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Editorial

Two New Loudspeakers

IN the current number of the house-journal of the Telefunken Company two new loudspeakers are described the principal characteristic of which is their inconspicuousness. The first is a high-powered speaker for large open spaces, the second a low-powered speaker suitable for indoor use where several small speakers are preferable to one large one. They are both intended for use in circumstances where the more usual types would clash with the architectural surroundings or obtrude unduly in an otherwise clear field. An example of this is the gymnastic display where many thousands of athletes must move simultaneously under direction by speech or music through loudspeakers. In the past these loudspeakers were supported on poles but a type has now been developed which can be sunk into the ground.

Fig. 1.—(Below). The grille covering the Telefunken sunken loudspeaker, a section of which is shown in Fig. 2 (right).

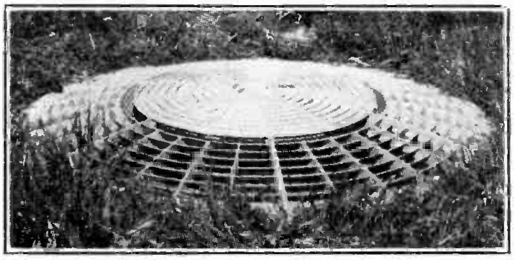
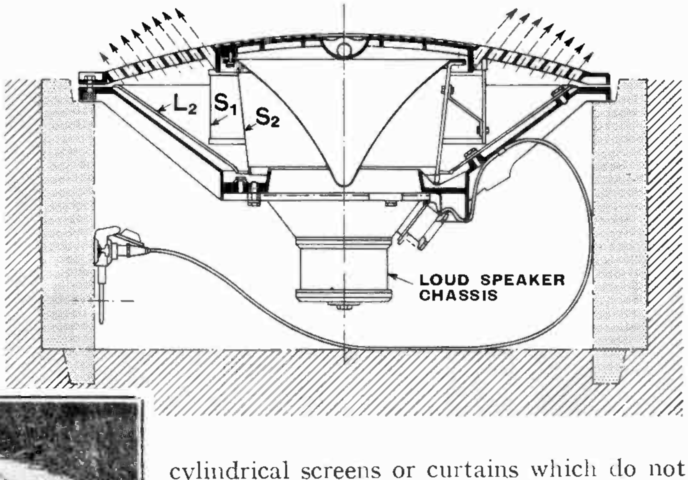


Fig. 1 shows a close up view and Fig. 2 a section. The wall of the hole is formed by a cement pipe on which the loudspeaker rests; when not in use the whole speaker can be removed with its flexible cable and plug and a cement cover placed over the recess. The diameter of the top is 88 cm. and it projects about 6.5 cm. above the surrounding level. The central portion is solid and carries a cone which deflects the sound radially outwards through the perforations. S_1 and S_2 are



cylindrical screens or curtains which do not obstruct the sound but prevent rain and other things that fall through the grid from gaining access to the central portion and thus to the loudspeaker itself. Rain falling on the conical part L_2 runs down into a groove and is drained away. Tests under artificial rain much heavier than anything occurring naturally showed that no drop reached the membrane. Loudspeakers up to 20 watts coil input can be employed, but this type of speaker, radiating sound waves from the ground level, is under a disadvantage compared with one mounted on a pole. If surrounded by a closely packed crowd the absorption will be very considerable and it is admitted that for general purposes the spacing of the speakers must be closer than with pole-mounted speakers.

The lines followed in the other type of loudspeaker are entirely different; here the object has been to reduce the overall depth from front to back and thus get a speaker which can hang on the wall very like a picture. Fig. 3 shows a section and Fig. 4 a front view of the speaker without any surround. The root idea is simply to mount the magnet and the moving coil inside the conical diaphragm. This is made possible owing to the reduction in size of the magnet by the use of the materials now available. The magnet is supported on a disc in which are three large openings, seen in Fig. 4, through which the sound passes. The membrane is protected at the back by a metal framework or basket. In the centre pole-piece is a screw whereby the flexible spider that carries the moving coil can be accurately centred. The overall depth is 43 mm. The instrument in this form, that is, without a baffle, might in an emergency be used for speech, but is quite unsuitable for music because of the absence of the lower frequencies in the resulting sound wave. With or without a baffle one must not put it too close to a wall or it becomes useless both for music and speech due to the interaction of the waves reflected from the wall. This could be prevented by making the wall very absorbent, but this is hardly a practical solution. A somewhat similar result is obtained by enclosing the back of the speaker in a closed shallow box; the result is not quite the same as with a baffle and open back because in the latter there is a definite low frequency cut-off dependent on the size of the baffle, whereas in the former this cut-off is prevented by the absence of the wave from the back of the speaker; on the other hand a new cut-off is introduced by the raising of the resonant membrane frequency due to the air cushioning.

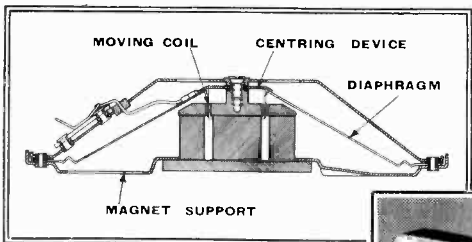
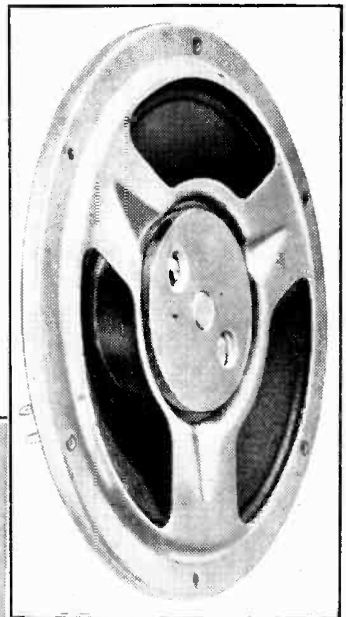
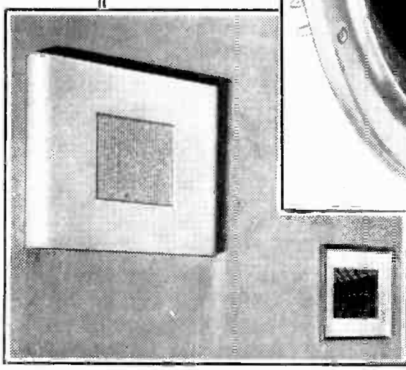


Fig. 3.—*Section of the Telefunken flat wall speaker.*



(*Right*) Fig. 4.—*Chassis of the wall speaker, which is 43-mm deep.*



(*Left*) Fig. 5.—*The 4-cm case in position on the wall.*

By keeping the power down to a modest value and allowing a resonant frequency of 100 cycles per second satisfactory reproduction has been obtained with a box 50 × 50 × 4 cm. A loudspeaker of this type is seen on the wall in Fig. 5, and it must be admitted that it is very inconspicuous. With a depth of less than two inches it would be a simple matter to recess it into the wall.

G. W. O. H.

A Loop Direction Finder for Ultra-Short Waves *

Waverange 6—11 Metres

By H. G. Hopkins, B.Sc., Ph.D., A.R.C.S.

(Radio Department, National Physical Laboratory)

ABSTRACT.—The paper describes an ultra-short wave direction finder of the rotating loop type incorporating a supersonic heterodyne receiver and suitable for use at a fixed station or in the field. The direction finder has a high order of instrumental accuracy, and the reciprocal error is about 0.1° over the band 8-10 metres (27-38 Mc/s) for which the receiver is designed. Means of extending the wave-range of the receiver down to 6 metres are indicated. The sensitivity of the system is high and under favourable conditions a bearing with a swing of ± 5° is obtainable on a vertically polarised emission of field strength 2 microvolts per metre. Under suitable conditions bearings can be observed with a swing as small as ± 0.1°, but it is necessary to remark that the bearings so obtained are seldom correct to this high order of accuracy. Reasons for these errors have been given elsewhere, and work is in progress to determine the criteria that must be satisfied so that the properties of the direction finder can be fully utilised.

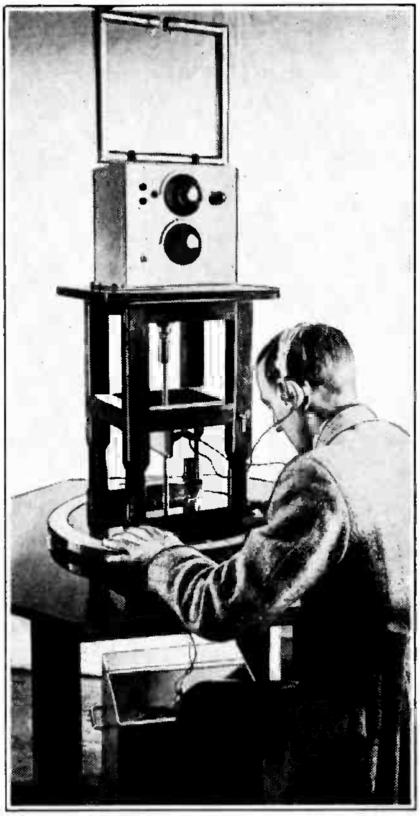


Fig. 1.—*General layout of the direction finder.*

1. Introductory

THE art of practical radio direction finding has been limited until recently to wavelengths of about 15 metres and over (frequencies below 20 Mc/s.). In order to extend the study into the ultra-short wave band below 10 metres, experiments have been carried out in the past few years and the first results of these have been described in another publication.† Based upon the experience gained in this work an improved type of rotating loop direction finder has been developed for both practical and experimental use, and details of this are given in the present paper. The instrument is intended primarily for use in observations to be carried out on meteorological sounding balloons fitted with radio transmitters, and has been designed to operate in the band 8–11 metres (27–38 Mc/s.) with a high order of instrumental accuracy when receiving vertically polarised radiation. Means of extending the wave-range of the apparatus to shorter wavelengths are given in the text.

The general layout of the apparatus is shown in Fig. 1. It consists of a screened loop mounted on a box containing the radio-frequency components, carried on a rotatable wooden structure. Pointers are carried on the rotating portion and bearings are read off on a large annular ivorine scale. The intermediate frequency unit stands on the floor directly under the rotating unit and a screened cable connects it to the radio frequency section, through a suitable slip ring arrangement. Audio-frequency signals are applied to the telephones by means of slip rings and jacks mounted at a convenient level on the rotating structure.

The mechanical design of the instrument

* MS. accepted by the Editor, June, 1938.

† "Radio Direction Finding on Wavelengths between 6 and 10 metres (frequencies 50 to 30 Mc/sec.)," by R. L. Smith-Rose and H. G. Hopkins, *Journ. I.E.E.*, 1938, Vol. 83, Pp. 87–97.

is such as to permit of easy dismantling and reassembly for field operation, and different kinds of aerial systems may be readily substituted for the existing loop frequency changer unit.

2. Electrical Considerations

In designing a loop direction finder it is important to preserve electrical, and therefore mechanical, symmetry of the loop and its associated circuits in order to minimise instrumental errors which will arise if equal and cophasal e.m.fs. in each vertical side of the loop produce a residual potential difference across the loop terminating impedance. Such exact symmetry is difficult to attain over an extended frequency band. A good first approximation is obtained by using a screened loop connected to a push-pull amplifier or detector stage. Precise balance may be obtained by providing sliding collars at the gap in the screen which effectively permit of capacity equalisation to earth from each loop terminal.

The circuit diagram of the frequency change stage of the receiver is given in Fig. 2. It was decided not to use a signal frequency amplifier stage as experience had shown that adequate sensitivity could be obtained by employing a push-pull detector stage equipped with retroaction. The use of ganged retroaction condensers might possibly lead to variations of balance with setting of the retroaction control if the condensers are not identical: preset condensers have therefore been used and the amount of retroaction is controlled by a variable resistance in the lead to the anodes of the detector valves. This method provides a simple and convenient means of varying signal frequency gain without altering the balance to earth.

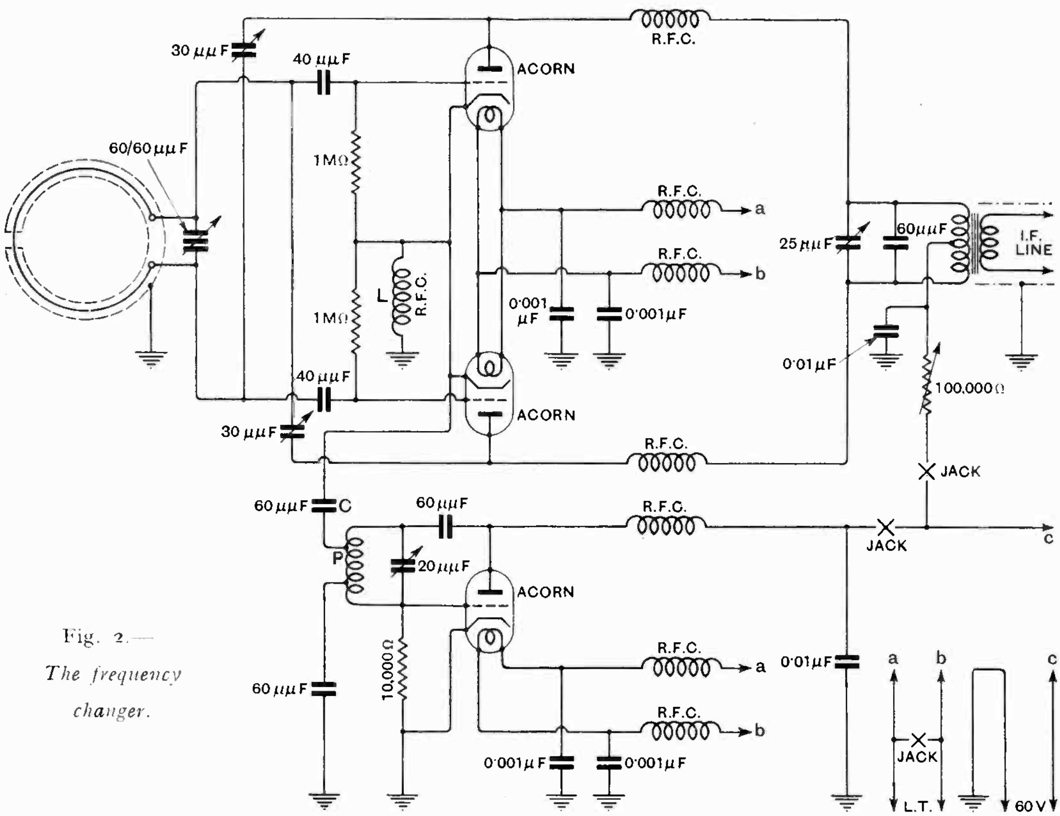


Fig. 2.—*The frequency changer.*

Arrangements for the symmetrical injection of local oscillator voltages at the detector stage are essential. Injection in antiphase to the grids of the detector stage was discarded as likely to necessitate very careful adjustment of the coupling impedances from the oscillator.

Two methods of cophasal injection have been tried, one using transformer coupling from the oscillator has been described elsewhere and the other using a condenser and choke arrangement as shown in Fig. 2. The oscillator supplies an e.m.f. via the coupling condenser C to the choke L common to the detector cathode circuits. Variation in the amplitude of the injected voltage can be obtained by altering the tapping point P on the oscillator coil. It should be noted that the choke has in parallel with it the two heater-cathode capacitances, and care must be taken in choosing the choke to ensure that a reasonably constant impedance exists at the injection point over the whole frequency range of the receiver. Output voltages at the intermediate frequency of 2 Mc/s are developed across the tuned primary of the iron cored transformer connected to the detector anodes, through the radio frequency chokes. The transformer serves to step down the high impedance of the tuned I.F. circuit to the low impedance of the line connecting the frequency changer to the I.F. amplifier.

The frequency changer is completely shielded and contains its own power supply—a 60-volt battery for high tension and non-spillable accumulators for heater current. In series with the I.F. line is a suitable slip ring unit to allow the frequency changer to rotate with respect to the I.F. unit.

The intermediate and audio frequency amplifier unit requires but little description. With the intermediate frequency at 2 Mc/s reasonably high gain can be obtained with quite a large band-width; this facilitates tuning, improves operation on frequency modulated signals and reduces trouble due to drifts in either local oscillator or transmitter frequency. The selectivity of the receiver is naturally not very high but this is not a serious disadvantage since at the present time a large proportion of the ultra-short waveband is but sparsely populated.

A suitable intermediate frequency and audio frequency unit consists of a line transformer feeding a two-stage amplifier followed by detector and audio-frequency output stages. The receiver is generally used on modulated signals but the inclusion of a beat frequency oscillator would permit of operation on continuous wave signals. The output stage is connected to a pair of telephones through a conventional choke capacity combination. The metal box in which the unit is housed also accommodates the associated power supply.

3. Constructional Details

(a) Screened Loop Aerials.

The constructional details of a typical loop aerial are shown in Fig. 3. The inner conductor I of $\frac{3}{16}$in. diameter copper rod is carried coaxially inside a copper screening tube S (1in. diameter × $\frac{1}{32}$in. wall) which is split at its top centre by a gap $\frac{3}{4}$in. wide.

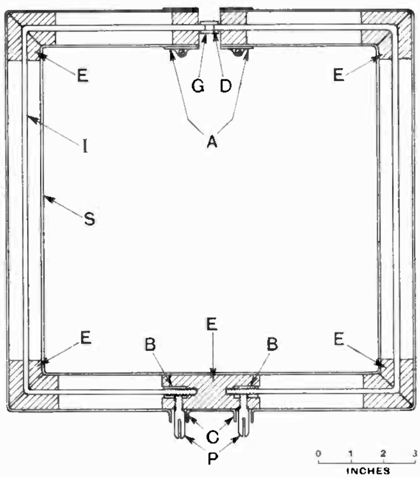


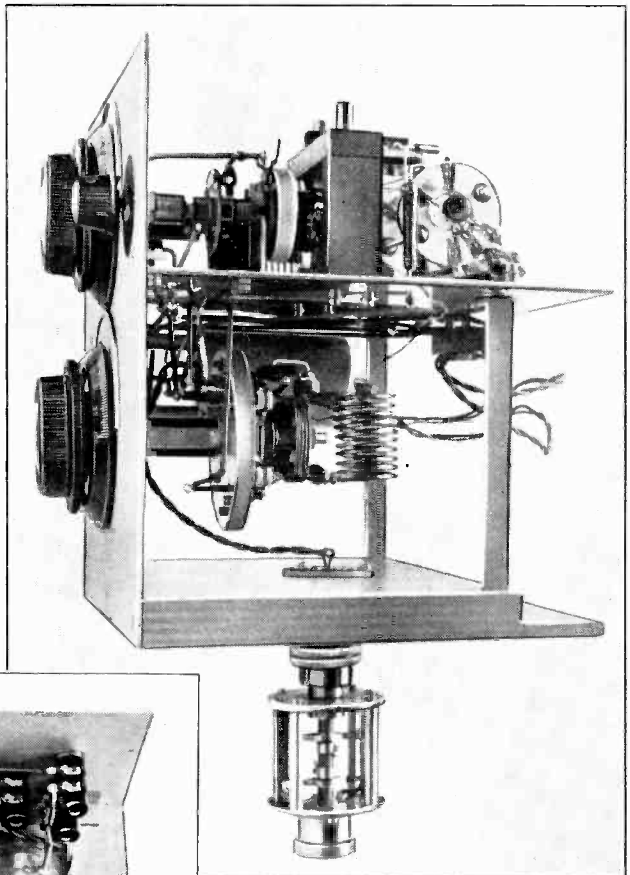
Fig. 3.—*Screened loop for 8- to 10-metre reception. Vertical section.*

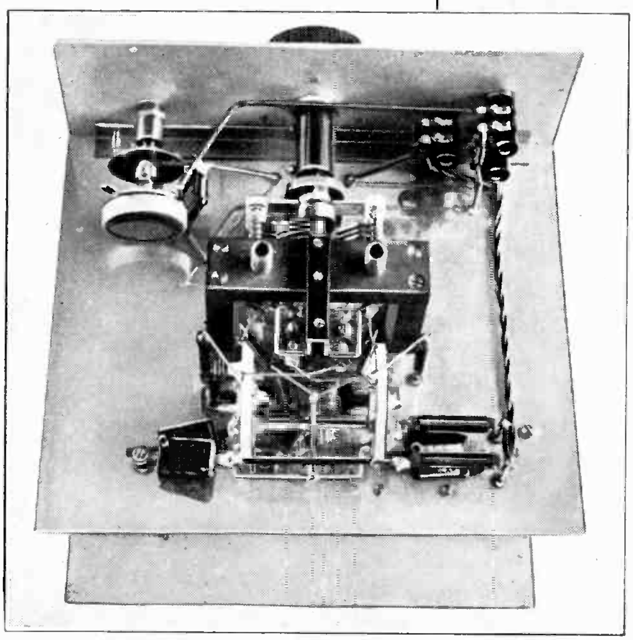
The inner conductor is supported by ebonite spacers E pinned into the screen, and is terminated by sleeves B, into which $\frac{1}{4}$in. diameter pins P are tapped. These pins fit corresponding input sockets of the frequency changer, and are screened by sleeves C, which are a push fit into suitable inserts in the metal box housing the frequency changer. Retaining clips clamp the loop firmly in position on the box. Two collars A, each 1in. long, bent from strip copper, are clamped to the screening tube, one on either side of the gap, and by adjusting the position of these collars the gap may be varied in position to secure electrical symmetry.

The assembly of the loop is carried out on a suitable jig—the inner conductor being cut in half at point D for this purpose. Starting at the lower member of the loop each half is bent and threaded through its appropriate pieces of screening tube and spacers. Care is taken to see that the bevelled ends of the screen fit snugly before they are soldered together. The break in the inner conductor at the top centre is repaired by a collar G joining the free ends. Suitable loops to cover the bands 8-11 metres and 6-8 metres have an inner conductor bent into the form of a square $11\frac{1}{2}$in. and 7in. side respectively.

(b) Frequency Changer.

The internal arrangements of the frequency changer are shown in Figs. 4 and 5. This unit with its associated power supply is contained in a metal box 10in. × 10in. × 8in. deep. The small unspillable accumulators are carried in a metal container placed across the back of the unit, and are readily accessible through a hinged door at the back of the box, which permits of access, in addition to the H.T. battery, to the oscillator unit and the I.F. transformer. Care is taken to ensure that the screening is complete when the door is closed.





(*Left*) Fig. 4.—*Detector stage with screening box removed.*

(*Above*) Fig. 5.—*Frequency changer assembly and I.F. slip-ring unit, with screening cans removed.*

The arrangements of the detector circuit are shown in Fig. 4. Points to observe are the symmetrical circuit layout, and the care taken to reduce the length of leads. Access to the retroaction condensers, mounted horizontally close to the loop sockets is obtained by means of a small cover plate in the top of the main box so that these may be preset with the apparatus in working condition.

The oscillator unit is carried on the lid of an aluminium can 3½in. diameter mounted horizontally at the centre of the lower part of the box, as will be seen in Fig. 5. The leads supplying power to this unit are brought in through the can lid, while the lead supplying oscillator voltage emerges through a small hole in the upper side of the can, and enters the detector unit through a hole in the horizontal detector sub-panel. Care is taken to keep this lead as short as possible by arranging for the oscillator inductance to be immediately under the detector valve assembly. The oscillator inductance consists of 10 turns of $\frac{3}{32}$in. diameter copper wire wound on a spiral 1¼in. diameter, and is mounted directly on the tuning condenser. This gives a rigid oscillator assembly which is desirable for reception of modulated waves, and essential for continuous wave reception. The inductance described, tuned with a 20 $\mu\mu$F condenser, gives a tuning range from about 8–11 metres (27–38 Mc/s): for a more extended tuning range a larger tuning capacitance should be used in conjunction with a smaller inductance.

The iron-cored step-down I.F. transformer 17 : 1 is mounted in the can showing immediately behind the oscillator unit in Fig. 5. To facilitate manipulation it is mounted on a five-pin valve base. The I.F. trimming condenser may be adjusted through the main door at the back of the box. The output socket is at the bottom centre of the baseboard and flush with its under surface so that the whole frequency changer may be withdrawn from the box for inspection by sliding the baseboard forward.

(c) Slip Ring Unit.

Provision must be made to permit of relative rotation about a vertical axis of the frequency changer with its loop aerial and the I.F. unit, which stands below. This object is attained by the provision of a detachable screened two-pole slip ring unit, which plugs into the frequency changer output socket, and is bonded to the frequency changer box. A diagram of this unit is shown in Fig. 6. It consists of a rotor carried in a bearing in the upper face plate A, and also located at the centre of the lower face plate B. The rotor carries two insulated brass rings C and connections from these are taken up the centre of the insulating spindle D to the shielded plug P carried at the upper end of the rotor. The brass face plates are held rigidly by brass pillars, and two further ebonite pillars F support horizontal brushes G bearing on the rotating brass rings C. These brushes are of phosphor-bronze strip (5 mils thick) and each consists of two strips in parallel, one strip contacting on each side of the brass ring. The constituent strips are joined at their adjacent ends and these are taken respectively to a small spring S mounted on one ebonite support and a small plate K carrying a tensioning screw H bearing on the other ebonite support. Small flanges on each plate prevent warping of the brushes about a horizontal axis. Leads are taken through the lower face plate to a metal shrouded socket L mounted on its outer side. A shielded plug carried on the braided twin transmission line mates with this socket and the screening is completed at this point by a union on the plug engaging with a thread on the outside of the socket. The movement is protected by an outer brass case sliding over the barrel of the unit*, and this also effectively completes the shielding. Any slight tendency for the unit to twist due to friction at the brushes may be counterbalanced by the rigidity of the I.F. line. If, however, the line is flexible—say a braided line—the braiding may tend to fray at the point of entry into the terminating plugs. This trouble has been eliminated by means of a vertical tube passing up through the bearing at the centre of the main table of the direction finder, and

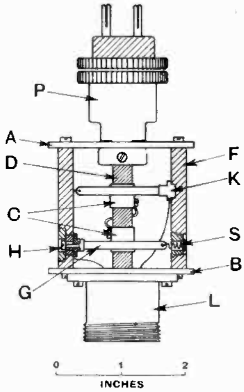


Fig. 6.—*I.F. slip-ring unit omitting brass supporting pillars and outer shield.*

* The series resistance of this unit is about 50 milliohms and the relatively "lumped" reactive constants do not appear to affect materially the properties of the I.F. line.

attached to the lower end of the bearing housing. Its upper extremity carries a detachable brass adapter which locates firmly on to the output socket of the slip ring unit and thus prevents it from rotating when the frequency changer is rotated. The flexible I.F. line is guided down the centre of this tube, out through the main bearing to the I.F. unit.

(*d*) *Intermediate Frequency and Audio Frequency Unit.*

The plug at the lower end of the I.F. line engages in a shielded socket mounted at the top centre of the I.F. unit, which is connected to the primary of the step-up input transformer. The audio frequency output jack, I.F. gain control and test jacks are arranged on the top panel. Access to the power supply for the unit is arranged by making one side of the shielding box detachable.

(*e*) *Audio Frequency Output Arrangements.*

In order to avoid errors due to reradiation from the telephone leads it is necessary to keep these as close to the central vertical axis as possible. The screening of the intermediate frequency line is utilised as one conductor, while the other is taken along the central axis to an insulated ring mounted on the intermediate frequency slip ring unit support tube. Phosphor-bronze brushes mounted on the rotating wooden structure bear on this ring and the support tube respectively, and are connected to a pair of jacks mounted at a convenient height at right angles to the plane of the loop. A radio frequency choke-condenser network is connected between the brushes and each jack, which effectively prevents any appreciable radio frequency voltages being developed in the horizontal portions of the telephone leads due to pick-up on the vertical portions. If this precaution is not taken reradiation from the horizontal portions results in a bearing error, the magnitude and sign of which depend on the position of the lead.

(*f*) *Mechanical Layout of the Apparatus.*

A general view of the apparatus is shown in Fig. 1. The main wooden table top is octagonal and measures 3ft. 3in. between parallel edges. It is supported on stout wooden legs set in towards the centre so that the observer is not inconvenienced. At its centre is carried a steel bearing seating, internal diameter $2\frac{1}{4}$in., carrying two ball races supported $3\frac{1}{2}$in. apart one above the other. These races support a hollow steel spindle, to the upper end of which is attached a face plate carrying a substantial wooden disc $17\frac{3}{4}$in. diameter. The disc clears the top of the main table top and supports the rigid wooden superstructure, which carries a table 20in. above the top of the disc. The frequency changer is bolted to the upper table and the general arrangement is such that while the loop is kept sufficiently remote from the observer's head, the tuning controls are conveniently to hand for an observer seated at the table.

The actual observation of a bearing is made by using either of two pointers, which are mounted on the surface of the rotating wooden disc, on a line normal to the plane of the loop. The pointers are set at the edge of the rotating disc and move flush with the surface of an 18in. inside diameter annular ivorine scale calibrated in $\frac{1}{2}°$ steps carried on a wooden ring held to the main table. In order to permit of accurate setting of this fixed scale with respect to the meridian, four brass plates with 30° slots of the appropriate radius are fixed to the main table immediately under the scale. Locating lugs fitted to the underside of the scale support drop into these slots and provision is made for locking the scale in any desired position with respect to the table. Provision is also made for locking the rotating unit in any required azimuth, a feature which is useful in setting up the direction finder initially. For field work the main table may be replaced by a tripod for supporting the frequency changer and a suitable arrangement has been described elsewhere.*

4. Performance of the Direction Finder

The characteristics of the intermediate and audio-frequency amplifier may be summarised as follows: At a working frequency of 2.0 Mc/s a band-width of $\pm$ 10 kc/s for half amplitude is obtained. The input impedance of the unit is 100 ohms approximately, and the overall sensitivity is such that 10 μV input modulated at 400 cycles per second to a depth of 30 per cent. gives one milliwatt audio output. The gain of the

* *Loc. cit.*

intermediate frequency stages is controllable manually over a range of some 60 decibels.

With this unit in conjunction with the high frequency equipment described a test at 8.3 metres (36 Mc/s) showed that the receiver will give audible output for fully modulated vertically polarised emissions with field strengths down to less than 1 μV/m.

The receiver is easy to handle. Tuning is not difficult as it is possible to keep the two high frequency circuits aligned to the intermediate frequency by tuning on noise voltages developed at the detector grids. Difficulties encountered in working continuous wave signals have been very much reduced by care in keeping all components rigidly located, and in the design of the mechanical portion of the direction finder.

As a general purpose portable receiver its chief limitation is its lack of selectivity.

The rotating portion of the direction finder is very easy to actuate and this property makes for high observational accuracy under a wide variety of conditions. The limiting visual discrimination with the pointer system in use is 0.1°, and tests on a local transmitter some twenty-five yards away from the direction finder have shown that the reciprocal error of the system is 0.1° or less. This high degree of balance is attained over the whole band 8–11 metres for the single setting of the loop adjusting collars. This adjustment is not difficult to make, and if the apparatus is treated with reasonable care, this one preset operation—which holds for the whole waveband—should be effective indefinitely.

The working sensitivity of the receiver is such that under favourable conditions, a swing of $\pm$ 5° can be obtained on a fully modulated carrier with a field strength as low as 2 μV/m. The most likely source of instrumental error seems to be that due to abnormal movements of the observer's head while taking bearings. Insertion of the R.F. blocking combination in the telephone leads has reduced this effect from $\pm$ 1.0° to $\pm$ 0.2° for extreme head movements: for all ordinary movements the range is $\pm$ 0.1°.

The chief disadvantage of the direction finder (apart from its unavoidably poor performance in the presence of downcoming horizontally polarised radiation) is that for maximum instrumental accuracy the observer may have to change his position in order to keep himself on a line normal to the plane of the loop. This trouble is sometimes tiresome when taking bearings on an elevated transmitter the bearing of which is steadily changing. A possible way of overcoming this difficulty would be to dispense with the observer and to use automatic recording apparatus, disposed as far as possible about the central vertical axis of the system. Manual operation might be retained by placing the observer in a symmetrically disposed screen, or by making the apparatus remotely controlled. The direction finder, however, in its present state, appears to be in a satisfactory form for general D.F. work and various possible applications will be investigated as occasion arises.

Acknowledgments

The instruments described above were constructed for the Director of the Meteorological Office, by whose permission this paper is published. The author is indebted to Dr. R. L. Smith-Rose for helpful advice and encouragement during the work; he also wishes to acknowledge the assistance rendered by Mr. W. Dougharty, B.Sc., in the experimental work, and by Mr. A. G. Wilson in the design and constructional work.

L'Antenne Rayonnante

By Pierre Baudoux. Pp. 235 and 44 Figs. Gauthier-Villars, Paris. Price 40f.

This is volume VII of a series published by L'Institut Belge de Recherches Radioscientifiques, although it is surprising to find that one of the volumes is on the thermodynamic study of surface tension, which is not usually regarded as a branch of radio. Of the ten chapters into which the book is divided, nine are devoted to a mathematical treatment of the radiation from aerials. In the final chapter experiments are described, made not on full size aerials but on models supplied from a short-wave oscillator. The total height of the model aerials was about 1.5 metres and the wavelengths employed varied from 2 to 5 metres.

In the introduction the author reviews and criticises all the earlier work on the subject, in which the aerial was treated either as a dipole or as an ellipsoid or as a transmission line in which unit length of the aerial was endowed with a self-inductance and a capacitance. He favours this last method but subjects the various assumptions made to very careful scrutiny.

The experimental work appears to have been limited to a measurement of the current distribution along the aerials by means of an inductive loop close to the aerial. On sliding this loop along the aerial the variation of E.M.F. induced in it is proportional to the variation of current in the aerial. The radiation diagrams for the various aerial models appear to have been calculated from these measured current distributions. A bibliography is given of 75 articles on the subject. G. W. O. H.

A Low Reading Mean Voltmeter *

By James Greig, M.Sc., A.M.I.E.E. and H. N. Wroe, B.Sc.

SUMMARY.—A combined amplifier and thermionic rectifier is described by means of which the true mean value of a distorted 50 cycle voltage wave of R.M.S. value not less than 0.025 volt can be determined to an accuracy of within 1%. The negative feed-back principle is employed in the amplifier in order to obtain the required degree of accuracy and constancy in calibration.

General

IN iron testing the peak value of the alternating magnetic flux is ordinarily determined from an observation either of the mean value of the induced voltage wave or of the R.M.S. value and the form factor of the wave. Commercial instruments are available by means of which any of these quantities may be observed with high accuracy provided the voltage available is of the order of 25 volts or upwards. Where the available voltage is low, the normal forms of herent characteristics of the rectifying elements themselves, in particular non-linearity of characteristics or electron initial velocity effects. The convenience and accuracy of the thermionic rectifier at high voltages render it worth while to consider the possibility of utilising amplification prior to rectification where low voltages are concerned. The amplifier voltmeter also has the advantage of an inherently high input impedance. It is possible to employ a carefully designed push-pull amplifier of

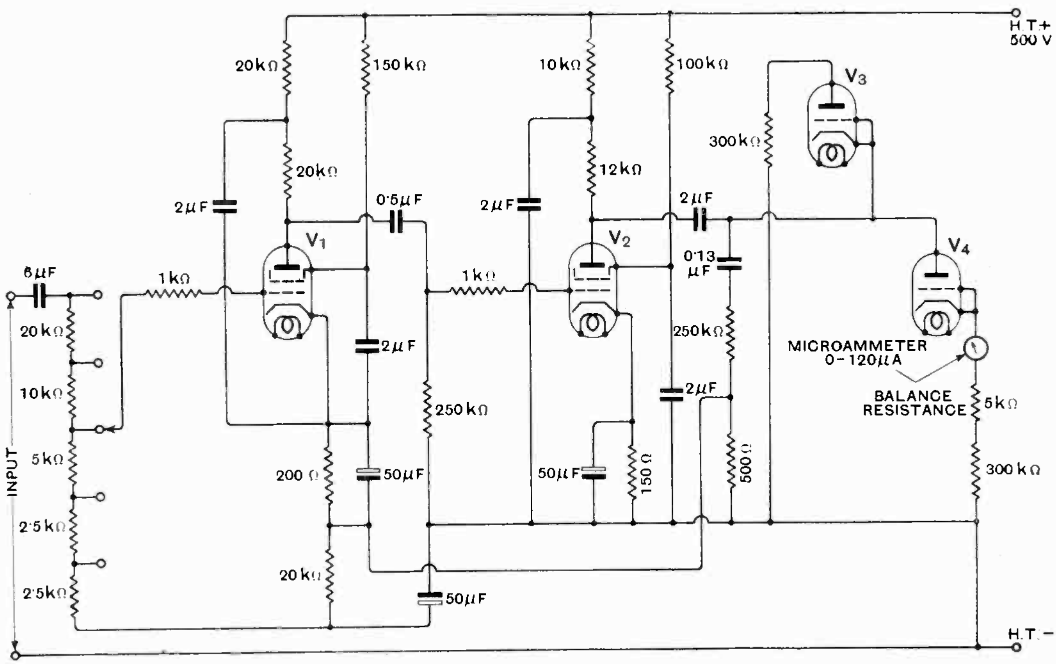


Fig. 1.—*The amplifier and rectifier circuit. V_1 and V_2 are Osram KT41's, V_3 and V_4 Osram ML4's.*

rectifier other than the synchronous commutator become inapplicable owing to in- normal type for this purpose, but the slight inevitable curvature of the characteristics of such an amplifier and its relative sensitive-

* MS. accepted by the Editor, June, 1938.

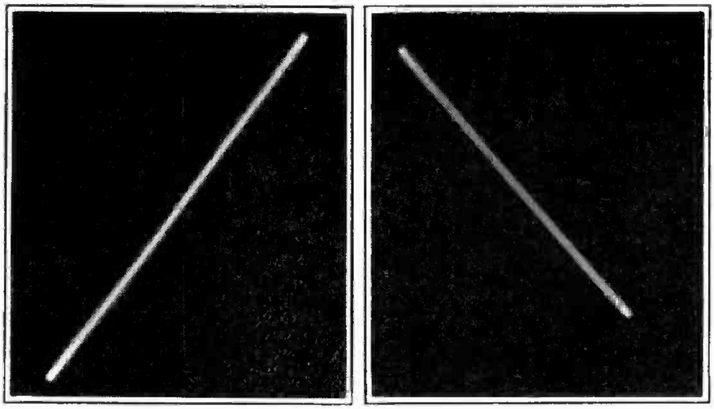
ness to voltage variations limit its use to conditions under which high accuracy is not required and where frequent recalibration is possible. The special characteristics of the negative feed-back type of amplifier which have rendered it such a powerful tool in the field of telephonic communication are exactly those called for in an amplifier to be employed for measurement purposes such as that under consideration. These special features are :—

1. That the harmonic content introduced by the amplifier itself is controllable and can be reduced to a negligible amount.

2. That the phase shift introduced by the amplifier is controllable and can, over a reasonable frequency range, be rendered negligible.

3. The characteristics of the amplifier are insensitive to relatively large changes in supply voltage and to changes in the static characteristics of the valves employed.

In order to investigate the possibility of employing a negative feed-back amplifier with a thermionic rectifier for the measurement of the mean value of a distorted voltage wave a simple two-stage amplifier of this type was constructed with its output stage feeding a symmetrical rectifier circuit. The circuit arrangement and the results of a series of tests made on it are outlined in the next section.



(*a*) (*b*)

Fig. 2.—*Linearity curves of amplifier.* (*a*) 50 *c/s*, (*b*) 1,000 *c/s*.

Experimental Tests

The complete circuit arrangement of the amplifier and rectifier is shown in Fig. 1. The instrument was required primarily for the measurement of 50 cycle voltages of the order of 0.1 R.M.S., but an input potentiometer was provided for the possible extension of the range up to 2 volts. The output circuit of the amplifier will be seen to contain two rectifier circuits (balanced experimentally so as to take equal currents) connected "back to back." This arrangement, or a full wave bridge circuit, was necessary to enable the rectifier to be fed through blocking condensers and to provide a symmetrical load on the amplifier.

The amplifier was first tested for linearity and phase shift on the cathode ray oscillograph, the method of test being simply to apply to the horizontal deflectors of the oscillograph a voltage proportional to and in phase with the input voltage to the amplifier,

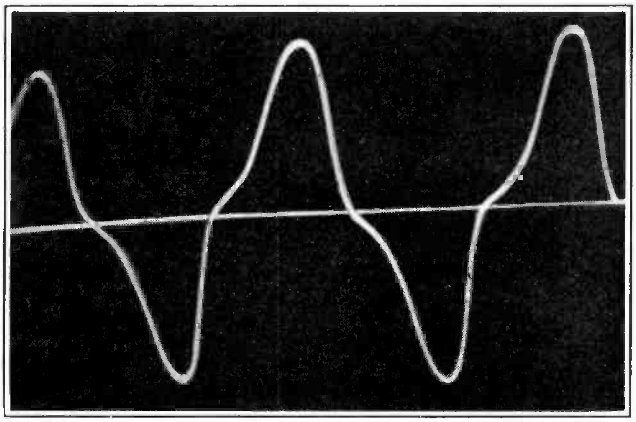


Fig. 3.—*Symmetrically distorted wave.* *Form factor* 1.316.

and to the vertical deflectors the output voltage of the amplifier. With these voltages adjusted to approximate equality, correct operation of the amplifier would be indicated by a 45° straight line on the oscillograph screen. Curvature of the line of course indicates amplitude distortion, or the presence of an ellipse, phase distortion. After some trial and error adjustment of various circuit components, satisfactory operation was obtained over a frequency range from 50 to 1,000 c/s, which was considered adequate for the purpose. The oscillograph traces for 50 and 1,000 c/s are shown in Fig. 2. The voltage amplification obtained was approximately 475.

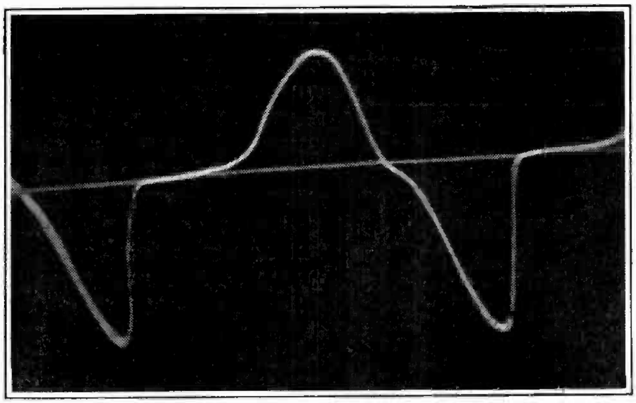


Fig. 4.—*Asymmetrically distorted wave. Form factor* 1.304.

Table I gives relative values of output voltage for constant input voltage over the frequency range 50–1,000 c/s.

TABLE I.

Frequency.	Output Voltage (Arbitrary units).
50	100
150	100.4
250	100
500	100.45
750	100.45
1,000	101

The complete instrument was calibrated as follows—a fixed, accurately determined, sinusoidal voltage was maintained across a calibrated potentiometer from which known fractions of the voltage were tapped off and applied to the input of the amplifier, the corresponding deflections of the microammeter being noted.

For checking the voltmeter on distorted wave forms a similar procedure was followed. The distorted voltage applied to the potentiometer was made sufficiently high to ensure the accuracy of a simple diode mean voltmeter connected across it. This voltmeter was known to be accurate to within ½ per cent. provided the mean value of the voltage to be rectified was in excess of 25 volts. Readings of output current were taken for a range of known mean voltages, read on the diode voltmeter, applied to the input.

Two types of highly distorted wave form were used. In one, the half waves were symmetrical while in the other, which was obtained from a polarised transformer, there was marked asymmetry. Figs. 3 and 4 show oscillographic traces of the two wave forms. The observed points for the calibration curves with distorted waves are plotted, along with the sinusoidal calibration, in Figs. 5 and 6.

A 25 per cent. reduction in cathode heater voltage altered the sine wave calibration by under 2 per cent., the maximum deviation occurring at the lower end of the range.

A further calibration on sinusoidal voltage was carried out with the anode voltage applied to the amplifier reduced by 25 per cent., the object being to determine the extent to which the performance of the amplifier was sensitive to such variation. The readings for this test are compared with those for normal H.T. voltage in Table II.

TABLE II.

Input Volts. Mean.	Output Microamperes.	
	Anode Voltage—400.	Anode Voltage—500.
0.0135	10.7	10.8
0.0405	31.0	31.2
0.0675	51.2	51.5
0.0945	71.7	72.7
0.1215	91.4	92.10
0.1485	111.8	112.8

It will be seen that in all cases agreement within about 1 per cent. is obtained throughout the entire range. At the extreme upper end of the calibration curves a slight drooping of the distorted wave points below the sinusoidal calibration will be noted. This is due, presumably, to the high peaks of the distorted waves employed causing slight overloading of the amplifier. Obviously the upper limit of mean voltage which can be observed with accuracy is reduced as the peak to mean ratio of the wave form is increased. Practically, the presence of any serious overloading can always be detected by comparing readings on the voltage range in use with those on the next higher range. At the other end of the scale, the limit below which accurate readings cannot be obtained is set by the presence of the "no input" or "initial velocity" current of the rectifier which prevents the calibration curves of the instrument from passing through zero.

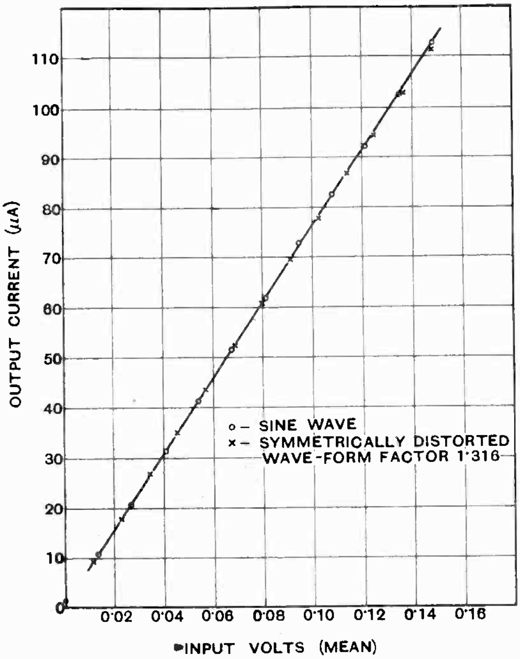


Fig. 5.

Having regard to the fact that the voltages with which the instrument would be required to operate would lie between 0.02 and 0.1 volt and would, in all cases, be considerably less distorted than those employed in the preliminary tests, it was considered that the operation was satisfactory.

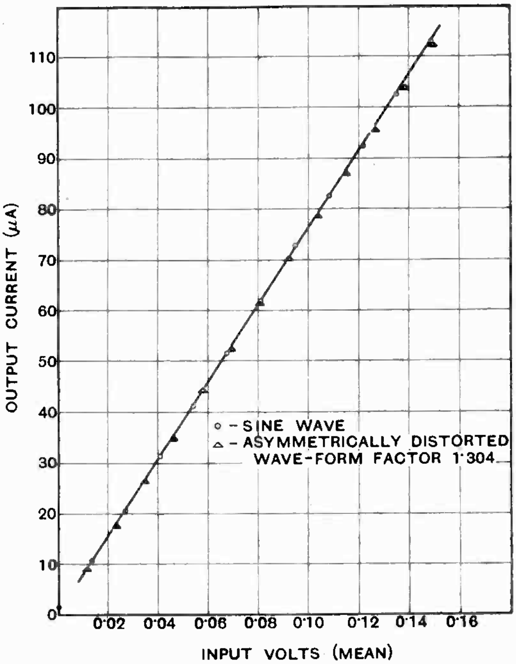


Fig. 6.

The possibility of A.C. mains operation of the amplifier and of using copper oxide rectifiers in place of thermionic rectifiers has not, so far, been investigated.

The authors have pleasure in acknowledging the kindness of Mr. L. I. Farren of the Research staff of the General Electric Co., Ltd., in furnishing advice and information in regard to the design of negative feed-back amplifiers and of Professor William Cramp in providing facilities for the experimental work.

Dielectric Loss Measurements at Radio-Frequencies *

By A. Dunford, B.A., A.Inst.P. and S. E. Goodall, M.Sc.(Eng.), A.M.I.E.E.

I. Introduction

THE increasing use of high-frequency apparatus, for such purposes as short-wave radio communication and diathermy, has necessitated the study of the behaviour of insulating materials over a wide frequency range.

At frequencies of the order of 10 megacycles per second the temperature rise of an insulator due to dielectric loss may become, and very often is, excessive, particularly where the electric stress is high. The insulation used to support high-frequency tuned coils in oscillators and kindred apparatus may produce serious damping if the losses are appreciable. A considerable number of new materials is now available for these purposes.

Apart from these practical considerations the possibilities of extending the current theories of dielectric behaviour in the light of results obtained at high frequencies are of considerable importance.

At power and audio-frequencies well recognised methods of measuring the power factor and permittivity of dielectrics are available. These methods have been extended in one or two laboratories to cover a frequency range up to 10^6 cycles per second.

At frequencies of this order, however, one or other of the methods dependent upon resonant circuits is usually preferred.

There are three principal methods of this type, popularly designated "change of resistence," "change of reactance" and "change of frequency." In each case the sample to be tested forms part of a condenser tuning a circuit which is loosely coupled to an oscillator.

In the "change of resistance" method different values of resistance are inserted in the tuned circuit and the relative magnitudes of the currents are measured, care being taken to ensure that there is no change in the induced voltage. The main difficulty lies in the fact that it is essential to maintain constant inductance in the circuit. Consequently each of the resistances inserted must have the same inductance residual. This becomes of increasing importance as the frequency is raised. Practically, the method becomes inconveniently difficult at frequencies above 10 megacycles per second.

The "change of frequency" method involves accurate measurements of extremely small increments of frequency and the provision of heterodyne oscillators for this purpose.

The "change of reactance" method requires the provision of a calibrated vernier condenser of rather special design, but otherwise seems to offer decided advantages over either of the other methods particularly at frequencies above 10 megacycles per second.

A description of one application of this method has been given by Hartshorn and Ward.†

It is the purpose of this article to describe an equipment which has been developed for the measurement of losses in sheet materials over a frequency range of 10,000 cycles per second to 60 megacycles per second, at temperatures from 20 deg. C. to 100 deg. C. Representative results on some typical insulating materials are included.

II. The Change of Reactance Method

The measuring circuit, shown in schematic form in Fig. 1, consists of the capacitance C, and an inductance L. A small variable air condenser C_1 is connected in parallel with C. The coil L is loosely coupled, inductively, to a valve oscillator, and the voltage across C is measured by means of the thermionic voltmeter V. The losses in the circuit are represented by the equivalent parallel conductance G.

* MS. accepted by the Editor, June, 1938.

† *Journ. I.E.E.*, November, 1936, Vol. 79, p. 597.

The voltage across C is given by the expression

$$V = \frac{E}{j\omega L + \frac{1}{j\omega(C_1 + C) + G}} \times \frac{1}{j\omega(C + C_1) + G}$$

$$= \frac{E}{1 - \omega^2 L(C + C_1) + j\omega LG}$$

where E is the voltage induced in the coil.

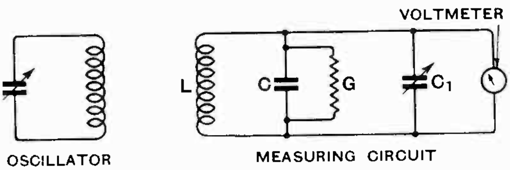


Fig. 1.

When the circuit is tuned the voltage will be a maximum and will be given by

$$V_0 = \frac{E}{j\omega LG}.$$

Now if C_1 is changed by an amount ΔC_1 the voltage becomes

$$V_1 = \frac{E}{j\omega LG - \omega^2 L \Delta C_1}$$

so that $$\left(\frac{V_1}{V_0}\right)^2 = \frac{G^2}{G^2 + \omega^2(\Delta C_1)^2} \quad \quad (1)$$

Suppose C_1 is adjusted so that

$$\frac{V_1}{V_0} = \frac{1}{\sqrt{2}}, \text{ then } G = \omega \Delta C_1.$$

If this adjustment is made with the sample to be tested forming part of the condenser C and also with the sample removed but with C readjusted to the same total capacitance, the amount by which the capacitance has to be adjusted will give a measure of the capacitance of the sample C_s. Also the difference between the two values of G so obtained will give the equivalent parallel conductance of the sample G_s. Incidentally the tangent of the loss angle of the sample is equal to $\frac{G_s}{\omega C_s}$. This is equal to the power factor of the sample for low values.

Hence the tangent of the loss angle of the sample is equal to $\frac{\omega \Delta C_1}{\omega C_s} = \frac{\Delta C_1}{C_s}$ where ΔC_1 is the difference between the incremental changes of C_1 made with the sample in circuit and out of circuit.

In order to check the general behaviour of the apparatus, it is desirable to plot the ratio $\frac{V_1}{V_0}$ against the quantity ΔC_1. From equation 1 it is apparent that a curve should result of the type shown in Fig. 2.

It will be noted that the expression for power factor contains neither the capacitance C_1 in parallel with the specimen capacitance (and which may be considered as including the voltmeter capacitance and all stray capacitances) nor the frequency. The only circuit parameters which have to be known are the specimen capacitance C and the change in capacitance ΔC_1, neither of which presents any special difficulties in its evaluation. The problem of voltage measurement is simplified by the fact that relative and not absolute values are required.

It is in the comparative ease and certainty with which these necessary quantities can be measured that this method offers advantages over the "change of resistance" and "change of frequency" methods.

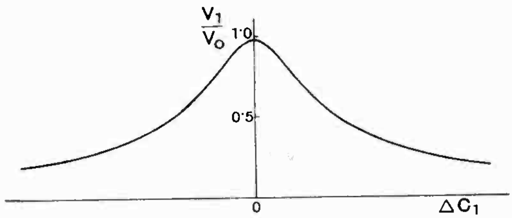


Fig. 2.—*Typical resonance curve.*

It has been assumed in the above discussion that there is no residual inductance or resistance in series with either of the capacitances C_1 or C_2. In practice these quantities are reduced to negligible dimensions by careful design of the apparatus, the current paths to the condensers being made as direct and as short as possible. The effect of resistance in series with the inductance L has also been neglected, as its effect can in practice be considered as due to an equivalent parallel conductance, which becomes part of G. Strictly, such series resistance also has the effect of making the resonance curve asymmetric, but here again the resistance can be kept so low by careful design that the amount of asymmetry is negligible.

In making observations, values of ΔC_1, both positive and negative, are generally found such that the voltage is reduced first to $\frac{1}{\sqrt{2}}$ and then to $\frac{1}{2}$ of its resonance value, and these should be in the ratio of $1 : \sqrt{3}$. This forms a useful check on the proper working of the apparatus, and ensures that the assumptions mentioned in the previous paragraph are justifiable.

The capacitance of the specimen is found when the main condenser is adjusted to retune the circuit to resonance after the specimen has been removed, its capacitance as an air condenser being then calculated from its dimensions. (The simple parallel plate formula is usually sufficiently accurate, but Kirchhoff's formula for edge correction may be applied if greater accuracy is required).

(In the apparatus described a single parallel plate air condenser is used, and the distance between the plates is adjusted either to accommodate the specimen or to form an air condenser of equal capacity. By this means the important condition is satisfied that the change from specimen condenser to air condenser is made without making any appreciable change in the geometry of the circuit.)

The small variable condenser C_1 is calibrated by comparison with a standard air condenser, using a resonance substitution method, at a frequency of about 10^6 cycles per second.

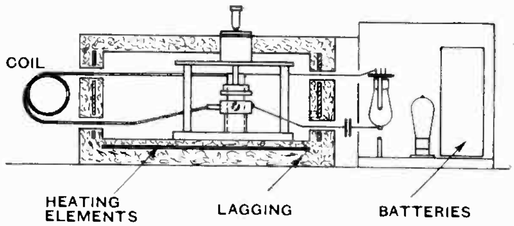


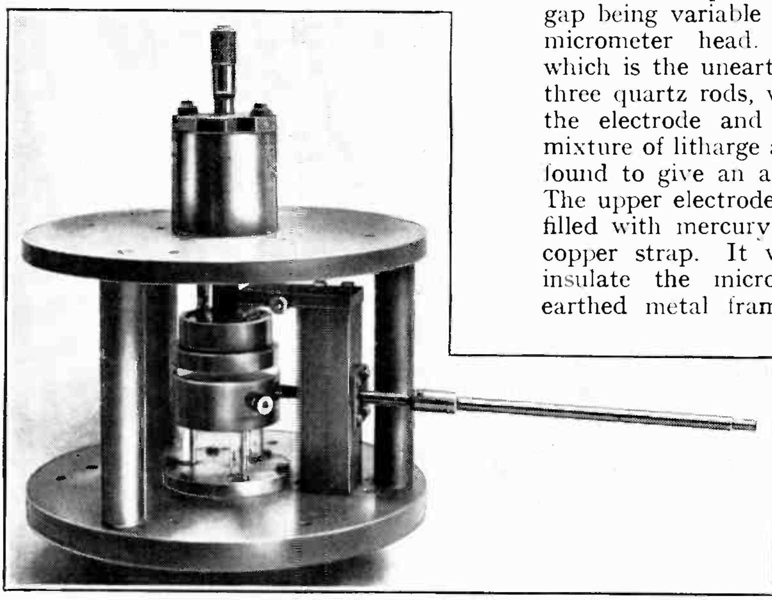
Fig. 3.—*Arrangement of condenser, heating enclosure and voltmeter.*

Frequencies are measured by simple absorption type wavemeters. That for the highest frequencies is calibrated by Lecher wires. For the lower frequencies a standard wavemeter is used.

III. Description of the Apparatus

(1) *The Measuring Circuit.* The essential features are illustrated in Fig. 3. The photograph shows the specimen condenser and variable condenser assembly.

The specimen condenser consists of two 2in. diameter parallel copper electrodes, the gap being variable by means of a standard micrometer head. The lower electrode, which is the unearthed one, is mounted on three quartz rods, which are cemented into the electrode and the base-plate with a mixture of litharge and glycerine. This was found to give an amply rigid construction. The upper electrode is in the form of a cup filled with mercury, into which dips a flat copper strap. It was found necessary to insulate the micrometer head from the earthed metal frame of the apparatus, as variations in the contact resistance of the micrometer thread were found otherwise to produce erratic effects, although the conducting path from the



Condenser assembly.

electrode to earth through the thread was in parallel with that through the mercury contact.

A ¼in. diameter brass rod, one end of which is threaded with a 1/40in. pitch thread and is carried by an earthed brass pillar, and the other end of which projects into a cylindrical hole in the lower (unearthed) electrode of the main condenser, forms the small variable condenser. The brass pillar also carries the contact strip which dips into the mercury cup in the upper electrode of the main condenser.

Special attention has been paid in the design of this assembly to the necessity of keeping the current paths to the main and vernier condensers as short and direct as possible, and also to giving it the rigidity which is necessary where accurate measurements are to be made.

The coils are of various types. Those for the highest frequencies consist of self-supporting solenoids of one or more turns of ⅛in. diameter bare copper wire. For lower frequencies, single layer solenoids of suitable sizes of insulated wire wound on bakelite formers are used. For the lowest frequencies special toroidal coils wound on ferromagnetic cores are used.

(2) *The Voltmeter.* For measurements at the highest frequencies a thermionic valve type of voltmeter becomes essential. The one used is of the bridge type which is described by Hayman‡ and whose circuit is shown in Fig. 4. Special valves are used which have bases of a low loss ceramic material and in which the grid-filament capacitance is kept low by bringing the grid lead out through the top of the valve.

As the voltmeter would otherwise introduce considerable extra loss into the measuring circuit, it is coupled to it by a small capacitance C'.

The voltmeter gives a deflection proportional to the square of the input voltage to within less than 1 per cent. with input voltages up to 2 volts. As has been pointed out above, an absolute calibration is not required.

(3) *The Oscillator.* The oscillator is battery operated, and is of straightforward design. The circuit is based on the well-known Hartley circuit, modified so as to use two valves in push-pull. (A push-pull design offers the advantages (1) that it makes possible a more compact arrangement of the high-frequency circuits, thereby raising the upper frequency limit of the oscillator, and (2) that it helps to ensure a pure wave form, as all even harmonics are eliminated.) The coils are similar to those used in the measuring circuit at corresponding frequencies, except that for the lowest frequencies coils with laminated silicon iron cores are used.

It is extremely important for its present purpose that the oscillator output shall not

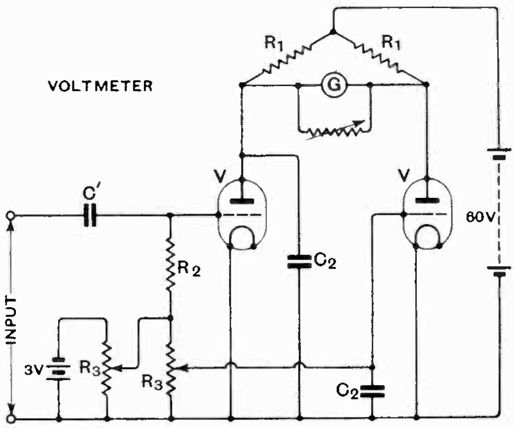


Fig. 4.—*V*, *D210 SW* ; *C*, 5 *μμF* ; C_2, 0.1 *μF* ; R_1, 10,000 *ohms* ; R_2, 1 *megohm* ; R_3, 6,000 *ohms*.

vary in either magnitude or frequency as the measuring circuit is detuned. This is a question partly of the inherent stability of the oscillator and partly of its output being so large that the coupling between it and the measuring circuit can be made very loose. Actually no great difficulty was found in fulfilling this condition.

(4) *Screening.* At these frequencies very complete screening is necessary, (1) to prevent any adverse effects due to movement of extraneous objects, (2) to ensure that there is no coupling between the oscillator and measuring circuits other than the inductive coupling between the coils, and (3) to prevent interference from outside sources. Screening is simplified by the fact that all the components of the measuring circuit (Fig. 2) are in parallel, which means that one

‡ *Experimental Wireless*, Vol. 7, p. 556.

end of each component and all screens may be connected to a common earth point.

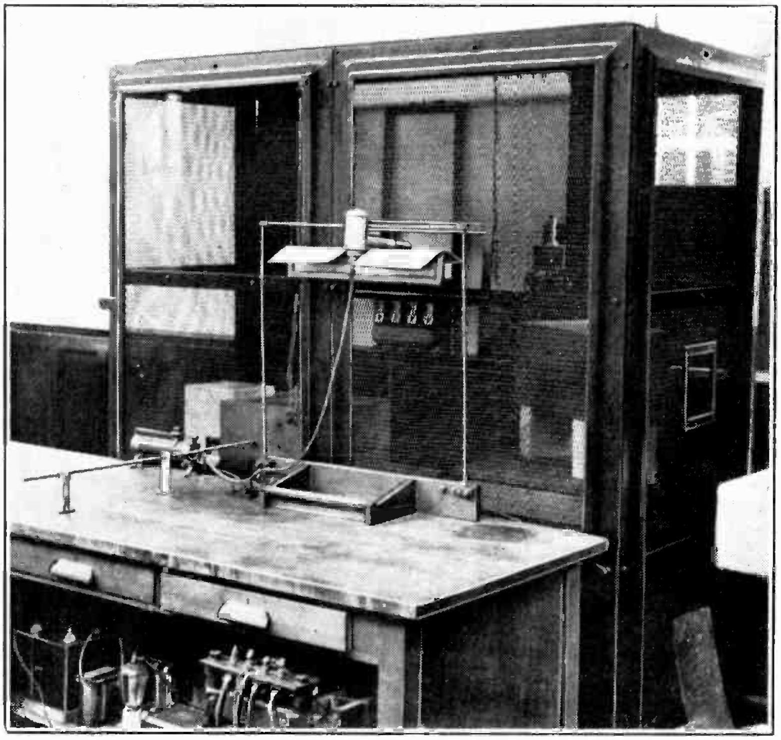
The actual screening arrangements are as follows: The specimen condenser and variable condenser assembly is contained in a brass screening box, and the voltmeter and oscillator are contained in separate screening boxes. Inductive coupling between oscillator and measuring circuit is provided by allowing their respective coils to project outside the screens. The lead from the voltmeter to its reflecting galvanometer, which is a few feet away, is also screened.

The complete apparatus is contained in an expanded metal cage (shown in the photograph) outside which the observer stands whilst making measurements. The vernier condenser is controlled by an ebonite rod which, with its scale, is brought outside the cage. The lamp and scale of the galvanometer are also outside the cage.

(5) *Heating Arrangements.* Provision has been made for making measurements over a temperature range from room temperature up to 100° C. For this purpose the condenser screening box is made double-walled, the space between the walls containing the resistance heating elements and asbestos wool lagging. A thermojunction dipping into the mercury cup of the top electrode enables the temperature of the specimen to be measured. The heating current is hand-controlled.

Precautions have been taken in designing the condenser assembly to ensure that it will withstand the highest temperature, and that the calibration of the vernier condenser does not vary appreciably with temperature.

(6) *Electrodes.* As it is in practice almost impossible to ensure that there is no air space between a specimen and the copper electrodes between which it is held, especially if the material is liable to warp or has a rough surface, it is necessary to provide some type of electrode which makes really intimate contact with the specimen. Various types of electrodes have been used. Tinfoil, attached to the specimen with a very thin layer of vaseline, is generally satisfactory, but may give trouble at the higher temperatures, as some materials tend to absorb the vaseline as it melts. Metal sprayed electrodes are



Complete equipment.

very satisfactory where they can be used; the main difficulty is that the spray will not adhere to a smooth surface. Aluminium deposited by the vacuum distillation process has been tried, but the resistance of the film, which is only a few molecules thick, is too high. It is possible to make power factor measurements with the specimen clamped between the bare copper electrodes, but the result then obtained is that for the specimen in series with an air capacitance, and it is still necessary to determine the capacitance of the specimen itself in order to interpret the results.

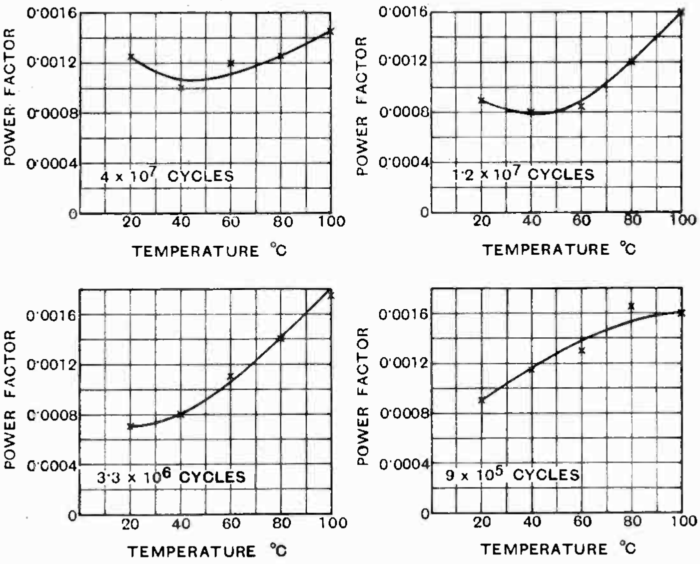


Fig. 5.—*Power factor—temperature curves for ceramic.*

IV. Range and Accuracy of Measurements

The electrodes of the specimen condenser are 2in. in diameter, and specimens of the same diameter are generally suitable. Larger diameter specimens can be used, and may occasionally be necessary when surface leakage is liable to occur. A specimen of high permittivity which projects beyond the electrodes increases the edge capacitance, for which correction has to be made.

The apparatus is designed to work with specimens of about 30 $\mu\mu$F. capacitance. The capacitance range of the vernier condenser over the straight part of its calibration curve is $\pm$ 1·8 $\mu\mu$F., enabling values of tan δ up to 0·035 (of which 0·008 is due to circuit losses) to be accurately measured. When greater values of tan δ have to be measured it is necessary either to measure ΔC_1 for a smaller value of $\frac{V_1}{V_0}$, or to use the curved part of the vernier calibration curve. (This is caused by the flat end of the vernier condenser rod approaching the bottom of the hole, and increases the capacitance range to $\pm$ 4 $\mu\mu$F.) Values of tan δ up to 0·1 can thus be measured, but with rather less accuracy.

The accuracy with which very small specimen power factors can be measured is limited by the power factor of the circuit losses, which should be kept as low as possible. Attention to the design of the circuit, including the voltmeter input arrangements, has enabled its power factor to be reduced to 0·008.

Power Factor and Permittivity of Various Materials

Material.	Temp. °C.	Power factor at approximate frequencies.			Permittivity at approximate frequencies.		
		4×10^7	10^7	10^6	4×10^7	10^7	10^6
Ceramic	20	0.0012	0.0009	0.0009	5.10	5.10	5.05
	40	0.0010	0.0008	0.0011	5.10	5.10	5.05
	100	0.0014	0.0016	0.0016	5.15	5.10	5.05
Micanite	20	0.0015	0.0015	0.0033	3.70	3.40	3.40
	100	0.0017	0.0023	0.0058	3.30	3.50	3.35
Ebonite	20	0.016	0.0175	0.023	2.92	2.92	3.00
	100	0.054	0.058	0.083	3.05	3.18	3.52
Paxolin T.	20	0.052	0.035	0.031	4.10	4.05	4.00
	100	0.044	0.032	0.022	4.55	4.50	4.45

Measurements on a given specimen of low power factor show a maximum variation of $\pm$ 0·0002, so that by taking the mean of a number of observations, a probable error of not more than $\pm$ 0.0001 is obtainable.

Comparisons which have been made between results obtained by the present method and by the change of resistance method show agreement within the limits of experimental accuracy.

V. Typical Measurements

The table shows the results of measurements on various materials at various temperatures and frequencies. The results of a complete series of measurements, showing the variation with temperature and over a range of frequencies of the power factor of a low loss ceramic material, are plotted in Fig. 5.

VI. Acknowledgments

The authors' thanks are due to Dr. A. P. M. Fleming, C.B.E., and to the Metropolitan-Vickers Elec. Co. Ltd. for permission to publish this paper. They would also like to record their appreciation of the advice and encouragement afforded by Mr. B. G. Churcher and Dr. C. Dannatt.

Admiralty Handbook of Wireless Telegraphy, 1938.

Vol. I. Magnetism and Electricity. Pp. 144, 216 Figs. 4s. Vol. II. Wireless Telegraphy Theory. Pp. 288, 400 Figs. 6s. H.M. Stationery Office.

This replaces the single-volume edition of 1931, of which the first seven chapters are reproduced almost verbatim as Vol. I of the new edition, while Vol. II covers the same ground as the old chapters VIII to XX, but with considerable additions, many sections being completely rewritten. The type has been entirely reset and a larger page adopted (11in. × 9in.)—rather a large size for a " handbook " and not easily accommodated on civilian or landsman's bookshelves, which seldom admit much over 9 or 10 inches ; are bookcases of more generous dimensions fitted on H.M. Ships ?

The author's name ought to appear on the title-page, for the author of a good piece of work deserves the public credit which he would thus receive, while the knowledge that his reputation would suffer from any errors or omissions would ensure that he would take meticulous care that revision should be thorough and complete. Unfortunately there is a tradition that all Official Publications must be anonymous, which is always unfair to the author, and sometimes injurious to the quality of the work.

The revision has been curiously lopsided, while there is much excellent new work, one occasionally finds old matter incorporated without alteration which could with advantage have been amended to fit in better with the new.

In the old edition, equations were written, as they always should be, so that signs of equality (=) occurred only once in each line of type, and ranged vertically beneath one another in successive lines, " in a neat and seamanlike manner " as we read in the *Manual of Seamanship* by the same publishers. In the new edition, the ease of following the mathematical argument which this arrangement affords has been needlessly sacrificed.

Until last year, the Naval unit of Capacitance was the *jar* of 1000 absolute electrostatic units, or $\frac{1}{900}$ μF. One's pleasure in reading the statement in heavy type at the end of §167, that " The Jar is now obsolete as a Service unit, having been replaced by the Farad and its submultiples," is somewhat diminished when in the very next line a numerical example occurs about " a capacity of 500 *jars*," and it becomes almost an evanescent quantity when further examination reveals that in all the rest of the book the *jar* is invariably used, never the microfarad. In a future edition this will perhaps be remedied, and by their unexpected decision to fall in with international custom in the matter of the unit of capacitance, one is led to hope that the authorities may one day see fit to write the international symbol μH for microhenry, in place of the present " mic."

It is also most encouraging to see that the Admiralty have officially decided on a convention for the sign of mutual inductance which appears to be the same as that adopted everywhere else in the world—except, one understood, at Teddington, where the National Physical Laboratory and the Admiralty Research Laboratory use, or used until recently, the opposite convention. Presumably the official definition is binding on the A.R.L. ; one wonders whether the N.P.L. will follow suit, or whether the value of the " M " between two coils will officially change sign whenever the coils are carried across the road which divides the buildings of the N.P.L. from those of the A.R.L. ?

C. R. C.

The Industry

GAS-HEATED electric generators functioning on the thermo-pile principle, intended for accumulator charging or for supplying L.T. to a broadcast receiver, are described in a booklet issued by Milnes Electrical Eng. Company, Church Street, Bingley, Yorks.

Concise details of Avo measuring instruments are given in a folder issued by the Automatic Coil Winder and Electrical Equipment Co., Ltd., Douglas Street, London, S.W.1.

Changes of address : Wingrove and Rogers, Ltd. (London office), to 12, Dartmouth Street, London, S.W.1. Telephone : Abbey 2272-3. Reliance Manufacturing Co. (Southwark), Ltd., to Sutherland Road, Higham Hill, Walthamstow, E.17. Telephone : Larkswood 3245.

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.

AERIALS AND AERIAL SYSTEMS

489 774.—Short-wave aerial built up of overlapping tube sections giving a "broadcast" or uniform field in the horizontal plane.

Marconi's W.T. Co. (assignees of C. W. Hansell and N. E. Lindenblad). Convention date (U.S.A.) 3rd February, 1936.

489 775.—Short-wave television aerial in which alternate half-wave sections are screened to ensure a uniform radiation horizontally and a broad frequency response.

Marconi's W.T. Co. (assignees of C. W. Hansell and N. E. Lindenblad). Convention date (U.S.A.) 3rd February, 1936.

490 192.—Method of matching an aerial to a concentric or other feed-line for any desired working frequency.

Telefunken Co. Convention date (Germany) 21st December, 1936.

RECEIVING CIRCUITS AND APPARATUS

(*See also under Television.*)

489 849.—Non-resonant feed-back circuit for a valve generator or amplifier in which no phase-displacement occurs at a selected frequency, but producing a phase-shift in opposite senses above and below that frequency.

N. L. Yates-Fish; P. W. Willans; and Muirhead and Co. Application date 4th January, 1937.

489 914.—Tuning-control system in which a brake is automatically applied at the point of resonance and the loud speaker simultaneously release from a "muted" condition.

N. V. Philips' Lamp Co. Convention date (Holland) 11th December, 1936.

489 923.—Preventing the rapid deterioration of a secondary-emitting electrode by regulating the temperature at which it works.

N. V. Philips' Lamp Co. Convention date (Holland) 22nd June, 1936.

489 950.—Low-impedance coupling for an amplifier handling a wide frequency-band and designed to prevent attenuation of the higher frequencies.

A. D. Blumlein. Application date 5th February, 1937.

490 058.—Automatically controlling tuning, selectivity, or volume in a wireless receiver by the action of an element which possesses a magnetic "after effect."

L. L. de Kramolin. Convention date (Germany) 11th February, 1936.

490 104.—Automatically compensating for the detuning effect of an alteration in the mutual coupling of two high-frequency circuits.

C. Lorenz Akt. Convention date (Germany) 5th September, 1936.

490 136.—Coil unit with adjustable iron cores, particularly for the I.F. stages of a superhet, in which the cores may be moved without altering the degree of coupling between the circuits they tune.

Marconi's W.T. Co. Convention date (U.S.A.) 31st December, 1935.

490 158.—Means for preventing distortion due to variations in the impedance of the rectifier from which a delayed A.V.C. voltage is derived.

The General Electric Co. and A. J. Biggs. Application date 10th June, 1937.

490 244.—Means for reducing the shift in frequency which tends to occur owing to the application of A.V.C. voltage to the grid of the mixing valve in a superhet receiver.

E. K. Cole and H. A. Brooke. Application date 10th March, 1937.

490 272.—Wireless receiver in which the tuning is automatically corrected by means of a local L.F. oscillation derived from A.C. supply mains.

Philips' Lamp Co. Convention date (Germany) 2nd November, 1936.

490 400.—Annular tuning scale in which the various stations are marked along radial lines and are intersected at an angle by a "cursor" rotating about the common centre.

Marconi's W.T. Co. and J. D. Brailsford. Application date 20th February, 1937.

490 497.—Remote-controlled loud speaker provided with a feed-back current to the transmitter for control purposes.

C. Lorenz Akt. Convention date (Germany) 22nd December, 1936.

490 525.—Valve amplifier circuit having a high stage gain and giving uniform amplification over a wide frequency range.

W. S. Percival. Application date 14th January, 1937.

TELEVISION CIRCUITS AND APPARATUS

FOR TRANSMISSION AND RECEPTION.

489 716.—Television transmission system in which the carrier-wave is first modulated with the synchronising impulses, and then multiplied in frequency before the picture signals are applied.

Baird Television and A. J. Brown. Application date 2nd February, 1937.

489 717.—Television system in which one scene can be superposed on, or replaced by another, at will, and in which the direct-current component is maintained throughout.

Baird Television; V. A. Jones; and T. C. Nuttall. Application date 2nd February, 1937.

489 964.—Photo-electric cell provided with electrodes of metal so thin as to be transparent, so that light passes through without "scattering."

Baird Television and J. L. Baird. Application date 8th February, 1937.

490 029.—Projection type of television receiver in which two fluorescent screens are used, the first of high brilliance and the second to correct for the undesirable "colour" effects of the first.

British Thomson-Houston Co. and W. J. Scott. Application date 4th February, 1937.

490 093.—Safeguarding the operation of a potentiometer controlling high-voltages, particularly in a television receiver.

The General Electric Co. and N. J. McAinsh. Application date 30th June, 1937.

490 150.—Time-base circuit for a television receiver with means for maintaining a predetermined voltage across the charging condenser during the intervals between synchronising signals.

Electric and Musical Industries and A.D. Blumlein. (*Addition to* 455 375.) *Application date 4th March*, 1937.

490 205.—Method of preventing the so-called "tilt" effect in a television transmitter by the application of periodical signals having a definite datum value.

A. D. Blumlein and C. O. Browne. Application dates 10*th November*, 1936, *and* 23*rd March*, 1937.

490 294.—Rotary arrangement for deriving synchronising impulses, as used in television, from the electric supply mains.

Scophony; G. Wikkenhauser; and A. F. H. Thomson. Application date 12*th February*, 1937.

490 391.—Cathode ray television transmitter in which an acceleration is applied to the electron stream during a portion only of each scanning cycle, thereby preventing the "blurring" of rapidly-moving objects.

Fernseh Akt. Convention date (*Germany*) 14*th February*, 1936.

490 396.—Means for varying the amplitude of the picture signals in television without altering the amplitude of the synchronising impulses.

E. L. C. White and O. L. Ratsey. Application date 18*th February*, 1937.

490 523.—Television system in which the signal currents produced by a mosaic of light-sensitive cells are transmitted through a commutator to a bank of Neon lamps.

Sir O. Stoll. Application date 13*th January*, 1937

490 529.—Generating saw-toothed oscillations for television scanning from a condenser connected across a direct-current supply.

Telefunken Co. Convention dates (*Germany*) 13*th and* 28*th February*, 27*th March, and* 7*th September*, 1936.

490 676.—Screen-grid valve circuit for separating line and frame synchronising impulses, in television, and for generating a saw-toothed oscillation at line frequency.

Telefunken Co. Convention date (*Germany*) 19*th March*, 1936.

490 732.—Band-pass coupling for a R.F. amplifier, designed to handle a wide range of frequencies particularly in television.

N. V. Philips' Lamp Co. (*addition to* 465 030). *Convention date* (*Germany*) 14*th January*, 1937.

TRANSMITTING CIRCUITS AND APPARATUS

(*See also under Television.*)

489 743.—Controlling the depth of modulation in carrier-wave signalling to equalise attenuation, or to secure volume-expansion and similar effects.

Standard Telephones and Cables (*assignees of Le Matériel Téléphonique Soc. Anon.*). *Convention date* (*France*) 18*th April*, 1936.

490 281.—Two-way carrier-wave communication system operating over the lines of an electric supply system.

International Carrier-call and Television Corpn. (*assignees of S. J. Levy*). *Convention date* (*U.S.A.*) 23*rd May*, 1936.

490 390.—Short-wave oscillation-generator in which a "jet" of electrons is made to oscillate to and fro through a collecting electrode.

Marconi's W.T. Co. and G. F. Brett. Application date 20*th February*, 1937.

490 622.—Valve circuit for generating high-frequency oscillations of "square" wave-form, particularly for multi-channel carrier systems.

The General Electric Co.; T. C. Skipper; and A. Steele [*addition to* 428 708]. *Application date* 7*th June*, 1937.

CONSTRUCTION OF ELECTRONIC DISCHARGE DEVICES

489 846.—Electrode arrangement designed to enable the focusing of an electron-optical system in a cathode-ray tube to be varied, or the magnification adjusted at will.

Marconi's W.T. Co. Convention dates (*U.S.A.*) 30*th November*, 24*th December and* 31*st December*, 1935.

490 230.—Electron multiplier in which permeable electrodes are used to control the direction of flow of the amplified stream.

Baird Television (*communicated by Fernseh Akt.*). *Application date* 10*th February*, 1937.

490 511.—Design and assembly of short-wave valves with low-loss leads.

E. Y. Robinson and Metropolitan-Vickers Electrical Co. Application date 16*th November*, 1936.

490 533.—Electron discharge device fitted with a linear electrode of the mosaic-cell type.

Baird Television and V. A. Jones. Application date 16*th February*, 1937.

490 566.—High-powered high-frequency pentode with a shielding member interposed between the control-grid and suppressor-grid leads.

M-O. Valve Co.; J. Bell; and D. A. Boyland. Application date 3*rd June*, 1937.

491 011.—Constructing a mosaic of photo-electric elements from caesium alloy laid on a foundation of resin supported by a backing-plate of copper.

A. M. Low. Application date 19*th February*, 1937.

491 050.—Cathode-ray tube in which all the electrodes of the "lens" system are formed from a single body of insulating material suitably metalised.

E. Michaelis. Convention date (*Germany*) 28*th August*, 1936.

SUBSIDIARY APPARATUS AND MATERIALS

490 265.—Amplifying arrangement comprising an electron multiplier energised by a constant source of light and coupled to a constant-current device such as a pentode.

The General Electric Co. and W. H. Aldous. Application date 2*nd July*, 1937.

490 649.—Frequency-multiplier depending upon the production of higher harmonics by non-linear resistance elements.

N. V. Philips' Lamp Co. Convention date (*Germany*) 27*th January*, 1937.

490 750.—Method of mounting and centering the diaphragm of sound-reproducing devices, such as microphones and loud-speakers.

L. Young and A. Young. Application date 19*th February*, 1937.