of articles to this journal entitled, "An Experimenter's Wireless Laboratory," in which were described methods of making shunts, valve attachments, etc., by means of which the majority of measurements requiring an indicating instrument likely to be wanted in a wireless laboratory could be made with a single galvanometer. The instrument recommended was a Type I Unipivot galvanometer, but on comparing this with its elder sister, Type L, the writer came to the conclusion that the increased accuracy obtainable with the latter, with its scale length double that of the Type I, and other advantages, were well worth the extra cost. After examining many patterns and ranges, a form of the Type L known as the Versatile Galvanometer was selected.

This instrument has now been in use for four years; several attachments, to enable a large range of D.C. and A.C. measurements to be made with it, have been constructed, and it has indeed proved "versatile"; on looking over experimental notebooks there are few tables of measurements in which a column of figures is not found to bear the footnote "L 14277," indicating that this particular instrument was used.

Although no original principles are involved, some of the attachments possess novelty of detail and arrangement; and on account of the general usefulness of the instrument thus equipped, it was thought that a description of the galvanometer and accessories might be of interest.

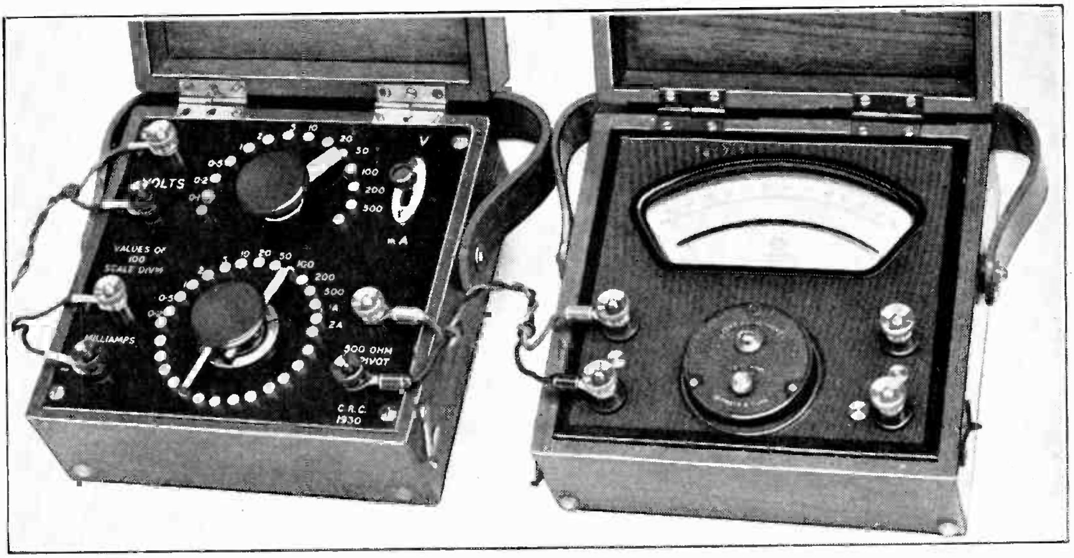


Fig. 1.—*D.C. Range-box and Versatile Galvanometer.*

### I. Description of Versatile Galvanometer

A photograph of the Versatile Galvanometer connected to a "Range box" for D.C. measurements is given in Fig. 1; Fig. 2 shows a full-size illustration of the scale and Fig. 3 a diagram of connections. It is essentially a micro-ammeter giving full-scale deflection for 240 $\mu$A., but being standardised for resistance it is also a millivoltmeter of

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

very low current consumption. As indicated in Fig. 3, the copper moving-coil, having a resistance (including leads) of 10 ohms, is approximately a horizontal position, but since the construction is the "Unipivot" type first introduced by R. W. Paul in 1903,

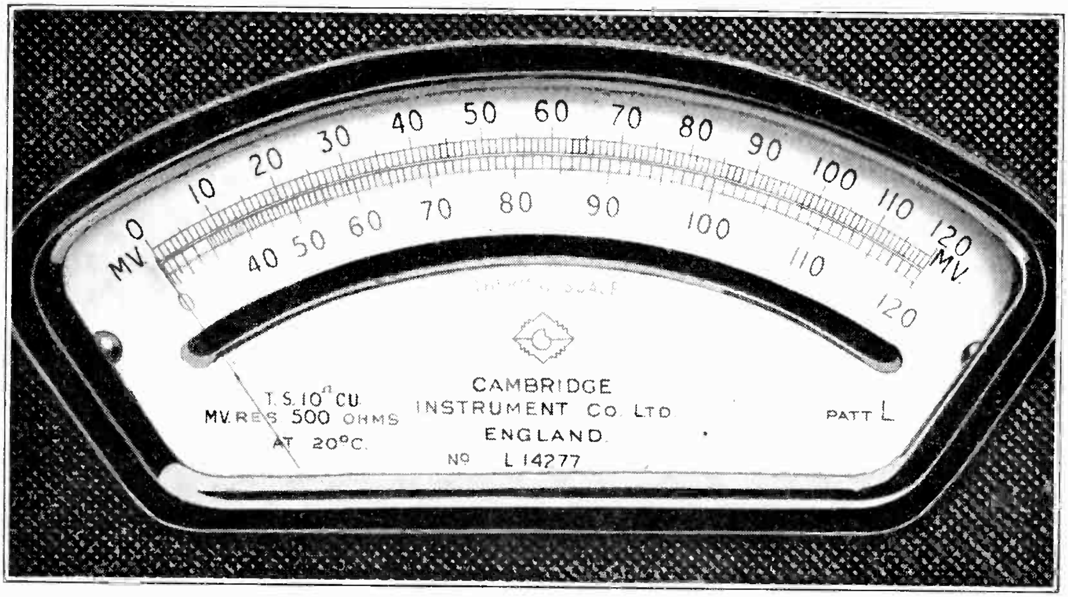


Fig. 2.—*Full-size reproduction of scale.*

connected between the right-hand terminals, so that full-scale deflection is given by a p.d. of 2.4 millivolts across these. Between the left-hand terminals a manganin resistance of 490 ohms is connected in series with the moving-coil, so that when these terminals are used the instrument is a direct-reading millivoltmeter, giving 120 mV. full scale (120 divisions), the high resistance of the manganin relative to the copper coil makes temperature error quite negligible.

A knife-edge pointer moves over two scales, which are mounted on a mirror by which parallax error can be eliminated. One scale, printed in black, is uniformly divided and is direct reading in millivolts (1 mV. per scale division using the left-hand terminals, or 0.02 mV. per scale division using the right-hand terminals). The second scale, printed in red, has its zero and 120 marks coincident with those of the black scale, but is divided according to a square law; intended by the makers for use with thermocouples connected to the right-hand terminals, the e.m.f. of which is proportional to the square of the heater current, this square-law scale is also useful for other purposes.

The instrument is used with the scale in errors of several degrees in level have negligible effect on the reading; no levelling is necessary and any reasonably flat table top is used to stand the instrument on.

The whole is contained in a teak case fitted with a hinged lid (removable on sliding hinges when opened), and the lid is so arranged that the act of closing it actuates the coil clamping device which holds the movement clear of the pivot-jewel, a valuable feature since there is then no risk of damage by forgetting to clamp before moving.

## II. Range Box for D.C. Measurements

The galvanometer is well adapted for use with "range multipliers," *i.e.*, series or shunt

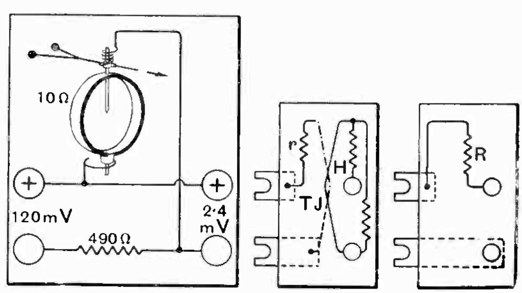


Fig. 3.—*Connections of the copper moving-coil.*

resistances by which any D.C. voltage or current can be measured. For this purpose the multipliers are connected to the left-hand terminals (0–120 mV. 500 ohms). A separate multiplier can be made for each range, as recommended in the articles referred to above or such multipliers can be bought ready made from the makers of the galvanometer. But for many reasons it is much more convenient to have all the multipliers in one self-contained "Range Box," with a change-over switch for volt and milliamp measurements, the ranges being controlled by stud switches. For one thing, in wireless work we often need to make measurements of quantities of whose magnitudes we have the vaguest ideas only, before the measurement is made, and risk of damage from using too low a multiplier and overloading the galvanometer is avoided if we start on the highest range and reduce the multiplier by merely rotating a stud-switch until we get a reasonable deflection.

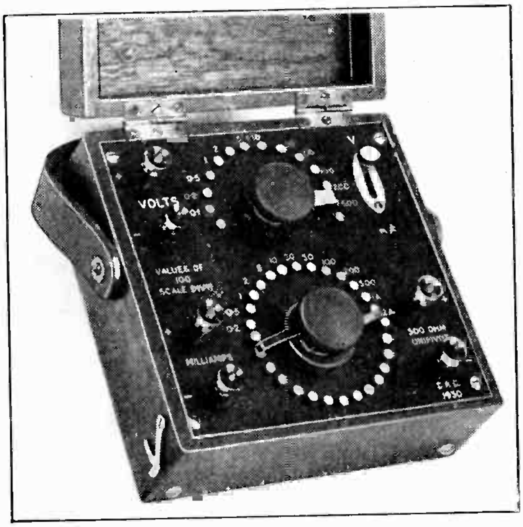


Fig. 4.—*Range-box for D.C. measurements.*

Again, for accuracy we clearly want to use the upper part of the galvanometer scale only (an error of 1/5 scale division at 100 is 0.2 per cent., but at 10 it is 2 per cent.), *i.e.*, the ratio of successive ranges should not be too great, this means a large number of multipliers, which is extravagant in storage space as well as in cost.

Since the only multiplications most of us can do "in our heads" without risk of error are by 2 and ½ (multiplied by any power of 10) the series of multipliers should be 1, 2, 5, 10, 20, 50, etc. We shall then never need to use the scale below 1/2.5 or 0.4 of

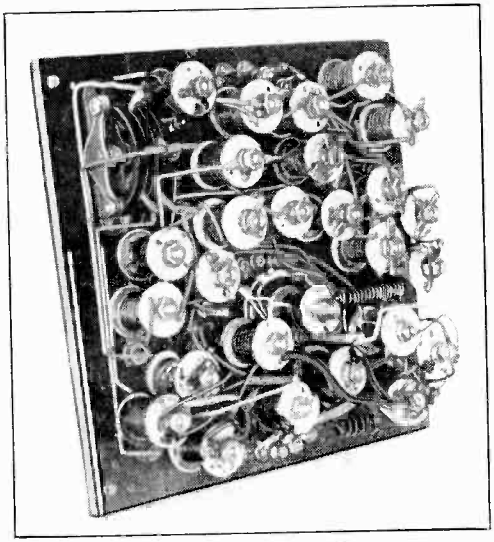

Fig. 5.—*Interior of Fig. 4.*

full-scale reading (*i.e.*, below 48 scale divisions).

The value of each multiplier is usually indicated either in the form "volts per scale division" or "volts for full-scale deflection," but neither of these is so convenient as specifying the volts (or current) for 100 scale divisions, which we shall call "the range"; this avoids error in placing the decimal point, as provided we use the lowest range possible without overloading it indicates the order of the result at once, it also gives an indication of the maximum allowable on that range (actually the maximum will be 20 per cent. greater, since full scale is 120 divisions).

Starting with no extra series resistance, the lowest range is 100 millivolts, or 0.1 volt, and successive ranges will be 0.1, 0.2, 0.5, 1, 2, 5 . . . 500 volts, giving twelve voltage ranges, the maximum voltage readable at full scale on the highest range will be 600, which is high enough for most purposes.

The lowest (unshunted) current range is 200 $\mu$A. for 100 scale divisions, *i.e.*, 0.2 mA. and thirteen current ranges give 0.2, 0.5, 1, 2, 5 . . . 500 mA., 1 A., 2 A.; with a maximum current readable on the highest range at full scale of 2.4 A. Higher ranges are comparatively seldom needed in the wireless laboratory, and in any case shunts for these cannot conveniently be made of wire, manganin strip is necessary, and if required such shunts may best be made as separate attachments, not included in the "range box."

The whole twelve voltage and thirteen current multipliers are mounted in a box the same size as that containing the galvanometer. Fig. 4 is a photograph of the finished range-box; Fig. 6 is a diagram of connections. The whole of the "works" is attached to the top panel, which is shown removed and inverted in Fig. 5, from which it will be seen that a certain amount of "scheming" is necessary to get everything into the somewhat limited space.

The method of fixing the bobbins to the panel without showing numerous screw-heads on the top of the panel is simple, but does not appear to be generally known or it would more often be used; it may be called the double panel system. A thin ($\frac{3}{16}$in.) ebonite panel is cut and squared, and a paxolin panel $\frac{1}{4}$in. thick and a shade smaller (say, $\frac{1}{2}$ mm. each way) is cut. Positions of all holes for switch studs, terminals, etc., are marked out on the paxolin with a scriber and drilled, then two holes near opposite corners are drilled through the ebonite and used to bolt the two panels together, after which the paxolin is used as a jig for drilling the ebonite. The ebonite can now be removed and sent to be engraved; the paxolin is cut away under the change-over switch, and counter-sunk holes made through the paxolin for the bolts holding the resistance bobbins. After inserting these, the two panels are held together by the switch-studs, etc.

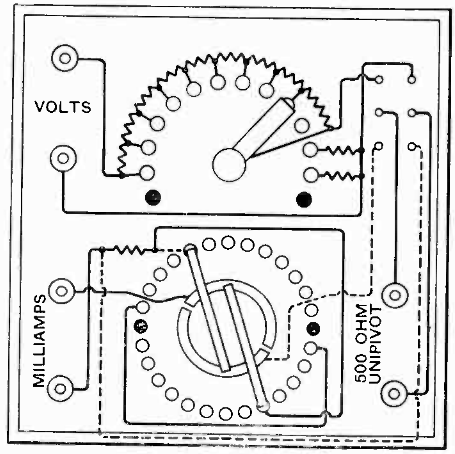


Fig. 6.

Table A shows the values of the series and shunt resistances for the volt and current ranges. Manganin is used through-

TABLE A.

D.C. RANGE-BOX FOR 500 Ω UNIPIVOT (1 mV. PER SCALE DIVISION).

| Milliampere Ranges. | | | Volt Ranges. | | | |
|---|---|---|---|---|---|---|
| mA. per 100 Scale Divisions. | Resistance (Ohms). In Circuit. | Resistance (Ohms). Shunt only. | Volts per 100 Scale Divisions. | Resistance (Ohms). Total in Circuit. | Resistance (Ohms). Section. | Material of Section. |
| 0.2 | 500 | ∞ | 0.1 | 500 | 0 | |
| 0.5 | 200 | 333.3 | 0.2 | 1,000 | 500 | |
| 1 | 100 | 125 | 0.5 | 2,500 | 1,500 | Manganin |
| 2 | 50 | 55.56 | 1 | 5,000 | 2,500 | |
| 5 | 20 | 20.83 | 2 | 10,000 | 5,000 | |
| 10 | 10 | 10.20 | 5 | 25,000 | 15,000 | |
| 20 | 5 | 5.05 | 10 | 50,000 | 25,000 | |
| 50 | 2 | 2.008 | 20 | 100,000 | 50,000 | Eureka |
| 100 | 1 | 1.002 | 50 | 250,000 | 150,000 | |
| 200 | 0.5 | 0.5005 | 100 | 500,000 | 250,000 | |
| 500 | 0.2 | 0.2001 | 200 | — | 500 Ω shunt | |
| 1 amp. | 0.1 | 0.1000 | 500 | — | 125 Ω shunt | Manganin |
| 2 amp. | 0.05 | 0.0500 | — | — | — | — |

All shunts of Manganin. Shunts of 50 mA. (2 ohms) and beyond have separate current and potential leads.

The 200 V. and 500 V. ranges have all the series resistance of the 100 V. range (249,500 ohms) in series with the shunted galvanometer.

out except for the higher volt ranges, where any thermal e.m.f. due to eureka would be much too small noticeably to affect the readings.

For the two highest volt ranges the galvanometer is shunted; in the professionally made range multipliers this device is adopted for all ranges greater than 2 volts on account of the errors, liable to arise from leakage, in ordinary commercial "heavy current" engineering, if very high series resistances are used. But in the wireless laboratory the value of a voltmeter taking a

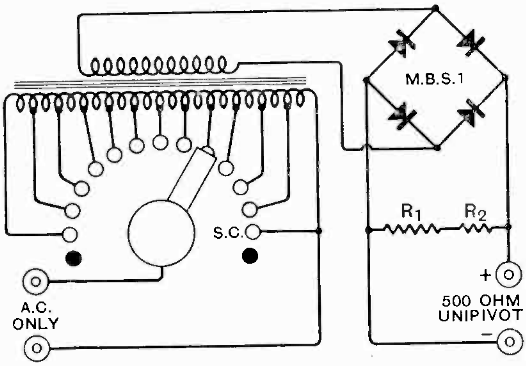


Fig. 7.

very small current is so great (and leakage is less to be feared) that shunting is only adopted for these two ranges, so we have "1,000 ohms per volt" on the 500 V. range, 2,500 on the 200 V. range, and 5,000 ohms per volt on all lower ranges.

### III. Current Transformer and Metal Rectifier

For measuring alternating currents at supply and low audio-frequencies a combination of current-transformer and metal rectifier is adopted. The output terminals of the rectifier are connected to the left-hand terminals of the galvanometer, and a shunt across the galvanometer is used to render the combination direct-reading, and to avoid damage should the transformer be left in circuit with the galvanometer disconnected On the 1, 2, 5 range principle suggested in the last section, we have twelve current ranges, namely, 100 scale divisions for 1, 2, 5 . . . 500 mA., 1 A., 2 A. and 4 A. (the latter would be better 5 A. to conform to the principle, but this cannot be obtained without an increase in the turns on the current transformer). Fig. 8 shows a photograph of the finished accessory, and Fig. 7 a diagram of connections. Table B gives details of windings, etc.

The core is a ring built up of a continuous ribbon of mumetal wound into a coil, a form of construction much cheaper than using ring stampings, and equally efficient. (It was obtained ready coiled up and annealed and taped from The Telegraph Construction and Maintenance Co., Ltd., Greenwich.)

The winding process is rather tedious; the wire is first wound on bobbins small enough to pass through the ring with ease, the ring is clamped in a horizontal plane in a retort-stand or similar device, and the bobbin threaded through the ring for each turn. Counting turns is greatly facilitated by a device suggested to the writer by Mr. R. R. Mallock; after putting on five turns, tie them with a loop of thread having a long end, and lay the end over to the left (if winding from left to right). Put on five more turns,

TABLE B.—CURRENT TRANSFORMER AND METAL RECTIFIER.

(*For use with* 500 Ω *Unipivot.*)

Unipivot.—0–120 scale divisions, 2 $\mu$A. per division. (C.I. Co., L 14277).

Rectifier.—Westinghouse MBS 1. 500 mV., 1mA.

Transformer Core.—"Mumetal," section 4 cm.$^2$; mean diameter 8 cm.

Transformer Secondary.—4,000 turns 36 S.W.G. = res. 201.3 $\omega$.

Transformer Primary (tapped).

| Range. | Turns Total. | Turns Section. | S.W.G. Section. | Resistance Ohms, Total. |
|---|---|---|---|---|
| 1 mA. | 4,000 | 2,000 | 36 | 234.7 |
| 2 mA. | 2,000 | 1,200 | 36 | 117.5 |
| 5 mA. | 800 | 400 | 36 | 39.7 |
| 10 mA. | 400 | 200 | 32 | 12.5 |
| 20 mA. | 200 | 120 | 32 | 5.35 |
| 50 mA. | 80 | 40 | 28 | 1.04 |
| 100 mA. | 40 | 20 | 24 | 0.34 |
| 200 mA. | 20 | 12 | 22 | 0.13 |
| 500 mA. | 8 | 4 | 18 | 0.05 |
| 1 A. | 4 | 2 | 16 | $0.0_2$ |
| 2 A. | 2 | 1 | 16 | $0.0_1$ |
| 4 A. | 1 | 1 | 16 | $0.00_4$ |

[N.B.—"Range" = Current required for 100 scale divisions.] Instrument is direct-reading in R.M.S. values on a sine-wave.

Shunt [$R_1 + R_2$] across galvanometer terminals :

$R_1$ = 130.7 Ω Manganin.

$R_2$ = 14.0 Ω Copper [at 15.5° C.]

$R_1 + R_2$ = 145.7 Ω at 15.5° C.

N.B.—Although calibrated in R.M.S. values, the reading is proportional to *mean* values on non-sinusoidal wave-forms.

and change thread to right, repeating every five turns. Then turns 1 to 5, 11 to 15, 21 to 25, etc., will lie *under* the thread, while turns 6 to 10, 16 to 20, etc., lie *over* the thread. That exactly five turns have been made in any group is easily verified (with a watchmaker's glass if of very fine wire) but the eye cannot easily appreciate an error of a turn if many more turns form a group. The groups are easily counted by counting the threads. It was found convenient to mark 50's and 100's with another thread of different colour. By this device one avoids losing count, especially if the winding has to be interrupted for a time.

The secondary of 4,000 turns is wound on first, this is good practice in counting, as a small error is not important here, and will be corrected for when adjusting the shunt.


Fig. 8.

It is roughly speaking, pile wound, and just covers the ring.

The whole is then dipped in melted paraffin wax, and taped one layer silk tape before the wax cools and sets. Each section of the primary is similarly wound, waxed and taped, except the last four, which are waxed and taped together.

It is convenient to slip short lengths of coloured systoflex over the "tails," for identification.

The wiring up is sufficiently explained by the diagram (Fig. 7). The shunt is adjusted with the instrument on test until exactly 100 scale divisions correspond to a current of 1 A. on the 1 A. range. Above 40 scale divisions the instrument is then direct reading without any corrections. Part of the shunt is made of copper to compensate for temperature errors in the rectifier.

The instrument was adjusted at 50 ~ to read in R.M.S. values, it is not free from frequency error, due to capacity of the rectifier. Checked against a thermocouple it reads correctly at 50~, is ½ % low at 500~, and apparently 36 % low at 5,000~. The rectifier alone should not be more than 5 % low at the latter frequency, and although part of the error may be due to the capacity of the current transformer, it is believed that the bad wave form of the oscillator accounts for most of this (for the thermocouple reads R.M.S. values, while the rectifier instrument, of course, reads proportionally to mean values). The Westinghouse Company have now produced a new type of instrument rectifier which is practically free from error up to 100,000~; one of this type is being fitted in place of the M.B.S.1, and the instrument should then be suitable for use without correction for all audio-frequencies.

Although calibrated in R.M.S. values, the reading will be proportional to *mean* values on non-sinusoidal waveform.

## IV. Valve Voltmeter

This is copied, with a few alterations, from the design given by F. M. Colebrook in the *Wireless World*, October 14th, 1931. A photograph is given in Fig. 9, and a diagram of connections in Fig. 10 (the 2 V. filament battery is actually external, and connected to suitable terminals, but for clearness it is shown in Fig. 10, in dotted lines, as though it were inside the instrument).

To set up and adjust, the grid-terminal $A$ is connected to $E$, which is earthed; and with $S$ open the grid bias is adjusted by the 400 $\Omega$ potentiometer and the 40 $\Omega$ fine adjustment in series until the galvanometer reads full scale (240 $\mu$A.). The switch $S$ is then closed and the 2,000 $\Omega$ variable resistance is adjusted until the galvanometer reads zero. The e.m.f. to be measured is then applied between $A$ and $E$.

On testing the finished instrument, it was found that with the Mullard PM 202 valve used, the deflection was almost exactly proportional to the square of the applied e.m.f. For 1 volt R.M.S. the galvanometer deflection was rather more than 110 divisions on the red (square law) scale on the galvanometer, marked "Thermal Scale," and if the galvanometer was shunted with 2,860 $\Omega$ the reading was exactly 100 scale divisions


Fig. 9.

for 1 volt. A resistance-bobbin of this value was therefore wound in manganin wire and connected as shown in the figure; being connected to the opposite side of $S$ to the galvanometer, as shown, it does not affect the preliminary grid bias setting, as $S$ is then open.

With this additional resistance fitted, the instrument is direct reading on the red (thermal) scale in volts

$$\left( i.e., V = \frac{\text{scale divisions}}{100} \right)$$

On again testing it was found that the error did not exceed 0.4 scale divisions at any point of the scale, so that where extreme accuracy is not required it is unnecessary to apply any corrections to the red scale reading. A table of corrections for every 10 divisions is available for the few occasions on which it is necessary.

(Different samples of valve may require different values of galvanometer shunt to render the scale direct reading.)

Where a metallic connection does not exist between the points where P.D. is to be measured, terminal $A$ is joined to $B$, and the e.m.f. is applied between $D$ and $E$; the same process is adopted if it is desired to measure an A.C. potential difference in the presence of D.C. superimposed.

The anode and grid-bias by-pass condensers $C_1$ and $C_2$ each consist of a 2 $\mu$F. "non-inductive" paper condenser in parallel with a 0.01 $\mu$F. mica; the mica is fitted "*ex abundanti cautela*" to form a low-impedance path at frequencies approaching the resonant frequency of the paper condenser, which then presents a high impedance.

$C_3$ is a 0.1 $\mu$F. mica condenser selected for high insulation.

The valve is decapped and mounted in sponge rubber with the leads as near to terminal $A$ as possible.

The three terminals $A$, $B$, $D$, at high-frequency potential are quartz-insulated, following an unpublished suggestion due to L. B. Turner. The quartz is short lengths of tube cut from broken cases of thermocouples (of which a supply is always available in any metallurgical laboratory). They can be "nicked" on the edge of an emery-wheel, broken, and the ends squared up by grinding on the side of the wheel; it is also possible to scratch round the quartz tube with a 3-square file as with glass tubing, getting a

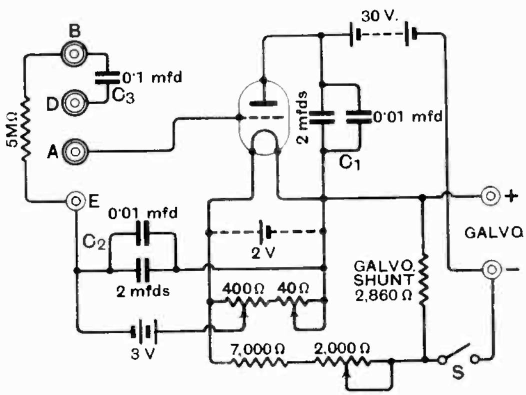


Fig. 10.

clean break, but one cut is enough to finish the corner of the file, so that it costs one file to make three cuts.

The tubes are fitted to the panel and terminals as shown in the sketch (Fig. 10*a*), which is approximately half size. Brass caps are turned up a "sloppy" fit on the ends

B

of the tube, and threaded to take 4 B.A. brass rod, to which the upper cap is sweated. The fixing to the panel is effected by taking a short piece of thick brass tube or solid rod, drilling out a sloppy fit on the quartz tube, and threading the top of the brass (say $\frac{1}{2}$in.

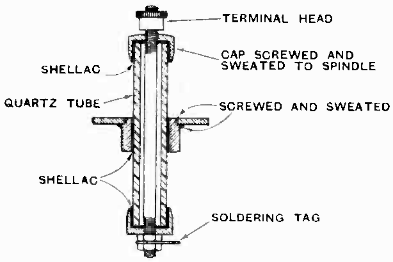


Fig. 10a.

26 T.P.I.) this is screwed and sweated to a brass plate as shown in section in the sketch. The assembly is finally secured by melted shellac, shown by thick black in sketch, both for caps and fixing plate. As the heat used to melt the shellac would ruin lacquer used on the brasswork, and as it is not possible to fix first and lacquer subsequently, the brasswork is nickel-plated. To assemble, shellac is melted in top cap and quartz inserted and temporarily clamped in place by the bottom cap (without shellac as yet). The tube is then fixed through the hole in the flat fixing plate with more shellac, carefully adjusting for height and perpendicularity before the shellac cools. Finally the bottom cap is unscrewed, filled with melted shellac, and replaced, without screwing up more than hand-tight for fear of breaking the quartz from excess pressure on cooling. The whole is cleaned up by first scraping the quartz with a knife to get rid of the larger part of the mess, and then cleaning with alcohol and cotton-wool (it is well to be somewhat sparing of the alcohol, or the cementing may come unstuck). Finally the surface of the quartz is washed with absolute alcohol and dried with ether.

Large holes are drilled through the panel to allow the brass tubes of the fixing plate to pass through; as will be seen from the photograph (Fig. 9) this carries three quartz-insulated terminals, in addition to an "earth" terminal which is sweated to the plate itself before nickelling. The fixing plate is held to the panel by four screws.

It may be well to mention that, in the author's opinion, this valve voltmeter, if made or used for commercial purposes, would be an infringement of Moullin's patents.

## V. Low-reading Micro-ammeter

This is a complementary instrument to the "Versatile Galvanometer," for reading currents too small to be measured accurately on the latter; the lowest range gives full scale for 24 $\mu$A., and scale-multipliers of 1, 2, 5, 10, 20, 50 are fitted, giving full scale for 48, 120, 240, 480, 1,200 $\mu$A.; the last three overlapping the ranges of the "Versatile Galvanometer" and range-box.

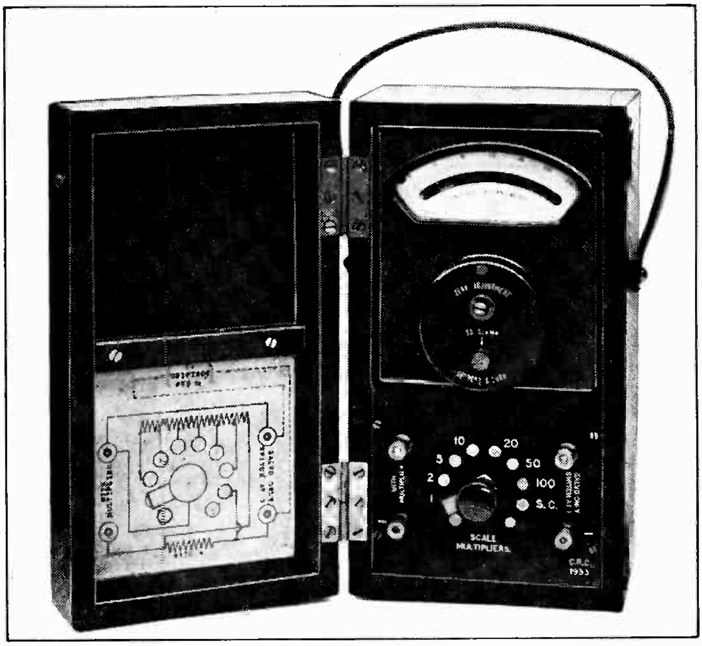


Fig. 11.

A diagram of connections is shown in Fig. 12; and a photograph in Fig. 11.

The galvanometer is a Type I Unipivot, full scale 24 $\mu$A. copper coil resistance about

1,000 Ω (in the example used, 832 Ω). When the terminals on the right, marked "with multiplier" are used, a swamp resistance of manganin is in series with the galvanometer, bringing the total resistance up to 5,000 Ω, so that the full-scale drop is 120 mV. (the same as for the right-hand terminals of the Versatile Galvanometer).

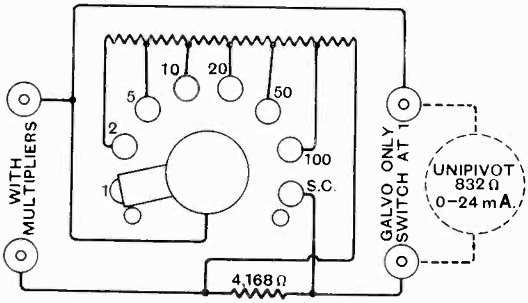

Fig. 12.

As well as the shunts mentioned, a short-circuit position is provided.

The right-hand terminals, marked "GALVO ONLY, SWITCH AT 1," can be used if it is desired to use the galvanometer only without added series resistance; if the switch is on stud "× 1," it will be seen from Fig. 12 that the galvanometer only is in circuit.

A teak case with lid removable on sliding hinges is fitted, the wooden bar across the lid is arranged to press down the galvanometer clamp when the lid is closed, lifting the coil off the pivot-jewel. The simplest way to ascertain the exact thickness required was found to be as follows. Having locked the clamp down, which is done by a half-turn after depressing, a lump of plasticine was put in the lid just over the clamp, and the lid closed. On opening, an impression of the clamp knob was seen; the thickness of the plasticine was carefully callipered, and the wood planed a shade thinner.

Table C gives details of the shunts, resistances, etc.

This instrument is found very useful for such things as measuring grid-currents of valves, and "gun currents" of a cathode ray oscillograph, etc.

Its accuracy can be checked by adjusting the shunt to "× 10" and connecting in series with the Versatile Galvanometer, when "$X$ μA." on this instrument should be given by $5x$ scale divisions on the Versatile Galvanometer.

## VI. Thermo-junctions and "Thermal Converters"

The "Versatile Galvanometer" is also eminently suited for use with thermo-junctions, the couple being connected to the right-hand (10 ohms) terminals. Suitable vacuum thermo-junctions can be obtained from the Cambridge Instrument Company for this purpose.

Where a direct-reading instrument is required, with freedom from temperature error due to the change of resistance of the copper coil, a shunted thermo-junction may be used, the principle being explained by Moullin ("High Frequency Measurements," 2nd edition, Ch. IV, §4, p. 164).

TABLE C.

MULTI-RANGE UNIPIVOT MICRO-AMMETER. TABLE OF RESISTANCES OF SHUNTS.

| Switch at | Shunt Resistance (Ohms). | Resistance of Section. |
|---|---|---|
| 1 | ∞ | — |
| 2 | 5,000 | 3,750 |
| 5 | 1,250 | 695 |
| 10 | 555 | 292 |
| 20 | 263 | 161 |
| 50 | 102 | 51.5 |
| 100 | 50.5 | 50.5 |

Series resistance, shown in Fig. 12 as 4,168 Ω, to be adjusted so as to be (5,000 Ω — galvanometer resistance).

Suitably shunted thermo-junctions, with a resistance $r$ in series with the couple adjusted to make the scale direct-reading can be obtained from the Cambridge Instrument Company under the name Thermal Converters, also Range Multipliers can be obtained for use with the Thermal Converters, giving a number of volt and ampere ranges. (These are, of course, not suitable for high frequency measurements for which an unshunted thermo-junction should be used.) A Voltage Range Multiplier and a Thermal Converter are shown in Fig. 3 to the right of the galvanometer.

## VII

Mention may also be made of the ohm-meter attachment described by M. G. Scroggie (*W.E. & E.W.*, Vol. X, 1933, p. 606).

The Cambridge Instrument Company are shortly putting on the market some of the attachments described above.

# Design of Constant Resistance Attenuators*

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**SYNOPSIS.**—Expressions for the values of the resistance elements in lattice, ⊓⊓, and ⊤ type attenuators both in balanced and unbalanced form are derived from their analogy to a general Wheatstone network, and data are tabulated in terms of four coefficients which enable one to design quickly and easily any of these types of networks for any given attenuation and characteristic resistance.

CONSTANT resistance attenuators are resistance networks which are generally used in transmission measurements and in volume controls, and which are actually potential dividers possessing two essential properties, provided they are terminated by their characteristic resistance, namely,

(1) The input resistance is a constant quantity irrespective of the value of attenuation.

(2) The output current or voltage is a predetermined fraction of the input current or voltage, there being a logarithmic relationship between the two. For instance, if $I_2$ represents the output current and $I_1$ the input current to the attenuator, then $\frac{I_2}{I_1} = e^{-\theta}$ where $e$ is the Neperian base and $\theta$ depends on attenuation.

In this paper it is proposed to derive the equations for the values of the elements in different types of attenuators, namely, the lattice type, the ⊓⊓ type and the ⊤ type from the analogy of these types of networks to a general Wheatstone network. Also data are tabulated in terms of four coefficients which enable one to design quickly any of these types of networks for given attenuation and characteristic resistance.

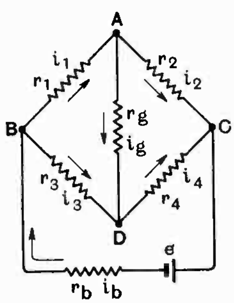



Fig. 1.

Let Fig. 1 represent a general Wheatstone network and let the resistances and currents in various arms be as shown. Then, applying Kirchoff's laws we get

$$r_b i_b + (r_1 + r_2)i_2 + r_1 i_g = e \quad \ldots \quad \ldots \quad (1)$$

$$r_3 i_b - (r_1 + r_3)i_2 - (r_1 + r_3 + r_g)i_g = 0 \quad (2)$$

$$r_4 i_b - (r_2 + r_4)i_2 + r_g i_g = 0 \quad \ldots \quad \ldots \quad (3)$$

* MS. accepted by the Editor June, 1934.

The solution of the simultaneous equations (1), (2) and (3) can be expressed in the form of determinants as follows:

$$\frac{i_b}{\begin{vmatrix} r_1+r_2 & -e & r_1 \\ -(r_1+r_3) & 0 & -(r_1+r_3+r_g) \\ -(r_2+r_4) & 0 & r_g \end{vmatrix}} = \frac{i_2}{\begin{vmatrix} r_1 & -e & r_b \\ -(r_1+r_3+r_g) & 0 & r_3 \\ r_g & 0 & r_4 \end{vmatrix}}$$

$$= \frac{i_g}{\begin{vmatrix} r_b & -e & r_1+r_2 \\ r_3 & 0 & -(r_1+r_3) \\ r_4 & 0 & -(r_2+r_4) \end{vmatrix}} = \frac{1}{\begin{vmatrix} r_b & r_1+r_2 & r_1 \\ r_3 & -(r_1+r_3) & -(r_1+r_3+r_g) \\ r_4 & -(r_2+r_4) & r_g \end{vmatrix}} \quad \ldots \quad \ldots \quad (4)$$

The resistance $R$ of the Wheatstone network between points $B$ and $C$ (Fig. 1) is given by the following equation, since we have $R = \frac{e}{i_b}$ when $r_b = 0$.

$$R = \frac{\begin{vmatrix} 0 & r_1 + r_2 & r_1 \\ r_3 & -(r_1 + r_3) & -(r_1 + r_3 + r_g) \\ r_4 & -(r_2 + r_4) & r_g \end{vmatrix}}{\begin{vmatrix} r_1 + r_2 & -1 & r_1 \\ -(r_1 + r_3) & 0 & -(r_1 + r_3 + r_g) \\ -(r_2 + r_4) & 0 & r_g \end{vmatrix}} \quad \ldots \quad (5)$$

## Case 1.—Lattice Type Attenuator

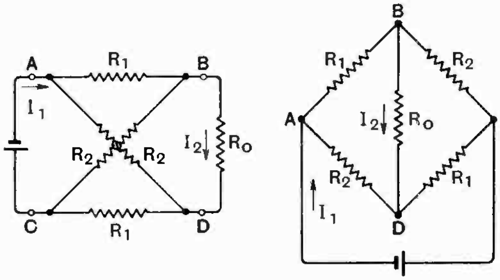
Fig. 2a represents a lattice type of attenuator terminated by a resistance $R_0$ equal to the characteristic resistance of the structure. In Fig. 2b the same structure is represented as a Wheatstone network. In this case $r_b = 0$, $r_1 = R_1$, $r_2 = R_2$, $r_3 = R_2$, $r_4 = R_1$, $r_g = R_0$, $I_1 = i_b$, $I_2 = i_g$. By making use of equation (5) the input resistance of the network between the points $A$ and $C$ is given by the equation

$$R = \frac{\begin{vmatrix} 0 & R_1 + R_2 & R_1 \\ R_2 & -(R_1 + R_2) & -(R_1 + R_2 + R_0) \\ R_1 & -(R_1 + R_2) & R_0 \end{vmatrix}}{\begin{vmatrix} R_1 + R_2 & -1 & R_1 \\ -(R_1 + R_2) & 0 & -(R_1 + R_2 + R_0) \\ -(R_1 + R_2) & 0 & R_0 \end{vmatrix}}$$

Expanding the determinant by the Rule of Sarrus, this reduces to

$$R = \frac{R_0(R_1 + R_2) + 2R_1R_2}{R_1 + R_2 + 2R_0}.$$

In order to determine expressions for the values of $R_1$ and $R_2$, we make use of the two




(a) Fig. 2. (b)

fundamental properties of the attenuating network, mentioned in the opening paragraph of this paper, namely,

$$R = R_0$$

and $$\frac{I_2}{I_1} = e^{-\theta}.$$

$$\therefore \quad R_0 = \frac{R_0(R_1 + R_2) + 2R_1R_2}{R_1 + R_2 + 2R_0}$$

or $$R_1R_2 = R_0^2 \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

By using equation (4) we get

$$\frac{I_2}{I_1} = \frac{\begin{vmatrix} 0 & -e & R_1 + R_2 \\ R_2 & 0 & -(R_1 + R_2) \\ R_1 & 0 & -(R_1 + R_2) \end{vmatrix}}{\begin{vmatrix} R_1 + R_2 & -e & R_1 \\ -(R_1 + R_2) & 0 & -(R_1 + R_2 + R_0) \\ -(R_1 + R_2) & 0 & R_0 \end{vmatrix}}$$

$$= \frac{R_2 - R_1}{R_1 + R_2 + 2R_0}$$

$$\therefore \quad \frac{R_2 - R_1}{R_1 + R_2 + 2R_0} = e^{-\theta} \quad \ldots \quad (7)$$

Solving equations (6) and (7) for $R_1$ and $R_2$ we get

$$R_1 = R_0 \tanh\frac{\theta}{2} \quad \ldots \quad \ldots \quad (8)$$

$$R_2 = R_0 \coth\frac{\theta}{2} \quad \ldots \quad \ldots \quad (9)$$

**Case 2.—Π Type Attenuator**

Fig. 3a represents a Π type attenuator terminated by a resistance $R_0$ equal to the characteristic resistance of the structure. In Fig. 3b the same structure is represented as a Wheatstone network. In this case $r_1 = R_3$, $r_2 = R_2$, $r_3 = R_2$, $r_4 = 0$, $r_g = R_0$, $r_b = 0$, $I_1 = i_b$, $I_2 = i_g$. The input resistance of the network is given by

$$R = \frac{\begin{vmatrix} 0 & R_1 + R_3 & R_3 \\ R_2 & -(R_2 + R_3) & -(R_3 + R_2 + R_0) \\ 0 & -R_2 & R_0 \end{vmatrix}}{\begin{vmatrix} R_2 + R_3 & -1 & R_3 \\ -(R_2 + R_3) & 0 & -(R_3 + R_2 + R_0) \\ R_2 & 0 & R_0 \end{vmatrix}}.$$

This reduces to the relation

$$R_0^2 = \frac{R_3R_2^2}{2R_2 + R_3} \quad \ldots \quad \ldots \quad (10)$$

Now,

$$\frac{I_2}{I_1} = e^{-\theta} = \frac{i_g}{i_b} = \frac{\begin{vmatrix} 0 & 1 & R_2 + R_3 \\ R_2 & 0 & -(R_2 + R_3) \\ 0 & 0 & -R_2 \end{vmatrix}}{\begin{vmatrix} R_2 + R_3 & 1 & R_3 \\ -(R_2 + R_3) & 0 & -(R_3 + R_2 + R_0) \\ -R_2 & 0 & R_0 \end{vmatrix}}$$

$$= \frac{R_2^2}{R_2(R_2 + R_3 + R_0) + R_0(R_2 + R_3)}$$

$$\therefore \quad R_0 = \frac{R_2^2(e^{\theta} - 1) - R_2R_3}{R_3 + 2R_2} \quad \ldots \quad (11)$$

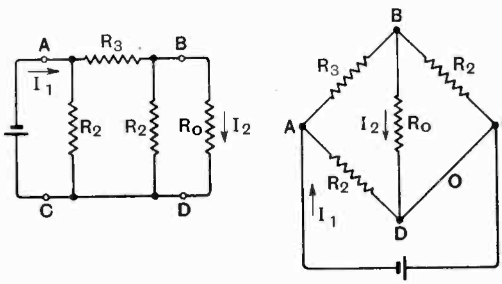
Solving (10) and (11) for $R_2$ and $R_3$ we get

$$R_2 = R_0 \coth\frac{\theta}{2} \quad \ldots \quad \ldots \quad (12)$$

$$R_3 = R_0 \sinh\theta \quad \ldots \quad \ldots \quad (13)$$

**Case 3.—T Type Attenuator**

Fig. 4a represents a T type attenuator terminated by a resistance $R_0$ equal to the characteristic resistance of the structure.



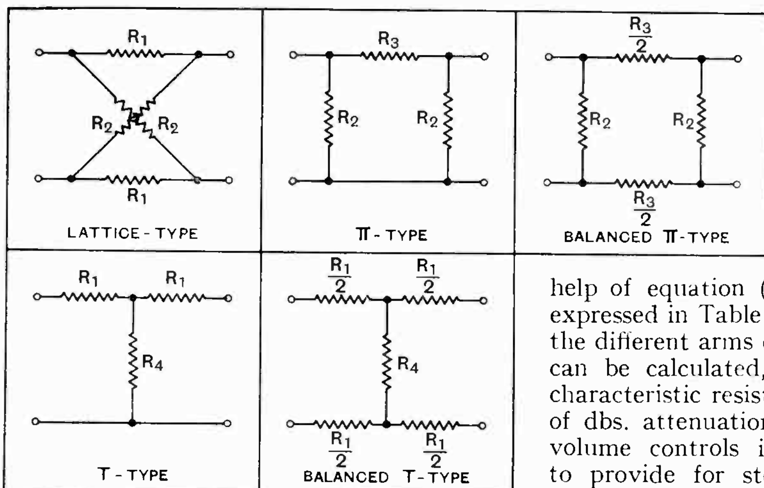

(a) Fig. 3. (b)

In Fig. 4b the same structure is represented as a Wheatstone network. It is to be noted that the terminating resistance $R_0$ is represented as two parallel branches of value $2R_0$ each. This is done to avoid the otherwise indeterminate equations obtained when computing the values of $R_1$ and $R_4$ by the method adopted here. In this case $r_1 = R_1$, $r_2 = 2R_0$, $r_3 = R_4$, $r_4 = 0$, $r_b = R_1$, $r_g = 2R_0$ $i_b = I_1$, $i_g + i_2 = I_2$.

Here,

$$R = \frac{\begin{vmatrix} 0 & R_1 + 2R_0 & R_1 \\ R_4 & -(R_1 + R_4) & -(R_1 + R_4 + 2R_0) \\ 0 & -2R_0 & 2R_0 \end{vmatrix}}{\begin{vmatrix} R_1 + 2R_0 & -1 & R_1 \\ -(R_1 + R_4) & 0 & -(R_1 + R_4 + 2R_0) \\ -2R_0 & 0 & 2R_0 \end{vmatrix}} = \frac{R_4(R_1 + R_0)}{R_1 + R_4 + R_0}.$$

TABLE I




*In all these types,* $R_1 = R_0 \tanh\frac{\theta}{2}$. $R_2 = R_0 \coth\frac{\theta}{2}$.

$R_3 = R_0 \sinh\theta$. $R_4 = \frac{R_0}{\sinh\theta}$.

$$\therefore \quad R_0 = R_1 + \frac{R_4(R_1 + R_0)}{R_1 + R_4 + R_0}$$

$$\text{or} \quad R_0^2 = R_1(R_1 + 2R_4) \quad \ldots \quad \ldots \quad (14)$$

$$\frac{I_2}{I_1} = e^{-\theta} = \frac{i_g + i_2}{i_b}$$

$$= \frac{\begin{vmatrix} R_1 & 1 & R_1 + 2R_0 \\ R_4 & 0 & -(R_1 + R_4) \\ 0 & 0 & -2R_0 \end{vmatrix} + \begin{vmatrix} R_1 & 1 & R_1 \\ -(R_1 + R_4 + 2R_0) & 0 & R_4 \\ 2R_0 & 0 & 0 \end{vmatrix}}{\begin{vmatrix} R_1 + 2R_0 & 1 & R_1 \\ -(R_1 + R_4) & 0 & -(R_1 + R_4 + 2R_0) \\ -2R_0 & 0 & 2R_0 \end{vmatrix}}$$

$$\text{or} \quad e^{-\theta} = \frac{R_4}{(R_1 + R_4 + R_0)} \quad \ldots \quad \ldots \quad (15)$$

Solving (14) and (15) for $R_1$ and $R_4$, we get

$$R_1 = R_0 \tanh\frac{\theta}{2} \quad \ldots \quad \ldots \quad (16)$$

$$R_4 = R_0 \cdot \frac{1}{\sinh\theta} \quad \ldots \quad \ldots \quad \ldots \quad (17)$$

In Table I the formulae for the values of the elements comprising the various types of attenuators in both balanced and unbalanced form are summarised.

## To Express Attenuation in Decibels

Since the load current is $I_2$ and the input current is $I_1$, the attenuation $A$ of the network can be expressed by the relation

$$A = 20 \log_{10}\frac{I_2}{I_1} \text{ decibels.}$$

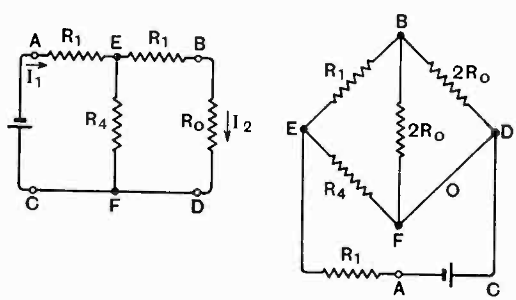
$$= 20 \log_{10}(e^{-\theta}) \text{ dbs.}$$

$$= -8.686 \,.\, \theta \text{ dbs.} \quad \ldots \quad \ldots \quad (18)$$

The negative sign in equation (18) indicates attenuation. With the help of equation (18) and the relationships expressed in Table I, the resistance values of the different arms of any type of attenuator can be calculated, given the value of the characteristic resistance $R_0$ and the number of dbs. attenuation required. In designing volume controls it is ordinarily sufficient to provide for steps of 2 dbs. since the smallest difference in sound level which the average individual can appreciate when two sounds are heard in succession is approximately 2 dbs.

### Example

It is required to construct a balanced T type attenuator of characteristic resist-




(a) Fig. 4. (b)

ance 600 ohms to give an attenuation of 15 dbs. What are the values of the resistance elements?

Let Fig. 5 represent the required attenuator (*vide* Table I). Here $R_1 = R_0 \tanh\frac{\theta}{2}$

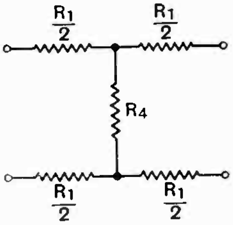



Fig. 5.

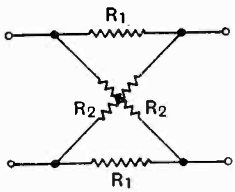



Fig. 6.

and $R_4 = \frac{R_0}{\sinh\theta}$. The values of the elements are $\frac{R_1}{2}$ and $R_4$.

From equation (18),

$$15 = 8.686\,\theta$$

$$\text{or} \quad \theta = \frac{15}{8.686}.$$

Since $R_0 = 600$ ohms,

$$\frac{R_1}{2} = \frac{600}{2} \times \tanh\frac{15}{2 \times 8.686}$$

$$= 300 \times \tanh .8636$$

$$= 300 \times \frac{e^{.8636} - e^{-.8636}}{e^{.8636} + e^{-.8636}}$$

$$= 209.4 \text{ ohms.}$$

$$R_4 = \frac{600}{\sinh\frac{15}{8.686}} = \frac{600}{\sinh 1.727}$$

$$= \frac{600}{\frac{e^{1.727} - e^{-1.727}}{2}} = 220.4 \text{ ohms.}$$

Any type of attenuator shown in Table I can be similarly calculated for any given attenuation and characteristic resistance.

To facilitate rapid design, Table II has been prepared. It is to be noted that corresponding to $R_1$, $R_2$, $R_3$ and $R_4$ in Table I, four coefficients $C_1$, $C_2$, $C_3$ and $C_4$ are tabulated where $C_1 = \tanh\frac{\theta}{2}$, $C_2 = \coth\frac{\theta}{2}$, $C_3 = \sinh\theta$, and $C_4 = \frac{1}{\sinh\theta}$, for different values of $\theta$ expressed in dbs. To get the values of the resistance elements for various types of attenuators it is only necessary to multiply the coefficients as found from Table II by the value of the characteristic resistance required.

TABLE II

| db | $C_1$ | $C_2$ | $C_3$ | $C_4$ |
|---|---|---|---|---|
| 0.25 | .01470 | 68.03 | .02955 | 33.85 |
| 0.5 | .02874 | 34.79 | .05761 | 17.361 |
| 1.0 | .0575 | 17.39 | .1153 | 8.669 |
| 1.5 | .0860 | 11.62 | .1739 | 5.750 |
| 2.0 | .1146 | 8.726 | .2323 | 4.305 |
| 2.5 | .1430 | 6.993 | .2924 | 3.420 |
| 3.0 | .1710 | 5.848 | .3524 | 2.838 |
| 3.5 | .1986 | 5.035 | .4138 | 2.417 |
| 4.0 | .2260 | 4.425 | .4776 | 2.094 |
| 4.5 | .2530 | 3.953 | .5416 | 1.847 |
| 5.0 | .2802 | 3.569 | .6080 | 1.645 |
| 6.0 | .3325 | 3.007 | .7469 | 1.339 |
| 7.0 | .3824 | 2.614 | .8961 | 1.116 |
| 8.0 | .4305 | 2.323 | 1.0575 | .9452 |
| 9.0 | .4760 | 2.101 | 1.2316 | .8117 |
| 10 | .5194 | 1.925 | 1.4229 | .7028 |
| 15 | .6980 | 1.432 | 2.720 | .3675 |
| 20 | .8183 | 1.222 | 4.95 | .2020 |
| 25 | .8940 | 1.119 | 8.876 | .1127 |
| 30 | .9389 | 1.065 | 15.8 | .06332 |
| 35 | .9651 | 1.036 | 28.131 | .03555 |
| 40 | .9804 | 1.020 | 50.00 | .0200 |

## Method of Using Table II

**Example.**—What are the values of the resistance elements of a lattice type attenuator to give 20 dbs. attenuation and to have a characteristic resistance of 600 ohms?

Let Fig. 6 represent the required attenuator. From Table I the resistances are to be designated $R_1$ and $R_2$. The corresponding coefficients $C_1$ and $C_2$ from Table II are $c_1 = .8183$ and $c_2 = 1.222$.

$$\therefore R_1 = 600 \times .8183 = 490.98 \text{ ohms.}$$

$$R_2 = 600 \times 1.222 = 733.2 \text{ ohms.}$$

I wish to express thanks to the authorities of the Indian Radio and Cable Communications Co., Ltd., for giving me permission to publish this paper.

# A Note on Self-Bias Circuits*

*By Emrys Williams, B.Eng.*

GRID-BIAS voltage for amplifier-valves is often derived from the p.d. across a resistor in the anode circuit of the valve. This causes a reduction of amplification, owing to feeding back to the grid the alternating voltage developed across this bias-resistor. The usual methods of avoiding this are :

(*a*) Connecting a large condenser in parallel with the bias-resistor.

(*b*) Decoupling. A potentiometer consisting of a condenser and resistor in series is connected across the bias-resistor, and only the voltage across the condenser is applied between grid and filament.

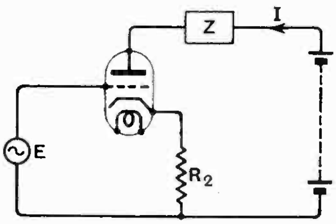



Fig. 1.

The object of this note is to derive expressions for the reduction of amplification, first with the simple circuit of Fig. 1, second with method (*a*) above, and third with method (*b*). It will be seen that under certain circumstances an *increase* in amplification is to be expected.

### Case I

If $R_2$ is a negligible part of the load, we have, with the notation of Fig. 1,

$$I = \frac{\mu(E - R_2 I)}{\rho + Z};$$

where $\mu$ and $\rho$ are respectively the amplification-factor and the anode impedance of the valve. Hence

$$I = \frac{\mu E}{\rho + Z + \mu R_2};$$

Thus, for voltage-amplifying valves, the amplification is reduced in the ratio :

$$\left|\frac{\rho + Z}{\rho + Z + \mu R_2}\right| \quad \ldots \quad \ldots \quad (1)$$

For voltage-amplification $Z$ is usually large with respect to $\rho$. Moreover, it can be seen from Fig. 2 that $\mu R_2$ is of the same order of magnitude as $\rho$, for, if $AB$ be the working grid-bias voltage,

$$R_2 = \frac{AB}{OB} = \frac{AB}{BC} \cdot \frac{BC}{OB} = \frac{1}{g_m} \cdot \frac{BC}{OB} = \frac{\rho}{\mu} \cdot \frac{BC}{OB};$$

The value of the ratio $BC/OB$ varies according to the position of the working point, $A$. The reduction of amplification in an actual case can be calculated from (1), but for the purpose of illustration we shall assume a representative value of 2 for the ratio $BC/OB$, and write $\mu R_2 = 2\rho$. (This simplification proves useful in Cases II and III, in which methods (*a*) and (*b*) are considered.) Thus, for voltage-amplifying valves, the ratio (1) is often sufficiently near to unity to make unncessary the devices (*a*) and (*b*).

For output valves, however, the output power is reduced in the ratio :—

$$\left|\frac{\rho + Z}{\rho + Z + \mu R_2}\right|^2$$

where $Z$ is of the same order of magnitude

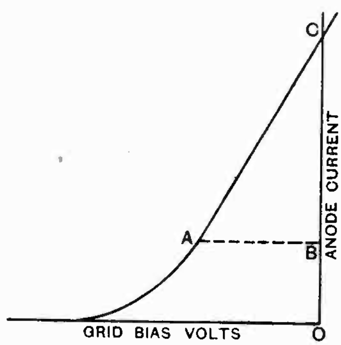



Fig. 2.

as $\rho$. Writing $Z = 2\rho$ and $\mu R_2 = 2\rho$, we see that the output is reduced in the ratio 9/25.

* MS. accepted by the Editor, June 1934.

**Case II**

With the notation of Fig. 3 we have

$$I = \frac{\mu[E - I/(1/R_2 + jC\omega)]}{\rho + Z};$$

giving

$$I = \frac{\mu E}{\rho + Z + \mu R_2/(1 + jR_2C\omega)};$$

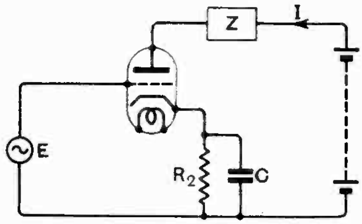



Fig. 3.

Thus the output power is reduced in the ratio

$$\left|\frac{\rho + Z}{\rho + Z + \mu R_2/(1 + jR_2C\omega)}\right|^2 \quad .. \quad (2)$$

If $Z$ is non-reactive, $R_1$, this ratio may be written

$$\frac{(\rho + R_1)^2}{\left(\rho + R_1 + \frac{\mu R_2}{1 + R_2{}^2C^2\omega^2}\right)^2 + \left(\frac{\mu R_2 \, . \, R_2C\omega}{1 + R_2{}^2C^2\omega^2}\right)^2}$$

which simplifies to

$$\frac{1}{1 + \frac{\mu R_2(2\rho + 2R_1 + \mu R_2)}{(\rho + R_1)^2(1 + R_2{}^2C^2\omega^2)}} \quad .. \quad (3)$$

In an actual case the reduction of output

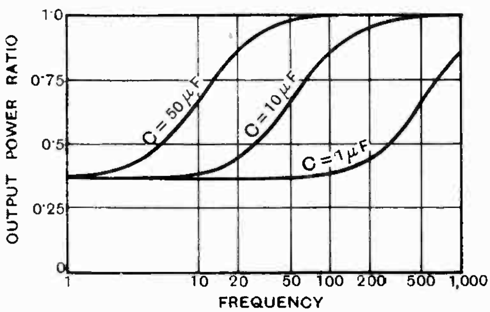



Fig. 4.

can, of course, be determined from (3), but for the purpose of illustration we shall write $\mu R_2 = 2\rho$, and $R_1 = 2\rho$. Expression (3) then becomes

$$\frac{1 + x^2}{2 \, . \, 8 + x^2}; \text{ where } x = R_2C\omega,$$

and in Fig. 4 this ratio is shown plotted against frequency for a bias resistor of 500 ohms and for various values of $C$. It will be seen that capacities of one or two microfarads are useless if frequency distortion is to be avoided above 50 cycles per second.

If $Z$ is inductive, the ratio (2) may be written

$$\frac{(\rho + R_1)^2 + L^2\omega^2}{[\rho + R_1 + \mu R_2/(1 + x^2)]^2 + [L\omega - \mu R_2x/(1 + x^2)]^2}$$

which simplifies to

$$\frac{1}{1 + \frac{\mu R_2(2\rho + 2R_1 + \mu R_2 - 2L\omega \, . \, x)}{[(\rho + R_1)^2 + L^2\omega^2][1 + x^2]}} \quad .. \quad (4)$$

This ratio exceeds unity when

$$2L\omega \, . \, x > 2\rho + 2R_1 + \mu R_2,$$

and, after reaching a maximum, tends asymptotically to unity as $\omega$ increases.

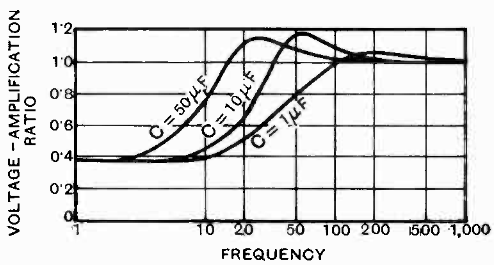



Fig. 5.

Thus an *increased* output may be obtained with an inductive load. If $C$ is sufficiently large to avoid frequency distortion on non-reactive load, then the maximum value of this ratio with *slightly inductive* loads (*e.g.* $R_1 = 3{,}000$ ohms, $L \not> 0.5$ henry) will not exceed 1.01.

The case of transformer-coupled voltage-amplifying-valves is, however, interesting. The ratio in which the voltage-amplification is altered is the square root of (4). For the purpose of illustration we write $\mu R_2$ equal to $2\rho$ as before. Also, let $L\omega/\rho$ equal about 3 at the lowest frequency to be amplified—say $L\omega/\rho = \pi$ at 50 cycles per sec. This gives $L = 10^{-2}\rho$, where $L$ is measured in henrys and $\rho$ in ohms. Further, take

$R_1 = \rho/5$ (*i.e.* about 20 ohms per henry for the transformer). With these assumptions, the ratio in which the voltage-amplification is altered is given by

$$\left[\frac{1}{1+\dfrac{88{,}000 - 400\,.\,x\omega}{(1+x^2)(14{,}400+\omega^2)}}\right]^{\frac{1}{2}} *$$

and in Fig. 5 this ratio is shown plotted against frequency for a bias resistor of

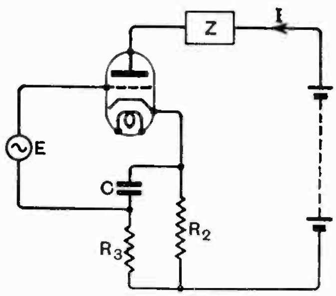



Fig. 6.

500 ohms and for various values of $C$. By adjusting the working point (and thus the value of $R_2$) the increase may be made more pronounced, and might conceivably be used to ameliorate the frequency-distortion which results from insufficient primary inductance of the transformer. Certain marketed valves, used as recommended by the makers, give greater calculated values of this ratio than Fig. 5 would suggest.

### Case III.—Decoupling

Proceeding as in Cases I and II, and using the notation of Fig. 6, we find that the expression for the ratio in which the power output is reduced is identical with that given in (4) above, except that $x$ now equals $R_3C\omega$ and not $R_2C\omega$. It follows that decoupling is much more effective than shunting, since, with quite moderate values of $C$, $x$ may be made sufficiently large to avoid frequency-distortion simply by making $R_3$ large.

The ratio in which the voltage amplification is changed is the square root of (4), remembering that $x$ equals $R_3C\omega$, and it will be seen that, with transformer-coupling, an increase in amplification may again be secured. By giving the product $R_3C$ the same value as $R_2C$ in Case II, increases of the same order may be obtained; by giving the product $R_3C$ sufficiently large values, the increase may be made very small.

We have assumed hitherto that the impedance of the bias-resistor and its parallel circuit is a negligible part of the load impedance. In Case II this will almost always be true. In Case III, however, it is often otherwise, in which case a further reduction of output will result, owing to the sharing of the output power between the load ($Z$) and the biasing circuit. It would appear that, in such cases, maximum "undistorted" output in the load is to be obtained by suitable matching of the valve impedance *to the series impedance of the load* (Z) *and the biasing circuit.*

* This expression may be shown to reach a maximum at a frequency given by

$$\omega = \left[\frac{220}{m} + \left(\frac{220}{m^3} + \frac{62{,}900}{m^2} + \frac{3.17 \times 10^6}{m}\right)^{\frac{1}{2}}\right]^{\frac{1}{2}}$$

where $m = R_2C$.

## The Industry

Mr. A. L. Williams, President and Chief Engineer of the American Brush Company, recently visited this country in connection with further manufacturing developments of the piezo-electric loud speakers, pick-ups, etc., which have been developed by his firm. These instruments are being made in the London factory of R. A. Rothermel, Ltd., of Canterbury Road, London, N.W.6.

The office of Haynes Radio has been transferred from Hatton Garden to the enlarged factory at Queensway, Enfield, Middlesex, where all communications should now be addressed. Telephone, Enfield 2726.

Ferranti, Ltd., of Hollinwood, Lancs., have sent us a copy of their latest list, "Ferranti Mains Components."

Courses of instruction offered by the Technical and Commercial Radio College, of Cromwell House, High Holborn, London, W.C., are described in a recently issued book. The institution is specialising in the teaching of modern servicing methods.

Many T.C.C. condensers of the dry electrolytic and tubular paper types have been reduced in price.

At the recent Olympic Motor Show, a 40–50 h.p. Rolls-Royce Limousine on the makers' stand was fitted with an Ekco car set.

A new Philco car set, with an exceptionally large output, is now being produced. It is for operation on 12-volt systems.

# U.R.S.I. London Congress

## A Short Account of the Subjects Discussed and Recommendations Adopted

OUR last issue gave a brief account of the London meeting of the Union Radio Scientifique Internationale which took place between 11th and 18th September, and it is now possible to give in this issue a further account of the work of the Congress.

U.R.S.I. is one of the International Scientific Unions. As such it has no definite executive function, its activities being the consideration of the scientific aspects of its subject and the making of recommendations for the scientific workers in the various participating countries, using the resolutions adopted as the basis of financial grants (from government, university or other authorities) for the prosecution of the work. This function is, however, very valuable, as so many of the subjects concerned are matters of international interest, calling for some form of concerted international observation.

During the London Congress the discussions of the Union were divided up in the manner indicated in our last issue, Commission IV (Liaison) not meeting during the Congress.

The work of Commission I on Standards and Measurements was divided into the two branches of Frequency Standards and Field-Strength Measurements. The committee on the former subject met once during the Session when its Chairman, Dr. E. H. Rayner of the National Physical Laboratory, referred to the value of accurate frequency measurements both in radio and in other branches of science, e.g., astronomy, geodesy, etc., quoting, also, recent international comparisons indicating the high degree of accuracy that had now been attained. It was recommended that the development of standard-frequency apparatus should be continued, and that international comparisons should also be maintained by measurements both of carrier frequency and of a very precise modulation-frequency (e.g., the 1,000-cycle source of the N.P.L.).

The subject of field-strength measurement was one of considerable discussion, arising out of a report prepared by Dr. Smith Rose based on replies received to a questionnaire circulated to all countries. The recommendations reached were that methods of measuring field intensities should be continued and that national laboratories should be asked to set up field-strength standards with a view to international comparison. The study of the effective heights and lengths of open aerials and of dipoles was also recommended, while it was considered desirable that the accuracy shown in the following table should be aimed at in each of the wavelength ranges stated.

The subject of Propagation of Waves, the field of Commission II, proved to be one of considerable discussion. A most important aspect of the subject was the consideration of the results obtained during the International Polar Year (August, 1932—August, 1933), to which a whole day's discussion was devoted. Prof. Appleton opened the discussion, outlining the results obtained by the British Polar Year Expedition at Tromso. This was followed by similar reports from parties to Polar Regions organised by France, Holland, and U.S.A., in addition to correlated observations made during the Polar Year by these and other countries in temperate latitudes. A valuable conclusion arising out of this and out of the subject of ionospheric measurements generally was the recommendation that the type of correlated wireless observations originated during the Polar Year should be continued in as many places as possible, with the drafting of an international programme for this work. The frequency of 3 megacycles (100 metres) was recommended for international ionospheric measurements, while the word "ionosphere"—hitherto, perhaps, only tentatively accepted—was formally adopted with the cautious definition of "that part of the upper atmosphere which is sufficiently ionised to affect the propagation of wireless waves."

Other wide-scale phenomena concerned in the discussion of propagation of waves were solar eclipses and sunspots. In connection with the former it was emphasised that the organisation in advance of all observational work was of importance and that charts of the paths of the optical and corpuscular eclipses should also be prepared in advance. In relation to sunspots it was recommended that efforts be made to continue the correlation of solar phenomena and radio propagation.

Another subject of considerable importance was the discussion of the "Luxemburg effect," i.e., the effect by which, in certain conditions, the modulation of a powerful broadcasting station can be detected "riding in" or superimposed upon the carrier of another station, the carriers of the two stations being neither close to each other in frequency nor related to each other in any simple ratio. The present view is towards the suggestion of non-linearity in the ionosphere (cf. *Wireless World*, 28th September, 1934) but the information on the subject is at present so limited that U.R.S.I. recommended the organisation of a series of international experiments to examine the matter.

The subject of Atmospherics is also essentially one of an international character, although it is possibly just to say that British work, under the direction of the Radio Research Board, has achieved a unique degree of international eminence. In

| Wavelength. m. | Minimum Field. $\mu$V/m. | Accuracy at Minimum Field. per cent. | Maximum Field. $\mu$V/m. | Accuracy at Maximum Field. per cent. |
|---|---|---|---|---|
| Above 2,000 | 1.0 | $\pm 5.0$ | $10^6$ | $\pm 1$ |
| 2,000–200 ... | 1.0 | $\pm 5.0$ | $2 \times 10^6$ | $\pm 1$ |
| 200–60 ... | 1.0 | $\pm 5.0$ | $10^5$ | $\pm 5$ |
| 60–10 ... | 0.1 | $\pm 20$ | $10^5$ | $\pm 5$ |
| Below 10 ... | 10 | $\pm 20$ | $10^5$ | $\pm 10$ |

connection with the origin of atmospherics the discussion was directed mainly to consideration of thunder-clouds and lightning discharges as the main sources of disturbance. The recommendations adopted were chiefly concerned with the details of this study, including one for the correlation of "non-radio" methods. The discussion of the propagation of atmospherics revealed new features of difficulty now brought out for the first time, and suggestive of considerable importance in relation to radio propagation generally as well as to the case of atmospherics. The recommendation in this connection was chiefly towards the extension of work in countries where it is already in progress to a limited extent, and in other countries where it is effectively non-existent.

Another section of the discussions on atmospherics concerned methods of measurement, and a recommendation was made for the setting-up of a permanent committee to organise the recording of atmospherics on a world-wide scale. Frequencies of 12, 24, 60, 90, 300, 1,500, 7,500 and 20,000 kilocycles were recommended for international adoption for purposes of atmospherics recording, while the Union also recommended the increase of directional observations, laying stress on the cathode-ray type of direction finder in relation to the study of the nature and origin of atmospherics.

The discussions of Commission V, on Radio Physics, were of a very varied character. The chief subject of discussion was that of very short waves, and recommendations were made urging the study of the propagation of waves below 10 metres (the study to include consideration of the effect of the atmosphere), and for the further investigation of "electronic oscillators." Another subject on which a recommendation was offered was that of amplifier noise, where it was thought that there was need for the further theoretical and experimental study of Brownian movements of electrons in conductors, and of the Schrott effect in the valves themselves (cf. *W.E. & E.W.*, January, 1934).

Radio physics and the mechanism of propagation are so closely linked that a joint committee met on this subject. The discussions were of a highly theoretical character. The recommendation reached was that of further investigation of the theory of propagation and absorption of waves in the atmosphere with the view to the submission of a report on the subject for the next congress of the Union.

# Book Review

**Modern Acoustics**

By A. H. Davis, D.Sc. Pp. xi + 345. G. Bell & Sons, Ltd., York House, Portugal Street, London, W.C.2. 1934. Price 26s. net.

It is remarkable that Rayleigh's "Theory of Sound," 2nd Edition, which is now 40 years old, should have remained the standard work on a subject which has shown revolutionary developments during the last 20 years. The first account of the new acoustics, with its analogies between mechanical and electrical oscillations, was given by Crandall, "Vibrating Systems and Sound," in 1926, and was followed by Fletcher's "Speech and Hearing." In 1932 there appeared Wood's "Text-Book of Sound," which may be regarded as the lineal successor to Rayleigh's treatise, with a harmonious welding of the new ideas to the classical treatment, and in the same year Beatty's "Hearing in Man and Animals" broke new ground in delving deeply into the reactions of the human animal to acoustic stimuli.

Now comes Dr. Davis's book, which is a well-balanced account of acoustics as it is known to-day, with special reference to the important work carried out at the National Physical Laboratory. The production, transmission and reception of sound receive careful fundamental treatment as a basis for copious details of the practical engineering aspects of the subject, such as reverberation in auditoriums and the methods of adjusting it to a value commensurate with clear reception of speech and music, and also the vital subject of absorption and transmission of sound by building materials, a subject of which no architect can now afford to be ignorant.

As might be expected from a book originating in the N.P.L., considerable attention is given to methods of measurement. The vibrations of sound are notoriously difficult to measure with accuracy, for, as with wireless waves of high frequency, the power dealt with is very small and distortion is produced by the measuring instruments themselves and their surroundings. Dr. Davis gives an excellent account of the difficulties and the devices employed to overcome them.

But when the author leaves the objective domain and embarks upon the sensations of hearing he gives the impression of one who fears that he has ventured too far from home. This is an attitude common among physicists, as if sensation were something only to be discussed by mysterious people called psychologists and physiologists. But surely our sensations are fundamental, for it is only through them that we can appreciate, or find any meaning in, the science and art of acoustics.

As a treatise on physical acoustics the book is to be commended as a thorough and painstaking effort. J. H.

# 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.*

## Lightning Effects

*The Editor, The Wireless Engineer*

SIR,—I have been examining a radio set which was struck by lightning in the storm of September 15th. A description will be of interest. In the first place, the outside switch was a delusion. It was formed by a terminal on the end of an ebonite rod, which, when pushed forward, was supposed to contact with a blade of brass. There was, however, a gap of $\frac{3}{16}$in. owing to the blade being bent. This should serve as a warning to those who put their trust in cheap earth switches and then do not examine them.

The discharge entered the set, a 1 . v . 1, and met an A.S.C. which it shattered, apparently negotiated the grid condenser and leak, cracked the H.F. valve and completely scattered the Det. and L.F., blew open the lid and passed out by the L.F. anode lead to the speaker, which stood across the room on a wall shelf 8in. from a large mirror which stood above the mantelpiece. A lady was sitting in a chair under the speaker by the fireplace. The copper was apparently disintegrated for the lead is quite flabby now. The speaker, an old Celestion, had the cone all torn up, and the front of the case, though held on by eight screws and with a large fret opening, was blown off and fell on the lady below. The current did not return by the other lead, but got to the mercury backing of the mirror, leaving it by the two lower corners, spoiling the coating for about 3in. in each case. From here the rest of the path is not visible. It seems to me that the mirror must have been a lucky protection, though it might also have been the cause of that path.

The aerial, which fell down, showed the flash had passed the first egg insulator by jumping to the connecting wire, and across the second insulator to the flexible steel wire used to hold it to the roof, where it broke off. The down lead was a rubber-covered flex which showed lengths of charred rubber. The flash had divided at the bad switch and part had gone to ground by jumping the gap. Not much electricity appears to have left the set by its earth wire, for though broken off it is not discoloured. It will be noticed that as the lightning had none but high resistance paths available, it went along all of them. There is no discoloration of the tuning coil wire, which looks undamaged. I forgot to test the speaker winding, but it was probably protected by its inductance as the current went over to the mirror.

H. E. ADSHEAD.

Essex.

## Symbolism in Electro-Acoustics

*To the Editor, The Wireless Engineer*

SIR,—I should like to make a few comments on Dr. McLachlan's article, "Symbolism in Electro-acoustics," which appeared in the September issue of *The Wireless Engineer*.

In the first paragraph, he writes, "$V$ for volume, $C$ for capacity, $E$ for electromotive force and $P$ for power." Would it not serve its purpose better to use the word "capacitance" in place of capacity? There is an esthetic uniformity in the names resistance, inductance, conductance, capacitance. When one says "capacity of a condenser," does he mean capacitance of an electrostatic condenser or capacity of a steam condenser? Capacity has a double meaning and is sometimes confusing. Manufacturers of electrical equipment advertise "capacitors" in their catalogues and give their capacitances in microfarads and capacities in KvA. Capacitance seems to be a logical term and unambiguous.

The use of the script Greek letters gamma, zeta, mu, xi, and upsilon are very troublesome in manuscripts for the reason that they are too easily confused with our English script letters; and the average handwriting of the present day is not meticulous enough in its details to differentiate between the two where they are used in the same manuscript. This is a very pertinent subject to the teacher who attempts to read mathematical papers written in haste by students, and I always groan inwardly when I see an article in which the author insists upon using those letters above named.

I am glad to see someone suggest the honoring of Lord Rayleigh by naming some units after him. The proposal to use "Ray" for acoustical resistance and "Ram" for acoustical impedance is well taken. I should like to make an additional suggestion. Dr. McLachlan objects to the name "bar" for the dyne per square centimeter; therefore, why not use a Lord Rayleigh derivative and call it "Rum"?

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# Abstracts and References

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## PROPAGATION OF WAVES

The Influence of Electric Waves on the Ionosphere [Mathematical Analysis of Disturbances in the Ionosphere produced by Electric Waves, with Application to "Interaction" Effects noticed (*e.g.*) between Signals from Luxembourg and Beromunster, and to Possible Increase of Ionisation Density in Ionosphere by Lightning Flashes: etc.].—V. A. Bailey. (*Phil. Mag.*, August, 1934, Vol. 18, No. 118, pp. 369–386.)

"The application of the methods and results of Townsend and his associates shows that a powerful radio emitter is capable of appreciably modifying the collision frequency of electrons with the molecules in the ionosphere. In this way are explained the observations of Tellegen. . . . Some observable consequences of the theory are predicted [variation of impressed modulation with conditions—spatial considerations, influence of the frequency of the interfering station, influence of the modulation frequency, diurnal variation of the impressed modulation, variation of interference with the power and modulation coefficient of the interfering station]. It is also shown that a short undamped pulse, comparable in intensity with an atmospheric, is able to produce a notable increase in the ionisation of the ionosphere [up to 6.5 times that initially existing]. Since the above was written, two further instances of interference of the type discussed in this paper have been found [March Abstracts, p. 144, where references to Tellegen's letter are also given]. In each case the interference was caused by an emitter using a wavelength in the long end of the broadcasting spectrum. These additional experimental facts appear to confirm Tellegen's observations and to support the arguments developed in section 8.2 above on the variation of the impressed modulation with the wavelength of the interfering emitter." For other letters on the "interaction" effect *see* Abstracts, May, p. 260, and August, pp. 433 and 438.

Study of the Magneto-Ionic Theory of Wave Propagation by means of Conformal Representation.—V. A. Bailey. (*Phil. Mag.*, September, 1934, Vol. 18, No. 119, pp. 516–523.)

"The complexity introduced by the frictional term is such that much labour is required for the computation of the refractive indices, absorption coefficients, and polarisations which is needed in order to examine the effect of the ionosphere on the passage of radio waves. . . . By means of conformal representation, a graphical method is established for the rapid detailed study of the propagation of plane electric waves in an ionised region of space where a constant magnetic field is also present. The two charts needed for the determination, respectively, of the polarisation and the refractive index are easily drawn, as they involve only circles, ellipses, and parabolas. In another paper Dr. Martyn will give an account of an actual survey of the circumstances of propagation by means of such charts."

The Refractive Index of an Ionised Medium [Lorentz Polarisation Term to be Omitted for Ionosphere and Metals].—C. G. Darwin. (*Proc. Roy. Soc.*, Series A, 1st Aug. 1934, Vol. 146, No. 856, pp. 17–46.)

For recent literature on this moot point *see* Abstracts, March, pp. 142 (Hartree) and 142–143 (Darwin), and back references. Sections 3–6 deal with the problem without a radical change in the older method of approach, and lead to the conclusion that "there is good reason to believe that a free electron is influenced by the 'pipe-force' [field-strength which would act in a pipe-cavity cut in the material along the line of the force] and not the Lorentz force. The collisions of the electrons with the other particles are an essential feature of the process. If the collisions are frequent, one may say that they make the electrons forget the phases of their oscillations, and this makes it easy to see that there should be no allowance for the Lorentz force. But it was shown in section 5 that even without many collisions the Lorentz force would not be effective, and it will be found in section 9 that the frequency of collisions does not enter into the argument."

In section 7 and onwards the writer develops a new method free from most of the difficulty of the old, since it does not call for analysis of the internal fields. In this, the refractive index is derived from the electric moment of a small sphere of the medium, the size of the sphere being such that the retardation of the waves is negligible. "It is confirmed that a gas of electrons neutralised by a continuum of positive electricity will obey the $S$ formula [Sellmeier, $S = \mu^2 - 1$], while a set of self-contained atoms will obey the $L$ [Lorentz, $L = 3(\mu^2 - 1)/(\mu^2 - 2)$]. The main problem is that of electrons neutralised by protons. It is shown that, subject to certain prescribed conditions, the contribution to the moment from the collision of an electron with a proton is on the average the same as that from an empty region of the same size; this shows that it is legitimate to . . . regard the protons as though they were a continuum. An important point in the argument is that it fails if the electrons have not a certain speed, and the failure leaves room for all those substances which obey the $L$ formula. The conditions for the $S$ formula are fulfilled in the ionosphere and in metals. The mixture of an $L$ medium and an $S$ medium is considered, and it is shown that the correct rule for the index is to add the $S$'s of the two media together. Finally the effects of 'collision damping' are considered, and previous results are confirmed."

ON THE REFLECTION OF RADIOTELEGRAPHIC WAVES IN THE UPPER ATMOSPHERE [Test of H. Gutton's Electron Resonance Theory, by Echo Observations using Highly Damped Pulses].—C. Gutton, J. Galle and H. Joigny. (*Comptes Rendus*, 20th Aug. 1934, Vol. 199, No. 8, pp. 470–473.)

If H. Gutton's laboratory results, which showed an electron resonance involving a phase inversion and sudden change in refractive index, are reproduced in the upper atmosphere, the reflection of waves should present strong analogies with the optical reflection of radiations corresponding to an absorption band in the reflecting medium. But a resonance phenomenon requires a large number of oscillations in the signal train: in previous echo tests this condition has been fulfilled, since continuous-wave oscillations have been employed. The writers therefore carried out tests with heavily damped spark-signal pulses, produced with a Tesla coil exciting an oil-immersed spark gap at the mid-point of a dipole aerial. The diagrams show one record taken with a Blondel oscillograph in May, 1934, using a c.w. pulse transmitter (75–82 m), and one taken immediately afterwards using the spark transmitter. The former shows a double echo; in the various c.w. tests the echo amplitudes were generally 1/4th or 1/5th of the direct signal amplitudes, as in this case. The second record, on the other hand, shows a very much smaller echo, although the direct-signal amplitude is about equal to that of the first record; throughout the tests these echoes of spark-generated pulses were "very weak and often hardly visible." The stations were close together so that the incidence was practically normal: the trace at the bottom of the records is of a 50-cycle current.

The writers conclude: "The result agrees with the idea which suggested the tests—the existence of resonances which provoke the reflection. But it must be taken into account that an ionised gas is, for radiotelegraphic waves, a very dispersive medium, and that a train of highly damped waves emitted by a spark may, in its passage through this medium, be so distorted and spread out that its reception would become less clear."

DISCUSSION ON "MEASUREMENT OF THE ANGLE OF INCIDENCE AT THE GROUND OF DOWNCOMING SHORT WAVES FROM THE IONOSPHERE" [and the "Multiple Hop" Idea: Difficulty as to why Energy is concentrated mainly in a Ray making a Certain Number of Hops: Author's Reply].—J. Hollingworth: Wilkins. (*Journ. I.E.E.*, September, 1934, Vol. 75, No. 453, pp. 353–354.) For Wilkins's paper see August Abstracts, pp. 431–432.

METHODS OF IONOSPHERIC INVESTIGATION [Requirements for Fine-Structure Investigations: Methods adopted by British Polar Year Expedition, and a Specimen Record].—R. Naismith. (*Nature*, 13th Jan. 1934, Vol. 133, No. 3350, p. 66.) For a Note on this letter see *ibid.*, p. 57.

IONOSPHERIC INVESTIGATIONS [of Critical Penetration Frequencies, showing Diurnal and Annual Variations].—T. R. Gilliland. (*Nature*, 8th Sept. 1934, Vol. 134, p. 379.)

SOME OBSERVATIONS ON PROPAGATION, DURING THE POLAR YEAR, AT SCORESBY SOUND.—Douguet. (*L'Onde Élec.*, July, 1934, Vol. 13, No. 151, pp. 277–288.)

(1) Attempts at layer-height measurements: during the period of these particular tests (polar day) there were apparently no echoes on the wavelength used, 63 m. (2) Field strengths of French, Rugby and Tokio stations: annual variation. Sunspot numbers showed the usual 27-day periodicity during the winter months, but this disappeared from May onwards: the auroral and magnetic variation curves also showed the 27-day periodicity from December to April, and then lost it. After pointing out that the phase displacement between the co-phasal auroral and magnetic curves and the solar activity curves demands, for the recently proposed explanation of auroras, a very great curvature of electron trajectory in the solar magnetic field, the writer records that the reception of the various transmissions was in opposite phase to the auroral and magnetic activity (Fig. 1) and that from May onwards, when auroras were no longer observable and the magnetic activity showed no more regular fluctuation, reception as a whole behaved accordingly (Fig. 2). In mid-May and in June there were brief returns of agitation, with corresponding effects on reception. In the traffic with the Cherbourg naval station, both ways, the 27-day periodicity was again found. The waves used were 33–34 m, which "passes pretty badly during the polar day," and 55–61 m, "which passes pretty well (path largely nocturnal)." As regards diurnal variation, Fig. 3 (based on average values of observations on Pontoise and Fort d'Issy in April, May and June) shows "a clear correspondence" with the average curve of the sun's declination, with apparently a slight lag on the part of the declination. "During the polar day the diurnal variation is more irregular, but has a clear nocturnal minimum. During periods of normal days, the hours of sunrise and sunset do not appear to produce, as clearly as in our own regions, changes in the form of the variation."

(3) Atmospherics: here again the sunrise and sunset hours do not have the definite effects which

they have in our regions: in normal days the most that can be observed is, occasionally, an irregularity in the curve at these moments; otherwise the variation follows the same course as the short waves. "There are practically no local atmospherics, only distant ones [records on 12 and 27 kc/s]. During the polar night there are practically no atmospherics during the daytime; they start fairly regularly at about $21^h$, the return to calm occurring about $9^h$ in the morning." This latter fact suggests that the most prolific source lies, roughly, in Brazil. During the polar day there are practically no atmospherics; they start again at the beginning of August.

MEASUREMENTS OF ELECTRICAL STATE OF UPPER STRATOSPHERE IN POLAR REGIONS (KENNELLY-HEAVISIDE LAYER) [Russian Polar Year Observations: Pulses of 10–20 kw with Consumption of only about 100 w, by Rotary Spark Gap connecting Valve Generator to Charged Condenser].—M. A. Bontch-Bruewitch. (*Proc. Inst. Rad. Eng.*, September, 1934, Vol. 22, No. 9, pp. 1124–1138.) For a preliminary letter on the results *see* April Abstracts, p. 199.

REPORT OF [Daytime] IONOSPHERE INVESTIGATIONS AT THE HUANCAYO MAGNETIC OBSERVATORY (Peru) DURING 1933 [Equipment for Manual Multifrequency Operation: E, $F_1$ and $F_2$ Layers: $F_1$ formed by Separation from a General F Region rather than by Direct Ionisation of a Separate Layer: Frequency Separation of 390 kc (at 4 100 kc/s) between the Two $F_1$ Layer Critical Frequencies, agreeing with Magneto-Ionic Theory: probably about 340 kc for $F_2$: Reasons for Discrepancy: Calculation of Upper Limit of Ratio of Heavier Ions to Electrons in $F_1$ and $F_2$: Effect of Heavier Ions on Propagation at Any Angle to Magnetic Field: etc.).—L. V. Berkner and H. W. Wells. (*Proc. Inst. Rad Eng.*, September, 1934, Vol. 22, No. 9, pp. 1102–1123.)

REFLECTIONS FROM THE IONOSPHERE [Intermittent or Continuous Photographic Recording Technique with Commutator-Keyed Pulses: Reflections from E (?) Layer as low as 40 km: Sixth Multiple F Reflection recorded at Good Strength: Suggestion of Layer at about 1 100 km: etc.].—S. Sillitoe. (*Canadian Journ. of Res.*, August, 1934, Vol. 11, No. 2, pp. 163–170.)

The 3-segment commutator gave 90 pulses/sec., and the cathode-ray oscillograph time base was synchronised by 60 c/s mains, so that three transmitted pulses, corresponding to the three segments, were viewed in succession. This was of great advantage for the elimination of extraneous effects. The usual frequency was 3 492 kc/s, but tests on higher and lower frequencies were included. "It is a curious fact that an apparent multiple reflection may die out, while the two adjacent echoes remain. This effect was generally noticed near sunset and sometimes suggested, for short periods, another layer extremely high up, about 1 100 km. The explanation of the fact that $F_4$, for example, has not returned to earth, while $F_5$ has successfully done so, may be that the reflection of $F_4$ took place from the top of a low E layer [*see* title]. . . . Indeed, at other times, echoes were observed coming apparently from heights corresponding to E + F."

PROPAGATION TEST BETWEEN THE VATICAN STATION AND SYDNEY, AUSTRALIA: INSTANTANEOUS RETRANSMISSION AND PHOTOTELEGRAPHIC RECORDING: MAXIMUM PATH HEIGHT OF 240–300 KM INDICATED.—Gianfranceschi. (*Alta Frequenza*, June, 1934, Vol. 3, No. 3, pp. 363–364: summary only.)

RADIO ECHOES [of Long Delay: Note on Special Transmissions from GSB and HBL.].—U.S. National Bureau of Standards. (*Journ. Franklin Inst.*, August, 1934, Vol. 218, No. 2, pp. 259–261.)

OBSERVATIONS ON LONG-DELAY RADIO ECHOES: AN OPPORTUNITY FOR AMATEUR CO-OPERATION [American Collaboration with the "World Radio" Tests].—J. H. Dellinger. (*QST*, August, 1934, Vol. 18, No. 8, pp. 42 and 88.) *See* also *Proc. Inst. Rad. Eng.*, August, 1934, Vol. 22, No. 8, pp. 939–940.

LUMINOUS NIGHT SKIES CAUSED BY COSMIC DUST.—Hoffmeister. (*Sci. News Letter*, 18th Aug. 1934, Vol. 26, No. 697, p. 110.) *See* also October Abstracts, p. 549.

EXPLOSION SOUND BEARS NEWS OF STRATOSPHERE [Polar Night Explosion Tests indicate that the Temperature Rise (if any) in Upper Stratosphere is not due to Sun's Rays: might be due to Cosmic Rays or to Ozone Layer].—K. Wolcken. (*Sci. News Letter*, 28th July, 1934, Vol. 26, No. 694, pp. 62–63: summary only.)

THE ILLUMINATION OF THE UPPER ATMOSPHERE AND THE TWILIGHT TABLES OF M. JEAN LUGEON [Influence of Atmospheric Refraction and Absorption on the Values given].—F. Link: Lugeon. (*Comptes Rendus*, 23rd July, 1934, Vol. 199, No. 4, pp. 303–305.)

RESEARCHES ON THE TRANSPARENCY OF THE LOWER ATMOSPHERE AND ITS OZONE CONTENT [Concentration increasing from Ground upwards].—D. Chalonge and E. Vassy. (*Journ. de Phys. et le Rad.*, July, 1934, Series 7, Vol. 5, No. 7, pp. 309–319.) *See* also July Abstracts, p. 374, r-h column.

ULTRA-VIOLET SOLAR SPECTRUM AND OZONE IN THE STRATOSPHERE [70% below 31 km: Preliminary Letter].—E. Regener and V. H. Regener. (*Nature*, 8th Sept. 1934, Vol. 134, p. 380.)

These results confirm the work of Götz, Meetham and Dobson (Abstracts, 1933, p. 560, and October, p. 553.)

VARIATIONS IN REFRACTIVE INDEX OF $CO_2$-FREE DRY AIR, AND A STATISTICAL CORRELATION WITH SOLAR ACTIVITY [23-Year Periodicity superimposed on 11-Year Cycle].—L. W. Tilton. (*Journ. of Res. of Nat. Bur. of Stds.*, July, 1934, Vol. 13, No. 1, pp. 111–124.) The journal named was formerly the *Bureau of Standards Journal of Research*.

INFLUENCE OF A FOREST ON THE TEMPERATURE OF THE AIR, *and* THE VERTICAL DISTRIBUTION OF TEMPERATURE IN A FOREST.—P. Seltzer. (*Comptes Rendus*, 6th and 27th Aug. 1934, Vol. 199, Nos. 6 and 9, pp. 435–438 and 534–535.)

TRANSMITTING AND RECEIVING EXPERIMENTS WITH ULTRA-SHORT WAVES [7–8.5 m Waves, Powers up to 200 w: Three Times Optical Range on Certain Paths: No Return of Space Wave within about 1 000 km: Excellent Two-Way Telephony over 1 150 km on 8 and 8.5 m (Summer Day-Time only)].—Y. Takata and T. Tojo. (*Rep. of Rad. Res. in Japan*, April, 1934, Vol. 4, No. 1, pp. 35–39: in English.)

THE PROPAGATION OF MICRO-WAVES [and how they exceed the Optical Range].—I. Gianfranceschi. (*L'Onde Élec.*, May, 1934, Vol. 13, No. 149, p. 26A: short summary only.)

ON THE REFLECTION AND REFRACTION OF [Ultra-Short 3 m] ELECTROMAGNETIC WAVES BY PLATE WALLS [Iron Plates, Water-Filled and Sand-Filled Boxes, etc.].—T. Koshiguchi. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, No. 316: English summary p. 43.)

"By the experiments, we have assured that a good conductor is more reflective than a poor conductor, and the reflection coefficient and reflection phase-angle of the combined plate walls of two different materials are the resultant of the two. . . . We have assured that there are many angles of reflection of the electromagnetic waves by the plate walls which are not subject to Snell's Law in optics, and that there are many angles of transmission." *See* also below.

ON THE ATTENUATION OF THE [Ultra-Short 3 m] ELECTROMAGNETIC WAVES THROUGH PARALLEL PLATE WALLS.—H. Kikuchi. (*Ibid.*, p. 318: English summary pp. 43–44.) *See* also preceding abstract.

INVESTIGATIONS OF THE RADIATION FIELD OF A DIPOLE AT [Ultra-Short] 1 METRE WAVELENGTH.—Hübner. (*See* under "Aerials and Aerial Systems.")

THE EMISSION OF SPECIAL RADIO SIGNALS FOR THE STUDY OF THE IONOSPHERE [New National Physical Laboratory Transmitter for Frequency-Change and Pulse Transmissions over Continuous Range of 50–1 200 Metres: with Cathode-Ray Monitoring Equipment].—H. A. Thomas. (*Journ. I.E.E.*, August, 1934, Vol. 75, No. 452, pp. 240–250.)

SOME MEASUREMENTS OF THE ELECTRICAL CONSTANTS OF THE GROUND AT SHORT WAVELENGTHS BY THE WAVE-TILT METHOD.—R. H. Barfield. (*Journ. I.E.E.*, August, 1934, Vol. 75, No. 452, pp. 214–220.)

The wavelengths used ranged from 12–300 m. "It is concluded that no seasonal change of $\sigma$ was detectable, but that changes from wet to dry weather had an appreciable effect and that the conductivity was not appreciably different from its long-wave value [the values on typical sites in S. England, for wavelengths 15–50 m, varied between $0.5 \times 10^8$ and $4 \times 10^8$ e.s.u.]. The series of measurements taken on a large area of ice over deep fresh water probably constitute the most interesting results, giving values of 100 for $\kappa$ and $1.4 \times 10^8$ for $\sigma$. Theory indicates that the results may be regarded as applying to the water rather than to the ice. This is confirmed by the value of $\kappa$ obtained, which corresponds approximately to the normal 'static' value of the dielectric constant of water and is many times greater than that of ice." Thus the experiments show that, as theory predicts, where there is a layer of low conductivity or low refractive index on top of a medium for which these constants are high, the lower layer will have a dominating influence in determining the effective constants of the ground.

ELECTRICAL MEASUREMENTS ON SOIL WITH ALTERNATING CURRENTS [Survey of Past Work and Description of Laboratory Results on Samples of Soil from 12 Different Sites in England and Scotland].—R. L. Smith-Rose. (*Journ. I.E.E.*, August, 1934, Vol. 75, No. 452, pp. 221–237.)

Extension of the work dealt with in 1933 Abstracts, p. 382. "In the majority of these cases, samples were obtained . . . at various depths down to 10 ft., while in one case the depth was extended to 300 ft. It is shown that, at a typical frequency of 1 200 kc/s, the conductivity of surface soil varies between $0.16 \times 10^8$ and $4.0 \times 10^8$ e.s.u. for different sites, while at various depths the values range from $1.6 \times 10^5$ to about $10^{10}$ e.s.u. In general it is shown that the clay soils have a high conductivity (*i.e.* above $10^8$ e.s.u.) accompanied by high dielectric constant [up to 125 for the frequency mentioned], and the loam and chalk soils an average value of about $10^8$ e.s.u. for conductivity and 20 for dielectric constant, while soil of a sandy or gritty nature gives a much lower conductivity value. The lowest values (of the order of $10^5$ e.s.u.) . . . were obtained on the solid granite or slate subsoils found at some of the sites." Regarding penetration, curves are given which "illustrate the fact that while at a frequency of 100 kc/s a few per cent of the current at the surface may penetrate to a depth of 20 metres, at a frequency of 10 000 kc/s the current is practically confined to the first 3 or 4 metres of depth." Most of the work was on frequencies between these two limits, but in some cases the measurements were extended through the audible range down to a power frequency of 50 c/s.

THE APPARENT RESISTIVITY OF SOILS AS A FUNCTION OF THEIR HYDRODYNAMICAL CHARACTERISTICS [Porosity, Permeability, Resistivity of Water Content, etc.].—H. Laferrere. (*Bull. de la Soc. franç. des Élec.*, September, 1934, Series 5, Vol. 4, No. 45, pp. 923–940.)

ABSORPTION OF LIGHT BY SEA WATER.—E. B. Stephenson. (*Journ. Opt. Soc. Am.*, August, 1934, Vol. 24, No 8, pp. 220–221.)

THE POLARISATION OF THE FLUORESCENCE OF SOME DYE SOLUTIONS EXCITED IN VARIOUS ABSORPTION REGIONS [Preliminary Note].—L. Grisebach. (*Naturwiss.*, 14th Sept. 1934, Vol. 22, No. 37, pp. 633–634.)

A NEW INTERFERENCE DEVICE [Monoprism, with Refractive Angle only about 1°: used for comparing Velocities of Light over Two Paths, etc.].—Q. Majorana. (*Comptes Rendus*, 3rd Sept. 1934, Vol. 199, No. 10, pp. 552–554.)

ALTERNATING AND PULSATING CURRENTS IN A LOADED TELEPHONE CABLE.—Marro. (*See* under "Acoustics and Audio-frequencies.)

## ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

ON ATMOSPHERICS AT BANGALORE DURING THE POLAR YEAR [and Their Correlation with Meteorological Data].—S. P. Chakravarti and B. H. Paranjpye. (*Journ. Indian Inst. Sci.*, Vol. 17B, 1934, Part I, pp. 1–18.)

Among the conclusions reached are :—The mean of the hourly direction of arrival of maximum disturbance for Aug. 1932/Aug. 1933 varies from 40° to 105° East of true North, and there is a greater constancy of this hourly direction in winter than in summer; on each day of local thunderstorm the frequency of atmospherics increases, and in a month of many thunderstorms (local and distant) the monthly average of atmospherics/minute is high; and the atmospherics on a particular day appear to be related to the mean local temperature of the same day or of the previous day. Fig. 11 shows the close similarity between the atmospherics/minute curve throughout the period and a curve of "combined effect," the latter being made proportional to $0.45L + 0.20D + 0.40T + 0.105S$, where $L$, $D$, $T$ and $S$ are taken from the local and distant thunderstorm curves, the mean (monthly) temperature curve and the sunspot-number curve respectively. The observations were made at first on 15 kc/s, but from 21st November, 1932, this was changed to 27 kc/s at the suggestion of the Polar Year Sub-Commission.

RECORDS OF ATMOSPHERICS AT TAMANRASSET (HOGGAR: 22° 45′ N, 5° E) DURING THE POLAR YEAR [on 11 and 25 Thousand Metres: Preponderance of Distant over Local Atmospherics, in spite of Nearness of Tropical Stormy Zones: No Increase due to Sand Storms: etc.].—R. Failletaz and R. Bureau. (*Comptes Rendus*, 30th July, 1934, Vol. 199, No. 5, pp. 376–378.)

SOME OBSERVATIONS ON PROPAGATION [including Atmospherics] DURING THE POLAR YEAR, AT SCORESBY SOUND.—Douguet. (*See* under "Propagation of Waves.")

STUDY OF THE POLAR AURORAS AT SCORESBY SOUND DURING THE POLAR YEAR.—A. Dauvillier. (*Journ. de Phys. et le Rad.*, August, 1934, Series 7, Vol. 5, No. 8, pp. 398–412.) *See* also June Abstracts, p. 317.

ON BLUE GLOBULAR LIGHTNING.—E. Mathias. (*Comptes Rendus*, 27th Aug. 1934, Vol. 199, No. 9, pp. 505–507.)

PROPOSAL OF A METHOD OF OBSERVING THE SOLAR CORONA WITHOUT AN ECLIPSE [using Technique of Television Scanning].—A. M. Skellett. (*Proc. Nat. Acad. Sci.*, 15th Aug. 1934, Vol. 20, No. 8, pp. 461–464.) For a preliminary letter on this subject *see* August Abstracts, p. 435.

ORIGIN OF THE COSMIC CORPUSCLES [Sun and Earth form Cosmic Electrostatic Generator].—L. G. H. Huxley. (*Nature*, 15th Sept. 1934, Vol. 134, pp. 418–419.)

A NEW COMPONENT OF THE COSMIC RADIATION [New Results indicating that the Radiation producing Showers is a New Component of the Primary Radiation].—B. Rossi and S. de Benedetti. (*La Ricerca Scient.*, 15th/31st Aug. 1934, 5th Year, Vol. 2, No. 3/4, p. 95.)

INTENSITY OF THE COSMIC ULTRA-RADIATION IN THE STRATOSPHERE WITH THE TUBE-COUNTER [Identical with that found by Ionisation Chamber: Preliminary Letter].—E. Regener and G. Pfotzer. (*Nature*, 1st Sept. 1934, Vol. 134, p. 325.)

ON THE MATHEMATICAL ANALYSIS OF COSMIC-RAY DATA.—L. V. King. (*Phys. Review*, 1st Aug. 1934, Series 2, Vol. 46, No. 3, pp. 154–156.)

REPORT ON THE WORK OF THE BARTOL RESEARCH FOUNDATION, 1933–1934 [including Summary and Bibliography of Work on Cosmic Rays].—W. F. G. Swann. (*Journ. Franklin Inst.*, August, 1934, Vol, 218, No. 2, pp. 173–241.)

THE COSMIC RAYS [Survey].—L. Leprince-Ringuet. (*Ann. des P.T.T.*, July, 1934, Vol. 23, No. 7, pp. 639–657.)

THE PRESSURE DEPENDENCE OF THE RESIDUAL IONISATION CURRENT, IN CONNECTION WITH COSMIC RAY MEASUREMENT.—P. Pfundt. (*Zeitschr. f. Phys.*, 4th Sept. 1934, Vol. 90, No. 7/8, pp. 440–456.)

ON THE STOPPING OF FAST PARTICLES AND ON THE CREATION OF POSITIVE ELECTRONS.—H. Bethe and W. Heitler. (*Proc. Roy. Soc.*, Series A, 1st Aug. 1934, Vol. 146, No. 856, pp. 83–112.)

## PROPERTIES OF CIRCUITS

THE NON-LINEAR THEORY OF ELECTRIC OSCILLATIONS [Survey, with Bibliography of 87 Items].—B. van der Pol. (*Proc. Inst. Rad. Eng.*, September, 1934, Vol. 22, No. 9, pp. 1051–1086.)

The non-linear theory is involved whenever the characteristic surface of a valve, $i_a = f(V_a, V_g)$ is not approximated by a plane, and the bends of the characteristic have therefore to be taken into account. "From what follows, it will appear that most of the typical oscillation phenomena considered can be investigated and explained with the aid of a simple anti-symmetrical characteristic of the form $i = \alpha v - \gamma v^3$. On the one hand, the presence in this equation of a term like $\beta v^2$, which is well known, to explain detection and modulation, is *not* essential for a clear insight into most of the many oscillation phenomena which we discuss below. On the other hand, the introduction of the non-linear term $-\gamma v^3$, through which our non-linear treatment differs from the elementary and well-known linear consideration of oscillation phenomena, has, in the course of fourteen years, proved to yield a great amount of information on, and deeper insight into, many oscillation phenomena which the radio worker almost daily encounters, and which cannot be understood on the basis of the elementary linear theory." The approximations introduced in the writer's treatment are mostly of a physical nature, but in the many cases where a later, more rigorous mathematical treatment has led to the same results, references are given to enable the mathematically inclined reader to study the subject in greater detail.

The cases studied are :—The triode oscillator with one degree of freedom : free oscillations. The same, with two more terms in the approximation to the characteristic. The triode oscillator with two degrees of freedom (coupled circuits : including the phenomenon of oscillation hysteresis). The triode oscillator with external electromotive force. Free relaxation oscillation. The relaxation oscillator with impressed electromotive force (frequency demultiplication).

CONTRIBUTION TO THE THEORY OF NON-LINEAR CIRCUITS WITH LARGE APPLIED VOLTAGES [Trigonometric Polynomial Method, for Resistance Circuits, and Its Advantages over Power Series, Graphical and other Methods : Calculation of Amplification, Modulation, and Demodulation Products : Approximation for Parallel Resonant Circuit Load : Modulated Amplifier : Need for Extension].—W. L. Barrow. (*Proc. Inst. Rad. Eng.*, August, 1934, Vol. 22, No. 8, pp. 964–980.)

SELF-OSCILLATIONS IN CONTINUOUSLY DISTRIBUTED SYSTEMS.—Witt. (*See* under " Transmission.")

SKIN EFFECT IN RECTANGULAR CONDUCTORS AT HIGH FREQUENCIES [Experimental Confirmation of Cockcroft's Theoretical Formulae].—W. Jackson : Cockcroft. (*Phil. Mag.*, September, 1934, Vol. 18, No. 119, pp. 433–441.)

For Cockcroft's paper *see* Abstracts, 1929, p. 224. For the low-loss air condenser, specially designed so that the conductor resistance might form a sufficiently large proportion of the total circuit resistance, *see* Jackson, under " Subsidiary Apparatus and Materials." The theoretical and experimental curves (at 45 m wavelength) agree well. In Fig. 3 the calculated resistance/perimeter curve is compared with that for an elliptical section, calculated from Strutt's formula, and with the d.c. resistance of a strip of width equal to the perimeter of the rectangular section.

NEW REPRESENTATION OF THE PROPERTIES OF TWO COUPLED CIRCUITS [leading to a Method of obtaining, by Suitable Choice of Coupling and Decrements, a Practically Constant Secondary Amplitude over a Wide Frequency Band, while preserving a High Efficiency].—R. Mesny. (*L'Onde Élec.*, July, 1934, Vol. 13, No. 151, pp. 289–316.)

" Thanks to suitably chosen notations, the writer represents the secondary intensity by a surface whose examination allows the different forms of its variations to be perceived at a glance : he also shows how a plane diagram can be constructed which is valid for all cases and on which the numerical values of the intensity can be determined graphically, or the problems involved in the coupling can be solved. . . ."

CURVE TABLES FOR THE CALCULATION OF THE WORKING ATTENUATION OF A SERIES OF QUADRIPOLES.—P. Behrend. (*T.F.T.*, July, 1934, Vol. 23, No. 7, pp. 159–162.)

THE USE OF LOCUS CURVES FOR THE CALCULATION OF THE CHARACTERISTIC IMPEDANCE, ATTENUATION AND IMPEDANCE ANGLE OF QUADRIPOLES WITH LOSS RESISTANCES.—F. Vilbig. (*T.F.T.*, August, 1934, Vol. 23, No. 8, pp. 185–191.)

INPUT RESISTANCE AND WORKING ATTENUATION OF QUADRIPOLES.—W. Weinitschke. (*T.F.T.*, April, 1934, Vol. 23, No. 4, pp. 87–93.)

PERFORMANCE DIAGRAMS FOR NON-DISSIPATIVE SYMMETRICAL LATTICE-TYPE NETWORKS [showing the Effect of Different Terminal Resistances], *and* ON THE CHARACTERISTICS OF AN ELECTRICAL WAVE FILTER WITHOUT THE SENDING END TERMINATING RESISTANCE.—Z. Kamaychi. (*Rep. of Rad. Res. in Japan*, April, 1934, Vol. 4, No. 1, Supp. p. 4 : abstracts only.)

ON THE CHARACTERISTICS OF DISSIPATIVE TRANSMITTING NETWORKS, WITH SPECIAL REFERENCE TO THE ATTENUATION CHARACTERISTICS.—Z. Kamayachi. (*Journ. I.E.E. Japan*, May, 1934, Vol. 43 [No. 5], No. 550, p. 405 : English summary p. 61.)

TRANSMISSION ADMITTANCE AND SIGNAL DISTORTION IN TELEGRAPH SYSTEMS WITH LINEAR DEPENDENCE OF PHASE ON FREQUENCY [and a Comparison between Systems with Rectangular and Cosine Admittance Curves, as regards Speed, Distortion and Interference].—O. Erhardt. (*E.N.T.*, August, 1934, Vol. 11, No. 8, pp. 267–281.

NOTE ON METHODS OF COMPUTING MODULATION PRODUCTS [Bartlett's Method particularly suitable when First Few Derivatives are sufficient : a More General Method based on Bromwich's Work on Contour Integrals].—W. R. Bennett and S. O. Rice : Bartlett. (*Phil. Mag.*, September, 1934, Vol. 18, No. 119, pp. 422–424.)

For Bartlett's paper *see* Abstracts, June, p. 320, l-h col. For Bennett's previous work giving expressions for modulation products in terms of contour integrals *see* 1933, p. 389. " In this note it will be shown that Bartlett's result can be derived from a contour integral provided that the derivatives of the characteristic of the device are continuous, a restriction that need not be satisfied if the modulation products are computed from the contour integral directly. The contour integral thus appears to have a more general field of application than the operational formula."

STRAIGHT-LINE DETECTION WITH DIODES.—Roberts and Williams. (*See* under "Reception.")

THE DEPENDENCE OF THE AMPLIFICATION RATIO ON THE VALVE CHARACTERISTIC.—Emersleben. (*See* under "Valves and Thermionics.")

## TRANSMISSION

SELF-OSCILLATIONS IN CONTINUOUSLY DISTRIBUTED SYSTEMS [Mathematical Investigation of Lecher-Wire Systems, as a First Step to a General Theory].—A. Witt. (*Physik. Zeitschr. der Sowietunion*, No. 6, Vol. 5, 1934, pp. 777–795.)

"Only the case of approximately sinusoidal oscillations is considered. The excitation conditions are set out, the amplitudes of stationary oscillations calculated, and their stability examined. As an example the oscillations of a Lecher system are chosen, at one end of which a capacity is connected and at the other a negative resistance with falling characteristic. In a given condition a number of overtones can, in general, be excited. On an increase of the resistance all first overtones become unstable, and the system, if it was originally oscillating to one of these overtones, jumps to higher overtones with smaller amplitudes. On cutting out the resistance [or reducing it, as by decreasing the wire spacing] the oscillations do not break off but continue with greater amplitudes. In this way the system can be changed from one oscillation system to another. The work represents only a first attempt at the mathematical treatment of non-linear continuously distributed oscillation systems. From a mathematical standpoint it is not based sufficiently strictly."

THE CONSTRUCTION OF NEW VALVES TO PRODUCE VERY SHORT ELECTRIC WAVES [Micro-Waves] IN THE RETARDING-FIELD CIRCUIT [Preliminary Communication].—O. Pfetscher and K. Müller. (*Physik. Zeitschr.*, 15th Aug. 1934, Vol. 35, No. 16, pp. 654–657.)

The writers' object was to lessen, if possible, the number of degrees of freedom of the Lecher-wire system external to the oscillating valve, and to design generators to give definite wavelengths, determining their dimensions beforehand. The principle of the arrangement adopted was that two electrodes (grid and anode), with their leads, were combined inside the tube to form a closed, homogeneous double system of conductors, while the 3rd electrode (the cathode) took the form of a capacitatively coupled, tunable, secondary single wire resonator. The energy was tapped off symmetrically from the double system. Figures are given of possible electrode arrangements to satisfy these geometrical conditions. In practice it was found that such a valve generated only the fundamental wavelength of the double system. A push-pull arrangement for $\lambda \sim 60$ cm is also described which gives very stable oscillations and delivers an output of several watts.

ELECTRON OSCILLATIONS WITHOUT TUNED CIRCUITS [Positive-Grid Generator without Lecher-Wire System: Several Regions of Oscillation observed: Comparison of B-K, Scheibe, Hollmann and Rostagni Wavelength Relationships: etc.].—W. H. Moore. (*Proc. Inst. Rad. Eng.*, August, 1934, Vol. 22, No. 8, pp. 1021–1036.) Further development of the work dealt with in 1931 Abstracts, p. 612.

AN INFLUENCE OF THE GRID EXTERNAL CIRCUIT ON THE PRODUCTION OF ULTRA-SHORT-WAVE [Micro-Wave] ELECTRONIC OSCILLATIONS.—I. Yamamoto and Y. Degawa. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 402: English summary p. 60.)

PHASE ANGLE OF VACUUM TUBE TRANSCONDUCTANCE AT VERY HIGH FREQUENCIES.—Llewellyn. (*See* under "Valves and Thermionics.")

FACTORS INFLUENCING THE OUTPUT AND EFFICIENCY OF MAGNETRON OSCILLATIONS [and the Design of a Magnetron to give 100 w Radiated Power at 70–90 cm with an Efficiency of about 30%].—Slutzkin, Leljakow, Kopilowitsch and others. (*Physik. Zeitschr. der Sowietunion*, No. 6, Vol. 5, 1934, pp. 887–901.)

Dependency of intensity on the angle between directions of field and filament; influence of the field strength on intensity and efficiency (zero filament/field angle); of the voltage, on the same; of the heating; of the gap between the anode half-cylinders; of the anode dimensions. Mechanism of the production of oscillations in split-anode magnetrons: some constructional points in the design of high-output magnetrons (desirability of having the oscillating circuit inside the container, with the aerial either led into this or inductively coupled outside: fracturing of bulb when strong fields are used, its cause, and its prevention by discs between filament and bulb, perpendicular to lines of magnetic field: protection of filament ends and bulb against electron bombardment, by these discs: difficulties in preventing the overheating of filament, with progressive increase of oscillation intensity, by currents produced by the ultra-high-frequency field, leading to the necessity for limiting the input energy by a resistance of several thousand ohms inserted in the anode circuit).

MAGNETRON OSCILLATIONS [Identical with "Dynatron" Oscillations].—E. C. S. Megaw. (*Nature*, 1st Sept. 1934, Vol. 134, pp. 324–325.)

The magnetron oscillations discussed were described by Posthumus (Abstracts, October, pp. 557–558), and the "dynatron" oscillations by Megaw (1933, p. 324, and February, p. 94).

A NOTE ON MAGNETRON THEORY [Experimental Confirmation of Megaw's Defence of Hull's 1921 Interpretation ("Quasi-Cardioid" Paths) against his 1924 ("Concentric Circles" for Magnetic Fields above Critical Value)].—F. T. McNamara. (*Proc. Inst. Rad. Eng.*, August, 1934, Vol. 22, No. 8, pp. 1037–1039.) *See* Megaw, 1933 Abstracts, pp. 270 and 324 (l-h column).

ULTRA-SHORT WAVE GENERATOR [Avoidance of Fused-In H.F. Connections by Enclosing Push-Pull System with Grid and Anode Circuits in Bulb: Inductive Coupling to External Circuit: Tuning Condenser (Differential) with Fixed Plates inside Bulb and Movable Plates outside].—V. K. Zworykin. (U.S.A. Pat. 1 930 499: pub. 17.10.1933: *Hochf:tech. u. Elek:akus.*, May, 1934, Vol. 43, No. 5, p. 178.)

SOME SUCCESSFUL EXPERIMENTAL GEAR FOR 2½ AND 1¼ METRE ULTRA-SHORT WAVES.—R. A. Hull. (*QST*, September, 1934, Vol. 18, No. 9, pp. 13–15 and 88.)

QUENCHED-SPARK GENERATOR FOR MICRO-WAVES [Concentric Tube Type].—L. Rohde and H. Schwarz. (German Pat. 591 276, pub. 19.1.1934: *Hochf:tech. u. Elek:akus.*, May, 1934, Vol. 43, No. 5, p. 178.) *See* 1933 Abstracts, pp. 501–502.

MICRO-WAVE GENERATOR USING A DISCHARGE IN A COLLOIDAL SOLUTION OF METAL PARTICLES.—C. W. Hansell. (U.S.A. Pat. 1 945 039, pub. 30.1.1934.)

PIEZOELECTRIC STABILISATION OF HIGH [and Ultra-High] FREQUENCIES [Quartz preferable to Tourmalin].—Osterberg and Cookson. (*See* under "Measurements and Standards.")

NEW POLICE TRANSMITTER [50 Watts, for Moderate Area Coverage: Crystal-Controlled Oscillator with Ganged Switching for Rapid Frequency Shifts between 1.5 and 3 Mc/s].—Western Electric Company. (*Rad. Engineering*, August, 1934, Vol. 14, No. 8, pp. 7–9.)

FREQUENCY VARIATION IN COMMERCIAL SHORT-WAVE TRANSMITTERS.—I. Koga and M. Hase. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 409: Japanese only.)

NOTE ON THE SYNCHRONISATION OF BROADCAST STATIONS WJZ AND WBAL.—Norton. (*See* under "Stations, Design and Operation.")

ON THE CAUSE OF THE WANDERING OF THE INTERFERENCE WAVE OF COMMON-WAVE TRANSMITTERS [Wandering of Maxima and Minima Points in the Interference Zone of Cable-Controlled Systems: Improvement by Introduction of Mechanical Delay Device (Separately-Excited Tuning Fork) between Fundamental-Frequency Generator and Transmitter at the Controlling Station].—P. R. Arendt. (*T.F.T.*, August, 1934, Vol. 23, No. 8, pp. 198–200.) For previous papers *see* September Abstracts, p. 496. *See* also next reference.

COMPARISON OF VARIOUS SYSTEMS OF COMMON-WAVE BROADCASTING.—Arendt. (*See* under "Stations, Design and Operation.")

DISCUSSION ON "OPTIMUM OPERATING CONDITIONS FOR CLASS C AMPLIFIERS" [Definitions of Linear and Class A, B, "B′" and C Amplifiers].—Everitt. (*Proc. Inst. Rad. Eng.*, September, 1934, Vol. 22, No. 9, pp. 1139–1140). *See* April Abstracts, p. 205.

EXPERIMENTS ON THE MODULATION OF A TETRODE POWER AMPLIFIER [and the Success of Constant-Voltage Modulation in the Screen-Grid Circuit].—D. Hiraga. (*Rep. of Rad. Res. in Japan*, April, 1934, Vol. 4, No. 1, Supp. p. 6: abstract only.)

A "SHORT-CUT" METHOD FOR CALCULATION OF HARMONIC DISTORTION IN WAVE MODULATION ["Ordinate-Difference Harmonic Analysis" Graphical Method, for All Stages of a Class B Audio Amplifier].—I. E. Mouromtseff and H. N. Kozanowski. (*Proc. Inst. Rad. Eng.*, September, 1934, Vol. 22, No. 9, pp. 1090–1101.)

A time-saving procedure applicable to all symmetrical periodic curves containing harmonic components plotted to the sine of the fundamental frequency, for the calculation of such components up to the 11th order.

ELECTRON-COUPLED OSCILLATION EXCITED BY THE DYNATRON "KIPPSCHWINGUNG." PART I [and a Method of generating Sharply-Peaked Voltage Wave Form].—T. Hayasi. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 401: English summary p. 60.)

EXPERIMENTAL AND ANALYTICAL STUDIES OF NEGATIVE-RESISTANCE OSCILLATORS BY MEANS OF SECONDARY ELECTRONS [Dynatrons and Duo-Dynatrons].—T. Hayasi. (*Rep. of Rad. Res. in Japan*, April, 1934, Vol. 4, No. 1, pp. 1–34: in English.) In two parts. For Part I *see* September Abstracts, p. 497, and for Part II, *ibid.*, pp. 496–497.

## RECEPTION

THE RECEPTION OF WIRELESS SIGNALS IN NAVAL SHIPS [Aerials and Cable Systems: General Requirements of Naval Receivers (with Discussion of Selectivity Problem): Description of Receivers: Power Supplies].—W. F. Rawlinson. (*Journ. I.E.E.*, September, 1934, Vol. 75, No. 453, pp. 293–316.) The full paper and Discussion, a *Wireless Engineer* summary of which was referred to in July Abstracts, p. 382.

AN EXAMINATION OF THE CAUSES AND NATURE OF THE INTERFERENCE TO WHICH THE WIRELESS COMMUNICATIONS OF THE MERCANTILE MARINE ARE SUBJECTED.—J. A. Slee. (*Journ. I.E.E.*, September, 1934, Vol. 75, No. 453, pp. 355–378.) The full paper, with Discussion, a *Wireless Engineer* summary of which was referred to in October Abstracts, p. 561.

THE NEW "STANDARD" RADIO RECEIVERS FOR COMMERCIAL LINKS (R.M.6, R.M.7 and R.M.8).—L. J. Heaton-Armstrong and L. T. Hinton. (*Elec. Communication*, July, 1934, Vol. 13, No. 1, pp. 69–75.)

ON CONVERSION DETECTORS [for Superheterodyne Receivers: Theoretical and Experimental Comparison of Diodes, Variable-Slope Detectors, Double-Grid (including Octode and "Emission Valve") and Grid-Anode Detectors: Equation covering All Types: Apparatus for Measurement of Conversion Gain and Harmonics].—M. J. O. Strutt. (*Proc. Inst. Rad. Eng.*, August, 1934, Vol. 22, No. 8, pp. 981–1008.)

This is the work promised in the writer's previous theoretical paper, dealt with in March Abstracts, p. 148. Measured and calculated data agree as well as could be expected. Conversion gains of more than 400 were found with modern valve conversion detectors. It is pointed out that distortion can be determined by measuring the harmonics. There is a bibliography, chiefly of 1930/1934 work.

SUPPRESSION OF INTERLOCKING IN FIRST DETECTOR CIRCUITS: ADDENDA TO BIBLIOGRAPHY.—P. W. Klipsch. (*Proc. Inst. Rad. Eng.*, September, 1934, Vol. 22, No. 9, p. 1050.) *See* September Abstracts, p. 498.

STRAIGHT-LINE DETECTION WITH DIODES [Theoretical Treatment with Experimental Confirmation and Cathode-Ray Oscillograms: Almost Perfect Detection even with 100% Modulation, by Proper Choice of Circuit Constants: Beneficial Effect of Positive Grid Bias: Treatment applicable to Power-Grid and Power-Anode Detection and Duo-Diodes].—F. Roberts and F. C. Williams. (*Journ. I.E.E.*, September, 1934, Vol. 75, No. 53, pp. 379–388.)

A NOVEL REGENERATIVE RECEIVER [Pentagrid Converter Valve used as Combined Renegerative Detector and Beat Oscillator, S-G Section as Detector: for all Frequencies between 10 kc/s and 28 Mc/s].—R. C. Couppez. (*QST*, September, 1934, Vol. 18, No. 9, pp. 42–43.)

(1) ON THE SENSIBILITY OF A SUPER-REGENERATIVE RECEIVER [for Ultra-Short Waves]: (2) STUDY ON SUPER-REGENERATION WITH A CATHODE-RAY OSCILLOGRAPH: *and* (3) SYNCHRONISATION OF A SUPER-REGENERATIVE RECEIVER.—H. Ataka. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, pp. 413, 414 and 415: English summaries pp. 63–64.)

(1) For too small quenching frequencies the sensitivity is as low as for too high; there is an optimum frequency. Except in the case of very low quenching frequencies, the sensitivity increases generally as the quenching voltage increases; the optimum quenching frequency moves to lower frequencies as the quenching voltage decreases. (2) "From these figures it is found that the signal affects chiefly the start of the oscillation. . . . The maximum amplitude of the oscillatory voltage remains almost constant, irrespective of the intensity of the incoming signal." This agrees with Roosenstein's theory (January Abstracts, pp. 35–36). The characteristic background-noise in the absence of a signal is due to the initiation of oscillation by irregular shot and thermal-agitation effects, etc.; the irregularity is shown by the heavy fluorescent spot. (3) The suppression of the characteristic noise by the arrival of the signal is due to the synchronising effect of the latter. Synchronisation occurs when $\lambda = m\lambda_0$ or $\lambda_0/n$, where $m$ and $n = 1, 2, 3 \ldots$. This has been verified for values of $m$ up to 63 and $n$ up to 2. The application of these phenomena to a super-regenerative wavemeter has already been described (February Abstracts, p. 105, l-h col.) and here, as an example, the calibration of a short-wave wavemeter by a super-regenerative wavemeter for ultra-short waves is shown in Fig. 3. For other previous work *see* 1933 Abstracts, p. 620.

SOME SUCCESSFUL EXPERIMENTAL GEAR FOR 2½ AND 1¼ METRE ULTRA-SHORT WAVES.—R. A. Hull. (*QST*, September, 1934, Vol. 18, No. 9, pp. 13–15 and 88.)

DISCUSSION ON "THE SPONTANEOUS BACKGROUND NOISE IN AMPLIFIERS DUE TO THERMAL AGITATION AND SHOT EFFECTS."—F. B. Llewellyn: Moullin and Ellis. (*Journ. I.E.E.*, September, 1934, Vol. 75, No. 453, pp. 395–398.) Further discussion of the Moullin and Ellis paper dealt with in Abstracts, June, p. 321. Llewellyn deals with the wide difference between some of the results and conclusions and those reached by himself (1930, pp. 279–280). The authors reply.

A MEASURING METHOD FOR THE COMPARATIVE ESTIMATION OF BROADCAST INTERFERENCE [for Judging the Efficacy of Interference-Quenching Measures].—F. Conrad and H. Reppisch. (*Funktech. Monatshefte*, August, 1934, No. 8, pp. 315–318.)

The writers' *ENT* paper (July Abstracts, p. 380) dealt with the actual measurement of the strength of interference. The test equipment here described gives no absolute values but is used by the German P.O. to test the efficacy of quenching measures applied to electrical appliances. The test room is provided with a double-walled copper-gauze cage containing a broadcast receiver with two r.f. stages and a graduated sensitivity control, together with apparatus for judging the signal strength both subjectively and objectively. For the latter purpose either an impulse meter (with galvanometer) or a "barometer" glow-discharge tube is employed (*see* Fig. 3). The receiver is connected to an aerial, outside the cage, which can be raised or lowered so as to vary its coupling with a double overhead line of variable length or with a power cable of about 300 metres' length (*see* the theoretical diagram Fig. 1), either of which can be made to supply the interference source *Stö*. In each test this aerial coupling is altered so as to give a suitable interference strength, after which the graduated sensitivity control is adjusted till some standard strength (*e.g.*, threshold of audibility on loudspeaker) is reached.

The last part of the paper gives a discussion of what the writers call the "normal interference condition" and the value of the maximum permissible r.f. interference. It is shown that this value depends on three independent quantities—the local field strength of the station received, the overall acoustic transmission loss measuring the ratio between the volumes at the transmitting microphone and at the reproducer, and the nature of the programme item. The necessity for involving acoustic quantities in the quantitative specification of interference is recognised in the Austrian instructions (*see* next reference) according to which the received interference is compared with "normal" reception which is taken at a given distance from the loudspeaker in a room of specified dimensions: the maximum permissible interference must be at least 40db below the "normal" reception.

REGULATIONS CONCERNING THE ELIMINATION OF INTERFERENCE WITH BROADCAST RECEPTION.—(*Elektrot u. Maschbau*, No. 19, Vol. 52, 1934, p. 223.) *See* end of preceding abstract.

GERMAN P.O. RESULTS IN TREATING CASES OF INTERFERENCE.—(*E.T.Z.*, 30th Aug. 1934, Vol. 55, No. 35, p. 866: paragraph only.)

Between January, 1930, and June, 1934, the P.O. has cured 140000 cases. The causes were :—small motors, etc., in home, farm or commerce, 30%; faults in the receiving installation, 24%; atmospherics and untraceable sources, 18%, etc. 48% of the cases were dealt with at the source and 31% at the receiving end.

ANTI-INTERFERENCE SCREENING OF IGNITION LEADS INCREASES DETERIORATION OF RUBBER BY OZONE.—Viehmann. (*See* abstract under "Subsidiary Apparatus and Materials.")

ELECTRICAL INTERFERENCE.—A. Morris. (*Wireless World*, 27th July, 1934, Vol. 34, pp. 59–60.)

Describing some of the problems involved in defining what degree of radiation from electrical plant constitutes interference with broadcast reception.

POINTERS ON NOISE-REDUCING RECEIVING ANTENNA SYSTEMS.—Hatry. (*See* under "Aerials and Aerial Systems.")

THEORY AND OPERATION OF A NEW ALL-WAVE NOISE-REDUCING ANTENNA SYSTEM.—Aceves. (*See* under "Aerials and Aerial Systems.")

NOTE ON A CAUSE OF RESIDUAL HUM IN RECTIFIER-FILTER SYSTEMS [Capacitance of Power Transformer Secondary to Earth by-passes Filter System when Chokes are in Negative Lead and Negative Output is earthed].—F. E. Terman and S. B. Pickles. (*Proc. Inst. Rad. Eng.*, August, 1934, Vol. 22, No. 8, pp. 1040–1041.)

VOLUME-RANGE "COMPRESSION" AND "EXPANSION" AT TRANSMITTER AND RECEIVER RESPECTIVELY: IMPROVED REPRODUCTION OF BROADCAST MUSIC AND GREATLY INCREASED SIGNAL/NOISE RATIO.—Nestel: Sowerby. (*See* abstracts under "Acoustics and Audio-frequencies.")

RESISTANCE TUNING.—(*Wireless World*, 27th July, 1934, Vol. 34, p. 58.)

A short description of the new method of tuning due to Cabot (September Abstracts, p. 497.)

PERMEABILITY TUNING [and the Varley Permeability Tuner].—(*Wireless World*, 17th Aug. 1934, Vol. 34, pp. 139–140). *See* also Polydoroff, 1933 Abstracts, p. 393.

THE MEASUREMENT OF RECEIVER PERFORMANCE.—(*Wireless World*, 17th Aug. 1934, Vol. 34, pp. 136–138.)

"RADIO RECEIVER MEASUREMENTS" [Text Book for Service Engineer: Review].—R. M. Barnard. (*Electrician*, 17th Aug. 1934, Vol. 113, No. 2933, p. 219.)

STEP-BY-STEP WAVEBAND COVERAGE.—(*Wireless World*, 31st Aug. 1934, Vol. 34, p. 195.) A suggested modification to the "Single-Span" principle of reception dealt with in June Abstracts, p. 322.

OLYMPIC S.S. SIX ["Single Span" Tuning, A.C. Mains].—W. C. Cocking. (*Wireless World*, 10th, 17th and 24th Aug. 1934, Vol. 34, pp. 90–93, 129–134 and 155–156.)

THREE-VALVE HEXODE UNIVERSAL SUPERHET.—K. König. (*Funktech. Monatshefte*, August, 1934, No. 8, pp. 303–308.)

1935 A.C. SHORT-WAVE RECEIVER [3-Valve].—(*Wireless World*, 31st Aug. and 7th Sept. 1934, Vol. 34, pp. 192–194 and 210–212.)

AMERICAN SETS AND VALVES.—J. H. O. Harries. (*Wireless World*, 27th July, 1934, Vol. 34, pp. 52–54.) A general description of current American practice, especially in the matter of car and battery sets and their associated equipment.

A REVIEW OF GERMANY'S PREMIER EXHIBITION [1934 Berlin].—(*Wireless World*, 31st Aug. and 7th Sept. 1934, Vol. 34, pp. 196–199 and 216–218.)

1934 PARIS RADIO EXHIBITION.—(*Wireless World*, 21st Sept. 1934, Vol. 34, pp. 248–250.)

OLYMPIA [1934: a Stand-to-Stand Report].—(*Wireless World*, 24th Aug. 1934, Vol. 34, pp. 157–180.)

RADIOLYMPIA 1934.—(*Nature*, 25th Aug. 1934, Vol. 134, p. 294.)

THE TREND OF PROGRESS [in the Design of Receivers and Associated Apparatus, as reflected by the Olympia Show].—(*Wireless World*, 10th Aug. 1934, Vol. 34, pp. 94–99, 104–106, 108–110, 111–112 and 113–114.)

THE ALPHABETICAL STATION SELECTOR [Tuning Scale].—AEG. (*Zeitschr. V.D.I.*, 18th Aug. 1934, Vol. 78, No. 33, p. 977.)

AUTOMATIC RADIO TUNING ["Tune-o-matic" Clock for Pre-Selected Programme Switching].—A. A. Kent. (*Scient. American*, September, 1934, Vol. 151, No. 3, pp. 144–145.)

## AERIALS AND AERIAL SYSTEMS

[Experimental] INVESTIGATIONS OF THE RADIATION FIELD OF A DIPOLE AT 1 METRE WAVE-LENGTH [and the Effects of Metal, Glass and Wood Screens: the Influence of Earth Reflection on the Vertical Distribution, for Horizontally and Vertically Polarised Ultra-Short Waves].—W. Hübner. (*Archiv f. Elektrot.*, 18th Aug. 1934, Vol. 28, No. 8, pp. 468–476.)

For the necessary point-by-point measurement of the field strengths, without upsetting the fields, a small receiver was used connected by a screened cable to the test table. Fig. 2 shows the diagram of connections, with anode repose-current compensation. The receiver valve was found to show a marked photo-sensitivity (*cf.* Pungs and Schulze, Abstracts, 1931, p. 387) and had therefore to be protected by a metal screen.

In investigating the action of the various screens interposed in the radiation field, the transmitter and screen were kept stationary (*contrast* Seiler, 1931, p. 262) and the receiver moved from point to point of the horizontal plane, about 1.20 m above the ground, the current change being taken at about every 25 cm. The distorting effect of re-radiation from the receiver was shown to be small. For these tests the dipoles were vertical. Results are shown in Figs. 5–8, which give the lines of equal field strength in the absence of any screen, and with a metal, glass and wooden screen, respectively. The formation of standing waves in front of the metal screen is seen: at the edges there is diffraction, which is so great that behind the screen, at the centre, the resulting field is stronger than at the sides. The field strength behind the glass screen (8 mm thick) is greater than behind the metal (0.2 mm); behind the wood screen (6 mm) it is still greater.

For investigation in the vertical plane the receiver was raised and lowered from an 11 m gallows, while the horizontal range was varied by moving the transmitter. Equal field strength lines in the vertical plane are shown in Figs. 9–11 for a horizontal dipole, for transmitter heights of 1.15, 3.30 and 3.85 m respectively. The maxima and minima due to interference between direct and ground-reflected waves are clearly seen. Their number increases with the height of the transmitter above ground. In Figs. 10 and 11 the theoretical hyperbolas of the interference minima, calculated on the assumption of a phase shift at reflection of 180° for all angles of incidence, are introduced. The observed interference minima are shown by small circles, *and are seen to correspond almost exactly with the theoretical hyperbolas.* Since, by theory, the phase shift is 180° for an angle of incidence of 0° and decreases with increase of the angle, the decrease being smaller the greater the conductivity of the earth, the above agreement between the calculated and observed hyperbolas indicates that the conductivity is so great for these short waves that the lines of equal field strengths can be drawn on the assumption of an image dipole under the ground. For a transmitter height of $2n \cdot \lambda/4$ and $(2n + 1) \cdot \lambda/4$ there must exist, vertically above the transmitter, minima and maxima (respectively) of field strength, as a result of the interference of direct and reflected waves and the 180° phase shift at reflection.

The interference maxima and minima are more marked near the earth than at greater heights: this conforms to theory, since the path difference of direct and reflected waves increases with increasing height, and with it the difference in amplitudes: and the greater this difference in amplitude, the weaker the interference. Moreover, the amplitude difference is increased by the fact that penetration into the ground increases with increasing angle of incidence—an added reason for the less marked maxima and minima at the greater heights. For an angle of incidence of 0° the path difference between direct and reflected waves is zero: the amplitude loss due to penetration disappears and the phase shift amounts to 180°: the field strength along the surface therefore vanishes, as is actually found to occur.

With vertical dipoles the field strength maxima and minima also occur (Fig. 12), but the curves are less easily constructed. The maxima and minima are not so pronounced as in the case of horizontal polarisation, and the ratio dipole-length/wavelength has more influence. A horizontal dipole has all its parts approximately at points of equal field strength, so that at a suitable distance from the transmitter the wave-front may be regarded as plane: a vertical dipole, on the other hand, has its ends extending into regions of higher field strength, so that what is measured is the mean field strength. To explore the field more accurately the shortest possible dipole would be needed, necessitating also a more sensitive receiver. Comparison of Fig. 12 with the curves for the horizontal dipoles shows that the upwards radiation, as would be expected from its characteristic, is less for the vertical dipole. "In general, at a given distance, the vertical dipole seems to give a lower field strength than the horizontal dipole. At the distances in question a rotation of the plane of polarisation was not observed."

The writer points out that if these results can be taken to apply at longer ranges over a flat terrain (the tests were on a small drill-ground), it must be concluded that the transmitter should be placed so low that only one interference maximum can be formed, so that the position of the receiver may be as little critical as possible. There would be, however, the disadvantage of lower field strength. Similarly a vertical dipole would be preferable, at transmitter and receiver, so far as maxima and minima are concerned, but here again a decreased field strength would be suffered. "The best solution appears to be the horizontal dipole with a low transmitter position."

ON THE GAIN OF A PARABOLIC REFLECTOR.—Y. Aoi. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 317: English summary p. 43.)

RADIATION CHARACTERISTICS OF OPEN WIRE TRANSMISSION LINES [and the Possibility of Narrow Lobes of Radiation of Appreciable Amplitude in spite of Low Total Radiation Loss].—T. Walmsley. (*Phil. Mag.*, August, 1934, Vol. 18, No. 118, pp. 236–240.)

Further development of the work dealt with in 1931 Abstracts, p. 616. Although not serious for transmitting systems, the narrow lobes might, if they existed, give a disturbing pick-up when the lines were used between aerial and receiver. The discussion leads to the conclusion that a perfectly balanced twin transmission line such as is used for feeding beam arrays does not produce high-amplitude lobes of radiation: and, conversely, that the pick-up of a long line, for radiation arriving in any particular direction, is not great relative to that of a short line.

DIRECTIVE PROPERTIES OF MEDIUM-WAVE AERIALS [Experimental Investigation of Effects of Phase Change and Current-Ratio Change in a System of Two Spaced Quarter-Wave Aerials for Directive Broadcasting Transmission].—H. J. Wassall. (*Marconi Review*, July/August, 1934, No. 49, pp. 11–17.)

It was found that phase control had a major effect on the general shape of the diagram. By this means a considerable variety of shape is obtainable. Thus "A" of Fig. 4 has a front/back ratio of about 2.5/1, while "B" is a dumb-bell diagram of front-or-back to side ratio of about 2/1 and should be particularly useful for a long and narrow country. The effect of alteration of current ratio, on the other hand, is in comparison only a second order effect; it is greatest along or near the line of the aerials. Thus by suitably proportioning both phase and magnitude it would be possible to obtain zero radiation in one direction along this line.

ANTI-FADING AERIAL SYSTEMS [for Broadcasting Stations].—M. Bäumler. (*Zeitschr. V.D.I.*, 18th Aug. 1934, Vol. 78, No. 33, pp. 969–973.)

THEORY AND OPERATION OF A NEW ALL-WAVE NOISE-REDUCING ANTENNA SYSTEM [Broadcast and Short-Wave Signals received on Same Aerial and Lead-In, without Cross-talk or Interaction and with Elimination of Man-Made Static].—J. G. Aceves. (*Rad. Engineering*, August, 1934, Vol. 14, No. 8, pp. 20–21.)

The gap of a dipole aerial is bridged by a double transformer with reversed secondaries, the twin down-leads being connected to these but also, through by-pass condensers, direct to the halves of the dipole. For short waves, therefore, the double transformer is by-passed by these condensers and the system acts as a dipole, interference in the down-leads being eliminated by opposition of currents in the receiving auto-transformer. With lower frequencies the double transformer comes into action: the primary currents direct from the two halves of the dipole now neutralise each other (since the doublet is no longer acting as a half-wave aerial) but the currents from the reversed secondaries are additive. For wavelengths in between there is a combined action of the two types.

POINTERS ON NOISE-REDUCING RECEIVING ANTENNA SYSTEMS [Shielded or Twisted Down-Leads: the "Double-Doublet" as an All-Wave Aerial with Twisted-Pair Line, particularly Effective for Ignition Noise on Short Waves: etc.].—L. W. Hatry. (*QST*, August, 1934, Vol. 18, No. 8, pp. 20–24 and 74, 76.)

ARE GOOD AERIALS WORTH WHILE?—H. F. Smith. (*Wireless World*, 10th Aug. 1934, Vol. 34, pp. 101–102.)

Tests leading to the conclusion that a highly efficient aerial is no longer necessary for its original purpose of compensating for lack of receiver-sensitivity, but is still desirable for the purpose of minimising the effects of mains interference.

INCREASING RADIATING EFFICIENCY FOR SHORT ANTENNAS: A "TUNED-TOP" SYSTEM FOR 80 AND 160 METRE WAVES.—R. B. Dome. (*QST*, September, 1934, Vol. 18, No. 9, pp. 9–12.)

RESEARCHES ON THE EARTHING RESISTANCE IN VARIOUS TYPES OF GROUND, AND THE PRELIMINARY CALCULATION OF EARTH ELECTRODES.—F. Sprecher. (*Bull. Assoc. suisse des Élec.*, No. 15, Vol. 25, 1934, pp. 397–404.)

## VALVES AND THERMIONICS

EXTENSION OF THE GERMAN VALVE PROGRAMME [Fading-Mixing Hexode, Octode, Duo-Diode and Output Pentode].—(*Funktech. Monatshefte*, August, 1934, No. 8, pp. 311–312.)

The Telefunken-Valvo fading-mixing hexode ACH1 (and BCH1 for d.c.) may be regarded as an ordinary fading hexode including in its bulb a triode oscillator system using the same cathode and with its grid connected to the third grid of the fading hexode. The AVC control voltage is not, as in the usual fading-hexode circuit, applied to this third grid: the latter is acted on by the oscillator system, so that the mixing takes place here. "By this separation of mixing and oscillating systems, the various frequency distortions occurring with the ordinary hexode are avoided, and above all the advantage is obtained that the mixing valve can be used successfully for AVC without the oscillator being put out of action. The advantage of the mixing hexode, in giving a complete de-coupling of the input circuit from the oscillator circuit, is retained."

The octode (*see* also October Abstracts, p. 564) may be regarded as a combination of fading hexode and mixing hexode, with the addition of the properties of a h.f. pentode. The oscillator circuit is connected to the first grid and to the cathode, and a putting out of action by too much AVC is impossible. The next grid acts as anode for the oscillator; then comes a screen grid as a screen between the oscillator and the next grid, which is the control grid for the signal frequency; finally another screen grid and a suppressor grid connected internally to the cathode and giving the valve a high internal resistance. In actual working the fading-mixing hexode and the octode should be very similar; the main difference is that in the former the oscillator system is more separated from the others. Also the octode is only made for a.c., under the type symbol AK1.

The duo-diode (AB1 and BB1) has been produced because the combination of a diode system with an amplifier system, as in the binode, was not always a success. The new output pentode BL2 is for d.c. only and has an anode dissipation up to 8 watts.

ON CONVERSION DETECTORS [Comparison of Different Types of First Detector for Superheterodyne Receivers].—Strutt. (*See* under "Reception.")

NOISES OF RECEIVING VALVES [Ratio of Valve Noise to Amplification measured for Commercial Valves: Advantage of Low Grid-Bias and Screen-Grid Voltages: Triode best, Pentode better than Tetrode].—S. Ueno and I. Sakamoto. (*Rep. of Rad. Res. in Japan*, April, 1934, Vol. 4, No. 1, Supp. p. 5: abstract only.)

MEASUREMENT OF FLICKER EFFECT [in Diodes].—R. C. Meyer and E. A. Johnson. (*Phys. Review*, 15th July, 1934, Series, 2, Vol. 46, No. 2, pp. 143–144.)

The slope of the line giving the frequency variation of the fluctuation voltage was found to be approximately −1. This slope existed when the space current was limited by space charge. Reduction of shot effect to as low as 1/300 of the calculated value was observed with increase in emission current. The fluctuation voltage rose again to values greater than the calculated value when the filament temperature was sufficiently increased.

ON THE MEASUREMENT OF FREE GRID POTENTIAL OF TRIODES [Data for Indirectly Heated Type: Empirical Formula connecting $E_g$ and $E_r$].—Y. Morita. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 403: English summary p. 60.)

ELECTRON-OPTICAL CURRENT DISTRIBUTION IN [Grid-] CONTROLLED ELECTRONIC VALVES.—M. Knoll and J. Schloemilch. (*Archiv f. Elektrot.*, 18th Aug. 1934, Vol. 28, No. 8, pp. 507–516.)

Authors' summary:—"To decide whether the current distribution in controllable electronic tubes (*e.g.* amplifying and transmitting valves) conforms to electron-optical laws, special tubes were constructed which enabled the current distribution to be observed directly by means of fluorescence at the anode or by gaseous excitation. [For the first method a funnel-shaped bulb was used in which the sloping sides were metallised internally to form the anode, and covered with a thin fluorescent layer: an indirectly heated cylindrical cathode surrounded by a concentric (spiral or mesh) grid was mounted on the axis of the funnel. The incidence of the electron current on the anode was observed (and photographed) slantingly through the clear-glass, slightly curved end of the bulb. For the gaseous excitation method, by which the course of the electron rays themselves could be observed, an altogether different design of tube was employed, with a smaller, rectangular electrode system (Fig. 9) with a meshed anode and control- and screen-grids perforated with three rows of about 17 holes each: helium at low pressure was the filling].

"The observations and measurements gave the following results: (1) Even in the controllable electronic valves worked at comparatively low pressures, the passage of current does not take place in the form of a continuously flowing 'electron gas' but in the form of separate rays [corresponding to the number of openings in the grid] which produce a series of typical current-distribution figures on the anode. (2) Cross section and form of the individual rays depend very much on the grid and anode voltages. (3) Each of the typical current-distribution figures on the anode can be produced by different grid and anode voltages. For a given anode figure (and therefore a given focal distance of the electron-optical system of the grid openings) the ratio of control-voltage $u_{con}$ to anode-voltage $u_a$ is constant: $u_{con}/u_a = (u_g + D \cdot u_a)/u_a =$ const. (4) Consequently, within certain limits imposed by the aperture and by the repulsive forces of the electrons at high current values and low electron velocities, the external form of the separate rays depends, for a given electrode system, not on the absolute values of the grid and anode voltages but on the ratio $u_{con}/u_a$. (5) Through the 'Umgriff' of the anode round the grid ['back-penetration' from the anode round the grid into the grid/cathode space] narrowly confined rays may be formed which impinge on the neighbouring glass walls. It can be directly observed by what paths the primary electrons, and the scondary electrons liberated at the glass walls, return to the anode."

ON THE FORM DISTORTION [Non-Linear Distortion] IN AMPLIFIER VALVES [Method of Calculating the Magnitude and Nature of the Distortion from Five Current Values taken from the Working Characteristic Curves of the Valve].—W. Kleen. (*E.N.T.*, August, 1934, Vol. 11, No. 8, pp. 293–296.)

A method is described which gives the amplitudes of the various harmonics as linear functions of current values taken from the working characteristic, for sinusoidal a.c. applied to the grid. The method, which was developed independently of a similar one recently published by Espley (January Abstracts, p. 40, r-h column) is limited to the case of a purely ohmic load, and does not consider the distortions caused by the presence of grid current. The function $y = f(x)$ of the characteristic is replaced, by means of the Lagrangian interpolation formula, by the fractional rational function given in equation 1. The function values are taken from the curve at 5 equidistant points, including the working point and symmetrical to this. If $2n + 1$ points are taken the number of overtones which can be calculated is $2n$; with three points, however, the process is too inaccurate, and with more than five points the calculation is too complicated. The procedure is as follows:—for a known grid a.c. of amplitude $a$ (taken as 1) the current values are obtained from the working characteristic (the $i_a/e_a$ diagram with the resistance straight line introduced—Fig. 1) at the working point $i_0$, the point $e_g = \pm a$ (*i.e.*, $i_{+1}$ and $i_{-1}$) and the point $e_g = \pm a/2$ (*i.e.*, $i_{+\frac{1}{2}}$ and $i_{-\frac{1}{2}}$); then these values are introduced into the various equations 16, giving $C_0$, the d.c. component, and $C_1 \ldots\ldots C_4$, the amplitudes of the harmonics. Tables 1 and 2 show the "klirr" factors for a RENS-type valve under different circuit conditions: calculated and observed values agree well in each case.

THE DEPENDENCE OF THE AMPLIFICATION RATIO ON THE VALVE CHARACTERISTIC.—O. Emersleben. (*E.N.T.*, August, 1934, Vol. 11, No. 8, pp. 297–303.)

"In spite of its age, the resistance-coupled amplifier has received its main development only in the last few years. Even to-day no satisfactory comprehension of all its relations has been attained. In particular it is not always remembered that the slope $S$ and the internal valve resistance $R_i$ are by no means constant but depend on the working point used, whereas the 'durchgriff' [$1/\mu$] is constant provided no grid current is flowing. In the following, therefore, it is taken as constant for one and the same valve, and in particular as independent of the negative grid- and the anode-voltages." The results obtained, quantitatively valid for the resistance-coupled amplifier, are applicable, with small corrections, to other types of amplifier.

Author's summary :—" In resistance-coupled amplifiers, whose characteristic in the working zone can be approximated by any parabola of the $n$th degree ($n > 1$), the dependence of the amplification ratio $V$ on the circuit and valve variables is investigated (Section III). In particular it is shown (Section I) that for very general cases there is a value of 'durchgriff' ($D_0$) for which the amplification ratio is a maximum. This optimum 'durchgriff' is calculated (Section IV). The practicability of the calculation (which also covers other relations in the resistance-coupled amplifier, taking fully into account the effect of anode re-troaction) depends on the introduction of two dimensionless auxiliary variables $a$, $u$ (Fig. 1) and especially of the 'voltage-distribution ratio' $w$, in which the anode voltage source (anode battery) is divided between the voltage drop in the anode resistance on the one hand and in the anode/cathode space on the other (Section V). This ratio, at the optimum amplification ratio, is at most $1/3$ (Fig. 2). The ratio of the anode resistance to the internal valve resistance is, at the optimum, equal to unity only in the exceptional case where $n = 3$; for smaller values of $n$ it is smaller (Table 1).

" For any value of 'durchgriff' (even not the optimum) the amplification ratio increases if the anode resistance $R$, the emission constant $c$, or the anode-battery voltage is increased. Although the amplification ratio is, as is known, always smaller than $1/D$ [*i.e.*, the amplification ratio is always smaller than the amplification factor $\mu$], so that the amount of this change depends very much on the momentary working point, nevertheless the change is equally great whether the anode resistance or the emission constant is altered in the same proportion."

NOTE ON METHODS OF COMPUTING MODULATION PRODUCTS.—Bennett and Rice. (*See* under " Properties of Circuits.")

PHASE ANGLE OF VACUUM TUBE TRANSCONDUCTANCE AT VERY HIGH FREQUENCIES [Experimental Confirmation of Theory].—F. B. Llewellyn. (*Proc. Inst. Rad. Eng.*, August, 1934, Vol. 22, No. 8, pp. 947–956.) Experimental confirmation, on wavelengths 7–8 m, of the writer's theoretical results (May Abstracts, p. 265).

THE CONSTRUCTION OF NEW VALVES TO PRODUCE MICRO-WAVES IN THE RETARDING-FIELD CIRCUIT.—Pfetscher and Müller. (*See* under " Transmission.")

A NOTE ON MAGNETRON THEORY.—McNamara. (*See* under " Transmission.")

A MAGNETRON GIVING 100 W AT 70–90 CM.—Slutzkin and others. (*See* under " Transmission.")

DYNAMIC CHARACTERISTICS [of Gaseous Discharges : Comprehensive Survey].—R. Seeliger. (*Zeitschr. f. tech. Phys.*, No. 9, Vol. 15, 1934, pp. 329–342.)

GAS-FILLED VALVE SYMBOLS [Distinction between Thermionic Valves and Thyratrons : the German Convention by Shading].—A. W. Clarke. (*See* under " Subsidiary Apparatus and Materials.")

" THERMIONIC EMISSION " [Book Review].—A. L. Reimann. (*Journ. Scient. Instr.*, August, 1934, Vol. 11, No. 8, p. 268.)

REFLECTION COEFFICIENT OF ELECTRONS [Potassium Atoms on Hot Tungsten Filament].—M. J. Copley and T. E. Phipps. (*Phys. Review*, 15th July, 1934, Series 2, Vol. 46, No. 2, p. 144.)

This note discusses previous work by the writers and others on the degree of ionisation and reflection coefficient of potassium and caesium on hot tungsten filaments [*see* Abstracts, January, pp. 40–41 (Taylor and Langmuir) ; June, p. 331 (Copley and Phipps) ; August, p. 443 (Becker and Brittain) ; and September, p. 503 (Reimann)].

THE USE OF THE ELECTRON MICROSCOPE FOR THE TESTING OF THERMIONICALLY ACTIVE MATERIALS.—Benham. (*See* reference under " Subsidiary Apparatus and Materials.")

CONTRIBUTIONS TO THE TUNGSTEN-THORIUM PROBLEM : II. THE ANOMALOUS ACTIVATION.—E. Chalfin. (*Physik. Zeitschr. der Sowietunion*, No. 6, Vol. 5, 1934, pp. 838–847.)

" It is shown that the anomalies . . . are due to fluctuations in the distribution of the thorium atoms on the tungsten surface. As a result, the electron emission of a thoriated tungsten surface depends not only on the number of thorium atoms, but also on their distribution on the surface. The calculation of the surface coating by Langmuir's formula is thus only possible when the activation curve is 'normal' ; in the 'anomalous' region the formula gives accidental values always greater than the true value of the surface coating." *See* also January Abstracts, p. 40.

THE EMISSION OF IONS AND ELECTRONS FROM HEATED SOURCES [Pin-Hole Photographs show Concentrated Point Sources of Intense Emission].—A. J. Dempster. (*Phys. Review*, 1st Aug. 1934, Series 2, Vol. 46, No. 3, pp. 165–168.)

THE INFLUENCE OF TEMPERATURE ON THE VOLTA POTENTIAL OF THE METALS.—G. Mönch. (*Zeitschr. f. Phys.*, 4th Sept. 1934, Vol. 90, No. 7/8, pp. 433–439.) *See* also under " Phototelegraphy and Television."

ON THE CALCULATION OF THE EXTERNAL WORK FUNCTION $W_a$ FROM THE COMPRESSIBILITY.—H. Bomke. (*Zeitschr. f. Phys.*, 4th Sept. 1934, Vol. 90, No. 7/8, pp. 542–550.) For other work by the same writer *see* May Abstracts, p. 269, r-h column.

## DIRECTIONAL WIRELESS

MICRO-WAVE WIRELESS BEACON FOR HARBOUR ENTRANCE OR NAVIGATION OVER A COMPLEX PREARRANGED COURSE: GENOA DEMONSTRATION OF OSCILLATING AND ROTATING TYPES.—Marconi. (*Marconi Review*, July/August, 1934, No. 49, pp. 27–29.)

When used for the oscillating type of beacon the platform, with its two aerial systems, swings left and right continuously, so that the narrow silence zone at the centre of the wide composite beam swings six degrees from left to right of the centre line of the harbour channel. A high note is transmitted during the left half of the arc and a low note during the right half. The change of note takes place as the silence zone coincides with the line for entering the harbour, when reception is nil for the navigator on this line. If the ship is off the line the change of note is perceptible and one note is stronger than the other. "This arrangement detects half a degree of error." Similarly, in visual reception, when the ship is on its proper course the change of note occurs when the indicating needle occupies its central position, and the deflection shows the same amplitude on either side. When the equipment is used as a rotating beacon for marking out a complex course, involving several changes, the aerial system makes a complete rotation every minute, the note changing when the zero line of rotation passes over the true South point; the bearing is determined by measuring with a stop watch the interval between the change of note and the passage of the zero line.

MARCONI'S WIRELESS PILOT [Descriptive Account].—E. C. Shankland. (*Nature*, 8th Sept. 1934, Vol. 134, pp. 387–388.)

NAVIGATION IN FOG: DEMONSTRATION OF NEW MARCONI APPARATUS AT GENOA.—Marconi. (*Electrician*, 3rd Aug. 1934, Vol. 113, No. 2931, p. 162.)

RADIO FOG NAVIGATION [Comments on Marconi's Ultra-Short Wave Proposals].—(*Science*, 10th Aug. 1934, Vol. 80, No. 2067, Supp. pp. 7–8.)

ROTATING RADIO BEACON ON ULTRA-HIGH FREQUENCY [for Aircraft: 5.1 m Wavelength].—R. Kimura. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 411: English summary p. 62.)

A NEW RETURNING TYPE OF ROTATING RADIO BEACON [Objections to Usual Method of timing Interval between North-South Signal and Minimum: New System by which Field Pattern turns back after each Half Revolution: Continuous Signal replaced by 90 Dots in each 180° Rotation].—M. Okada. (*Ibid.*, p. 412: English summary pp. 62–63.)

NEW RADIO AID TO NAVIGATION [Cathode-Ray Direction Finder].—(*Wireless World*, 3rd Aug. 1934, Vol. 34, pp. 76–77.)

DISTANCE DETERMINATION WITH THE LANDING BEAM FOR FOG LANDING [by use of Two Receiving Aerials, at Different Levels, giving Independent Indications].—A. Leib: Telefunken. (German Pat. 594 685, pub. 21.3.1934: *Hochf:tech. u. Elek:akus.*, July, 1934, Vol. 44, No. 1, p. 34.)

RADIO RANGE FINDER [Distance Determination by a Pulse repeatedly Received and Retransmitted: the Recorded Pulse Frequency as Direct Measure of the Distance].—A. McL. Nicholson. (U.S.A. Pat. 1 945 952, pub. 6.2.1934: *Hochf:tech. u. Elek:akus.*, July, 1934, Vol. 44, No. 1, p. 34).

DISCUSSION OF "STUDY OF THE MAGNETIC FIELD PRODUCED BY A L.F. CURRENT CIRCULATING IN A CONDUCTOR IN THE PRESENCE OF THE GROUND" [and the Production of a Magnetic Field equivalent to a Leader Cable: Confirmation by Aeronautical Research Service Tests: etc.].—Bourgonnier. (*Bull. de la Soc. franç. des Élec.*, September, 1934, Series 5, Vol. 4, No. 45, pp. 901–922.) On the paper referred to in June Abstracts, p. 326, r-h column.

THE MEASUREMENT OF ALTITUDE AND INCLINATION OF AIRCRAFT BY THE ECHO METHODS.—Delsasso. (*See* under "Directional Wireless.")

BONDING AN AIRPLANE [for Improved Radio Transmission and Reception].—R. Martin. (*Scient. American*, September, 1934, Vol. 151, No. 3, p. 150: short summary only.)

## ACOUSTICS AND AUDIO-FREQUENCIES

AMPLIFIERS WITH AMPLIFICATION VARYING WITH AMPLITUDE [for Volume-Range "Compression" and "Expansion": 2.45:1 or even 6:1 Increase of Signal/Noise Ratio: Successful Tests in Berlin/America Short-Wave Broadcasting: Great Reduction in Needle-Scratch in Gramophone Reproduction: Possibilities for General Broadcasting Purposes: Circuits, Curves and Difficulties].—W. Nestel. (*E.T.Z.*, 6th Sept. 1934, Vol. 55, No. 36, pp. 882–884.) *See* also Sowerby, below.

EXPANDING THE MUSIC.—A. L. M. Sowerby. (*Wireless World*, 24th Aug. 1934, Vol. 34, pp. 150–152.)

Discussing the question of arrangements in a receiver to compensate for the fact that at the transmitter the control engineer has to reduce "contrast." At least one commercial receiver already incorporates this idea. *See* also preceding reference, and Ballantine, *Proc. Inst. Rad. Eng.*, May, 1934, Vol. 22, No. 5, pp. 612–616.

PRINCIPLES OF AUDIO-FREQUENCY WIRE BROADCASTING.—Eckersley. (*See* under "Stations, Design and Operation.")

POWER AMPLIFIER FOR HIGHEST QUALITY REPRODUCTION.—W. Nestel. (*Funktech. Monatshefte*, August, 1934, No. 8, pp. 309–311.)

The drop in the loudspeaker characteristic at low frequencies is compensated for by a correcting section in the grid circuit of the output stage; loss at high frequencies due to h.f. selective circuits, by a correcting section in the grid circuit of the pre-amplifying stage; lack of bass in gramophone records (to avoid track jumping), by the use of a pick-up, or a pick-up and correcting section, giving an opposite frequency variation.

PUSH-PULL INPUT SYSTEMS.—W. T. Cocking. (*Wireless World*, 21st Sept. 1934, Vol. 34, pp. 245–247.) Discussing various methods of feeding the "push-pull quality amplifier" dealt with in August Abstracts, p. 445.

THE OPTICAL [Sound-on-Film] GRAMOPHONE.—P. Hatschek. (*Funktech. Monatshefte*, August, 1934, No. 8, Supp. pp. 44–46.)

The straight tape with one sound track (Nublat) and several tracks in alternating directions (Selenophon and Klangfilm); the endless band with several parallel tracks joined by steps (Mihaly) and with several tracks in a spiral; the twisted endless band of opaque material recorded on both sides (de Forest) giving twice the playing time for the same quality, but perhaps less good for transport; the "cylinder" form with spiral track, very convenient for manufacture in rectangular sheets. "Experience with narrow gauge sound films shows that a track width of 0.5 mm and a speed of 150 mm/sec. gives good reproduction up to 5 000 c/s; this corresponds to a surface consumption of 75 mm²/sec. Thus a sheet 30 cm × 50 cm, *i.e.* of surface 150 000 mm², would give a playing time of more than 33 minutes." Incidentally, if the maximum frequency was raised to 80 000 c/s for television transmission a playing time of about 2 minutes would be obtained. After discussing the use of transparent and opaque materials the writer remarks that "all technical and manufacturing advantages should be combined if sheets of transparent material are employed for recording and the duplication is carried out by contact photography on to grainless, cheap and non-inflammable Ozaphane film." The paper ends by quoting a number of patents.

THE NARROW SOUND FILM [including the Possibility of Multi-Contour Amplitude Recording (Vielfachzackenschrift) on 16-mm Films].—E. Busse. (*Funktech. Monatshefte*, August, 1934, No. 8, pp. 313–315.) For this recording system *see* October Abstracts, pp. 565–566 and 566.

HAS PICK-UP DESIGN STAGNATED?—P. W. Willans. (*Wireless World*, 3rd Aug. 1934, Vol. 34, pp. 70–72.) Suggesting various directions in which experimental work might be conducted with a view to improving performance.

FIELD STRENGTH MEASURING DEVICE FOR ANNULAR-GAP MAGNETS FOR MOVING-COIL LOUDSPEAKERS.—(*E.T.Z.*, 13th Sept. 1934, Vol. 55, No. 37, pp. 911–912: summary only.) *See* also Webb, 1932 Abstracts, p. 290.

A SIMPLE METHOD OF DETERMINING DIAPHRAGM CONSTANTS.—K. Kobayashi, T. Omori and T. Sato. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 340: Japanese only.)

THE CALIBRATION OF MICROPHONES [Survey of Constant-Field and Constant-Pressure Methods: the Attainable Degree of Accuracy: Constancy of Calibration: etc.].—R. Gatti. (*Alta Frequenza*, June, 1934, Vol. 3, No. 3, pp. 281–302.)

CHARACTERISTICS OF TELEPHONE RECEIVERS [Post Office Tests with "Artificial Ear"].—W. West and D. McMillan. (*Journ. I.E.E.*, September, 1934, Vol. 75, No. 453, pp. 317–332.)

CONTRIBUTIONS TO THE STUDY OF TELEPHONE RECEIVERS [Existence of a Maximum Value of Inductance for a Certain Distance between Diaphragm and Pole Pieces, due to working on Curved Part of Magnetisation Curve and giving Poor Electro-Mechanical Efficiency].—M. Marinesco. (*Ann. des P.T.T.*, July, 1934, Vol. 23, No. 7, pp. 631–638.)

ADDENDA TO "COMPLEX MAGNETIC CROSSTALK COUPLINGS IN TELEPHONE CABLES."—G. Wuckel. (*E.N.T.*, August, 1934, Vol. 11, No. 8, p. 303.) *See* September Abstracts, p. 505, r-h column.

ALTERNATING AND PULSATING CURRENTS IN A LOADED TELEPHONE CABLE [Turin/Vercelli Tests over 80 km Line: Attenuation for Alternating Current increases with Frequency, for Pulsating Current remains practically Constant for Frequencies 200–2 200 c/s, then begins to rise].—M. Marro. (*Phil. Mag.*, August, 1934, Vol. 18, No. 118, pp. 288–291.) *See* also July Abstracts, p. 388: also June, p. 315.

SUPPRESSION BY BACK-COUPLING IN AMPLIFILTERS.—J. Saneyoshi. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 406: Japanese only.) For other papers on this device *see* August Abstracts, p. 445 (two).

STUDY OF THE LINES OF VIBRATION AND THE AMPLITUDE VARIATIONS OF THE PRESSURE IN THE INTERIOR OF ACOUSTIC CAVITIES [Cylindrical, Spherical and "Bottle" Resonators: Pressure Investigations with a Special Type of Kundt's Valve].—M. Marty. (*Ann. de Physique*, May/June, 1934, Series 11, Vol. 1, pp. 622–655.)

ON THE INTENSITY DISTRIBUTION OF SOUND FROM A TUNING-FORK.—G. Araki. (*Phil. Mag.*, September, 1934, Vol. 18, No. 119, pp. 441–449.)

AUDIO-FREQUENCY MEASUREMENT BY THE ELECTRICALLY-EXCITED MONOCHORD: CORRECTIONS.—E. Williams. (*Proc. Inst. Rad. Eng.*, September, 1934, Vol. 22, No. 9, p. 1050.) *See* September Abstracts, p. 505, l-h column.

HARMONIC ANALYSIS OF SOUND-FREQUENCY OSCILLATIONS WITH A STROBOSCOPIC DISC [mounted on Larger Disc with Sine-Cut Edge].—T. von Nemes. (*Phil. Mag.*, August, 1934, Vol. 18, No. 118, pp. 303–307.)

"The arrangement discussed here is primarily suitable for the illustrative demonstration of the Fourier analysis, because the analysis occurs momentarily, simultaneously and discernibly to our eyes. Besides the applicability in acoustics the set can be used for measuring television amplifiers. In this case the mirror in Fig. 1 is omitted, the light, penetrating the disc, is projected upon the photocell, whilst we illuminate the stroboscopic disc with a neon lamp (or with another source of light which can be modulated with a linear characteristic). This lamp is supplied with the output current of the television amplifier, transmitter, or receiver. Thus, by means of photometry or photography, we get the linear and non-linear distortions with phase data at the examined exciting frequencies." *See* also 1932 Abstracts, p. 533.

PHONOMETRIC UNITS [Physical and Psychophysical: Causes of Uncertainty: etc.].—P. Lombardi and G. Sacerdote. (*Alta Frequenza*, June, 1934, Vol. 3, No. 3, pp. 260–280.)

ON A PHYSIOLOGICAL EFFECT OF SEVERAL SOUND SOURCES ON THE EAR, AND ITS APPLICATION TO THE ACOUSTICS OF ROOMS [Time Difference or Timbre Difference *separately* fulfil Law of Energy Addition, but *together* give a Much Greater Apparent Increase of Volume].—F. Aigner and M. J. O. Strutt. (*Zeitschr. f. tech. Phys.*, No. 9, Vol. 15, 1934, pp. 355–360.)

An account of collaborative tests in Vienna and Eindhoven. In all cases the time difference was kept below 0.06 second (air-path difference of 20 m) so that the two sources were heard as one. The tests were first made with broadcast reception: at Eindhoven the different timbres were produced by the loudspeakers themselves, while in the Vienna tests the tone-controls of the two receivers were employed for the purpose. Both sets of tests gave results which agreed. The departure from the law of energy addition was the greater, the greater the difference in timbre: the time difference was an essential second factor, but no marked alteration was found on varying it widely within the limit mentioned. The results were confirmed by gramophone tests in which (at Eindhoven) two pick-ups were arranged to run in the same track with a spacing of 1.5 cm and over: the timbre difference was again produced by the loudspeakers. The Vienna gramophone tests were rather more elaborate, but the results were the same. In favourable conditions the ear was affected as if the sound energy had been not merely doubled but multiplied by ten.

The reasons for the phenomenon are discussed, together with its effect on the technique of room acoustics, *e.g.* on the calculation of the reinforcement of direct sound by the reflecting action of ceilings, walls, etc.

STRUCTURAL-SOUND MEASUREMENTS IN THE ACOUSTICS OF ROOMS AND BUILDINGS.—E. Meyer. (*Zeitschr. V.D.I.*, 11th Aug. 1934, Vol. 78, No. 32, pp. 957–963.)

SOME NOTES ON THE REVERBERATION TIME OF BROADCASTING STUDIOS.—K. Hoshi. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 339: Japanese only.)

THE ACOUSTICAL INSULATION AFFORDED BY DOUBLE PARTITIONS CONSTRUCTED FROM SIMILAR COMPONENTS.—J. E. R. Constable. (*Phil. Mag.*, August, 1934, Vol. 18, No. 118, pp. 321–343.)

DEPENDENCE OF SOUND ABSORPTION UPON THE AREA AND DISTRIBUTION OF THE ABSORBENT MATERIAL.—V. L. Chrisler. (*Journ. of Res. of Nat. Bur. of Stds.*, August, 1934, Vol. 13, No. 2, pp. 169–187.) Summaries of this work were referred to in June and August Abstracts, pp. 328 and 446. The journal named was formerly the *Bureau of Standards Journal of Research*.

GENERATION AND APPLICATION OF INTENSE SUPERSONIC ACOUSTIC WAVES.—H. Oyama. (*Rep. of Rad. Res. in Japan*, April, 1934, Vol. 4, No. 1, pp. 41–55.) *See* Abstracts, p. 157, l-h column.

ON THE ACOUSTIC RADIATION FIELD OF THE PIEZO-ELECTRIC OSCILLATOR AND THE EFFECT OF VISCOSITY ON TRANSMISSION [Small Effect on Near Field, Marked Effect on Distant Range: Optimum Wavelength for Constant Output and Given Distance].—L. V. King. (*Canadian Journ. of Res.*, August, 1934, Vol. 11, No. 2, pp. 135–155.)

SUPERSONIC DISPERSION IN GASES [Hot-Wire Method used to measure Wavelength and Amplitude: Critical Examination of Anomalous Dispersion and Absorption shown by Certain Gases, and Suggested Explanation: Evidence that Some of the Radiation "absorbed" is scattered by the Gas].—E. G. Richardson. (*Proc. Roy. Soc.*, Series A, 1st Aug. 1934, Vol. 146, No. 856, pp. 56–71.)

SOUND TRANSMITTERS FOR FOG SIGNALS: INTERNATIONAL CONFERENCE, PARIS, 1933.—E. Wilckens. (*E.T.Z.*, 9th Aug. 1934, Vol. 55, No. 32, pp. 787–788.)

THE MEASUREMENT OF ALTITUDE AND INCLINATION OF AIRCRAFT BY THE ECHO METHODS.—L. P. Delsasso. (*Journ. Acoust. Soc. Am.*, July, 1934, Vol. 6, No. 1, pp. 1–15.) *See* also August Abstracts, p. 447.

APPLICATION OF SOUND MEASURING INSTRUMENTS TO THE STUDY OF PHONETIC PROBLEMS.—J. C. Steinberg. (*Ibid.*, pp. 16–24.)

A PHYSICAL DEFINITION OF "GOOD VOICE-QUALITY" IN THE MALE VOICE.—W. T. Bartholomew. (*Ibid.*, pp. 25–33.)

CERTAIN ANOMALIES IN THE THEORY OF AIR COLUMN BEHAVIOUR IN ORCHESTRAL WIND INSTRUMENTS.—J. Redfield. (*Ibid.*, pp. 34–36.)

DISCUSSION ON THE DESIGN OF A ROTATING MIRROR OSCILLOSCOPE.—R. F. Mallina. (*Ibid.*, pp. 37–42.)

A DISCUSSION OF SOUND ABSORPTION COEFFICIENTS.—R. F. Norris. (*Ibid.*, pp. 43–44.)

NOTE ON REVERBERATION CHARACTERISTICS [a Suggested Fifth Criterion].—M. Rettinger: Knudsen. (*Ibid.*, pp. 51–52.)

"PRACTICAL ACOUSTICS FOR THE CONSTRUCTOR" [Book Review].—C. W. Glover. (*Ibid.*, p. 53.)

NEW ACOUSTICS LABORATORY AT THE NATIONAL PHYSICAL LABORATORY.—G. W. C. Kaye. (*Nature*, 11th Aug. 1934, Vol. 134, pp. 202–204.)

ON A PROJECT FOR A VOCABULARY OF ACOUSTICS.—L. Bouthillon. (*Bull. de la Soc. franç. des Élec.*, July, 1934, Series 5, Vol. 4, No. 43, pp. 671–696.)

## PHOTOTELEGRAPHY AND TELEVISION

AMPLIFIER PROBLEMS IN TELEVISION [the Difficulties in covering the 0–500 000 c/s Range of Photocell Currents: Effects of the Various Types of Distortion: the D.C. Amplifier and the Methods of Compensating for Unwanted Potential Fluctuations, etc.: the Neglect of the D.C. Component and the Use of the Resistance-Capacity Amplifier: its Defects, and a Circuit which Avoids them].—G. Krawinkel. (*Funktech. Monatshefte*, August, 1934, No. 8, Supp. pp. 37–41.)

The defects avoided by the "suppressed d.c." circuit of Fig. 5 are the grid loading by the capacity to earth of the coupling condensers (prejudicing the amplification of the higher frequencies) and the slow rise of the amplification curve at the low frequencies. The latter defect is removed by a positive retroaction coupling (by the tapped resistance $R_k$), varying with frequency, from the second to the first stage: Fig. 6 shows that the amplification characteristic rises sharply to a maximum at 3 c/s. As regards the former defect, the circuit is provided with a small retroaction condenser $k$ carrying energy at the high frequencies from the second anode to the first grid.

RESEARCHES ON THE CONSTRUCTION OF CIRCUITS FOR HIGH-FREQUENCY CURRENTS [Parallel-Wire and Concentric Cables suitable for Television Transmission and Carrier-Current Telephony].—H. Jannès and P. Marzin. (*Ann. des P.T.T.*, July, 1934, Vol. 23, No. 7, pp. 605–630.) See June Abstracts, p. 331.

A SPECIAL STROBOSCOPIC ARRANGEMENT APPLICABLE TO THE MEASUREMENT OF DISTORTION IN TELEVISION APPARATUS.—von Nemes. (*See* abstract under "Acoustics and Audio-frequencies.")

TELEVISION IN FRANCE, RUSSIA, U.S.A., GREAT BRITAIN AND HUNGARY.—(*T.F.T.*, April, 1934, Vol. 23, No. 4, p. 99: translated into French in *Ann. des P.T.T.*, August, 1934, Vol. 23, No. 8, pp. 782–785.) For other Notes on television in various countries see *T.F.T.*, July, pp. 174–175; also August, pp. 204–205, where a slowing-down of development in America and "great confidence" in Europe is mentioned.

THE PRESENT POSITION OF TELEVISION IN THE GERMAN POST OFFICE.—F. Stumpf. (*T.F.T.*, June, 1934, Vol. 23, No. 6, pp. 133–137.)

TELEVISION IN GERMANY [as judged from Berlin Radio Exhibition].—(*Wireless World*, 14th Sept. 1934, Vol. 34, pp. 235–236.)

SOME EXPERIMENTS ON PHOTOGRAPHING THE TELEVISION TRANSMISSIONS FROM LONDON AND FROM A LOCAL SHORT-WAVE STATION [Number of Multiple Images reduced by use of much Smaller Aerial: also by replacing Superheterodyne by "Straight" Receiver].—D. Bodroux and R. Rivault. (*Comptes Rendus*, 23rd July, 1934, Vol. 199, No. 4, pp. 269–271.) For previous work *see* 1933 Abstracts, pp. 572–573.

IS VELOCITY MODULATION ["Line Modulation"] INCREASING IN IMPORTANCE? [Full Advantages only available when Cathode-Ray Scanning is used at Transmitter as well as at Receiver: the Suitability for use with the Zworykin "Iconoscope"; etc.].—R. Thun. (*Funktech. Monatshefte*, August, 1934, No. 8, Supp. pp. 46–47.)

THE APPLICATION OF THE CATHODE-RAY TUBE TO TELEVISION.—G. Parr and T. W. Price. (*Journ. Television Soc.*, March, 1934, Series 2, Vol. 1, Part 10, pp. 323–328.) The full paper, a summary of which was referred to in April Abstracts, p. 214.

IMPROVED HIGH-VACUUM HOT-CATHODE CATHODE-RAY OSCILLOGRAPH.—Graupner. (*See* abstract under "Subsidiary Apparatus and Materials.")

A NEW TYPE OF MULTIPLE-ELEMENT CATHODE-RAY OSCILLOGRAPH.—Kasai and others. (*See* under "Subsidiary Apparatus and Materials.")

RECORDING POWER OF THE COLD-CATHODE LOW-VOLTAGE CATHODE-RAY OSCILLOGRAPH.—Malsch and Westermann. (*See* under "Subsidiary Apparatus and Materials.")

APPARATUS FOR THE INVESTIGATION OF FLUORESCENT MATERIALS, ESPECIALLY THOSE USED IN TELEVISION RECEIVERS.—M. von Ardenne. (*Industrial Chemist*, September, 1934, Vol. 10, No. 116, p. 358: slightly compressed translation from *Zeitschr. f. angewandte Chemie*, 30th June, 1934, pp. 483–484.)

A special, mains-driven discharge tube is used, with replaceable cathode and a pierced-electrode electrostatic lens. A number of little cups, each containing a thin layer of one of the materials under test, are mounted on a perforated plate and introduced into the lower end of the tube by means of a ground joint. The cathode ray is directed on to each of these cups in turn by means of a magnet. The density of the electron stream is measured by directing it through the aperture (of known section) at the centre of the cup-carrying plate, behind which is a collector electrode. The sensitivity of the material for very slow (stray) electrons is measured by reversing the connections of the electrostatic lens so that this becomes a retarding and dispersing lens. The performance of each material is compared with that of a reference material in one of the cups by electrometric measurement of the voltage between the cup-carrying plate and the nearer lens electrode (main anode), giving a comparison of the secondary emission. The pressure is kept below $10^{-5}$ mm Hg. A rotating contact-breaker is provided in the associated circuit for measurements of after-luminescence. Fatigue and saturation phenomena and colour changes can also be detected and roughly measured.

The Use of Sound-on-Film Gramophone Records for Television Transmission.—Hatschek. (*See* abstract under "Acoustics and Audio-frequencies.")

Vision/Sound Gramophone Records.—Plew Television. (*Electrician*, 10th Aug. 1934, Vol. 113, No. 2932, p. 196: paragraph only).

Optical Generation of Carrier Frequencies ["Chopping" the Photocell Currents, for 180-Line Transmission, by the Use of Two Photocells and a Scanning Disc combined with a Stationary Reflecting Line Grating].—R. Möller: Fernseh Company. (*Funktech. Monatshefte*, August, 1934, No. 8, Supp. pp. 41–44.)

For 180-line transmission the grating requires 240 mirror faces inclined at one angle and 240 more inclined at another. It is made from a strip out of a plano-convex lens, silvered on the flat side with a coating a strip of which is machine-divided into ½ mm lines with ½ mm gaps. A flat glass plate (4, partly dotted, in Fig. 6a; 4 in Fig. 6b) is then cemented, with Canada balsam, on to the silvered surface. Part of this plate, with some of the flat lens surface itself, is ground away wedge-wise to the slightly slanting plane indicated by line 5, passing close behind the grating at 3. After polishing, the flat surface 5 is silvered. Fig. 6c shows a photograph of the completed element, while Fig. 6a shows how an incident ray is reflected at one of two slightly different angles according to whether it strikes a line or a gap in the silvered grating at 3; for the reflecting line is on the flat surface of the lens, whereas a ray falling at a gap passes about 1/10 mm further and is then reflected by the slanting silvered surface 5.

Fig. 4 shows the lay-out of the optical system, F being the film under transmission, N the scanning disc, R the grating element and $P_1$, $P_2$ the two photocells, connected in parallel with reversed polarities (Fig. 8). The method is directly applicable to "kino" and intermediate-film transmitters, but encounters difficulties in the case of a transmitter scanning with a light beam, even if an intermediate image is formed for the special purpose of the method.

Notes on the Amplification of Continuous Currents [down to $10^{-14}$ Ampere].—P. Donzelot and J. Divoux. (*Journ. de Phys. et le Rad.*, July, 1934, Series 7, Vol. 5, No. 7, pp. 357–372.)

Review of the Theory and Applications of Photoelectric Effects.—G. Windred. (*Journ. Television Soc.*, March, 1934, Series 2, Vol. 1, Part 10, pp. 329–338.)

An Additive Method for the Exact Study of the Variation of the Current given by a Photoelectric Cell as a Function of the Incident Luminous Flux [by Comparing the Outputs produced by Two Different Fluxes, carried by Rays of Same Form and Direction, first Separately and then Simultaneously].—P. Fleury. (*Comptes Rendus*, 16th July, 1934, Vol. 199, No. 3, pp. 195–197.)

Optical Factors in Caesium-Silver-Oxide Photoelectric Cells [The Existence of an Intrinsically Greater Emissive Power in the Red, independent of Angle of Incidence and Polarisation Effects: Possible Explanations].—H. E. Ives and A. R. Olpin. (*Journ. Opt. Soc. Am.*, August, 1934, Vol. 24, No. 8, pp. 198–205.)

A Differential Circuit for Blocking-Layer Photocells.—L. A. Wood. (*Review Scient. Instr.*, August, 1934, Vol. 5, No. 8, pp. 295–299.)

On Some Properties of Barrier-Layer [Photoelectric] Cells.—H. Suzuki. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 312: Japanese only.)

New Observations on Barrier-Layer Photo-Elements: the Einstein Quantic Relation and the Schottky Effect.—G. Liandrat. (*Journ. de Phys. et le Rad.*, July, 1934, Series 7, Vol. 5, No. 7, p. 142S.) For a *Comptes Rendus* Note *see* October Abstracts, p. 568.

On the Spectral Distribution of the Photoelectric Effect in Cuprous Oxide [and the Photoelectric Effect as a Result of the Decrease in Resistance of Barrier Layer].—Anne and A. Joffé. (*Comptes Rendus*, 10th Sept. 1934, Vol. 199, No. 11, pp. 569–571.)

In measurements of the photoelectric current in thin layers the writers have found that the current is directly proportional to the radiant energy absorbed by the layer. The spectral curve of the photoelectric effect depends on the thickness of the layer: the wavelength of the maximum becomes shorter as the layer is made thinner. Measurements on a wedge-shaped plate give the curves I, II and III for thicknesses of 300, 60 and 20$\mu$: the three maxima are at 650, 605 and 580 m$\mu$. On the same diagram appears the very similar curve IV representing the photoelectric effect of a barrier-layer cuprous oxide cell: its maximum is at 540 m$\mu$, corresponding to a still thinner layer of about 0.1$\mu$. Now it is known (Jusé, 1933 Abstracts, p. 636, r-h col.) that the optimum thickness for barrier layers is from 0.01 to 0.1$\mu$; it appears therefore that curve IV represents the photoelectric effect of the barrier layer itself.

From the results of other workers it would have appeared clear that the photoelectric effect of barrier-layer cells of cuprous oxide or selenium is due to the decrease of resistance provoked by illumination of the thin barrier layer: one contradictory point, however, remained, namely that the spectral distributions of the two effects were quite different, the photoconductivity having a maximum at

630 mμ while the maximum of the photoelectric effect of barrier-layer cells is at 540 mμ. "This contradiction no longer exists, as the diagram shows, since the difference in thickness is sufficient to explain the observed results."

THE TEMPERATURE DEPENDENCE OF THE VOLTA POTENTIAL OF CUPROUS OXIDE.—G. Mönch. (*Zeitschr. f. Phys.*, 6th Sept. 1934, Vol. 90, No. 9/10, pp. 576–585.) *See* also under "Valves and Thermionics."

ON THE PHOTOELECTRIC EFFECT FOR THE L-SHELL [Theoretical Investigation: Total Absorption per Atom = $1.3 \times 10^{-24}$ cm²].—H. Hall and W. Rarita. (*Phys. Review*, 15th July, 1934, Series 2, Vol. 46, No. 2, p. 143.)

PHOTOELECTRIC CONDUCTION AND ENERGY LEVELS OF THE ELECTRONS IN CRYSTALS.—P. Tartakowsky. (*Zeitschr. f. Phys.*, 4th Sept. 1934, Vol. 90, No. 7/8, pp. 504–511.)

THE ENERGY LEVELS OF THE ELECTRONS IN A FINITE CRYSTAL LATTICE.—A. Sokolow. (*Ibid.*, pp. 520–541.)

"ELECTRON MOVEMENT" IN A BOUNDED CRYSTAL LATTICE [Theoretical Investigation of Photoelectric Effect in Thin Metal Film on Metal or Dielectric Base].—S. Rijanow. (*Zeitschr. f. Physik*, 1934, Vol. 89, No. 11/12, pp. 806–819.)

INFLUENCE OF THE ADSORPTION OF ATOMS AND MOLECULES ON THE PHOTOELECTRIC EFFECT IN MERCURY [Excitation of Adsorbed Molecules (Preliminary Note)].—H. Cassel and W. A. Schneider. (*Naturwiss.*, 6th July, 1934, Vol. 22, No. 27, pp. 464–465.)

DISPERSION AND THERMAL VARIATION OF THE ELECTRICAL DOUBLE REFRACTION OF SOME OPTICALLY ACTIVE LIQUIDS [Kerr Effect in Ethyl and Butyl Right-Handed Tartrates: the Existence of a Negative Kerr Constant].—M. Schwob. (*Comptes Rendus*, 25th June, 1934, Vol. 198, No. 26, pp. 2232–2235.)

LOW PRESSURE GASEOUS DISCHARGE LAMPS. PART I.—S. Dushman. (*Elec. Engineering*, August, 1934, Vol. 53, No. 8, pp. 1204–1212.)

VARIOUS PAPERS ON THE SODIUM-VAPOUR LAMP. (*Gen. Elec. Review*, July and August, 1934, Vol. 37, Nos. 7 and 8.)

CHARACTERISTICS AND USES OF THE CARBON ARC.—W. C. Kalb. (*Elec. Engineering*, August, 1934, Vol. 53, No. 8, pp. 1173–1179.)

PHENOMENA OF EYE FATIGUE AND AFTER IMAGES WITH MONOCHROMATIC LIGHT.—P. J. Bouma. (*Physica*, April, 1934, Vol. 1, No. 6, pp. 429–436.)

## MEASUREMENTS AND STANDARDS

PIEZOELECTRIC STABILISATION OF HIGH [and Ultra-High] FREQUENCIES.—H. Osterberg and J. W. Cookson. (*Review Scient. Instr.*, August, 1934, Vol. 5, No. 8, pp. 281–286.)

From the writers' "Conclusions":—"It has been shown that the use of moderately large plates of both quartz and tourmalin is feasible at high frequencies [up to, and probably well over, 65 Mc/s]. No definite advantage is gained by grinding extremely thin plates. . . . These experiments do not indicate that tourmalin possesses any distinct advantages over quartz. On the other hand, it appears that the advantage of higher elastic constants in tourmalin is more than off-set by its optical and mechanical inhomogeneities, together with its lower piezoelectric constant. . . . Except for building circuits which would oscillate in the neighbourhood of 3.5 m, no more difficulties were met in exciting responses at 3.5 m than at 10 or 20 m."

FREQUENCY CONTROL OF A SELF-OSCILLATOR BY MEANS OF A HARMONIC OF A QUARTZ OSCILLATOR WITH A SINGLE PENTODE.—S. Matsumura and S. Kanzaki. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 400: English summary p. 60.)

MEASUREMENT OF A STRAIN RATIO IN AN X-CUT QUARTZ CRYSTAL [and an Experimental Confirmation of the Ratio of Strains along X and Y given by Voigt's Theory].—M. Y. Colby and S. Harris. (*Journ. Opt. Soc. Am.*, August, 1934, Vol. 24, No. 8, pp. 217–219.)

THERMAL CHARACTERISTICS OF THIN PIEZOELECTRIC OSCILLATING QUARTZ PLATES.—I. Koga and N. Takagi. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 399: Japanese only.)

MAKING VISIBLE THE VIBRATIONS OF A QUARTZ PLATE BY THE "SCHLIEREN" METHOD [*i.e.*, Toepler's Optical Method of detecting "Streaks" (Inhomogeneities) in Glass, etc.].—V. Petrzilka and L. Zachoval. (*Zeitschr. f. Phys.*, 6th Sept. 1934, Vol. 90, No. 9/10, pp. 700–702.)

The writers conclude:—"By these pictures it is again made clear that the change of the optical properties of vibrating quartz plates must depend on the even powers of the electrical or mechanical tension components. The comparison of dust figures, the pictures taken with polarised light, and those taken by the present method, will lead (it is to be hoped) to the determination of the relation between the mode of vibration and the optical behaviour of a quartz plate."

SOME CHARACTERISTICS OF THE MAGNETOSTRICTION RESONATOR [Equivalent Circuit: Damping Constant and Relaxation Time: Distribution of Alternating Magnetic Flux: Theory of Magnetostriction Oscillator and Explanation of Reversed Polarity of Grid Coil (Pierce Circuit) compared with Ordinary Hartley Circuit].—K. Aoyagi. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 398: English summary p. 59.)

A SERVICE WAVEMETER WORKING IN CONJUNCTION WITH THE QUARTZ CLOCKS OF THE PHYSIKALISCH-TECHNISCHE REICHSANSTALT.—H. Mögel. (*T.F.T.*, June, 1933, Vol. 23, No. 6, pp. 148–152.)

INTERNATIONAL FREQUENCY COMPARISONS BY MEANS OF MODULATION EMISSIONS.—L. Essen. (*Journ. I.E.E.*, September, 1934, Vol. 75, No. 453, pp. 289–292.)

From the National Physical Laboratory. "The results of early international comparisons of frequency are briefly discussed. In measurements carried out in 1925 the agreement obtained was 0.1%, and in 1929 an agreement of 0.006% was realised. At this time the frequencies of the standards at several laboratories could be determined absolutely with an accuracy greater than that with which the comparisons could be effected.

"The nature of the recent modulated emissions is described and the results of three of the emissions are given. In two of the comparisons [1932] measurements made at three different laboratories are in agreement within 1 part in $10^7$. An experiment is described showing that the frequency of modulation of an aerial current can be controlled by a distant standard with an accuracy of at least 2 parts in $10^8$; and that the frequency measurements can be effected with this order of accuracy."

A NEW DIRECT-READING RADIO-FREQUENCY METER [Principle applicable also to Low Frequencies and to Ultra-Micrometer Circuits: Electrodynamometer Element in place of Mutual Inductance in Campbell Bridge: Great Sensitivity, No Valves, and other Advantages].—S. Jimbo and S. Kimura. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 325: English summary p. 46.)

METHOD OF MEASURING AND RECORDING FIELD STRENGTHS [especially for Continuous Recording, avoiding Difficulties with Heterodyne Oscillator by Chopping the Carrier at Note Frequency and Amplifying with Ordinary Broadcast Amplifier terminating in Rectifier and Milliampere-Recorder].—W. Stoffregen. (*Funktech. Monatshefte*, August, 1934, No. 8, pp. 301–302.)

"The recording methods hitherto employed, using a local oscillator, offer the possibility of serious errors—particularly in prolonged working—arising from fluctuations in the heterodyne note or energy. It requires great care to avoid these errors in records taken over a long period, especially when a number of stations have to be dealt with and the oscillator wavelength has to be altered. A method is here described which avoids these errors." Fig. 1 gives the diagram of the apparatus. No heterodyne is used, the incoming h.f. being chopped up at an audio-frequency (3000 c/s) at the grid of the first h.f. valve. This chopping is accomplished in a simple manner by the use of negative bias setting the working point at the bottom of the lower bend of the characteristic (Fig. 2) and by introducing a note frequency (from tuning fork or toothed wheel, etc.) into the grid circuit, so that the valve conducts during the positive half-wave only. The method is particularly valuable also for directional recording where, for instance, two frames are used and a heterodyne generator is very inconvenient.

THE MEASUREMENT OF SMALL VALUES OF INDUCTANCE AND EFFECTIVE RESISTANCE [Special Bridge for use with 2-Metre Samples of Loaded Telephone Cable].—J. K. Webb and C. Brookes-Smith. (*Elec. Communication*, July, 1934, Vol. 13, No. 1, pp. 9–13.)

MEASUREMENT OF GRID/FILAMENT IMPEDANCE OF VALVE VOLTMETERS AT HIGH FREQUENCIES.—Chaffee. (*See* abstract under "Subsidiary Apparatus and Materials.")

CALCULATING SERIES AND PARALLEL IMPEDANCES [with Charts].—C. A. Mizen. (*Rad. Engineering*, August, 1934, Vol. 14, No. 8, pp. 14–15.)

MECHANICAL BALANCING METHODS FOR A.C. BRIDGES BY THE USE OF PHASE-SENSITIVE NULL INDICATORS [Theoretical Considerations].—H. Poleck. (*Archiv f. Elektrot.*, 18th Aug. 1934, Vol. 28, No. 8, pp. 492–506.)

DEPENDENCE OF THE DIELECTRIC CONSTANT OF AIR UPON PRESSURE AND FREQUENCY [Measurement by Capacity-Resistance Bridge].—A. R. Jordan, T. W. Broxon and F. C. Walz. (*Phys. Review*, 1st July, 1934, Series 2, Vol. 46, No. 1, pp. 66–72.)

AN INVESTIGATION OF AN ALTERNATING-CURRENT [Bridge] METHOD OF DETERMINING CRITICAL POTENTIALS [of Gases].—R. W. Hickman. (*Physics*, July, 1934, Vol. 5, No. 7, pp. 185–191.)

VALVE CREST VOLTMETERS [Defects of Previous Methods of Replacing the Static Voltmeter, and Their Cure].—E. Fujimoto. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 336: English summary p. 48.)

APPARATUS FOR MEASUREMENT OF CONVERSION GAIN AND HARMONICS IN CONVERSION DETECTORS IN SUPERHETERODYNE RECEIVERS.—Strutt. (*See* abstract under "Reception.")

THE SPEED OF RESPONSE OF A THERMOPILE-GALVANOMETER SYSTEM.—A. V. Hill. (*Journ. Scient. Instr.*, August, 1934, Vol. 11, No. 8, pp. 246–247.)

A NEW BALLISTIC GALVANOMETER OPERATING IN HIGH VACUUM [especially for Precise Magnetic Measurements at Low Flux Densities].—W. B. Ellwood. (*Review Scient. Instr.*, August, 1934, Vol. 5, No. 8, pp. 300–305.)

BROWNIAN MOTION AS A NATURAL LIMIT TO ALL MEASURING PROCESSES.—R. B. Barnes and S. Silverman. (*Reviews of Mod. Physics*, July, 1934, Vol. 6, No. 3, pp. 162–192.)

## SUBSIDIARY APPARATUS AND MATERIALS

RECORDING POWER OF THE COLD-CATHODE LOW-VOLTAGE CATHODE-RAY OSCILLOGRAPH [Improved Performance with Double Vacuum and 60 cm Overall Length: with 6 kv Exciting Voltage Single Processes up to 1 Mc/s can be recorded with Lens and Camera—Recording Speed 100 km/s: Further Improvement expected].—F. Malsch and E. Westermann. (*Archiv f. Elektrot.*, 18th Aug. 1934, Vol. 28, No. 8, pp. 517–519.)

"For hot-cathode tubes with gas concentration the maximum recording speed with lens and camera, for exciting voltages around 4 kv, is found to be about 5 km/s: this corresponds to a frequency around 30 kc/s, for a normal amplitude of 2 cm. In view of the need for an adequate cathode life a considerable increase of voltage or a raising of emission density for the oxide cathode (max. about 0.5 mA/mm²) seems at present hardly admissible, so that a marked improvement in recording speed can hardly be expected on the present lines. With the high-vacuum tube the same limitation of emission density occurs, but there is a free choice of exciting voltage . . . . Since, however, an increase here means a decrease of voltage-sensitivity, there are many purposes for which (apart from the increased cost) high-voltage tubes are unsuitable. Thus at present there is a lack of *a sensitive oscillograph with high recording performance*. The cold-cathode tube here described fills this gap."

The glass discharge tube is very narrow (4 mm diameter) and short, corresponding to the low exciting voltage of 3–8 kv; its pressure is comparatively high, being about $10^{-1}$ mm Hg for air. The anode screen is so constructed that the flow of gas from discharge tube to deflection chamber is only slight, so that the vacuum in the latter, connected to the pump, is very good. To avoid photographic distortion the earthed fluorescent screen is sloped so as to be normal to the optical lens axis. Zinc sulphide is considerably better than calcium tungstate, for the low electron velocities employed. Further improvement will be based on the use of a counter-field for increasing the sensitivity and for concentration—*see* Abstracts, April, p. 219. For a paper by Rogowski and the writer on *very* low-voltage cold-cathode tubes (down to 500 v) *see* 1933, p. 283.

A New Type of Multi-Element Cathode Ray Oscillograph [Single Ray through Focusing Coil, then divided by Earthed Thin Metallic Plate or Plates parallel to Ray Axis, with Outer Positive Plates to direct the Subdivided Rays].—K. Kasai, S. Ogihara, F. Tadano and K. Yoshida. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 332: English summary p. 48.)

A Contribution to the Technique of the Sensitive High-Vacuum Hot-Cathode Oscillograph [Improvements to the "Aachen" (Aix-la-Chapelle) Metal Type Tube: Recording Speeds of about 200 km/s (internal, contact) and 60 km/s (external, with Camera)].—H. Graupner: Rogowski. (*Archiv f. Elektrot.*, 18th Aug. 1934, Vol. 28, No. 8, pp. 477–485.)

Tube and circuit improvements to the oscillograph referred to in 1928 Abstracts, pp. 690 and 689–690. Regarding future development the writer suggests that for moderate requirements, including television, the sealed-off glass-tube type with a metal shell ensuring the requisite centering and screening should be satisfactory, while for more advanced requirements the all-metal type, with exact centering and easily replaceable hot-cathode and screen, will be necessary, using contact photography to combine sharpness of recording with very high recording speed.

Automatic Recording of an Unexpected Transient Phenomenon with Ordinary Electromagnetic Oscillograph.—K. Kasai and S. Ogihara. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 333: English summary p. 48.)

A Braun [Cathode-Ray] Visualiser of Electric Transients.—K. Kurokawa and S. Tanaka. (*Ibid.*, p. 334: Japanese only.)

Note on a Demonstration of a Low-Voltage Electron Microscope using Electrostatic Focusing.—W. E. Benham. (*Journ. I.E.E.*, September, 1934, Vol. 75, No. 453, pp. 388–389.)

Apparatus for the Investigation of Fluorescent Materials.—von Ardenne. (*See* under "Phototelegraphy and Television.")

Researches on Fluorescence: I. The Hyperbolic Decay Law of Fluorescent Materials: II. The Extinction of Fluorescence by Infra-Red Rays and Its Use for Photography in the Infra-Red Part of the Spectrum.—W. L. Lewschin and W. W. Antonow-Romanowsky: and Tumerman. (*Physik. Zeitschr. der Sowietunion*, No. 6, Vol. 5, 1934, pp. 796–810: 811–837.)

Measurement of the Spectral Intensity Distribution of the Fluorescent Light from X-Ray Screens and Intensifier Films.—H. Funk and H. Steps. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 15, 1934, pp. 301–306.)

On the Crystalline State of Thin Calcium Fluoride Films.—W. G. Burgers and C. J. Dippel. (*Physica*, May, 1934, Vol. 1, No. 7, pp. 549–560.)

Gases in Metals, with Particular Attention to Non-Ferrous Metals.—W. Koch. (*Zeitschr. f. tech. Phys.*, No. 7, Vol. 15, 1934, pp. 280–284.)

The Out-Gassing of Graphite at High Temperatures.—I. A. Eltzin and A. P. Jewlew. (*Physik. Zeitschr. der Sowietunion*, No. 5, Vol. 5, 1934, pp. 687–705.)

Grid Current Control for the Ionisation Gauge [used as Continuous Indicator of High Vacuum: Grid Current Stabilisation by Saturable-Core Transformer].—W. P. Overbeck and F. A. Meyer. (*Review Scient. Instr.*, August, 1934, Vol. 5, No. 8, pp. 287–289.)

The Ozone-Resisting Quality of Rubber-Insulated H.T. Cables, and Its Testing [with Application to Ignition Leads, especially when Screened to suppress Radio Interference].—H. Viehmann. (*E.T.Z.*, 13th Sept. 1934, Vol. 55, No. 37, pp. 909–910.)

Synthetic Insulating Varnishes and Their Composites.—R. Newbound. (*B.T-H. Activities*, July/August, 1934, Vol. 10, No. 4, pp. 117–121.)

VARIATION WITH TEMPERATURE OF THE ELECTRICAL RESISTANCE OF HEATER MATERIALS CONTAINING SILICON CARBIDE [" Silit," " Quarzilit " and " Globar"].—L. Nawo. (*E.T.Z.*, 13th Sept. 1934, Vol. 55, No. 37, pp. 904–905.)

ELECTRICAL INSULATING MATERIALS: DISCUSSION [including the Heat-Resisting Properties of " Sipa," " Thermisolsupra," and " Ardostan," and the Negative Temperature Coefficient of the Dielectric Constant of " Condensa " and " Condensa C "].—Vieweg and others. (*E.T.Z.*, 9th Aug. 1934, Vol. 55, No. 32, pp. 800–801.) Further discussion of Vieweg's paper referred to in September Abstracts, p. 513, r-h column.

THE DETERMINATION OF DIELECTRIC PROPERTIES AT VERY HIGH FREQUENCIES [up to at least 20 Mc/s: Simple and sufficiently Accurate Method using Slabs with Adhering Metal Foil Electrodes: Equivalent Series Resistance of Tuned Circuit measured by (*e.g.*) Added Resistance Method, and Test Condenser then Paralleled: Some Results: Application to Measurement of Grid/Filament Impedance of Valve Voltmeters].—J. G. Chaffee. (*Proc. Inst. Rad. Eng.*, August, 1934, Vol. 22, No. 8, pp. 1009–1020.)

THE ANALYSIS OF AIR CONDENSER LOSS RESISTANCE [at 35–63.5 m Wavelengths: Confirmation of Theoretical Expression for Effective Series Resistance].—W. Jackson. (*Proc. Inst. Rad. Eng.*, August, 1934, Vol. 22, No. 8, pp. 957–963.)

A special condenser for precision measurements of dielectric loss was employed, Moullin's method being used (1932 Abstracts, pp. 593–594). The results comply with the theoretical equation $R_s = r + \phi C_1/pC$, where $r$ is believed to be due to contact resistances between neighbouring plates of the same bank and is apparently constant and independent of the capacitance and frequency values, while the second term is due to dielectric loss in the insulation supporting one set of plates. The condenser capacitance $C$ is regarded as composed of a fixed and imperfect portion $C_1$, due to the supporting insulation, in parallel with a variable air portion devoid of energy loss. The power factor $\phi$ of the portion $C_1$ seems usually to be substantially constant over a wide range of frequency.

ON THE VOLT-AMPERE CAPACITY OF HIGH-FREQUENCY MICA CONDENSERS FOR RADIO TRANSMITTERS [Causes of Unsatisfactory Performance, *e.g.* in Short-Wave By-Pass Condensers: Necessary Improvements in Design and Construction].—H. Ikushima. (*Rep. of Rad. Res. in Japan*, April, 1934, Vol. 4, No. 1, supp. p. 6: abstract only.)

ELECTROLYTIC CONDENSERS FOR A.C. USE [Dry Condenser using Thick Anodic Film as Electrolyte Absorber and as Separator: Saving of Space, Weight and Time: Special Properties].—A. Miyama and J. Tojo. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 315: English summary p. 43.)

THE USE OF THE CATHODE-RAY OSCILLOGRAPH IN THE STUDY OF THE MAGNETISATION OF FERROMAGNETIC MATERIALS.—P. Bricout and R. Salomon. (*Comptes Rendus*, 27th Aug. 1934, Vol. 199, No. 9, pp. 529–531.)

ON THE NON-LINEAR DISTORTION OF FERROCART, AND ON A NEW AND SIMPLE METHOD FOR MEASURING NON-LINEAR DISTORTIONS OF DIPOLE CIRCUITS.—H. Faulhaber. (*E.N.T.*, August, 1934, Vol. 11, No. 8, pp. 289–292.)

The tests were made on a long-wave coil of inductance 1.92 mH and d.c. resistance 10.6 ohms, with a Ferrocart cross section of $5 \times 6$ mm². Preliminary tests showed that a change in the testing current of 5 mA$_{eff}$ in 25 mA$_{eff}$ produced an inductance change of barely 1°/$_{00}$, so that the effect of such a change could be neglected. The dissipative resistance showed no variation, though the tests were repeated at various frequencies between 500 and 8000 c/s. The next step was to examine the non-linear distortion by comparing the Ferrocart coil with its equivalent circuit (air-cored coil and ohmic resistance) as regards third-harmonic production; the method adopted was to measure the fundamental and third-harmonic voltages in a harmonic bridge, for the coil and for its equivalent circuit, in succession. The bridge had a resistance of 500000 ohms at the test frequency of 1000 c/s, so that it formed no appreciable load on the coil, whose impedance at this frequency was only 16 ohms. Care was taken that the transformer was distortionless, and various other precautions and corrections are described. Fig. 1c shows the results; the third harmonic is very small, increasing at a decreasing rate as the load increases. At 10 mA$_{eff}$ its ratio to the fundamental is about 0.3°/$_{00}$, rising at 25 mA$_{eff}$ to about 0.6°/$_{00}$. At the very small current values occurring in general in h.f. circuits there is therefore practically no distortion. For the sake of completeness it was ascertained that no even harmonics were produced.

Next, the effect of polarisation by d.c. current was investigated, a direct current being introduced over a large choke. Fig. 2b shows the variation of the Ferrocart coil inductance with magnetising current from zero to 120 mA. At 30 mA there is a maximum departure of 1.5°/$_{00}$ from the normal value, the curve being practically the same whatever the a.c. amplitude might be (not above 30 mA$_{eff}$). With d.c. polarisation the second harmonic comes into prominence, attaining values much greater than those of the third. Fig. 3 shows the course of the latter (dotted) and of the second harmonic, as the polarising current is increased from zero to 100 mA. Three curves are given in each case, for a.c. values of 10, 20 and 30 mA$_{eff}$. Each of the second harmonic curves has a marked maximum at about 30 mA polarisation current and a minimum at 78 mA: the maxima increase greatly as the a.c. current is increased. For a polarisation current of 30 mA the fourth harmonic becomes important (not shown in curves), so that altogether the distortion at this point is no longer negligible. The third harmonic varies only slightly with the polarising current.

These results show that for a.c. values under 10 mA$_{eff}$ the Ferrocart distortions can safely be neglected, and even with 30 mA$_{eff}$ the " klirr."

factor (non-linear distortion factor) is only 1 ⁰/₀₀. But a certain attention must be given to d.c. polarisation; it should not exceed 10 mA, and special care must be taken to avoid the critical value for the second harmonic (with the coil here tested, 30 mA), although there is the possibility of using a much greater d.c. load if the circuit is adjusted to the second harmonic minimum (here 78 mA). Although the measurements were made at 1 000 c/s, there is no reason to believe that the distortions at high frequencies would be seriously different, since they depend merely on the curvature of the hysteresis loop, and the greater magnetic skin effect at high frequencies only acts as if the Ferrocart cross section were reduced. The paper ends with a discussion of the application of the method by which the second and third harmonics were measured, to general purposes wherever the "klirr" factor of a dipole is required, provided the dipole has an ideal equivalent circuit. Certain refinements of the equipment are mentioned, such as the replacement of the harmonic bridge by a negatively biased amplifier in order that no energy may be removed from the one bridge-diagonal.

HIGH-FREQUENCY INDUCTANCE COILS WITH "SENDUST" CORES.—S. Chiba and T. Okabe. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 407: Japanese only.)

DUST FIGURES OF MAGNETISED IRON CRYSTALS.—S. Kaya. (*Zeitschr. f. Phys.*, 4th Sept. 1934, Vol. 90, No. 7/8, pp. 551–558.)

"MAGNETIC MATERIALS AT RADIO FREQUENCIES: RADIO RESEARCH SPECIAL REPORT No. 14" [Book Review].—F. M. Colebrook. (*Proc. Inst. Rad. Eng.*, September, 1934, Vol. 22, No. 9, pp. 1141–1142.)

EMPIRICAL FORMULAE FOR THE MATHEMATICAL EXPRESSION OF A MAGNETISATION CURVE.—J. Bethenod. (*Bull. de la Soc. franç. des Élec.*, August, 1934, Series 5, Vol. 4, No. 44, pp. 742–748.)

IRON-ARMOURED AERIAL COMMUNICATION CABLE [for Protection against Induction from Parallel-Running H.T. Line].—C. L. Gilkeson and A. J. Hanks. (*Elec. Engineering*, June, 1934, Vol. 53, No. 6, pp. 890–895.)

FACTS WORTH KNOWING CONCERNING THE USE OF IRON-CORED H.F. COILS.—K. Nentwig. (*Radio, B., F. für Alle*, August, 1934, No. 150, pp. 130–132.)

THE "IDEAL" MAGNETISATION OF A CRYSTAL OF IRON.—S. Procopiu. (*Comptes Rendus*, 9th July, 1934, Vol. 199, No. 2, pp. 126–127.)

IRON/PLATINUM ALLOYS: CURIE POINT AND MAGNETIC MOMENTS [Increase of Mean Magnetic Moment on adding Platinum: a Unique Case for a Non-Ferromagnetic Element].—M. Fallot. (*Comptes Rendus*, 9th July, 1934, Vol. 199, No. 2, pp. 128–129.)

THE FREQUENCY VARIATION OF THE PERMEABILITY OF IRON, NICKEL AND COBALT.—R. Sänger. (*Helvet. Phys. Acta*, Fasc. 5, Vol. 7, 1934, pp. 478–480.)

PERMEABILITY CHANGES IN FERROMAGNETIC MATERIALS HEAT-TREATED IN MAGNETIC FIELDS.—G. A. Kelsall. (*Physics*, July, 1934, Vol. 5, No. 7, pp. 169–172.)

ANALYTICAL REPRESENTATION OF A MAGNETISING CURVE.—A. van Niekerk. (*Elec. Engineering*, August, 1934, Vol. 53, No. 8, pp. 1186–1187.)

SMOOTHING CIRCUIT IN WHICH CHOKES AND SERIES RESISTANCES ARE REPLACED BY SUITABLE LENGTHS OF CAPACITY-FORMING CURRENT-CARRYING FILTER CONNECTIONS.—Süddeutsche App. Fab. (German Pat. 595 779, pub. 20.4.1934: *Hochf:tech. u. Elek:akus.*, August, 1934, Vol. 44, No. 2, pp. 71–72.)

"DER ARGONAL-GLEICHRICHTER" (The "Argonal" Rectifier [Book Review]).—F. H. Hellmuth. (*Hochf:tech. u. Elek:akus.*, July, 1934, Vol. 44, No. 1, p. 35.)

DYNAMIC CHARACTERISTICS [of Gaseous Discharges: Comprehensive Survey].—R. Seeliger. (*Zeitschr. f. tech. Phys.*, No. 9, Vol. 15, 1934, pp. 329–342.)

ION CURRENT DISTRIBUTION IN GRID-CONTROLLED GASEOUS-DISCHARGE TUBES.—K. Mahla. (*Zeitschr. f. tech. Phys.*, No. 9, Vol. 15, 1934, pp. 348–355.)

Author's summary:—The current distribution of an ion current proceeding from an ion-emitting anode was measured at the grid and cathode of a [special] discharge vessel, both for hydrogen and mercury vapour. The component $\eta$ of the ion current to the grid was investigated as a function of grid voltage, anode voltage, pressure of gas, nature of gas, and total current strength. The result is shown in Figs 2–9. These curves, on certain simple assumptions, give information on the field distribution in the test space, on the ion motion in this field, and on the space charges. Finally, the attempt was made to apply the experimental curves of the grid-current component to the relations existing in ordinary gaseous-discharge tubes. In order to make a comparison with the available experimental material [Nottingham, 1931 Abstracts, p. 269], the distribution of a pure *electron* current was examined at the electrodes of the discharge tube [now highly evacuated]. The grid-current component $\xi$ thus found for electrons and the previously found corresponding iónic component $\eta$ were found to be so connected that a curve was obtained completely similar to the [Nottingham] experimental results [except for a small discrepancy explicable by the different geometrical design of the tubes]. It was therefore deduced that the measured $\eta$-curves apply qualitatively to the ordinary tubes.

PROPOSALS FOR THE NOMENCLATURE AND SYMBOLS OF GASEOUS DISCHARGE TUBES.—H. Geffcken and H. Richter. (*E.T.Z.*, 26th July, 1934, Vol. 55, No. 30, pp. 738–739.)

The writers divide the whole class of ionic tubes into glow-discharge tubes (no grid), arc-discharge tubes, glow-discharge relays (with grid but cold cathode) and iontrons ("thermiontrons" with hot cathodes, such as the true "thyratron," and "mercutrons" with mercury cathodes, often spoken of as thyratrons). Regarding their proposed symbols they say :—" The fundamental difference between the grid construction of a gaseous discharge tube and of an electronic valve is that in the gas relay not only the 'durchgriff' but also the 'umgriff' must be kept small. The grid, therefore, has to surround the cathode or anode more or less completely. This difference is well brought out in the proposed symbols Figs. 1 b–e, for a glow-discharge relay (b), for a 'thermiontron' (c), and for two 'mercutrons' (d and e), as contrasted to the ordinary electronic valve symbol (a)." "Umgriff" may be translated as the "grip round," as contrasted with the "grip through" of the well-known "durchgriff" (penetration coefficient, $1/\mu$).

GAS-FILLED VALVE SYMBOLS [Distinction between Thermionic Valves and Thyratrons: the German Convention by Shading].—A. W. Clarke. (*Wireless Engineer*, July, 1934, Vol. 11, No. 130, p. 370.) Prompted by Maddock's letter (Abstracts, June, p. 325, l-h column): *see* also Geffcken and Richter, above.

INDUSTRIAL APPLICATIONS OF THYRATRONS.—B.T-H. (*Engineer*, 10th Aug. 1934, Vol. 158, No. 4100, pp. 141–142.)

NOTE ON A CAUSE OF RESIDUAL HUM IN RECTIFIER-FILTER SYSTEMS.—Terman and Pickles. (*See* under "Reception.")

SOME CONSIDERATIONS IN THE DESIGN OF HOT-CATHODE MERCURY-VAPOUR RECTIFIER CIRCUITS [the Importance of the Choke as First Element of a Smoothing Filter: its Calculation and Design].—C. R. Dunham. (*Journ. I.E.E.*, September, 1934, Vol. 75, No. 453, pp. 278–288.) Theoretical investigation prompted by the experimental work of Dellenbaugh and Quimby, 1932 Abstracts, p. 419 and back references.

BLEEDER RESISTANCE [Idle Load at Output of Smoothing Circuit] IMPROVES [Rectifier] POWER SUPPLY REGULATION.—R. Lee. (*Rad. Engineering*, August, 1934, Vol. 14, No. 8, pp. 18–19.)

RECTIFYING ACTION OF POWDERED COPPER SULPHIDE [compressed between Oxidised Aluminium Plate and Copper Plate].—I. Yamamoto and M. Sato. (*Journ. I.E.E, Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 313: English summary pp. 42–43.)

"In the current-passing direction the resistance was very small, say 0.15 ohm at 1.5 volt: in the current-stopping direction . . . the resistance is very large, the rectifying ratio is considerably great, say 1 600 ohms at 1 volt . . . The temperature rise is small, say 20° C for the continuous flow of 5 amperes."

THE TEMPERATURE DEPENDENCE OF THE VOLTA POTENTIAL OF CUPROUS OXIDE.—G. Mönch. (*Zeitschr. f. Phys.*, 6th Sept. 1934, Vol. 90, No. 9/10, pp. 576–585.) *See* also under "Valves and Thermionics."

A CONSTANT SPEED D.C. MOTOR CONTROL [Thyratrons and 60-Cycle Tuning-Fork-Controlled Oscillator: and a Comparison of Other Standard Frequency Sources, *e.g.* Frequency-Controlled Mains].—J. A. Bearden and C. H. Shaw. (*Review Scient. Instr.*, August, 1934, Vol. 5, No. 8, pp. 292–295.)

POWER SUPPLY FOR AIRCRAFT WIRELESS APPARATUS [Relative Merits of Supply direct from Aircraft Engine and from Wind-Driven Generator: etc.].—C. B. Carr. (*Marconi Review*, July/August, 1934, No. 49, pp. 18–26.)

SKIN EFFECT IN RECTANGULAR CONDUCTORS AT HIGH FREQUENCIES.—Jackson. (*See* under "Properties of Circuits.")

A STABLE D.C. AMPLIFIER USING 7567A TUBES [with Space-Charge Grid and Plate at Same Potential: Currents of $3 \times 10^{-15}$ Ampere give 1 Centimetre Galvanometer Deflection, with Readings every 15 Seconds].—M. Distad and J. H. Williams. (*Review Scient. Instr.*, August, 1934, Vol. 5, No. 8, pp. 289–291.)

A D.C. AMPLIFIER, ESPECIALLY FOR PHOTOELECTRIC PHOTOMETER [Fluctuation of Cathode Emission compensated by Potential Drop across Series Resistance to Space-Charge Grid].—R. Kurosawa. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 331: English summary pp. 47–48.) Supply instability is compensated by Soller one-valve balanced circuit (1932 Abstracts, p. 654).

NOTES ON THE AMPLIFICATION OF CONTINUOUS CURRENTS [down to $10^{-14}$ Ampere].—P. Donzelot and J. Divoux. (*Journ. de Phys. et le Rad.*, July, 1934, Series 7, Vol. 5, No. 7, pp. 357–372.)

ON THE QUARTZ WAVE FILTER [Its Advantages as Element in a Band-Pass Filter: Experimental Results: Design Calculations].—N. Kato, N. Matsuyama and T. Inoue. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 404: English summary pp. 60–61.)

WIRELESS BALANCING EQUIPMENT [and an Automatic Frequency Balancing Arrangement applicable to Telemetering and Remote Control].—N. Kato and N. Matsuyama. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 [No. 5], No. 550, p. 408: English summary pp. 61–62.)

FLASHING "OSGLIM" [Neon] LAMP, CONTROLLED BY A.C. MAINS OR BY VALVE OSCILLATOR, FOR STROBOSCOPIC INVESTIGATIONS.—E. Langton and E. Tyler. (*Phil. Mag.*, August, 1934, Vol. 18, No. 118, pp. 352–365.) In a paper on photographic time registration on a falling plate.

THE SPHERE SPARK GAP AND ITS BEHAVIOUR TO PULSES OF VERY SHORT DURATION [including Very Steep Surges produced by Oil Gap (0.6 Microsecond and less): Oscillographic Investigation].—W. Förster. (*E.T.Z.*, 12th July, 1934, Vol. 55, No. 28, pp. 689–691.)

THE [Very Great] INFLUENCE OF PRESSURE [and of Temperature] ON THE ELECTRICAL RESISTANCE OF A BUTTON OF IMPURE ZIRCONIUM OXIDE IN AIR.—J. Basset. (*Comptes Rendus*, 2nd July, 1934, Vol. 199, No. 1, pp. 38–41.)

## STATIONS, DESIGN AND OPERATION

PRINCIPLES OF AUDIO-FREQUENCY WIRE BROADCASTING [" Audio-Frequency Rediffusion "].—P. P. Eckersley. (*Journ. I.E.E.*, September, 1934, Vol. 75, No. 453, pp. 333–353.)

The full paper, with Discussion, summaries of which were referred to in Abstracts, June, p. 337, and October, p. 572. In reply to a statement that the average listener will not support rediffusion, the writer states that in Holland more urban listeners use rediffusion than use only wireless sets, and in Hull one householder in every four gets his programmes by rediffusion ; while in other English towns and cities, where rediffusion has not been installed so long as in Hull, the number of consumers are " mounting quickly and at much the same rate as they have done in Hull."

COMPARISON OF VARIOUS SYSTEMS OF COMMON-WAVE BROADCASTING.—P. R. Arendt. (*Zeitschr. f. tech. Phys.*, No. 9, Vol. 15, 1934, pp. 342–348.)

The best results with the simple method of independent, quartz-controlled transmitters are here given as corresponding to a deviation of $10^{-6}$. Of the inter-controlled systems particular attention is given to the comparison of the Lorenz system, with master tuning fork at the controlling station connected by cables to subsidiary forks at the controlled stations (*see* September Abstracts, p. 496), and the system using a master quartz oscillator similarly connected by cable to the quartz-controlled sub-stations, phase relays serving to adjust (through a mechanical train) the frequencies of the latter stations. The absolute variation of a tuning fork generator, as used by the German P.O., is given as around $10^{-5}$, but laboratory tests with improved thermostats and with forks having better temperature coefficients show that a value of $10^{-7}$ can be obtained. The most up-to-date quartz generators (as, for instance, at the Berlin broadcasting station) give a deviation of about $5 \times 10^{-6}$. Probably this could be improved to $10^{-7}$ or better, in view of Scheibe's results (with considerable outlay in apparatus) leading to a value of $10^{-9}$.

As regards the other important factor, the shortness of the control delay time, it was shown in a previous paper (*loc. cit.*) that the present reaction time of the Lorenz system with tuning forks—about 4 seconds—is satisfactory, since the phase shifts and amplitude pulses in the cable only exceptionally reach values which call for a longer time. It is not, however, yet known for certain whether a shorter time of, say, 3 seconds would be satisfactory. But in any case the phase-relay system also suffers from the same restrictions as regards cable disturbances, so that in this respect the two systems appear to be of equal merit. A marked difference between them is shown in Figs. 3 and 4 : in the tuning-fork system the curves for the main station and the sub-station are completely congruent, though displaced by the amount of the reaction time, whereas the phase-relay system gives a jerky curve for the sub-station frequency, which means that the carrier frequency of the sub-station has a frequency of regulation superposed on it which is liable to affect reception. In the final section (on future lines of development) it is suggested among other things that the phase relays should be improved so as to give a continuous adjustment instead of their present step-by-step contact adjustment. *See* also under " Transmission."

NOTE ON THE SYNCHRONISATION OF BROADCAST STATIONS WJZ AND WBAL [Effect on Fading and Consequent Distortion].—K. A. Norton. (*Proc. Inst. Rad. Eng.*, September, 1934, Vol. 22, No. 9, pp. 1087–1089.)

The field intensities were recorded continuously by the method dealt with in January Abstracts, p. 47. The two stations were synchronised on alternate days and nights, by an audio-frequency transmitted over a wire line and multiplied up to the 760 kc/s radio-frequency. " Fig. 1 illustrates the type of record obtained, showing that the fading is of a radically different character when the stations are synchronised than when not." " It is believed that no serious distortion would be introduced into the received modulation by the synchronisation fading in that part of the primary service area of the two stations where the ratio of the intensities of their two ground waves is about two to one or greater. The Federal Radio Commission states that a ratio of at least four to one . . . is necessary in order to prevent modulation distortion " [receivers without AVC : the writer's distortion test was with AVC].

THE GERMAN HIGH-POWER BROADCASTING STATIONS.—W. Meyer. (*Zeitschr. V.D.I.*, 18th Aug. 1934, Vol. 78, No. 33, pp. 975–977.)

THE CONSTRUCTION OF THE GERMAN BROADCASTING NETWORK. PART III.—THE BERLIN AND HAMBURG HIGH POWER STATIONS.—A. Semm. (*T.F.T.*, April, 1934, Vol. 23, No. 4, pp. 79–84.)

THE " FATIGUE " OF WIRELESS STATIONS [Weather Signals Not Due to Electrolytic Changes in Surrounding Earth but to Eleven-Year Sunspot Cycle].—(*E.T.Z.*, 9th Aug. 1934, Vol. 55, No. 32, pp. 797–798.) *See* March Abstracts, p. 166, r-h column.

VOLUME-RANGE " COMPRESSION " AND " EXPANSION " AT TRANSMITTER AND RECEIVER RESPECTIVELY : IMPROVED REPRODUCTION OF BROADCAST MUSIC AND GREATLY INCREASED SIGNAL/NOISE RATIO.—Sowerby : Nestel. (*See* abstracts under " Acoustics and Audio-frequencies.")

COMMUNICATION SYSTEM FOR THE ITALIAN SQUADRON TRANSATLANTIC FLIGHT.—E. W. Stone. (*Elec. Communication*, July, 1934, Vol. 13, No. 1, pp. 61–68.)

RADIO EQUIPMENT FOR AIRCRAFT.—D. B. Mirk and others. (*Elec. Communication*, July, 1934, Vol. 13, No. 1, pp. 76–91.)

Radio Waves to Transmit Weather Maps [Proposed Radio-Typing Forecasts for Air Lines].—(*Sci. News Letter*, 21st July, 1934, Vol. 26, No. 693, p. 40.)

The Micro-Wave Service between the Air Ports of St. Inglevert and Lympne.—(*Ann. des. P.T.T.*, June, 1934, Vol. 23, No. 6, pp. 580–595.)

Aeroplane and Car: Demonstration of Value of Two-Way Radio Communication for Police Action against Motor Criminals.—Marconi Company. (*Electrician*, 20th July, 1934, Vol. 113, No. 2929, pp. 93–94.)

Communication Trials between a Moving Train and the Telephone Network [Paris/Amiens Line: Wavelengths around 2 500–3 500 m].—A. Labrousse and A. Becq. (*Ann. des P.T.T.*, June, 1934, Vol. 23, No. 6, pp. 501–538.)

A System of Duplex Radio Communication [Telephony by Amplitude Modulation and Telegraphy by Frequency Modulation].—T. Hayashi. (*Journ. I.E.E. Japan*, May, 1934, Vol. 54 (No. 5), No. 550, p. 410: English summary p. 62.)

Overcoming the Danger of the Mutual Blocking by Echo Suppressors [Criticism of Previous Methods and Description of a New Method].—H. Decker. (*E.N.T.*, August, 1934, Vol. 11, No. 8, pp. 281–288.) Further development of the work referred to in Oct. Abstracts, p. 572.

## GENERAL PHYSICAL ARTICLES

The Wave Equation of the Photon [New Result].—L. de Broglie. (*Comptes Rendus*, 13th Aug. 1934, Vol. 199, No. 7, pp. 445–448.)

The New Field Theory [New Lagrangian Function].—B. Hoffmann. (*Nature*, 1st Sept. 1934, Vol. 134, p. 322.)

The New World-Picture of Modern Physics [General Survey].—J. H. Jeans. (*Nature*, 8th Sept. 1934, Vol. 134, Supp. No. 3384, pp. 355–365.)

General Theory of the Magnetic Electrons [and the Existence of Four Different Types of Electrons].—R. Zaïcoff. (*Journ. de Phys. et le Rad.*, August, 1934, Series 7, Vol. 5, No. 8, pp. 431–435.)

[First] Experimental Demonstration of the Existence of Dipolar Magnetic Radiation.—H. Niewodniczański. (*Comptes Rendus*, 18th June, 1934, Vol. 198, No. 25, pp. 2159–2161.)

Energy, Temperature and Atomic Weight: a Rapid Interconversion Scale.—C. H. D. Clark. (*Phil. Mag.*, July, 1934, Series 7, Vol 18, No. 117, pp. 80–90.)

On the Change of the Resistance of Alkali Metals in a Magnetic Field.—M. Koretz. (*Physik. Zeitschr. der Sowietunion*, No. 6, Vol. 5, 1934, pp. 877–886: in English.)

On the Stopping of Fast Particles and on the Creation of Positive Electrons.—H. Bethe and W. Heitler. (*Proc. Roy. Soc.*, Series A, 1st Aug. 1934, Vol. 146, No. 856, pp. 83–112.)

On the Theory of the X-Ray Determination of Elastic Scattering of Cathode Rays.—D. K. Froman: Bubb. (*Canadian Journ. of Res.*, August, 1934, Vol. 11, No. 2, pp. 156–162.)

Study of an Electrified Space containing Material Particles.—M. Pauthenier and M. Moreau-Hanot. (*Comptes Rendus*, 16th July, 1934, Vol. 199, No. 3, pp. 189–190.)

Note on the Electric Arc [and the Mechanism of Freeing Electrons from the Cold Cathode].—F. H. Newman. (*Phil. Mag.*, August, 1934, Vol. 18, No. 118, pp. 365–368.) For a previous paper *see* 1933 Abstracts, p. 55, l-h column.

## MISCELLANEOUS.

General Statistical Method applicable to Groups of Indistinguishable Particles [*e.g.* Electronic Gas in Absence of Magnetic Field, the Two Types being the Electrons of Opposite Spin].—G. Allard. (*Comptes Rendus*, 13th Aug. 1934, Vol. 199, No. 7, pp. 451–453.)

On the Statistical Theory of Errors.—W. E. Deming and R. T. Birge. (*Reviews of Mod. Physics*, July, 1934, Vol. 6, No. 3, pp. 119–161.)

Probability Likelihood and Quantity of Information in the Logic of Uncertain Inference, *and* Probability and Scientific Method.—R. A. Fisher: H. Jeffreys. (*Proc. Roy. Soc.*, Series A, 1st Aug. 1934, Vol. 146, No. 856, pp. 1–8 and 9–16.)

The "Ordinate-Difference Harmonic Analysis" Rapid Graphical Method for Symmetrical Periodic Curves.—Mouromtseff and Kozanowski. (*See* abstract under "Transmission.")

Relativity yields Formula Good for Many Machines [Generalised Theory of Electrical Machinery, using Tensor Methods].—G. Kron. (*Sci. News Letter*, 18th Aug. 1934, Vol. 26, No. 697, p. 109.)

The Engineer and Modern Civilisation [Gustave Canet Lecture].—F. E. Smith. (*Engineer*, 6th, 13th and 20th July, 1934, Vol. 158, Nos. 4095/6/7, pp. 4–6, 38–39 and 67–68.)

Invention in Relation to National Welfare and Legislative Control.—Ambrose Fleming. (*Journ. Television Soc.*, March, 1934, Series 2, Vol. 1, Part 10, pp. 313–319.) The full paper, a summary of which was referred to in June Abstracts, p. 340, r-h column.

Progress of Electrical Communications from the Field of Work of the German Post Office [Common-Wave, Directive and World Broadcasting: etc.].—(*T.F.T.*, April, 1934, Vol. 23, No. 4, pp. 85–87.)

TELECOMMUNICATIONS IN 1933 [including Radio Telegraphy and Telephony, Broadcasting and Television].—(*Ann. des P.T.T.*, August, 1934, Vol. 23, No. 8, pp. 744–768.)

CONFERENCE OF PROFESSORS AT THE GERMAN POST OFFICE [Summaries of Papers].—(*T.F.T.*, June, 1934, Vol. 23, No. 6, pp. 143–148.)

ESCALATOR CONTROL: AUTOMATIC VARIATION OF SPEED IN RELATION TO TRAFFIC [by Photocell Apparatus].—G.E.C. (*Electrician*, 27th July, 1934, Vol. 113, No. 2930, p. 134.)

PHOTOCELLS IN LIGHT-CONTROLLED MACHINES AND APPARATUS.—W. Kluge and H. Briebrecher. (*Zeitschr. V.D.I.*, 4th Aug. 1934, Vol. 78, No. 31, pp. 935–938.)

THE PHOTOELECTRIC MEASUREMENT OF THE DIAMETERS OF FINE WIRES [Photoelectric Micrometer for the Continuous Measurement of Plain and Covered Wires of 0.02–0.5 mm Diameter, and H.F. Litz Wire].—R. C. Schmid. (*E.T.Z.*, 9th Aug. 1934, Vol. 55, No. 32, pp. 785–786.)

PHOTOELECTRIC MEASUREMENT OF THE $p_H$-VARIATION IN MUSCLE TISSUE DURING CONTRACTION.—R. Margaria and A. von Muralt. (*Naturwiss.*, 14th Sept. 1934, Vol. 22, No. 37, p. 634.)

A PHOTOELECTRIC APPARATUS FOR TURBIDITY AND LIGHT PENETRATION MEASUREMENT [used by U.S. Bureau of Fisheries].—M. M. Ellis. (*Science*, 13th July, 1934, Vol. 80, No. 2063, p. 37.)

MEASUREMENTS OF THE CELL-SPACE RATIO IN WOOD BY A PHOTOELECTRIC METHOD [containing Description of Photoelectric Amplifier Circuit].—W. W. Barkas. (*Proc. Phys. Soc.*, 1st July, 1934, Vol. 46, Part 4, No. 255, pp. 545–558: Discussion pp. 558–559.)

REFLECTING POWER OF POWDERS IN THE FAR INFRA-RED REGION [as a Function of Particle Size and Applied Pressure].—C. W. Bryant. (*Journ. Opt. Soc. Am.*, May, 1934, Vol. 24, No. 5, pp. 139–142.)

GALVANOMETER AMPLIFICATION BY PHOTO-CELL.—A. V. Hill. (*Nature*, 25th Aug. 1934, Vol. 134, p. 289.)

Since the recent reference to the use of a Weston "photronic" cell arranged differentially for amplifying galvanometer deflections (Abstracts, July, p. 398, r-h column: *see* also Jones, September, p. 516, r-h column) the writer has found "(a) that a Bernheim cell [1933, p. 512] is several times as sensitive, and (b) that there is considerable advantage in cutting the cell into two halves, and opposing the two halves in parallel."

PHOTOELECTRIC MEASUREMENTS OF THE ABSORPTION OF FUSED AND CRYSTALLINE QUARTZ BETWEEN 1 633 and 1 463 Å.—W. M. Powell, Jr. (*Phys. Review*, 1st July, 1934, Series 2, Vol. 46, No. 1, pp. 43–46.)

"The extraordinary variations in the coefficient of absorption show the importance of actually testing a piece of quartz in the ultra-violet before incorporating it in an instrument for use in that region."

PIEZOELECTRICITY: AND A RECORDING INSTRUMENT FOR TRANSIENT PRESSURES [*e.g.* inside Fusible Cut-Outs].—H. W. Baxter. (*Electrician*, 27th July, 1934, Vol. 113, No. 2930, pp. 121–122.) Based on Report G/T58 of the British Electrical and Allied Industries Research Association.

SMOOTHNESS OF SURFACE NOW INDICATED BY SOUND [by use of Electrical Pick-Up: also by use of Photocell].—(*Sci. News Letter*, 21st July, 1934, Vol. 26, No. 693, p. 36.)

AN ACOUSTIC PROCESS FOR THE EXAMINATION OF STRESS [based on Vibration Frequency of Stretched Steel Wire].—(*Engineer*, 10th Aug. 1934, Vol. 158, No. 4100, pp. 142–143.)

ELECTROSTATIC MANUFACTURE OF SANDPAPER.—(*E.T.Z.*, 23rd Aug. 1934, Vol. 55, No. 34, pp. 847-848: summary only.) *See* also September Abstracts, p. 516, l-h column.

ON THE JOHNSEN-RABBECK [Rahbek] EFFECT [a New Interpretation based on Reboul's Potential Variation Discovery].—G. Dechêne. (*Comptes Rendus*, 23rd July, 1934, Vol. 199, No. 4, pp. 266–268.)

EMISSION OF A RADIATION OF LOW PENETRATING POWER BY ELECTRIFIED INSULATORS.—G. Reboul. (*Journ. de Phys. et le Rad.*, July, 1934, Series 7, Vol. 5, No. 7, pp. 329–342.) *See* also Abstracts, January, p. 54, and 1933, p. 463.

THE INFLUENCE OF THE FREQUENCY OF THE ELECTRICAL FIELD ON THE COMBUSTION VELOCITY OF A GAS [Tests up to $0.8 \times 10^7$ c/s].—A. E. Malinowski and others. (*Physik. Zeitschr. der Sowietunion*, No. 6, Vol. 5, 1934, pp. 902–905.) For previous papers *see* June and August Abstracts, pp. 339 and 433.

RADIO CURRENTS ADD TO KNOWLEDGE OF THE BRAIN [Short-Wave (100 m) Currents used to put certain Centres out of Function].—C. W. Brown. (*Sci. News Letter*, 21st July, 1934, Vol. 26, No. 693, pp. 35–36: paragraph only.)

ACTION OF SHORT WAVES [20 m] ON THE POISON OF ASP SNAKE.—M. Phisalix and F. Pasteur. (*Comptes Rendus*, 16th July, 1934, Vol. 199, No. 3, pp. 235–237.)

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

THE MAGNETO-OPTIC METHOD OF CHEMICAL ANALYSIS [and the Existence of Time Lag in the Faraday Effect: Negative Results].—F. G. Slack and J. A. Peoples, Jr.: Allison. (*Phys. Review*, No. 2, Vol. 45, p. 126.) *See* also Webb and Morey, June Abstracts, p. 340, l-h column.

# 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.*

## AUTOMATIC "CALLING" APPARATUS

*Application dates 24th November and 15th December, 1932. No. 410523*

A selector device, responsive only to distress signals or predetermined "code" messages, is provided with means for preventing spurious signals from operating the alarm. If the first impulse received is of correct length, then each subsequent impulse is individually measured, and the alarm is rung only if the entire sequence of impulses corresponds to the predetermined "call."

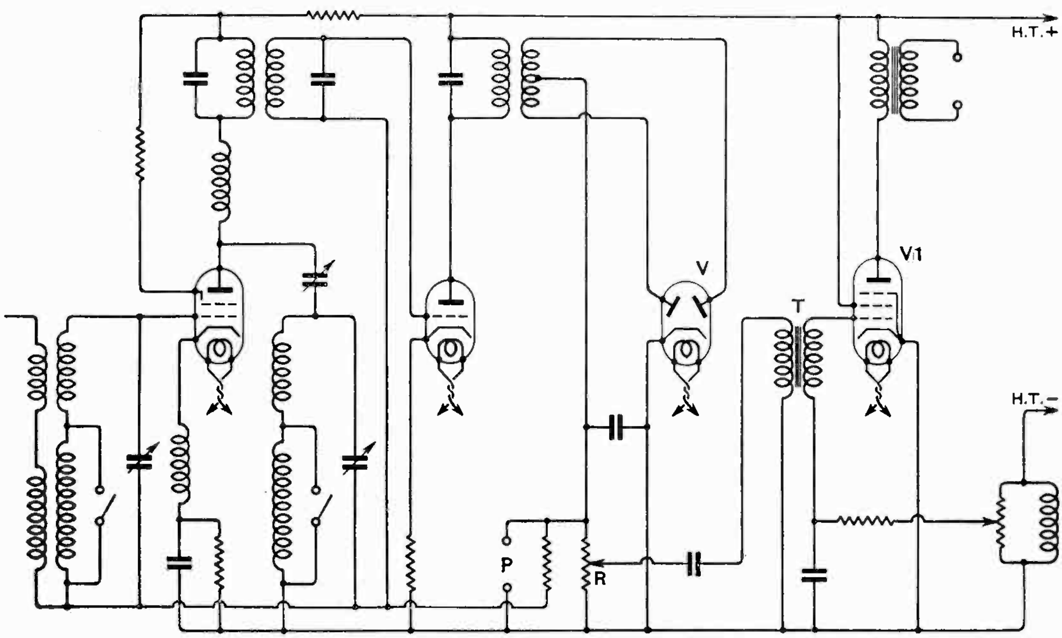
Patent issued to Standard Telephones and Cables, Ltd.

## VOLUME CONTROL

*Application date, 24th January, 1933. No. 410567*

In a radiogram it is desirable to have means for controlling the output both for the wireless programme and from the record. Usually a separate resistance is used in each case, but, according to the invention, the resistance *R* of the diode rectifier *V* is made to serve both purposes. It is in shunt with the pick-up terminals *P*, and also provides biasing voltage for the preceding amplifiers. The transformer *T* serves to feed both wireless and record signals to a pentode amplifier *V*1.

Patent issued to E. K. Cole, Ltd. ; E. J. Wyborn ; and A. W. Martin.




No. 410567.

## VALVE CONSTRUCTION

*Convention date (Germany), 14th March, 1933. No. 410658*

Lamps and valves have already been made with plane surfaces on the glass bulb so as to carry advertising matter, but this usually leads to a high percentage of breakages. According to the invention a bulb is made so as to have three or more slightly convex faces. That is, the radius of curvature of each face is greater than that of the circle which circumscribes the bulb as a whole. This permits the application of advertising or descriptive matter with less risk of breakage in manufacturing the bulb.

Patent issued to J. Inwald, A.G.

## ALL-MAINS SETS

*Convention dates (Germany), 24th June and 6th August. No. 410628*

The object is to make a receiver sufficiently flexible to be connected either to a 100 or 200 volts D.C. or A.C. supply. The detector valve has a high-mu factor, and grid current starts at zero grid bias. The specification contains a formula showing that for a given initial grid-bias, below the bottom bend, the anode current of the detector remains constant over a wide variation of the supply voltage.

Patent issued to Radio A. K. Loewe.

## TELEVISION RECEIVERS

*Application date, 18th October,* 1933. *No.* 410678

To facilitate the correct "setting" of the received picture on the viewing screen a "framing" signal operates to throw the normal synchronising gear out of action should the incoming picture signals not be in correct phase, and to keep it inoperative until such time as the picture drifts into correct position, whereupon the synchronising control becomes effective. The framing signals are produced at the transmitting end by a commutator during the interval between the last and first holes on the scanning disc.

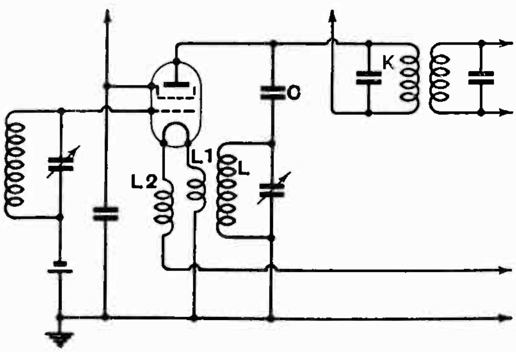
At the receiver the electron stream in the cathode-ray tube impinges on a special conductive strip at one end of, but separated from, the viewing screen. If the phase conditions are correct the synchronising control is maintained. Otherwise the "saw-tooth" oscillators are rendered ineffective during a drift period which lasts until the received picture falls into correct framing.

Patent issued to J. C. Wilson and Baird Television, Ltd.

## SUPERHET CIRCUITS

*Application date, 14th January,* 1933. *No.* 411208

A directly heated valve, preferably of the screen grid type, is used as a combined oscillator and first detector. As shown in the drawing, the anode circuit is back-coupled through a coil *L* to a coil *L*1 in one of the filament leads, and the resulting oscillations are fed through a condenser *C* to the tuned circuit *K* of the first intermediate-frequency amplifier. A heavier coil *L*2 in the second filament lead acts as a choke to prevent the H.F. oscillations from being short-circuited ineffectively to the cathode.



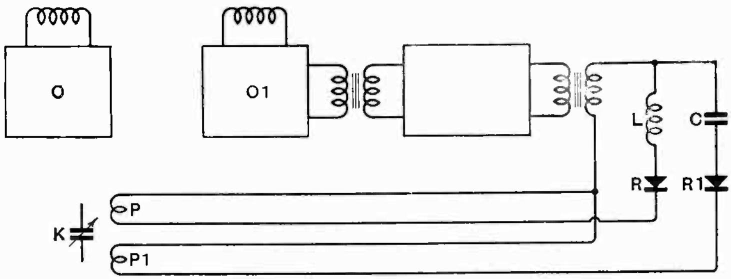

No. 411208.

Patent issued to The Mullard Radio Valve Co., Ltd., and R. G. Clark.

## STABILISING FREQUENCY

*Application date, 25th January,* 1933. *No.* 411217

Relates to means for stabilising and controlling the frequency of a transmitter by making use of the heterodyne beat note produced between the transmitter and a small standard oscillator. As shown in the drawing, the monitoring oscillator *O*1 is coupled to the main transmitter *O*, and the beat note produced is fed back through parallel circuits containing rectifiers *R*, *R*1 to two relay coils *P*, *P*1. One parallel circuit is inductively loaded at *L*, whilst the other is capacitatively loaded at *C*. If the transmitter frequency departs from its standard value, the currents passing through the relay coils *P*, *P*1 are no longer balanced, and the variable tuning condenser *K* is rotated in one direction or the other to restore the original conditions.




No. 411217.

Patent issued to H. A. Thomas.

## CATHODE-RAY TUBES

*Convention date (Germany), 30th November,* 1931. *No.* 411120

In the case of an indirectly heated oxide cathode, the dimensions of the emissive area are too large to be regarded as a "point" source. In order to compensate for this fact the distance between the cathode and the aperture in the Wehnelt cylinder is adjusted, according to a formula given in the specification, so as to concentrate the beam as though, in effect, it came from a single point.

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

*Convention date (Germany), 11th March,* 1933. *No.* 411411

The cathode, the Wehnelt cylinder, and, if necessary, the other focusing-electrodes in a cathode-ray tube are supported by a relatively springy or flexible member. This allows a small displacement to be effected, after the electrodes have first been fitted into the tube, so that they may be accurately centred, relatively to the aperture in the anode, before being finally fixed or sealed in position.

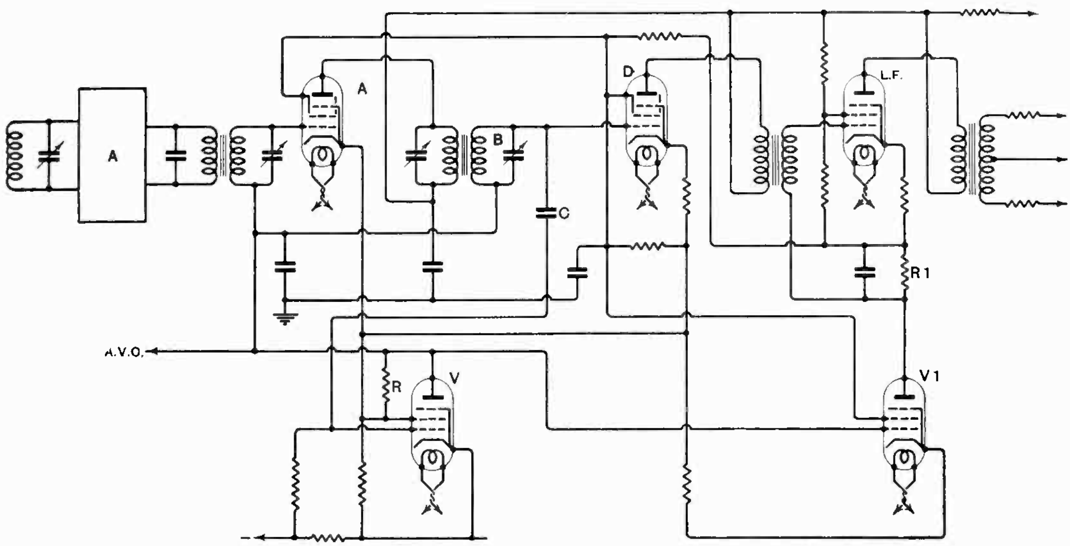
Patent issued to Telefunken Ges. fur drahtlose Telegraphie m.b.h.

## "QUIET" A.V.C.

*Convention date (U.S.A.), 1st November, 1932. No. 411351*

Relates to gain-control systems provided with means for suppressing background "noise" at intermediate settings of the tuning dial. The parts marked *A* in the drawing represent the stages preceding the second detector *D* of the superhet set. The ordinary A.V.C. valve shown at *V* is of the pentode type, and its anode is connected to the control grid of a second pentode *V*1, which functions as the noise-suppressor. When a signal is being received the voltage-drop across the resistance *R* is applied to the grids of the previous amplifiers in order to maintain the output at constant volume. For an intermediate setting of the tuning dial the valve *V* is at cut-off, and there is no voltage drop across *R*, so that sufficient current can flow through the valve *V*1 and its anode resistance *R*1 to paralyse the L.F. amplifier and so open-circuit the line to the loudspeaker. The control grid of the valve *V* is fed from the circuit *B* through a condenser *C*.

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




No. 411351.

## VISUAL TUNING INDICATORS

*Convention date (U.S.A.), 22nd June, 1932. No. 411659*

An incandescent lamp is arranged to illuminate the indicator scale with a diffused light, which is automatically altered in intensity as a station is tuned in. Various means are described for making the most effective use of the comparatively small current changes available. For instance, a carbon-filament lamp is arranged in the anode circuit of one of the amplifiers and is shunted with a resistance so that it is only in a state of incipient glow at the resonance point, but brightens up on either side of it. Or the lamp may be arranged on a bridge circuit so that it is brightest at the resonance point, and dimmer on either side of it. Or two lamps may be used to enhance the change in brilliance. One produces a general illumination of the dial which grows dim at the point of resonance, whilst the second lamp simultaneously throws a bright light on to a narrow slot or window.

Patent issued to Hazeltine Corporation.

## LIFE-SAVING EQUIPMENT

*Convention date (Italy), 23rd July, 1932. No. 411312*

A submarine is fitted with a float which can be released in an emergency to reach the surface of the sea. A balloon is then automatically liberated to elevate an aerial wire, from which messages asking for assistance are radiated. The float contains the high-frequency part of the transmitter, which is connected through a flexible wire cable to the interior of the submerged vessel, where the keying or modulating apparatus is located.

Patent issued to G. Urizio.

## TELEVISION RECEIVERS

*Convention date (Germany), 19th October, 1931. No. 411883*

A cathode-ray tube is made in two parts, one containing the cathode and the other the fluorescent screen. Both parts are hermetically sealed off, but are connected by a narrow tube, which may be of metal or silvered glass, and acts as an anode. As the electron stream flows through this tube it is modulated in intensity by the magnetic field from a coil carrying the signal currents.

Patent issued to International General Electric Co., Inc.

## CATHODE-RAY TUBES

*Convention date (Germany), 16th January, 1932. No. 411955*

The cathode is designed to have a relatively high thermal capacity in order to produce a ray of constant strength, particularly suitable for television-reception by intensity modulation or control. The holder for the emissive oxide is in the form of a pin, or a ring, mounted on a metallic rod which is, in turn, surmounted by two insulating sleeves with the heating-filament placed between them.

Patent issued to K. Schlesinger.

## ALL-MAINS SETS

*Convention date (Germany), 4th August, 1932. No. 412054*

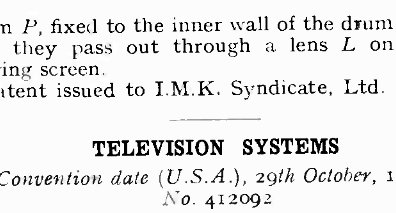
In a set designed for operation either from alternating or direct current mains, provision is made for a possible wrong "poling" in the case of a D.C. supply, where it is usual to employ resistances of the order of 1,000 ohms shunted by high-capacity condensers of the electrolytic type. As these are liable to be damaged or destroyed by a reversed voltage, a guard resistance is inserted between the mains terminal and the first smoothing condenser. If the polarity is wrong, a warning lamp is lit by the leakage current through the electrolytic condenser to notify the user before any serious damage is caused.

Patent issued to Radio A. G. Loewe.

## TELEVISION RECEIVERS

*Convention dates (Germany), 21st May and 5th November, 1932. No. 412026*

The scanning drum $D$ is driven by a motor $M$, and is located inside the axis of a spiral neon tube $N$, which is aligned with the helical series of perforations 1, 2 etc. The rays of light pass through the scanning-holes on to an inside rotating mirror $K$, which reflects them on to the surface of a prism $P$, fixed to the inner wall of the drum. From here they pass out through a lens $L$ on to the viewing screen.



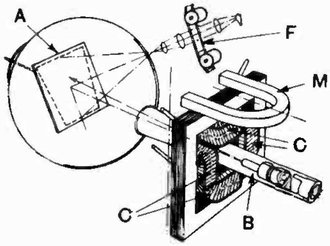

No. 412026.

Patent issued to I.M.K. Syndicate, Ltd.

## TELEVISION SYSTEMS

*Convention date (U.S.A.), 29th October, 1932. No. 412092*

Relates to a television transmitter of the type in which the image, say from a photographic film $F$, is projected on to the sensitive anode $A$ of a cathode-ray tube, and is then scanned by the electron stream from the cathode $B$. The conditions require that the "mosaic-cell" anode $A$ should be set at an angle to the path of the electron stream, in order to allow the pictures from $F$ to be projected on to it. In order to compensate for this inclination, an additional magnetic field, of constant intensity, from the magnet $M$ is superposed on the usual scanning control-field from the coils $C$, so that the cathode-ray moves over the wedge-shaped area shown in dotted lines. That is, as viewed from a plane at right-angles to the axis of the electron beam, but as projected on the inclined surface of the anode $A$ it becomes a true rectangle, and distortion is avoided.




No. 412092.

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

## RECORDING SOUNDS

*Application date, 10th September, 1932. No. 412206*

A method of recording sounds is described, in which one stage of the process consists in transforming the original acoustic vibrations into a band of light-frequencies, which are produced by spark-discharges across a pair of elongated electrodes. The band or line of light is then focused by a lens on to a photographic film. The theory of operation is based upon an assumption that the total theorectical range of audible frequencies between 20 and 20,000 cycles (about 10 octaves) can be adequately represented by approximately 1,280 distinct frequencies, owing to the limitations of the human ear. The microphone currents are modulated on a carrier frequency of 1,000 k.c. before they are applied to the pair of discharge electrodes. The latter are initially biased to a point just short of the normal sparking voltage, so that the extra voltage from the microphone initiates the discharge.

Patent issued to G. W. Walton.

## POWDER-CORE COILS

*Convention date (U.S.A.), 4th May, 1932. No. 412382*

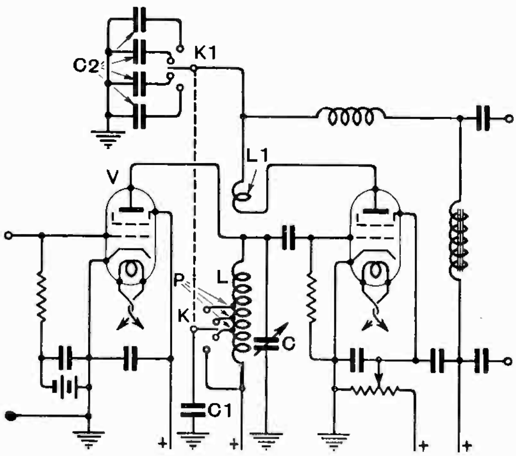
In ganged circuits using so-called permeability tuning, a straight-line-frequency response (or other desired characteristic) is ensured by using tapered or conical cores instead of cylindrical ones. The powdered iron is moulded into the desired shape under pressure, and the windings are suitably shaped to allow the cores to move in and out.

Patent issued to Johnson Laboratories, Inc.

## TUNING ARRANGEMENTS

*Convention date* (*U.S.A.*), *1st March*, 1933.
*No.* 412152

The main tuning circuit of a multi-range receiver consists of an inductance $L$ shunted by a variable capacity $C$ and designed to have a high $L/C$ ratio. The wave-change switch $K$ inserts a fixed condenser $C1$ across one or other of a series of intermediate tapping points $P$. This circuit is designed to have a low $L/C$ ratio, so that, when used in combination with the first circuit, a reduction of the total effective inductance of the coil $L$ does not introduce such losses as would occur if the tapped portions of the coil were merely short-circuited or left unused. The reaction coil $L1$ is shunted by one or other of a series of fixed condensers $C2$ by means of a second rotary switch $K1$ which is ganged




No. 412152.

to the main switch $K$. The input amplifier $V$ is shown as aperiodic, though this is immaterial.

Patent issued to British Thomson-Houston Co., Ltd.

## TELEVISION RECEIVERS

*Convention date* (*U.S.A.*), *11th August*, 1932.
*No.* 412435.

It is usual to "earth" the heating-filaments of the various amplifiers forming part of a cathode-ray television receiver to the metal chassis of the set. In practice the chassis may be the seat of local currents induced from the A.C. supply, which are liable to cause interference, both with the proper control of the scanning beam and with the reception of any sound accompaniment to the pictures. In order to prevent such interference, the chassis is connected to a centre tapping on the filament supply transformer. One end of the supply lead is then used to energise one group of valve amplifiers, whilst the opposite end is connected to a second group. The two groups being thus fed in phase-opposition, "local" interference is automatically balanced out.

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

## FREQUENCY-CHANGERS

*Convention date* (*U.S.A.*), *1st March*, 1933.
*No.* 412154

The object is to provide a simple yet efficient valve oscillator producing a pure sinusoidal wave free from distortion. The tuned input circuit of a screen grid valve, biased to operate as a dynatron, is coupled to a master oscillator which is controlled by a tuning-fork. The output circuit of the dynatron is tuned to any desired harmonic or sub-harmonic of the input, and acts as a frequency-changer. This stage is coupled in turn to a second dynatron valve, which may again step the frequency up or down as desired and also serves to restore the pure sine-wave form.

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

## LOUD SPEAKER MAGNETS

*Application dates, 21st December*, 1932, *and 7th March*, 1933. *No.* 412552.

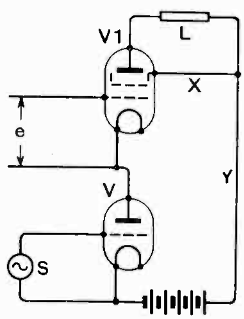
The inner pole-piece of a permanent magnet is made partly of cobalt-steel, a cheaper steel being used for the remainder of the structure. This is stated to give an efficiency which is at least comparable with that attained when the whole magnet is made of the dearer material. Preferably the limb of the centre pole-piece consists of cobalt-steel whilst the pole-tip is of ordinary steel or iron.

Patent issued to E. R. Dempster and Magnavox (Great Britain), Ltd.

## CONTROLLING AMPLIFICATION

*Convention date* (*Germany*), *5th November*, 1932.
*No.* 412477.

A disadvantage of the ordinary type of variable-mu valve, as used for automatic volume control, is that the means used to vary the slope give the valve a characteristic curve which is approximately logarithmic in shape, with practically no straight-line portion. The arrangement shown in the drawing is designed to afford an effective control over amplification, whilst at the same time providing a straight-line operating path free from distortion. The valves $V$, $V1$ are arranged in series across a common H.T. supply. The incoming signal $S$ is applied to the grid of the valve $V$, whilst a variable source of biasing voltage $e$ is inserted between the grid and filament of the valve $V1$. Amplification is controlled by varying the voltage $e$, so as to divert more or less current through the path $XY$, which is in shunt with the main output impedance or load $L$.




No. 412477.

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