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Editorial

The Physical Reality of Zenneck's Surface Wave

QUESTIONS concerning the physical reality of things which are largely mental concepts are continually arising in connection with electromagnetism. Presumably philosophers have definitions of physical reality, but it is doubtful whether they would be of much assistance to physicists and electrical engineers. Some years ago a letter appeared in *Nature* suggesting that the side-bands of a modulated carrier had no physical reality but had been invented by the mathematicians and utilised by the Post Office authorities for the purpose of hindering the development of television. On a very different level is the investigation with the above title published by W. Howard Wise, of the Bell Telephone Laboratories.

In the *Annalen der Physik* in 1907 Zenneck examined the possibility of an electromagnetic wave travelling along the plane interface between two media with exponential attenuation in the direction of propagation and at right angles thereto. The mathematical formulation of such a wave showed it to be possible and it was subsequently generally assumed that such a surface wave formed a component of the radiation from an antenna, although Zenneck had not shown that a vertical antenna or dipole could generate such a wave.

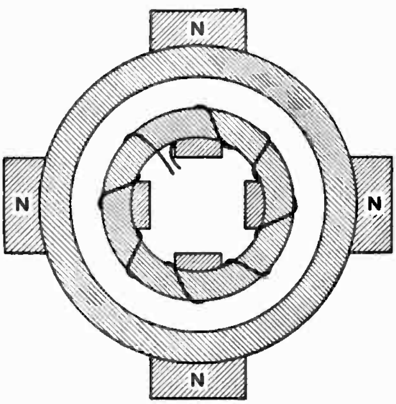
Different formulae and curves have been deduced by various mathematicians for the attenuation of radio waves travelling over land of given dielectric properties. C. R. Burrows recently drew attention to the disagreement between these results and stated that the formulae of Sommerfeld and Rolf gave values differing from those obtained from the formulae of Weyl and Norton by an amount corresponding to the Zenneck surface wave. Burrows also gave experimental evidence in favour of the Weyl and Norton results, i.e., against the existence of the surface wave. This conclusion is supported by Wise and also by S. O. Rice in a theoretical paper published in the same number of the *Bell System Technical Journal*, both coming to the conclusion that " Zenneck's surface wave is not generated by vertical dipoles and is not needed to explain wave antenna operation." As Wise says, readers familiar with wave antennas will at once ask why the wave antennas seem to justify the Zenneck surface wave theory by means of which they were conceived and designed, if there is no surface wave.

In answer to this Wise shows that a plane electromagnetic wave polarised with the electric vector in the plane of incidence and in the wave front, impinging on a plane solid at nearly grazing incidence produces a total field in which the horizontal electric field near the solid surface has very nearly the same ratio to the vertical electric field as in the Zenneck surface wave, and moreover, the wave-tilt near the ground at a great distance from a vertical dipole is almost the same as that found for the plane wave at nearly grazing incidence. We feel that the last word has not been said on this subject; the papers are of a very mathematical character and we shall look forward to further contributions elucidating the problem and setting out more clearly the physical questions involved. G. W. O. H.

The Validity of the Fundamental Laws of Electromagnetism

IT was with some surprise that we found published in a recent number of *Nature* (7th August) a letter maintaining that "some generally accepted laws of electrodynamics taught by such high authorities as Maxwell and Jeans were incorrect." . . . . "The law is sometimes ascribed to Laplace, sometimes to Biot and Savart, sometimes to Ampère, and sometimes to Maxwell."

One would have thought that this list of names would have served as a red light to any editor receiving a letter maintaining the incorrectness of one of the fundamental laws of electromagnetism. The law referred to states that the force on a conductor carrying a current of I amperes in a magnetic field of induction B is equal to $BI/10$ dynes per cm. of length.



The No-Torque motor.

The experimental evidence offered is a striking illustration of the old adage concerning a little knowledge. An outer stationary iron ring forms the N pole of a motor, and an inner iron ring, free to rotate, forms the S pole. The magnetic field in the gap between them is radial. A number of bar magnets complete the magnetic circuit through a similar pair of iron rings of opposite polarity, the two rotors being mounted on the same shaft, but we need only consider one pair of rings. The outer rings and bar magnets could be replaced by a magnetised cylinder. On the inner ring is a winding through which current is passed in such a way that it is in the same direction in all the conductors in the gap. Now the fact that such an armature shows no inclination to rotate is put forward as a proof that there is no force on the conductors, although they carry current in the radial magnetic field; Q.E.D., and Ampère and Laplace, Biot and Savart, Maxwell and Jeans all stand condemned in the pages of *Nature* by a Mr. W. F. Dunton. It is hardly necessary to point out, however, that the argument is entirely fallacious, since there is inside the winding a tangential magnetising force causing the magnetic field to enter the iron ring at such an angle that the mechanical tangential force on the iron produces a torque exactly equal and opposite to that on the conductors. Perhaps the simplest way to show this is to regard the radial induction B as corresponding to a pole strength $B/4\pi$ per sq. cm. of the iron surface. If IT are the ampere-turns on the armature and r the radius, the tangential value of H is $4\pi/10(IT/2\pi r)$. The tangential mechanical force on the iron per cm. of axial length is therefore $(2\pi rB/4\pi)(4\pi/10)(IT/2\pi r) = BIT/10$ dynes, which is, of course, the same as the force on the conductors as calculated by the usual formula. The resultant torque on the armature is therefore zero.

If anyone tries to lift himself by means of his own braces, the fact that he does not soar into the air does not prove that he exerts no force on his braces.

G. W. O. H.

The Wave-Slot, An Optical Television System*

By F. Okolicsanyi, D.Sc.

(The Scophony Television Laboratories)

1. Introduction

EARLIER television experimenters largely used mechanical methods for the realisation of television (Nipkow disc, mirror drums, and so on). The old known mechanical methods had, however, gradually to be abandoned as their light efficiency decreased in proportion to the increase in definition. The majority of television experimenters, therefore, in recent years concentrated their efforts on electronic methods, *i.e.*, on the cathode-ray tube with its constant light output, which has the advantage of being independent of the number of lines used.

The resulting popular belief that mechanical television was therefore entirely doomed was, however, belied by the high definition developments of Scophony optical mechanical methods during the last two years. One may say that the Scophony Company was almost the first to tackle the problem of television in earnest from the *optical* point of view, and as a result a series of novel optical principles were evolved in the Scophony laboratories—for instance, the "Split focus."[1] An advance of far-reaching importance was the use in conjunction with this optical principle of the Scophony Supersonic Light Control.[1]

By these means, in present-day Scophony receivers, many elements in the scanning line—indeed, in some cases the whole line—are made simultaneously active, and a storage effect is thereby obtained. Recent television developments have shown that the storage effect is of considerable advantage, both at the receiving and at the transmitting end.

The resultant increase in light in the Scophony receiver enabled Scophony to obtain projected pictures (on 240 and 405 lines) up to 40 square feet in area, with a brilliancy favourably comparing with that obtained by receivers employing the cathode-ray tube projection methods.

It is dangerous to make prophecies in technical and scientific developments, but the writer would call attention to the fact that in spite of considerable progress recently made in projection by cathode-ray tubes, the publicly demonstrated results of large screen projection by Scophony methods appear, at least at present, to give the best hope for cinema television. These methods use rotating scanners in each direction, and as such may be described as *optical mechanical*.

A further development of Scophony described in the following article will, it is hoped, be found of special interest. The investigations arose from a desire to eliminate the high-speed scanning mechanical component and use supersonic waves as a means of a novel type of scanning.

2. Supersonic Waves and their Applications to Light Relays

Investigations concerning supersonic waves have been published during the past thirty years[2], and in order to facilitate the explanation of the "wave-slot" a brief indication of how acoustic waves can be made visible in a liquid will be given.

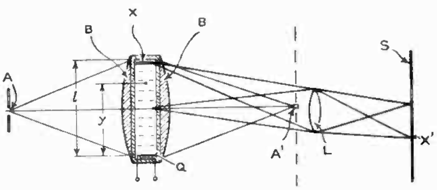


Fig. 1

In Fig. 1 a light source A is focused by the lenses (B, B) upon a bar A'. Between the lenses there is practically parallel light. A lens L, placed near the bar, forms an image of the supersonic cell on the screen S.

Oscillations of high frequency, applied to the quartz crystal Q cause this crystal to vibrate and therefore supersonic waves are propagated perpendicularly to it through the liquid with which the crystal is in contact.

* MS. accepted by the Editor, August, 1937.

At any instant a group of such waves at X will produce a system of interference fringes at A^1. The central image is obscured and the light of the secondary images passing through the lens L will produce a conjugate image at X^1. The intensity of light at X^1 is proportional to the intensity of the supersonic waves at X.

Suggestions have been made to use this effect for light modulation.[3] Modulated high frequencies (about 10 Mc/s) are applied to the crystal, which is mechanically damped and arranged electrically so that it transmits a band of 1 or 2 Mc/s either side of its resonance frequency. Therefore the conditions at any instant at the crystal will be reproduced at a time y/v seconds later at a plane in the liquid distant y from the crystal (where v is the velocity of propagation of acoustic waves through the liquid). The light relay has, therefore, a time delay, but its nature is different from that found in Kerr cells and modulated light sources, as the time lag is constant for all frequencies and it depends only on the distance from the crystal. Methods have been proposed for overcoming the time lag[3] by cutting out a small fraction of the cell surface by means of a slot. Such methods will obviously result in a substantial decrease of screen brightness.

In the Scophony Supersonic Light Control the line scanner (for instance, a polygon mirror) sweeps the image of the cell over the screen at a speed corresponding to that of the acoustic waves, and in this way the time delay is compensated and the use of the entire large aperture of the supersonic cell is made possible. In this way each element of the supersonic waves gives a storage of modulation over a considerable period of time (l/v). In spite of the propagation of the element along the cell, the light spot remains stationary on the screen, due to the optical compensation by the rotating scanner.

3. The Wave-slot Scanner

The following explanation shows how it is proposed by the author to use a supersonic cell to effect *scanning*, not in conjunction with but instead of a mechanical high-speed part.[4]

Turning again to Fig. 1, if a *pulse* of high frequency oscillations is applied to the crystal, a short group of supersonic waves will move through the cell and a spot of light across the screen. The source A may be modulated (or replaced by a Kerr cell) and the spot moving across the screen will vary in intensity in sympathy with the modulation impressed at A. In this case the time lag of the cell due to the finite velocity of acoustic waves does not need compensation; indeed, the progression of waves is now necessary to distribute in *space* the intensity variations which take place at A in *time*. Fortunately, the average acoustic speeds in liquids (1,000 metres per second) are just convenient for television scanning and a picture according to the present standard can be formed with a cell of 10 centimetres length.

The analogy between this method of scanning and that of the Nipkow disc can at once be seen.

The arrangement of Fig. 1 is in theory simple, but it was seen that other combinations might lead to improved light efficiency.

Three components are used in the formation of a picture line, viz.:

(*a*) Light source.

(*b*) Pulse modulated light relay.

(*c*) Picture modulated light relay.

The nature of any and every one of these may be varied, thereby giving combinations capable of producing, with greater or less efficiency, a picture line. The tables show a list of such combinations, some of which have been investigated experimentally.

The method of building up the line differs in different cases and no analogy can be drawn between the line-forming process of (A 1 2), (A 2 2_1), (A 2 2_2), etc., and that employed in the usual scanning methods (Nipkow disc, mirror drum and cathode-ray tube). Calling these latter cases classical methods, in which a light spot is swept over a screen simultaneously with the scanning taking place at the transmitter, it is clear that, *e.g.*, A 2 1, explained in Fig. 1, is of this type.

4. Case I.—Two Parallel Supersonic Cells (A 2 2_1)

According to Fig. 2, an image of the first supersonic cell is formed in the second cell.

Pulse modulated oscillations (Fig. 3) applied to the crystal of the first cell give rise to a spot of light moving across the second cell.

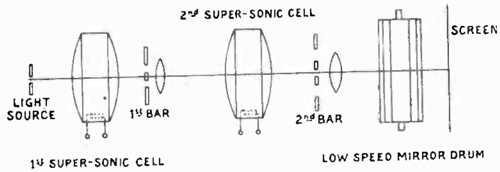


Fig. 2.

Within this cell and in a contrary direction is propagated the system of picture modulated acoustic waves.

The cells are so arranged (Fig. 4) that the synchronisation pulse illuminates the end of the cell farthest from the crystal when the beginning of a picture line has reached that end, *i.e.*, at half the time of one line later than the signal is transmitted. At the end of a line the wave pulse and the end of the picture line coincide at the crystal simultaneously with the radiation of the signal. While the transmitter is scanning the first half of the line no illumination takes place on the receiving side and the whole line is therefore scanned in the latter half of the

TABLE A.

Constant Light Source.

Pulse modulated component.	Picture modulated component.	Result.	Reference.
Homo-geneously modulated light relay (*e.g.*, Kerr cell).	Kerr cell type.	No scanning action.	A 1 1
	Supersonic cell.	Stroboscopic combination giving whole picture line of one picture element duration in time.	A 1 2
Supersonic cell.	Kerr cell type.	Classical case. One picture element width scanned along a picture line.	A 2 1
	Supersonic cell parallel to pulse modulated cell.	Wave-slot case. Scanning and complete formation of line takes place in the time of one-half line.	A 2 2_1
	Supersonic cell perpendicular to pulse modulated cell.	This arrangement gives a whole line visible for the duration of one line.	A 2 2_2

TABLE B.

Pulse Modulated Light Source.

Pulse modulated component.	Picture modulated component.	Result.	Reference.
Homo-geneously modulated light relay (*e.g.*, Kerr cell).	Kerr cell type.	No scanning action.	B 1 1
	Supersonic cell.	Stroboscopic combination. This arrangement gives a much greater light efficiency than A 1 2.	B 1 2
Supersonic cell.	Kerr cell type.	No full picture line.	B 2 1
	Supersonic cell parallel to pulse modulated cell.	Magnified image of pulse modulated cell projected on second cell. General case of time *and* space limitation.	B 2 2_1
	Supersonic cell perpendicular to pulse modulated cell.	The same as B 2 2_1.	B 2 2_2
None.	Kerr cell type.	No scanning action.	B 3 1
	Supersonic cell.	Stroboscopic combination. Ideal case. The lamp is assumed to flash for a duration of one picture element.	B 3 2

time of its transmission. The active length of the cells is one-half the product line-time × acoustic speed.

TABLE C.

PICTURE MODULATED LIGHT SOURCE.

Pulse modulated component.	Picture modulated component.	Result.	Reference.
Homogeneously modulated light relay (*e.g.*, Kerr cell).	Kerr cell type.	No scanning action.	C 1 1
	Supersonic cell.	The same as A 1 2. Modulation of light source is ineffective and unnecessary.	C 1 2
	None.	No scanning action.	C 1 3
Supersonic cell.	Kerr cell type.	Orthodox scanning but the brightness of picture element proportional to square of amplitude of incident carrier.	C 2 1
	Supersonic cell parallel to pulse modulated cell.	The whole picture line appears to be superimposed on a half part of itself.	$C\ 2\ 2_1$
	Supersonic cell perpendicular to pulse modulated cell.	This arrangement gives a whole line. The brightness of an individual element is also proportional to the average brightness of the line.	
	None.	Classical case. Similar to A 2 1.	C 2 3
None.	Kerr cell type.	No scanning action.	C 3 1
	Supersonic cell.	No scanning action.	C 3 2

A definition of one hundred elements per line will be given by a pulse of 1/100th of the line period. The corresponding space

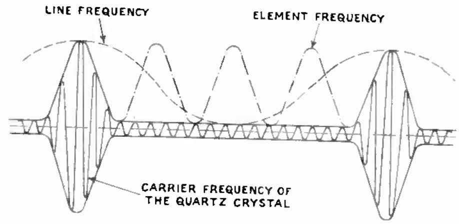
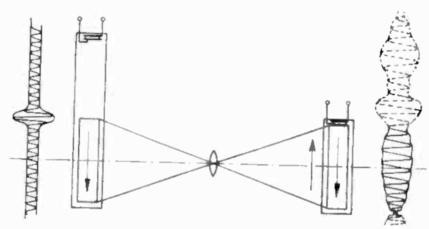


Fig. 3.

limitation of the pulse is 1/50th the length of the line on the screen since the active length of the cell is a half-picture line. On the other hand, the illumination of the screen lasts only $\frac{1}{2}$-line time. The product of these two limitations gives the figure of definition ($1/50 \times \frac{1}{2} = 1/100$). Subsequently it will be shown that other arrangements (*e.g.*, B 3 2) have different time and space limitations, but in every case the product gives the figure of definition.

The assembly of the whole "line-producing" unit and its associated electrical equipment is indicated in Fig. 5. There are indicated the three variable components in the above case ($A\ 2\ 2_1$) a constant light source and two parallel supersonic cells. Following these the slow-speed mirror drum and the screen are diagrammatically shown.



POSITION OF THE WAVES AT THE TIME ($T = \frac{1}{2}$)
T = TIME FOR ONE LINE

Fig. 4

The associated radio equipment is similar to that of the cathode-ray tube home receivers, but instead of synchronised time bases the separated picture and pulse signals are in the form of modulated high frequency fed to the crystals.

The synchronous drive of the slow-speed drum is not shown, since there is no problem in this respect. The required accuracy is less than that for the line formation by a factor equal to the number of lines in the picture. In the case of a time difference equal to the duration of a line the shift is not the picture width (length of a line) but only the thickness of a line, *i.e.*, about 1/200th part of the picture height.

The photographs (Figs. 6, 7 and 7*a*) show consecutively the components of a receiver built according to the above case (A 2 2_1).

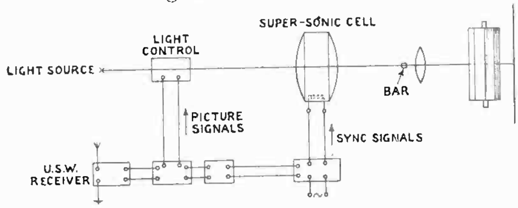


Fig. 5

In the first photograph can be recognised the different lengths of the two cells, as explained in Fig. 4. Rectangular quartz crystals (not shown) are mounted on the open end. Behind the slot a strip of concave mirror replaces the lens *L* and serves to keep the apparatus convenient in size. Fig. 7 is a complete line projector unit and 7*a* represents a complete receiver, including the modulated oscillator for the pulse cell.

5. Case II.—Some Combinations with One Supersonic Cell (A 1 2), (A 2 1), (B 1 2), (B 3 2)

An extremely compact arrangement of the model (A 2 1) is shown in Fig. 8; the Kerr cell, and the wave-slot cell being combined in one vessel.

The electrodes of the Kerr cell are placed between two Polaroid plates, the polarisation planes of which are at right angles.

The quartz crystal, which is driven by the electrical oscillator, produces the supersonic waves in the same liquid in which the Kerr effect takes place. This oscillator is modulated with short impulses corresponding to the line frequency, exactly as in the case of Fig. 1. The supersonic waves pulse thus produced builds up the picture line exactly as already described. In diagram *A* of Fig. 8 the intensity variations in time of the light source, the wave form applied to the crystal, and picture voltage applied to the Kerr cell indicate the way in which the intensity distribution on the screen is obtained.

During the tests with such a set up a very interesting result can be noticed, namely, it is possible to *interchange* the function of the two light-influencing components without influencing the correct line formation. That is, the picture current may be applied to the quartz crystal, and the synchronising impulses to the Kerr cell (case A 1 2). When the electrical components are changed over in this way the mode of operation is naturally quite different from the previously discussed cases. The quartz crystal makes a complete record of the picture current corresponding to a whole line and the whole of this line is then simultaneously made transparent for a short time (time of one picture element) by a flash of illumination from the Kerr cell. This second method of connection (the case of limitation in time) shows certain advantages over the first arrangement (limitation in space). The output valves driving the Kerr cell can be very much smaller since they are only loaded for a short time and therefore have a many times smaller anode dissipation. Secondly,

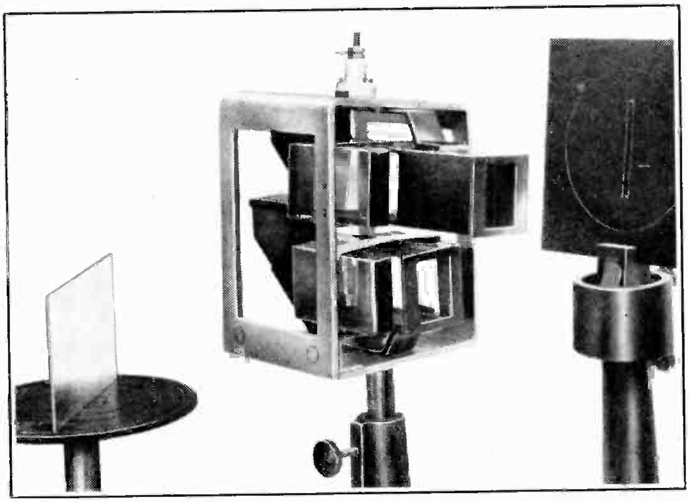


Fig. 6

in place of a constant light source, a high-pressure mercury lamp or similar device may be used in such a way that it flashes

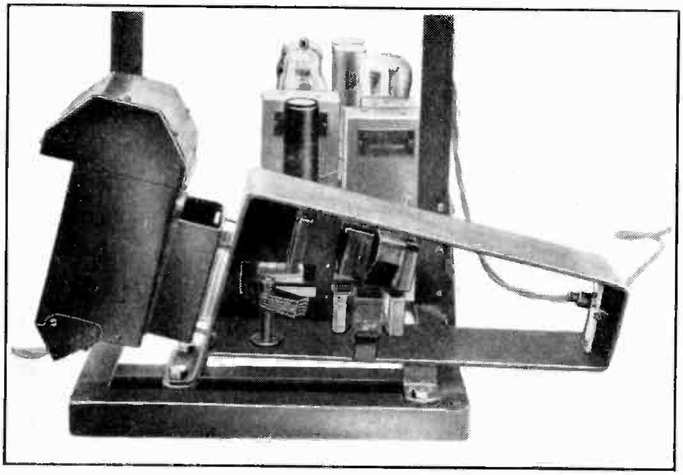


Fig. 7

with the Kerr cell for this short active instant (model B 1 2). This arrangement is explained by the diagram *B* of Fig. 8.

In this way the time integral of the thermal loading can be kept below the permissible value, the whole of the light energy being concentrated in a short time interval. The Kerr cell may be dispensed with in the case of an accurately flashing light source (case B 3 2).

6. Case III.—Two Perpendicular Supersonic Cells (A 2 2_2)

Another variation of the same type of apparatus, which is more similar to the (A 2 2_1) model of Fig. 2, is shown in Fig. 9. In this case the fundamental point is that the two supersonic cells are perpendicular to each other, and both are at 45° to the horizontal. The projection of the wave-slot cell cuts out of the video cell a segment in which *at every instant the whole of the picture elements* of a line are to be found.

Now the waves representing the shading of the picture line are moving forward in the video cell. Thus, in the segment cut out, the same picture details which were illuminated by the light from the upper end of the wave-slot cell (*e.g.* at X) are later illuminated by lower parts of the wave-slot cell when they have reached positions X_1 and X_2, etc. On account of the 45° tilt of both cells the parts such as X, X_1, X_2, corresponding to the same line detail, are found vertically above one another. A cylindrical lens is now used to bring the whole height of this pattern down to the thickness of a picture line, this line being thrown on to the screen via the slow-speed mirror drum.

The above combinations give line-producing units which are capable of working in conjunction with the present type of transmission, viz., scanning of a picture in two dimensions. The possibilities of using combinations in conjunction with other types (*e.g.*, simultaneous line trans-

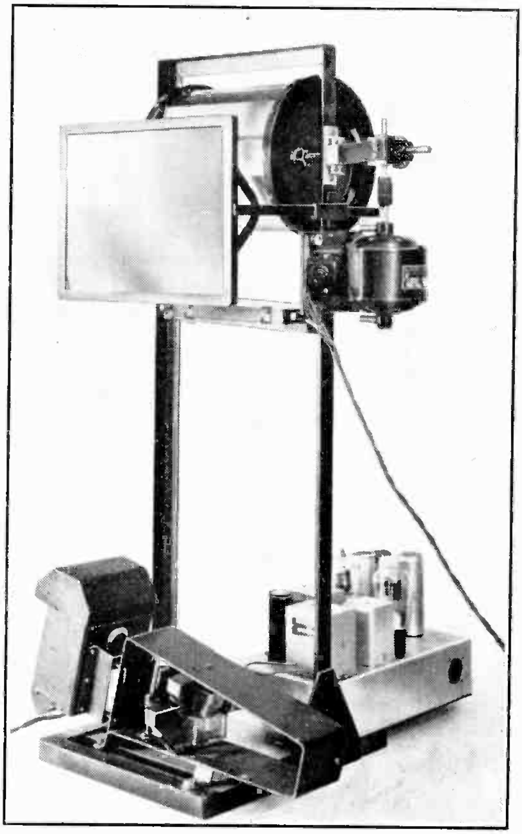


Fig. 7a

mission) do not lie within the scope of this article.

7. Slow-Speed Scanner with Supersonic Cell

The remaining mechanical part of the television receiver, namely, the slow mirror

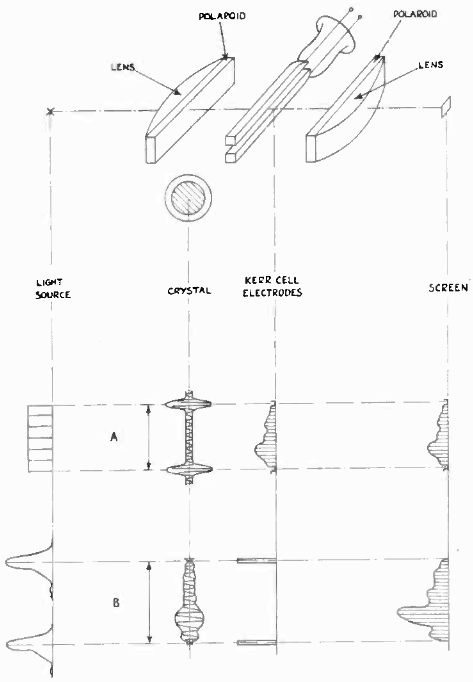


Fig. 8

drum, can also be replaced by an inertialess device. The simplest method is to arrange in the model (B 3 2) another supersonic cell at right angles to the picture line. The carrier for this cell is modulated with impulses whose frequency is somewhat higher or lower than the line frequency, and is preferably the sum or the difference of the line frequency and the picture frequency. With the present B.B.C. television standard, for example, a suitable frequency is

$$10{,}125 + 50 = 10{,}175 \text{ cycles/sec.}$$

The successive flashes of the light source then disclose one picture line below another until the whole picture has been reproduced. The vertical, slow-speed scanning supersonic cell is illuminated all over by the light emerging from the first cell so that the wave-slot of the former cuts out a horizontal transparent strip of its illuminated area. Thus the frequency of this wave-slot is 10,175, which results in a progressive advancing of its phase with respect to that of the light flashes, which have the frequency 10,125. This process is periodical and takes place in 1/50 sec.

8. Observations

The method of reception which has been outlined is different in many respects from that of standard intensity modulated cathode rays and from mechanical receivers described up to the present.

(*a*) *The first striking characteristic is the principle of the interchangeability of the two light relays.*

We saw, *e.g.*, in the case of Fig. 8 that the synchronising impulse could be interchanged with the picture signals. It is therefore not correct to consider the Kerr cell just as a light relay and the supersonic cell as a scanner, because the reverse statement is equally true. This interchangeability does not exist in the analagous case of a Nipkow disc and neon tube.

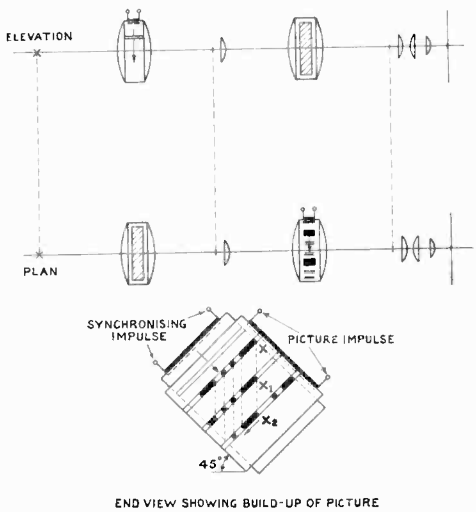


Fig. 9

In our case the function of the two light relays must be interpreted as follows:

In the present standard the *sum* of video and synchronising signals occupies the whole available 100 per cent. of modulation. After these signals have been separated by an amplitude filter one modulates one light relay, the other the other. The light of the lamp passes successively through the two cells and the *product* of the two light control effects appears on the screen.

Thus, if at a given position x at a time t the first relay has reduced the light to 0.2 of its original value, and if the second relay reduces it to 0.5 of its already diminished value, then we have on the screen for the corresponding point of the picture a light intensity of $0.2 \times 0.5 = 0.1$

$$F(x, t) = F_1(x, t) \cdot F_2(x, t).$$

F is the illumination in space and time on the screen.

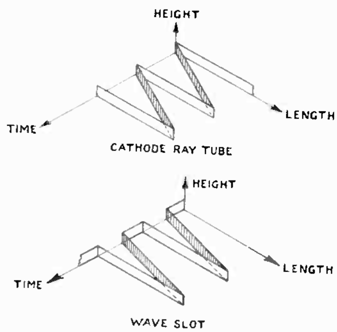


Fig. 10

Thus, the information, contained electrically in the picture signal, is made visible by optical means in the most direct manner possible.

(*b*) *Synchronisation*

In the early years of picture telegraphy the frequency clocks of the transmitter and receiver were compared with each other before each transmission ; later (television) synchronising signals were sent after each picture line, and it was sufficient for the scanner to run at constant speed only for the time required to complete one line. In the case of mechanical scanners this constancy is achieved through the inertia of the scanner and in electronic reception carefully constructed time bases maintain linearity.

In our case the generation of the wave-pulse accurately follows the synchronising signals and the waves, once started, travel with the constancy and speed of a rifle bullet discharged into empty space. Thus is combined the linearity of mechanical scanners and the flexibility of valve time-bases. Moreover, this result is achieved with an economy of apparatus (*e.g.*, the intermediate frequency of the vision superhet may be applied directly to the crystals) by the avoidance of time-bases and synchronising gear for motors.

Also the sensitivity to disturbance of synchronisation is reduced by a factor equal to the number of lines, since the electrical formation of the line is begun and ended within the element period.

(*c*) *Comparison with the Intermediate Film Method*

In the normal intermediate film system a light beam or electron pencil sweeps synchronously across a film which "carries" the record until it is projected a short time later. The wave-slot system also uses an intermediate recording. The recording at least for a picture line is, however, done, without any synchronous beam deflection, by the stationary piezo-electric crystal which continually produces new travelling waves. These waves automatically progress without the artificial expenditure of moving material as in the case of a moving film.

In our case the record does not need to be effaced after projection, because the supersonic waves are readily and completely damped out at the end of the cell (*e.g.*, with cork or glass wool).

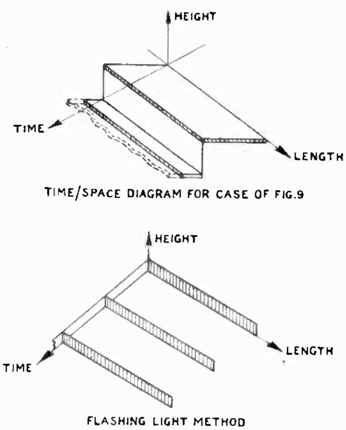


Fig. 11

(*d*) *Principles of Line Formation*

It was assumed in Sections 3 and 4 that the conditions for line formations, with the wave-slot methods of Tables A, B and C, were that the product of the time and space limitations should equal the required figure of definition. In the extreme cases (one limitation is unity) the examples respectively of orthodox scanning and stroboscopic illumination (flashing light) are given. To give some indication of the broader possibilities of line formation, Figs. 10, 11 and 12 are included.

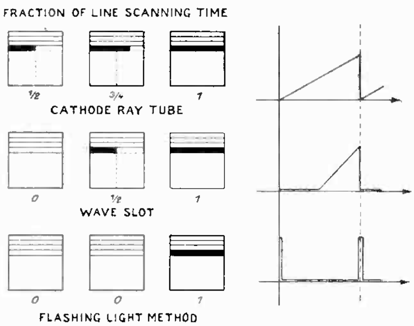


Fig. 12

The position of the illuminated spot in time is represented in both dimensions in Figs. 10 and 11, while 12 shows the movement only along a line. Generally, for the period of one line there is no movement (slow-speed scanning excluded) of the spot perpendicularly to the line and the function (as, for example, in the case of the cathode-ray tube) is represented by a strip of uniform height.

The horizontal section of the upper diagram of Fig. 10 is the well-known saw-toothed curve. In this case, as in other examples of orthodox reception, the transmitter and receiver have identical space-time ($s(t)$) functions of scanning. The lower represents the case A 2 2_1, where the scanning only takes place in the second half of the line period. The upper diagram of Fig. 11 shows that in the arrangement A 2 2_2 the whole line length is illuminated for the full duration of a line and that movement (imperceptible in practice) takes place within the thickness (height) of one line. In the flashing light methods (A 1 2, B 1 2, B 3 2) the lower diagram of Fig. 11 indicates that the scanning is fully replaced by a simultaneous illumination of picture elements in a very short time. Fig. 12 shows how much of a picture line has been illuminated after the lapse of the indicated fractions of line period.

(*e*) *General Remarks*

Practical work to date resulted in pictures about the size of those obtained with directly viewed cathode-ray tubes. The stage at present reached is that of transition from the type of Fig. 2 to the flashing light method. The author hopes in this way to have sufficient light for bright pictures of a much larger size.

The necessary light sources are already in an advanced stage of development,[5] both in the Scophony as well as in other laboratories. Fig. 13 shows some special light sources ; on the left is the "Strobotac" light source made by General Radio (U.S.A.) and on the right a similar lamp with mercury filling.

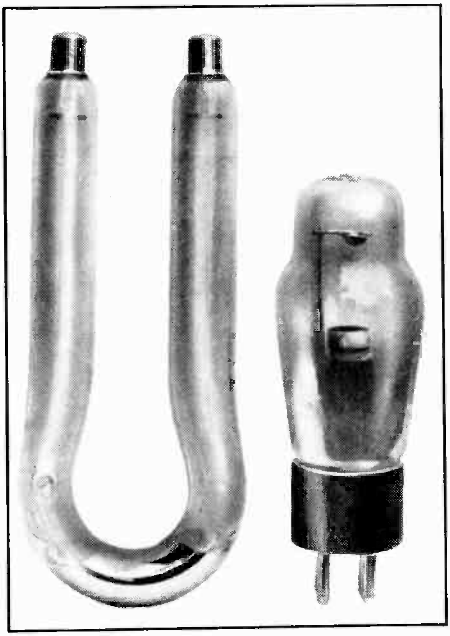


Fig. 13

Instead of liquid Kerr cells similar light relays employing solid media [6] are being considered.

Finally, one has the possibility, by combining the flashing light method with the principle laid down by the author in British Patent No. 468191, of projecting not only one line but the *whole* picture simultaneously at the receiving end.

Acknowledgment

The author wishes particularly to express his gratitude to Mr. S. Sagall, Managing Director of Scophony Limited, for the understanding which he has shown and for the encouragement which he has given him in this new development.

REFERENCES

(1) G. W. Walton, "Television," H.M. Stationery Office, Board of Education, 1937, pp. 54 ; J. H. Jeffree, *Television*, Vol. 9, 1936, pp. 260, "The Scophony Light Control," and British Patent No. 439236.

(2) Toepler, A., "Optische Studien nach der Methode der Schlierenbeobachtung," *Pogg. Ann. Bd.*, 137 (1867), S.33u. 180 ; Toepler, M., "Neue einfache Versuchsenordnung zur bequemen subjektiven Sichtbarmachung von Funkenschallwellen nach der Schlierenmethode." *Ann. Phys. Lpz.* IV Folge Bd. 27 (1908), S. 1043 ; Debye-Sears, *Proc. Nat. Acad. Amer.*, Washington 18, 410 (1932) ; Strong, J. A., *Nature*, 129, 59, 203 (1932) ; Bachem, Ch., "Die Sichtbarmachung fortschreitender Ultraschallwellen in Flussigkeiten mittels eines Hochfrequenzstroboskops und eine neue Methode zur Bestimmung der Ultraschallgeschwindigkeit." *Zeitschr. f. Physik.* 19, February, 1934 ; Grossman, E., "Ultra-akustik," S.463, *Handbuch der Experimentalphysik*, Bd. 17/1, Lpz. Akadem, Verlagsges, 1934 ; Hiedemann, E., "Ultraschall," Ergebnis exakter Naturwissenschaften, Bd. 14 (1935), S. 201 ; Bergmann, L., "Der Ultraschall," Berlin, 1937, S. 53.

(3) Biquard, Carolus, Jeffree, Becker, Maercks, (vide L. Bergmann "Der Ultraschall," pps. 54, 158, 159, and U.S.A. Pat. 2084 201, French Pat. 752910).

(4) Okolicsanyi, F., French Pat. No. 817994.

(5) Edgerton, H. E., Germeshauser, J. K., and Grier, H.E., "High Speed Photographic Methods of Measurements," *Journ. of Applied Physics*, January, 1937.

(6) F. Okolicsanyi, "Das Kristallichtrelais," *Fernsehen und Tonfilm*, August, 1933, see also "A Formula for the Birefringence of Vibrating Media," *Physics*, April, 1936. References concerning the Okolicsanyi cell : L. M. Myers, "Television Optics," pp. 155, 323, Pitman & Sons ; T. C. Wilson, "Television Engineering," pp. 240, Pitman & Sons.

The Elements of Mathematical Analysis.

By J. H. Michell, M.A., F.R.S. and M. H. Belz, M.Sc. 2 Vols. Pp. 1087 + XXXVI, 351 Figs. Macmillan and Co. Ltd., 42/– per volume.

These two volumes are eminently suitable for a course in advanced mathematics such as is taken by Honours students of Physics and Engineering in most Universities. For this purpose we do not see how they could be improved upon. The language is always clear and diagrams are freely employed to make the mathematical ideas real and to remove from the student's mind the impression that he is merely juggling with symbols. The beautiful type and diagrams and the general arrangement of the material add greatly to the attractiveness of the book, and there is no sacrifice of thoroughness to obtain this result.

Every chapter has a large selection of exercises which will prove of great value to the student—and to the teacher.

The opening chapter is a heavy one of over a hundred pages on the elementary properties of functions. This will probably be taken in small doses, mixed with the rest of the volume which is devoted to differential calculus, curvature, trigonometrical and hyperbolic functions, etc. The second volume deals with integral calculus, including numerical and mechanical approximate methods of integration, areas, volumes, method of least squares, Taylor's theorem, etc., and differential equations of the first and second order.

The books are so excellent that we wish that we could picture many students buying them, but at four guineas for the two volumes we find it difficult.

G. W. O. H.

Alternation Current Measurements at Audio and Radio Frequencies.

By David Owen, B.A., D.Sc., F.Inst.P. Pp. 120 with 80 figs. [18 × 12 cm.]. Methuen and Co. Ltd., 36, Essex Street, London, W.C. Price 3s. 6d.

This little book, one of the latest additions to the series of Methuen's Monographs on Physical Subjects, should appeal to the engineer even more than to the pure physicist, and every serious experimenter needs a copy on his shelves.

At a cost of but three shillings and sixpence, here is a summary of well-tried methods of making measurements at low and high frequencies, judiciously selected from the ever increasing variety which have been proposed and used. Not the least valuable feature of this book is the description of methods which enable measurements to be made to an accuracy of within a few per cent. with the minimum of apparatus, such as Turner's method (p. 33) for a large self-inductance.

Most existing treatises deal with either Audio-frequency or Radio-frequency methods, but not with both, and they cost a guinea or more apiece, so that this book exactly fills a need ; for it is sufficiently simple to be intelligible to the reader whose mathematical equipment does not extend beyond a bowing acquaintance with "*j*," yet it is so far from the slipshod "popular" handbook that teachers will welcome it as an inexpensive yet adequate introduction to recommend to their students.

The author's chief difficulty must have been to decide what to omit ; when the whole field of A.C. measurements is condensed into 120 pages one is inclined to regret that 20 of them should be expended on an explanation of "Alternating Current Theory" (Ch. 1), which, unlike the remainder of the book, is easily accessible elsewhere ; yet in spite of the restricted space, almost all really important methods of measurement receive brief but adequate treatment. It may be suggested that the list of books for further reading, in the preface, should include a reference to Moullin's "Radio Frequency Measurements" and to Terman's "Measurements in Radio Engineering" (of special interest to the experimenter for the detailed descriptions of home-made apparatus, with diagrams of connections in which the values of all component resistances and condensers are given).

The figures are drawn in such a manner as to be almost self-explanatory without reference to the text; only those who have themselves tried to produce such diagrams can realise the difficulties to be overcome and the expenditure of work that this represents.

C. R. C.

Indirect Ray Measurements on the Droitwich Transmitter*

By C. H. Smith, B.Sc., A.M.I.E.E.

A record of some investigations made by the Research Department of the British Broadcasting Corporation

SUMMARY.—Results are given of cathode ray oscillograph observations on the reception of Droitwich at Newcastle using a variable transmitter frequency. The records clearly indicate the existence of multiple transmission paths, give a satisfactory explanation of the observed distortion effects on transmitted programme and yield confirmatory evidence regarding the properties of the Heaviside layer.

THE power radiated by the B.B.C. long-wave transmitter at Droitwich is sufficient to provide a satisfactory day-time signal throughout the major part of England and Wales. It has been observed, however, that during the hours of darkness, and particularly during the winter time, reception on the limits of the service area is marred by fading phenomena.

Preliminary listening tests indicated that distortion of the received signals also occurred. It was noticed, however, that there was no simple correlation between the fading and the distortion phenomena. Observations showed that a complete fade out of the carrier wave at the receiving station invariably produced badly distorted

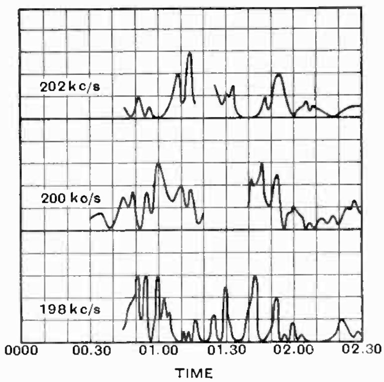


Fig. 1.—*Variation of field strength of 198 kc/s, 200 kc/s, and 202 kc/s signals from Droitwich at Newcastle.*

signals but with a smaller reduction in intensity than would be expected from field-strength observations. Moreover, periods of inferior quality of reproduction occasionally occurred with a received field strength equal to, or even greater than, the day-time value. It was therefore decided to make further

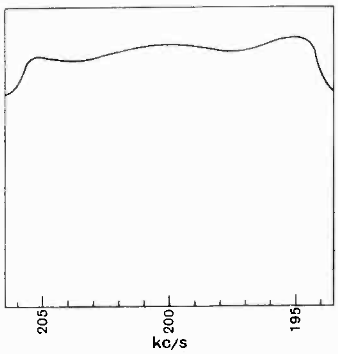


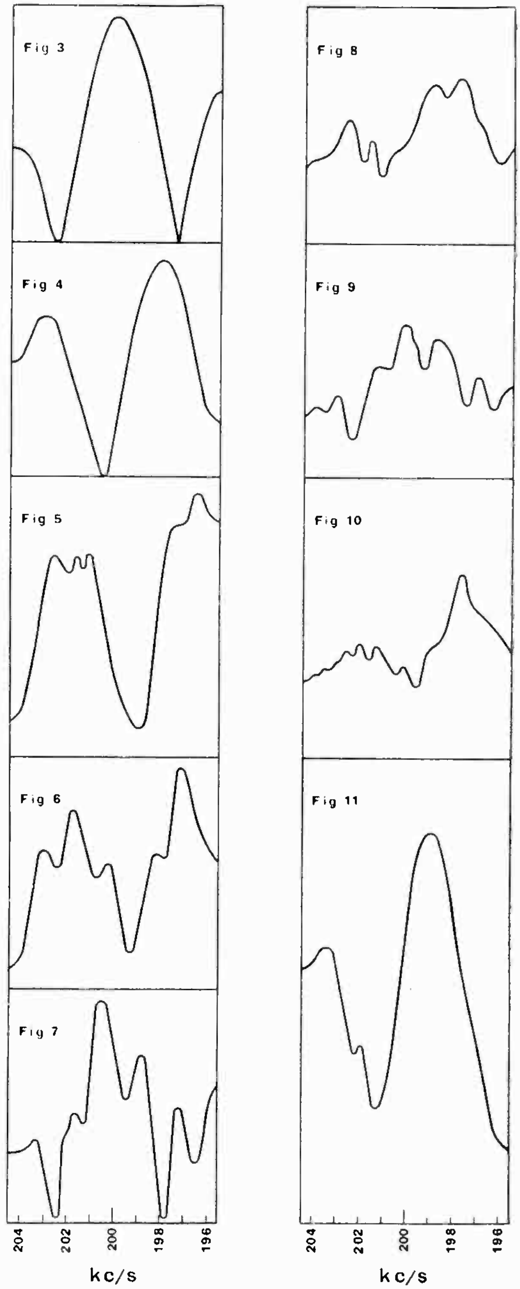
Fig. 2.—*Receiver characteristic.*

investigations into the nature of the phenomena.

Newcastle-on-Tyne, in which place a day-time field strength of 5mV/M is obtained, was chosen as a receiving point, and apparatus was installed in the B.B.C. offices in that town. An initial experiment was made by modulating the Droitwich carrier with a frequency of two kilocycles per second. Field-strength measuring apparatus was arranged to take simultaneous records of the variations in intensity of the carrier wave and the two sidebands. The results, illustrated in Fig. 1, showed completely independent fading of the three frequencies involved.

A further series of measurements was therefore made to give more precise information regarding this phenomenon. The

* MS. accepted by the Editor, June, 1937.



Figs. 3 to 11.—*Transmission characteristics. Droitwich to Newcastle.*

Droitwich transmitter was fitted with a temporary drive oscillator including a variable condenser coupled to an electric motor. By this means the drive frequency could be varied over a range of $8\frac{1}{2}$ kilocycles per second at a frequency of about 10 excursions per second. A timing contact was also fitted to the condenser shaft to enable synchronising impulses to be transmitted to the receiving station. Modifications had also to be made to the H.F. amplifier stages of the transmitter to enable them to operate efficiently over the range of frequencies generated by the driving stage. The receiving equipment included a mains-operated receiver with two stages of H.F. amplification and interstage circuits designed to give a flat response curve over a frequency band of $\pm$ 6 kc/s. The measured response curve is shown in Fig. 2. Two cathode ray oscillographs were also used, connected in parallel, with synchronised time-base equipment. One oscillograph was fitted with a Cossor type E tube and used for visual observations, while the other equipment included a type C tube and a camera attachment, and was used for taking photographic records. The Y plates of the oscillographs were connected to the anode of the detector valve of the receiver. The oscillograph spots were therefore deflected vertically by a distance proportional to the field strength of the received signal. The X plates of the oscillographs were connected to a "time-base" device, which was synchronised with the motor driving the transmitter drive condenser. This synchronisation was obtained by transmitting tone of about 1,000 cycles via a telephone line from the transmitter to the receiving station. The tone was interrupted by a cam operating contacts on the shaft of the motor rotating the transmitter drive condenser and, at the receiving station, was rectified. The resulting D.C. pulses were used to synchronise the oscillograph time-base with the variations in transmitter frequency. The oscillograph spot is therefore given a horizontal deflection proportional to the instantaneous transmitted frequency, and a vertical deflection proportional to the received signal intensity. The resultant trace will, therefore, in the absence of any anomalous transmission phenomena, represent the product of the response curves of the transmitter and the receiver, i.e., with satisfactory adjustments to these units the trace will be a horizontal line.

Representative samples of the results obtained during the period from midnight to 3 a.m., are shown in Figs. 3 to 11. They offer a ready explanation of the observations regarding the quality of transmission. When conditions, as in Fig. 3, apply, the field strength as indicated by an instrument tuned to 200 kc/s will be above the day-time value. Modulation frequencies of the order of 2 kc/s will, however, be very considerably attenuated compared with frequencies of a lower value, and reproduction will therefore suffer. Fig. 4 illustrates a condition in which the carrier experiences a partial fade-out. In this case, the lower frequency sidebands are considerably enhanced in amplitude compared with that of the carrier or the upper frequency sidebands ; signals will therefore suffer considerable distortion. Similar observations apply to a greater or less degree to the remainder of the records.

The shapes of the oscillographic records in Figs. 3 to 11, can be explained by assuming the existence of a ground wave together with indirect rays having experienced one or more reflections from the Heaviside layer. Typical calculated curves are shown in Figs. 12 and 13. Fig. 12(*a*) shows the variation in received signal with frequency, assuming that there exists, in addition to the ground ray, a ray reflected from a layer at a height of 90 kilometres, the two rays being of equal amplitude. Figs. 12(*b*) and 13 show the results which will be obtained when two indirect rays exist, one of which has been reflected once only from the Heaviside layer, whereas the other has experienced two reflections from the layer with an intervening reflection from the ground. In Fig. 12(*b*) the singly reflected ray is equal in amplitude to the ground ray, and four times as great as the doubly reflected ray. In Fig. 13 both reflected rays are equal in amplitude, and are each equal to one quarter of the ground wave amplitude.

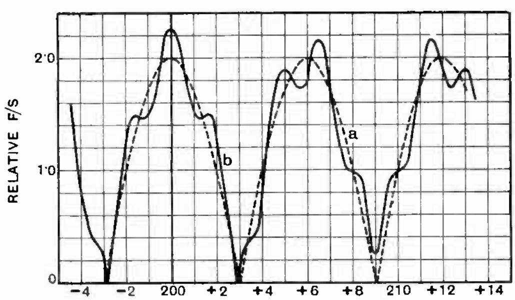


Fig. 12.—*Curve showing variation of amplitude with frequency for three rays of different path lengths corresponding to single and double reflections from Heaviside layer.* (*a*) *Amplitude of singly reflected ray equal to ground wave ;* (*b*) *Addition of doubly reflected ray of amplitude* $\frac{1}{4}$ *of ground wave.*

A comparison between the experimental results and the calculated curves reveals many similarities. It is obvious that Figs. 3 and 4 represent the reception of a reflected ray equal in amplitude to the ground ray ; Figs 5, 6 and 7 show a similar condition with the addition of a doubly reflected ray of progressively increasing amplitude. Figs. 8 and 9 show a close correspondence with the calculated curve of Fig. 13, representing singly and doubly reflected rays of about equal amplitude. Fig. 10 represents a condition which is not easily explained in terms of a single reflecting layer. Fig. 11 is of interest since it registers the only occasion on which the indirect ray was greater than the ground wave, a circumstance which can be inferred from the increase in the average height of the trace compared with the previous records. Quantitative analysis of the fading records enables an estimate to be made of the relative amplitude of the ground ray and the reflected rays ; the height of the reflecting layer can also be determined in terms of the frequencies at which minimum signal strength occurs, and the distance between the transmitter and the receiving station. An inspection of the whole of the records obtained gives an effective height of the reflecting layer varying between 93 and

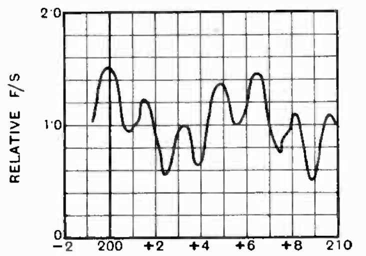


Fig. 13.—*Curve showing variation of amplitude with frequency for three rays of different path lengths corresponding to single and double reflections from Heaviside layer. Amplitude of both reflected rays = 25% of ground ray.*

97 kilometres. An analysis of one night's results has been made, and the variation with time of the amplitudes of the first and second order reflected rays has been plotted. The results are shown in Fig. 14. It will be seen that no proportionality exists between the variations in amplitude of the two rays, indicating that independent changes of the coefficient of reflection of the Heaviside layer occur at points 75 kilometres apart.

Conclusions

The above results demonstrate that the fading phenomena observed during the reception at Newcastle of signals from the long-wave transmitter at Droitwich are due principally to changes of the phase relation between the ground ray and a ray of comparable amplitude having experienced one reflection from the Heaviside layer.

A doubly reflected ray is often present; the amplitude, although measurable, is

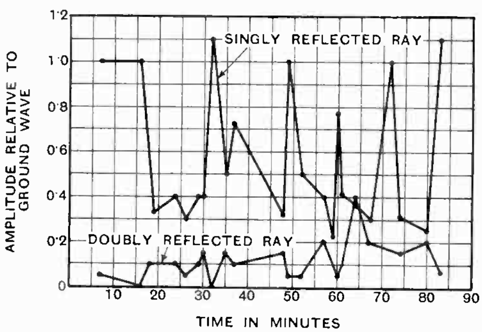


Fig. 14.—*Variation with time of amplitude of reflected rays.*

insufficient to affect reception adversely. The relative phase of the reflected and ground rays varies with frequency in such a manner as to produce audible distortion of modulated signals whenever the amplitudes are comparable, even though the phase relationship is such that the resultant amplitude at the carrier frequency is not less than the normal day-time value.

The day-time field strength corresponds to an attenuation of 6 dB due to finite ground conductivity and local screening; the maximum observed indirect ray corresponds to approximately 100 per cent. reflection at the Heaviside layer with no attenuation along the path. The observed phenomena may, therefore, be explained without the assumption of any abnormal conditions of radiation or transmission other than the rather low value of effective ground conductivity.

Patents for Inventions

By Reginald Haddon, Fellow of the Chartered Institute of Patent Agents. Pp. 99. Sir Isaac Pitman and Sons, Ltd., 39, Parker Street, London, W.C.2. Price 3s. 6d.

The inventor who seeks to take out Letters Patent must first negotiate the passage of his application through the Patent Office, where he is quite likely to find himself in deep waters. The object of Mr. Haddon's book is to explain as simply as possible the workings of the patent system, so that the inventor may learn to steer an intelligent course through what may appear to him to be an ocean of red-tape. More accurately stated, Mr. Haddon's aim is to persuade the applicant that in these circumstances he will be better advised to seek the professional assistance of a chartered patent agent. And in at least nine cases out of ten this advice is well founded.

Many things are required by the State from an inventor before it will give him the status of patentee. He is asking, in effect, for monopoly rights against the public at large, and it is only reasonable that he should give the public something of value in return. He will, of course, pay certain stamp fees, but that is only part of the story. First and foremost he must have invented something which represents a real addition to existing knowledge—and he must understand that it is part of the bargain that the benefits of his invention shall be passed on freely to the general public, as soon as his own monopoly period has expired.

This entails the filing at the Patent Office of a specification, in which the details of the invention must be set out in clear and unambiguous terms. In addition, the invention must pass the official test as regards novelty, and from these two requirements come most of the difficulties which beset the path of the would-be patentee.

Mr. Haddon throws some interesting light on the nature of a patent and explains its value as a weapon against infringers. He points out, however, that the grant of a patent can add nothing of value to an invention which, in itself, possesses no commercial utility. Again, even when an inventor succeeds in securing the Official Grant, it rests with the High Court alone to decide whether or not the patent is a valid one.

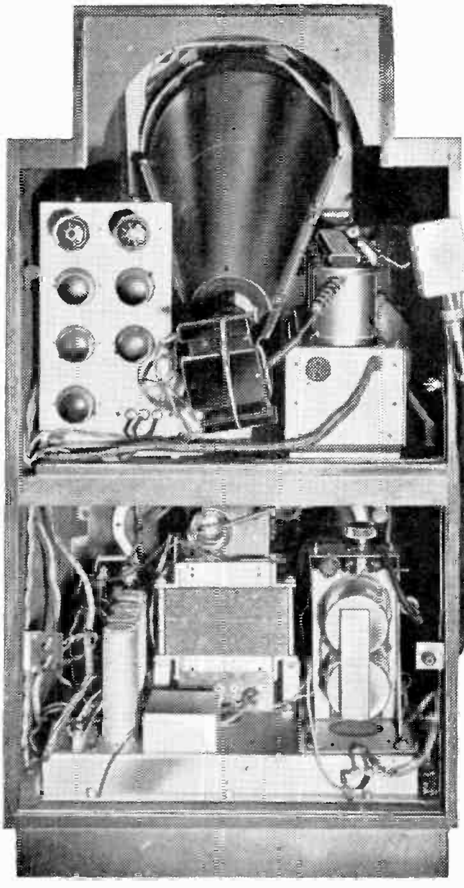
The book includes a useful section on Foreign and Colonial Patents, and a short account of Trade Marks and Designs.

Olympia, 1937

A Technical Survey

TO the technically minded the television apparatus on view at Olympia was undoubtedly one of the major attractions of the Show. Although akin to those of sound reception, the problems of television are much more complex, and considerable ingenuity is expended in efforts to overcome them.

The main difficulties confronting the designer are to obtain the necessary amplification and band-width with a reasonably small number of stages and to obtain good synchronisation so that the received picture is steady even when interference is present. There are many different ways of solving these problems, and television is as yet too new for any one to have become standard practice. The result is a refreshing variety of design.



The Pye Model 4046 television receiver.

The receivers can be divided into the usual two groups of the straight sets and the superheterodynes, and the latter category can be subdivided into single- and double-sideband types. The straight set is comparatively rare, but is used by H.M.V., Marconiphone, and Pye; in each case six R.F. stages are included before a diode detector, and in each case the detector feeds the vision signal directly to the C.R. tube. The H.M.V. and Marconiphone sets employ a single diode detector, whereas the Pye has a push-pull diode detector.

All these receivers include a type of C.R. tube which needs only a small signal, some 8 volts peak-to-peak, for modulation of the beam, and there is no doubt that it would not otherwise be possible to obtain sufficient output from the last R.F. valve and the use of a vision-frequency amplifier would be necessary. Although single-tuned circuits are used for the intervalve couplings in most stages, H.M.V. and Marconiphone adopt a coupled pair for the coupling to the detector in order to obtain better operating conditions for the last R.F. stage.

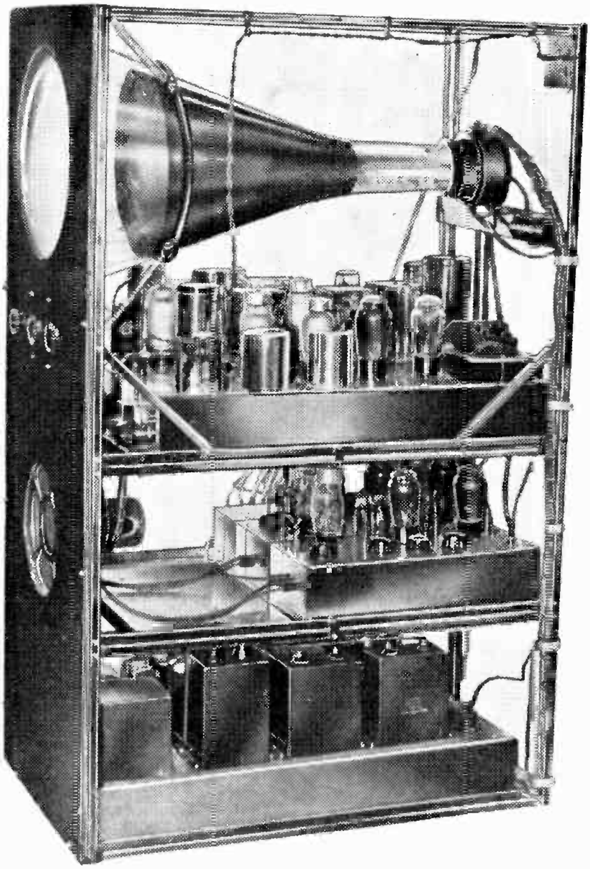
The band-width needed for the retention of modulation frequencies up to some 2.5 Mc/s makes the stage gain very low, but even so a total gain of the order of 50,000 times is claimed from six stages. The drop at the edges of the pass-band is, however, unspecified. The superheterodyne gives no greater gain per stage and the frequency-changer is often a passenger as far as gain is concerned; indeed, it is sometimes difficult to prevent it from attenuating. In all but the cheapest superheterodynes an R.F. stage is included to maintain the optimum signal-noise ratio.

Quite a number of sets are of the single-sideband type. In these the band-width of the I.F. amplifier is halved and the gain per stage is consequently doubled. The oscillator is tuned so that the intermediate frequency lies not at the middle of the pass-band but at a point at the side of the overall resonance curve where the response is – 6.0 db. At low modulation frequencies both sidebands are effective in producing the output, but at high frequencies only one.

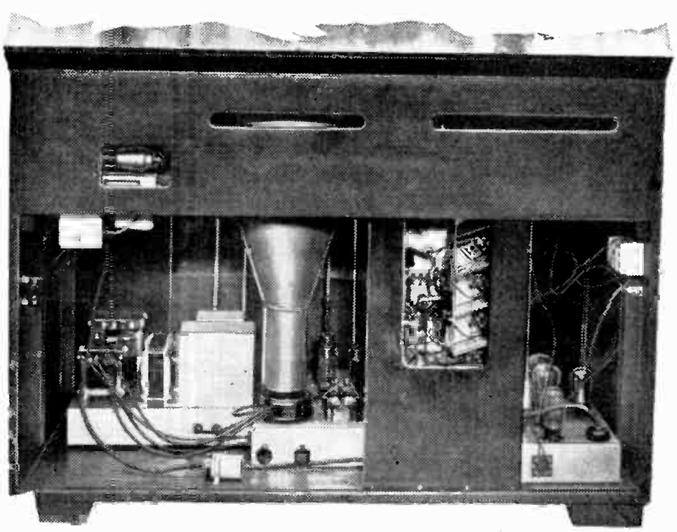
This system is adopted in the Ferranti receiver which has three I.F. stages and a pass-band of 11–13 Mc/s, the higher frequency being the intermediate frequency. The detector is a single diode. Philips in their projection receiver have four I.F. stages and a push-pull detector; the intermediate frequency is 11.1 Mc/s.

Other receivers retain both sidebands, but in spite of this the number of I.F. stages employed differs but little. Haynes Radio use four, Ultra Electric three at 6.1 Mc/s, Halcyon four, and R.G.D. four at 13.5 Mc/s. In all cases one vision-frequency amplifier follows the detector. This is somewhat surprising, because it would seem easier to secure an adequate output from the valve before the detector at the comparatively low operating frequency of a superheterodyne than at the high frequency of a straight set.

The reason probably lies in the special forms of interference to which the superheterodyne is subject. Harmonics of the intermediate frequency which are necessarily generated in the detector can cause serious interference if they are fed back to the input circuit. Extensive screening is needed to avoid such feed-back, and there is no doubt that the difficulties are considerably reduced by the lower I.F. amplification needed when a V.F. stage is included.

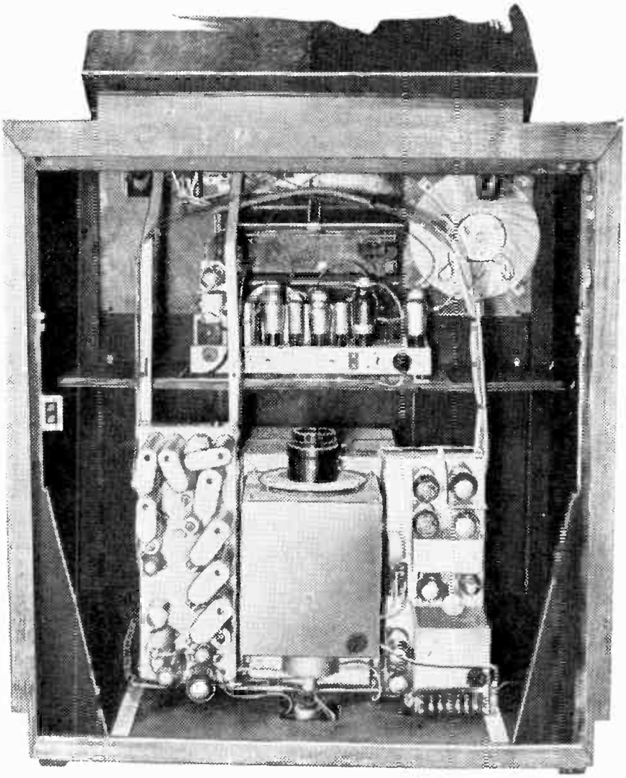


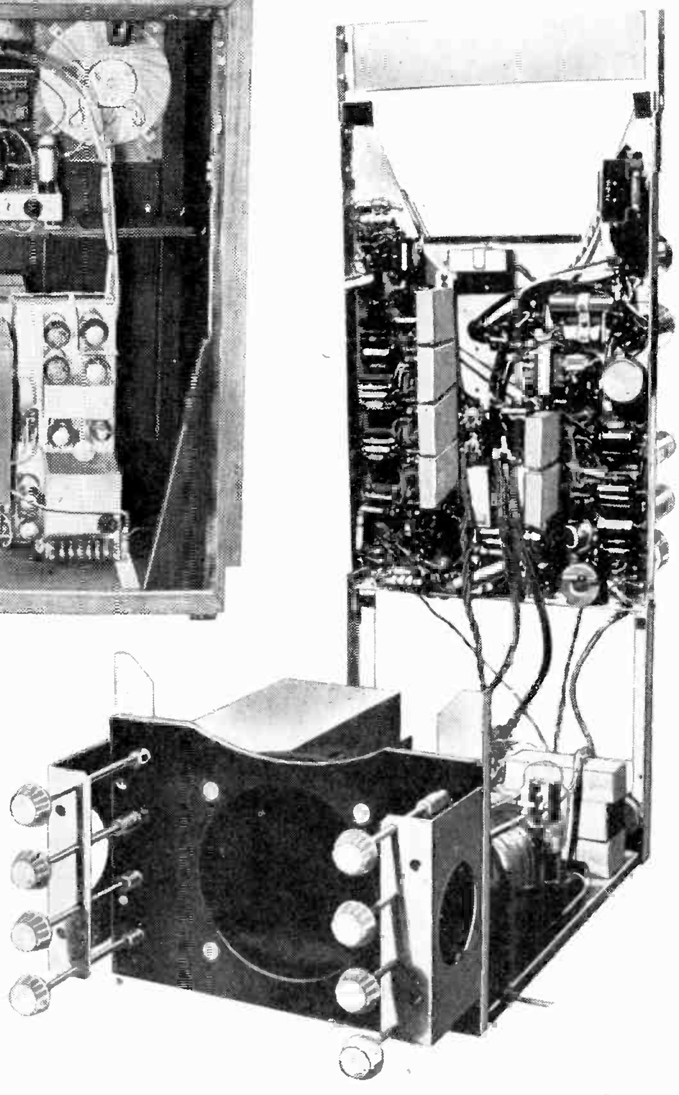
The Halcyon receiver with horizontally mounted tube.



A vertical tube mounting is adopted in the R.G.D. equipment shown on the right.

The use of a V.F. stage slightly complicates the arrangements for separating the synchronising impulses. It is rarely possible to employ D.C. amplification and the removal of the D.C. component of the signal results in a wandering zero of signal



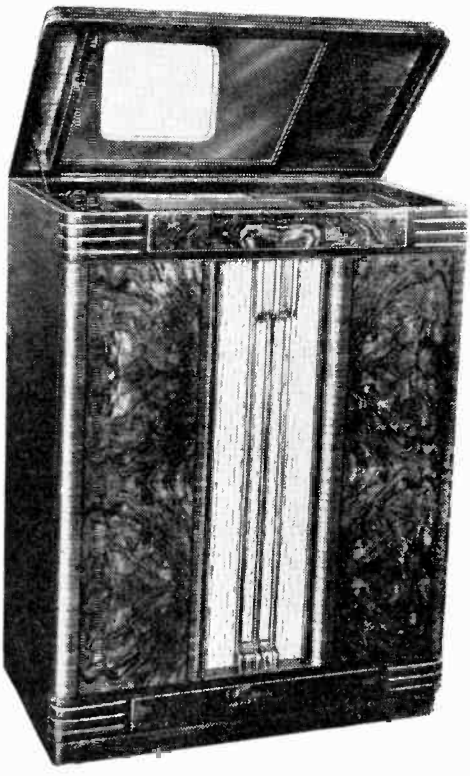


The small tube of the Philips projection-receiver is enclosed in the centre case with the lens above.

In the Ferranti apparatus the top deck of the chassis can be raised, as shown on the right, to obtain access to the underside components.

level. So far as the feed to the cathode-ray tube is concerned, the D.C. component can be retained, for it is easy to use direct coupling between a diode detector and a V.F. stage and also between such a stage and the tube. This course is adopted by many firms, including Ferranti, but others replace the D.C. component artificially. The most usual method is to shunt the grid leak of a resistance-capacity coupling by a diode, the polarity being such that the diode conducts on the sync pulses. The diode then passes current on each sync pulse and charges the coupling condenser to a value dependent on the signal amplitude; this charge, which varies slowly with changes in the signal, represents the artificially produced D.C. component. When the polarity is such that the sync pulses are positive, no diode is necessary, for grid current in the following amplifier or sync separating valve can effect the D.C. restoration.

D.C. restoration is adopted in one form or another almost without exception whenever a vision-frequency amplifier is employed. In the Haynes Radio Viceiver, for instance, the V.F. stage is followed by a diode D.C. restorer and a pentode amplitude filter for sync separation. Ferranti, however, follow the V.F. valve by a phase-reversing stage and then feed the signal into the amplitude filter, D.C. restoration being effected by grid current in this last valve.



The Ultra receiver has a vertically mounted tube.

The sync pulses when separated from the vision signals control the saw-tooth oscillators in the time-bases. Gas-triodes are widely used, but hard-valve oscillators are very popular. G.E.C., Halcyon, Haynes Radio and R.G.D. use gas-triodes for both line and frame circuits, and Philips and Pye use them for the frame scanning only and hard valves for the line. Ferranti, H.M.V., and Marconiphone use only hard valves. With one exception, the saw-tooth oscillators are followed by amplifiers. This exception is Ferranti, who in the frame circuit use only a single valve. This is a back-coupled triode and a saw-tooth current waveform is set up in a coil coupled to the grid and anode circuits of the oscillator ; this current is fed directly to the deflecting coil.

Where electromagnetic deflection is adopted the time-base amplifier is usually a pentode, but in the case of the line scan two pentodes are sometimes used in parallel. With electrostatic deflection, however, a pair of triodes in paraphase connection is more usual and is adopted so that the output is balanced to earth.

Electrostatic deflection is somewhat less widely used than magnetic, but is adopted by the G.E.C. and R.G.D., who also use electrostatically focused tubes. H.M.V., Haynes, Marconiphone and Pye adopt electrostatic focusing but electromagnetic deflection, but most other firms adopt an all-magnetic system.

The most usual tube size is 12in., but both Baird and G.E.C. have models with 15–16in. tubes and the latter firm has also a set with a 7in. tube. This was one of the cheapest sets in the Show, but it included no sound equipment, since it is intended for use in conjunction with an ordinary broadcasting set.

In the case of the small tubes, a horizontal mounting with direct viewing is universal, but with the large tubes many firms mount the tube vertically and arrange for viewing through a surface-silvered mirror carried by the cabinet lid. The Philips receiver departs most from standard practice, for the tube has a 4in. screen only. It operates at 25,000 volts and a brilliant picture about 2in. across is obtained and is projected with the aid of an f/1.9 lens and inclined mirror on to an etched-glass screen. The resulting picture size is 2[illegible]in. by 16in. as compared with the 10in. by 8in. picture obtained with a 12in. tube.

Cathode-ray tubes were shown by Baird, Cossor, Ediswan, and Mullard. The television types of Baird range from 12in. to 22in. in diameter and are for electromagnetic deflection and focusing ; Ediswan have 9in. and 12in. tubes of this type, and Mullard, 12in. and 15in. Cossor Ediswan, and Mullard have electrostatically focused and deflected tubes from 9in. upwards. These firms also showed oscillograph tubes in a wide variety of types. Cossor have both high vacuum and gas-focused models, but other makes are high-vacuum. Mullard have one which is specially designed so that an unbalanced input can be used without distortion.

Television has stimulated valve develop-

An innovation in cabinet work ; the Alba chair-side receiver. Several sets of this general type were shown.

ment and there is now a wide range of special types for vision amplifiers. R.F. pentodes with mutual conductances from 5.0–7.5 mA/V. are to be found by most makers. Cossor, Marconi, Mazda, Mullard and Osram all have specimens of this type, and many have special low-resistance diodes. Cossor has the DDL4, a low-resistance duo-diode, while Marconi and Osram have the D42, a single diode. Mazda has produced the D1, a single diode which is unbased to keep the capacity at a minimum.

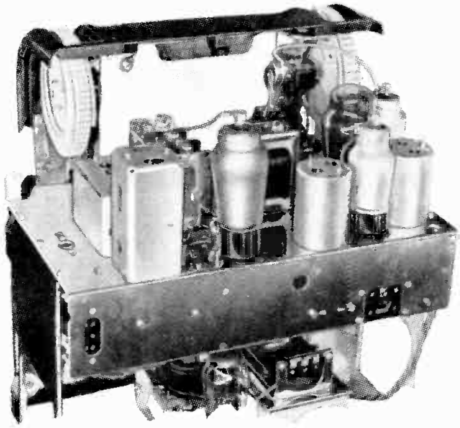
An indirectly-heated rectifier, the HVR2, rated for 20,000 volts peak inverse, is made by Mullard and intended for the high-voltage supply to cathode-ray tubes. Split-anode tetrodes for sync separation are made by Cossor, as well as a series of special triodes for time-base work and one designed to operate as an ultra-high frequency oscillator without local heating.

Marconi and Osram have an Acorn R.F. pentode, the ZA1, and have made a change from the usual practice in their new range of "non-specialised" valves. The new International valves have the American Octal base, the American 6.3 volt 0.3 amp. heater, and American characteristics. Similar valves are also marketed by Tungsram.

These firms, as well as Cossor, Hivac, and Mazda, are replacing output pentodes by tetrodes. The construction adopted is not the same in all cases, and in the Hivac range the usual tetrode negative-resistance kink is avoided by the adoption of the "critical distance anode." Some others, however, adopt the "beam" principle and earthed plates are included for the purpose of confining the electron stream to a beam.

It is claimed that the tetrodes have better characteristics than pentodes and that a greater output can be secured. The adoption of Class AB operation is also a help in this direction, and two valves in push-pull will now give 25–30 watts output as compared with 5–8 watts for a single valve of the same type.

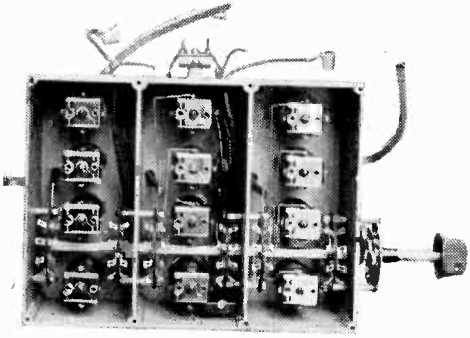
Judging by the tendency towards a slowing-down of technical progress that had become evident at the last few shows, it might have been anticipated that this season's broadcast receivers would in all essentials be very similar to their pre-



Edgewise control drums of the Ekco receiver.

decessors of last year. While it is true that there is little change in the basic circuit arrangement of the various classes of sets, the visitor to Olympia could not fail to be impressed by the way in which recent technical advances have found their way into production models. Indeed, the slowing-down process seems to have been arrested, and technical stagnation is clearly a long way off.

Perhaps the most noticeable single feature of the new sets is the great increase in rated output power. Anything more than 2½ to 3½ watts was last year a matter for comment in all but high-priced productions of specialist firms ; to-day 5 or 8 watts is commonplace among sets costing 15 guineas or even considerably less. This increase of output has been attained largely by the application of the negative feed-back principle to pentodes and also by the use of the newly introduced " beam " tetrodes, already mentioned in this article ; indeed, the ubiquitous pentode, which for so long has been universal in low-priced sets, has at last found a serious rival. In a few quite moderately priced sets triodes in push-pull were to be found ; an example of this practice was observed in the G.E.C. " All-wave Quality 8," with a rated output of 6 watts. " Beam " tetrodes in push-pull, giving an output of some 10 watts or more, are used in certain of the more ambitious H.M.V. and Marconiphone models, while Philips in the Type 837AX receiver, uses a pair of parallel-connected pentodes, which, with the help of negative feed-back, give 9 watts.

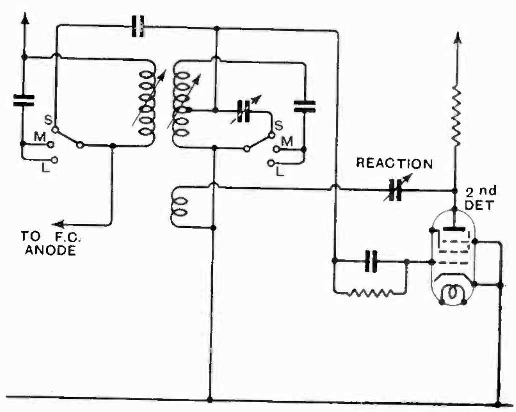


Coil and switch unit of a 4-band receiver (Eddystone).

Last year the inclusion of one or two short-wave ranges, entitling the set to be called " all-wave," was still a novelty. Nowadays, the typical domestic receiver has one or more short-wave ranges as a matter of course, except in very cheap models or in specialised sets designed primarily for high-quality reproduction. There is a distinct tendency to provide more wave-ranges, thus giving more continuous coverage and also extending the lower limit of wavelength. Most of the medium-priced sets (15 guineas or a little more) have four wave-ranges, and some five.

With a few exceptions, the short-wave ranges have been added more or less in the conventional and obvious manner by providing extra sets of coils with the corresponding extra number of contacts on the wave-changing switch. It follows, therefore, that the success or failure of the new receivers, so far as short-wave reception is concerned, is bound up largely with the mechanical excellence of the variable condenser drive and the facility with which extremely critical tuning adjustments may be made. Some very ingenious slow-motion drives were to be seen.

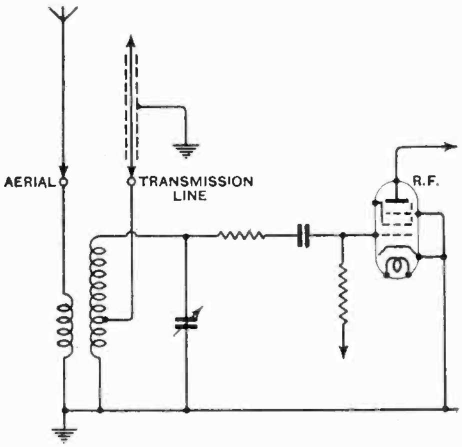
The reception of " television sound " is widely offered as an attraction by the makers of medium-priced and even relatively cheap sets. Some of those in the first-mentioned class even embrace the 5-metre waveband. One may, however, be permitted to doubt whether the sound accompaniment to television will, in fact, prove an acceptable source of entertainment to the average listener. For some unknown reason, even the makers of receivers with the widest wavelength coverage do not apparently lay any stress on the suitability of their productions for receiving the anticipated ultra-



Method of changing the value of the intermediate frequency (Cossor). Amplification is provided by regeneration, there being no I.F. valve.

short-wave broadcast service, which would appear to offer much greater attractions.

The downward extension of wave-range has been responsible for an important change



Provision for matching a screened aerial transmission line is made in the H.M.V. Model 650.

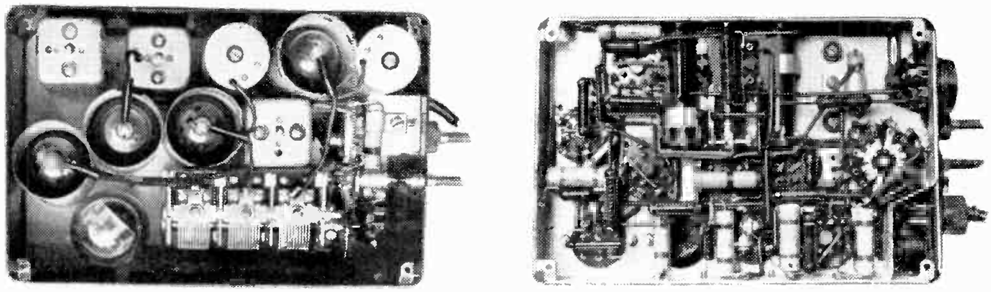
in the average domestic receiver ; the triode-hexode is now widely used as a frequency-changer, or where some other type of valve is employed, it often works in conjunction with a separate oscillator.

An intermediate frequency of 465 kc/s is most generally favoured in the all-wave superheterodyne, though in one of the number of valves, there is a distinct tendency to produce rather more ambitious receivers with such additions as a signal-frequency amplifier, an intermediate A.F. stage, and sometimes a second I.F. amplifier, to say nothing of the more liberal use of valves for what may be described as auxiliary purposes.

So far as domestic receivers are concerned, the tuned radio-frequency amplifier has almost entirely disappeared except in the cheapest form. Even the Dynatron firm, which has previously shunned the superheterodyne, have this year combined it with the T.R.F. principle in an extremely ambitious receiver with a total of 14 tuned circuits. The " straight " circuit is, however, preferred by several makers of specialised apparatus.

Designers of battery sets seem to have decided that, now the average audio-frequency output of mains-driven sets is so high, it is no longer possible to compete, particularly in view of the general reluctance to use anything larger than the " standard " capacity of H.T. battery. Thus there is a tendency for the push-pull output stage to give way to the simple pentode or tetrode giving only 400 or 500 mW ; perhaps the increasing sensitivity of permanent-magnet loud speakers has influenced this decision.

A signal-frequency amplifying stage has hitherto been widely used in battery superheterodynes in order to compensate for the



Top and underside views of the new Ferranti car radio set.

Cossor models this value is used only on medium and long waves, the frequency being increased automatically by operation of the wave change switch to 1,363 kc/s for short-wave reception.

Although the typical cheap set is still a small superheterodyne with the minimum lower general effectiveness of the valves, as compared with their mains-operated counterparts. Such a stage figures in comparatively few of the new seasons's sets, and it is to be assumed that the necessary sensitivity has been attained by increased coil efficiency and the use of improved valves.

Small self-contained receivers, of compact design and so light in weight that they may be described as truly portable, are now firmly established in favour. Most of the sets weigh less than 20 lb.; one or two little more than 10 lb. The circuit arrangement is simple and conventional, comprising a single RF stage, grid detector and one or two A.F. stages; considering the very low pick-up of the small frame aerials used in such sets, their average sensitivity is surprisingly high.

Tannoy high-powered projection loud speaker.

There can be no doubt that from a technical point of view one of the most interesting loud-speaker exhibits was the Tannoy high-powered projection loud speaker for use at sea. This unit is capable of handling at least 300 watts with an efficiency of the order of 50 per cent. A massive cast aluminium horn with a flare diameter of 2ft. is employed. The voice coil is 4in. in diameter and operates in a field of 16,000 lines per sq. cm. provided by the electro-magnet consuming 150 watts.

Another interesting P.A. reproducer is the Goodmans Concentric Diffuser unit. This is designed for use at large sports gatherings and projects sound energy more or less in a horizontal plane. A deflector cone in association with six radial cells determines the direction of the beam and throws a more or less well-defined shadow immediately below the loud speaker which may be taken advantage of in placing the microphone to avoid acoustic feed-back.

Improvements in the small loud speakers for use in receiving sets are not such as to be apparent to the eye. There has been little change in the form of diaphragms, but considerable advances have been made in magnet design as a result of the introduction of aluminium-nickel-cobalt alloys. The efficiency of permanent magnet speakers is such that in some cases manufacturers are fitting these units in mains-operated receivers in preference to the more usual energised types. Special models of which the Rola F742-PM is a good example, are being developed for use in battery sets where with the small output available from battery valves a high sensitivity and electro-acoustic efficiency is desirable.

In large-sized loud speakers for quality reproduction permanent magnets are also coming into general use and the Haynes Senior loud speaker and the Celestion Senior PM Auditorium may be quoted as examples. The latter has a flux density of the order of 14,000 lines per sq. cm. and the active magnetic material is concentrated in two concentric rings clamped between circular end plates. The magnetic properties of the alloy used in the inner ring differs slightly from that in the outer ring, and by this means it has been found possible to obtain a higher flux density than would be obtainable with a homogeneous single ring.

There has been some revival of interest in loud speakers in which a box baffle forms an essential part of the acoustic system, and examples of this form of construction were shown by Whiteley Electrical and Celestion.

It is also gratifying to note that more attention appears to have been given to the question of focusing at high frequencies and to the devising of methods for overcoming this disadvantage of cone-type diaphragms. In the loud speakers used in Philips sets, for instance, a small bakelite diffuser cone attached to the centre pole-piece achieves the desired object. Another possible solution is to be found in the adoption of an elliptical cone, and examples of this type of loud speaker were shown by Goodmans Industries, Whiteley Electrical and the Plessey Co.

Inexpensive signal generators intended mainly for the service engineer were shown by several firms this year at very reasonable prices. All the new models cover the short waves on fundamental frequencies and harmonics are now only being used to provide an ultra-short waveband.

The All-Wave Avo Oscillator has a coverage on fundamental frequencies of 100 kc/s to 30 Mc/s in six ranges and an ultra-short waverange of 30 to 60 Mc/s using second harmonics. All ranges are directly calibrated in frequency. The R.F. output is controlled by a four-position step attenuator and a continuous slide wire, and the maximum output under control is 500 micro-volts. A fixed output of one volt is also provided.

A separate valve generates a 400 c/s signal which can be used to modulate the R.F. oscillator or it can be used independently for testing L.F. equipment. The oscillator is battery-operated.

A new signal generator, also an all-wave model and using fundamental frequencies on all bands, was shown by Wearite. Seven plug-in coils are used to cover a range of 100 kc/s to 20 Mc/s, while internal modulation at 1,000 c/s is provided for this A.C. operated oscillator.

The All-wave Test Oscillator that was shown by Everett Edgcumbe gives an R.F. output on fundamental frequencies from 100 kc/s to 30 Mc/s, and provision is made for internal or external modulation. It embodies a calibrated attenuator which reduces the R.F. output to one microvolt on all ranges.

Avo All-Wave Oscillator.

An oscillator that can be used for routine test work or employed in conjunction with their C.R. oscilloscopes for visual examination of band-width of receivers and the alignment of circuits was shown by Cossor.

Cossor Model 3363 oscillograph with 12-inch tube.

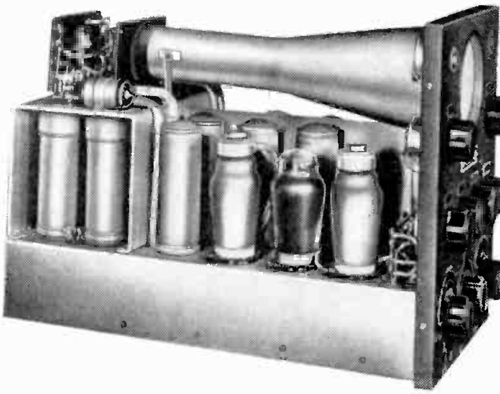
The sweep voltages from the oscillograph equipment is utilised to frequency-modulate the R.F. oscillator and trace a complete response curve on the oscilloscope screen.

In five ranges using fundamental frequencies it covers 85 kc/s to 20 Mc/s. Being intended chiefly for use with the oscilloscope the R.F. output is limited to 100 millivolts, which is controlled by a three-position attenuator and a continuously variable potentiometer. It has four valves and is A.C. operated.

The cathode-ray oscilloscope is rapidly assuming a rôle as important as that of the signal generator in the equipment of the modern radio laboratory. Not only is it indispensable for the visual confirmation and measurement of looked-for effects but it frequently reveals unsuspected parasitic oscillations and other secondary phenomena.

Two oscilloscopes and a very complete range of auxiliary amplifiers were shown by Cossor. Model 3332 is a compact instrument using a 4½-inch diameter gas focused tube. A self-contained power pack and a time base with a frequency range up to 50,000 c/s are included as well as a single triode input amplifier with a gain of approximately 26 db. and a frequency range of 20–100,000 c/s. Multi-range deflector coils are provided covering a range of 1 mA to 3 A. The

Model 3363 oscillograph is a recent addition to the range of Cossor equipment. It makes use of a 12-inch television tube and is equally suitable for laboratory measurement work or lecture demonstrations. It is housed in a large well-ventilated metal case and the power pack and time base units



Mullard cathode-ray oscilloscope, Type GM3152.

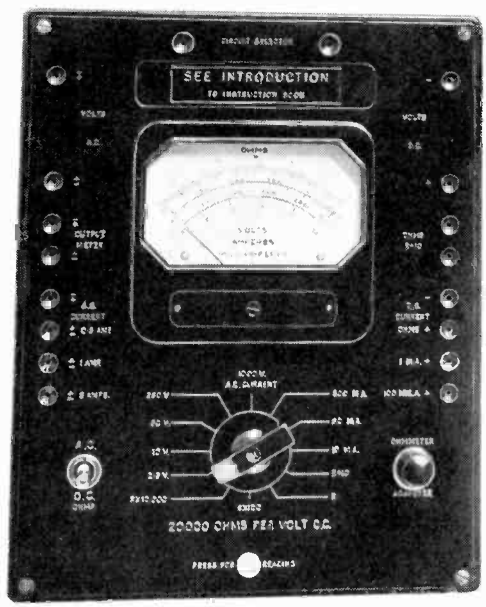
(the latter of the hard valve type) are separate units which can be easily removed for servicing. In addition to the usual controls for *X* and *Y* shift, focusing and brilliancy, there is a switch giving four alternative H.T. voltages with 4,000 volts maximum, beam trigger bias control and variable beam trigger time constant enabling single transients of any given duration to be photographed.

Auxiliary amplifiers designed for use with Cossor oscillographs include the Model 2355 D.C. amplifier with a range from zero to 100 kc/s for use with resistance pressure elements and the Model 3319 audio frequency amplifier with a range of 20 c/s–18 kc/s designed primarily for use with piezo-electric microphones.

The Mullard Company were showing a versatile cathode-ray oscillograph, Type GM3152, using a 4-inch diameter tube. The instrument includes a linear time base covering 10 c/s–150 kc/s in ten ranges, and a two-stage push-pull input amplifier with a range of 10 c/s–1 Mc/s level within $2\frac{1}{2}$ db. By means of a six-position switch the time base can be synchronised with the output from the amplifier, with the external frequency, with the mains, etc. For work at ultra-high frequencies direct connection to the deflector plates is possible through short leads connected to terminals on the back panel. This panel also carries a switch for suppressing the beam or momentarily increasing its brilliance for photographic purposes. Having regard to the comprehensive nature of the equipment the dimensions of $16\frac{1}{2} \times 8\frac{3}{4} \times 11\frac{1}{2}$in. are remarkably compact. The weight of the complete instrument is approximately 42 lb.

There was shown by the Weston Electrical Instrument Company a new wide-range test set described as the Super Sensitive Analyzer. It is for voltage, current, resistance, capacity and power output measurements and has a resistance on all voltage ranges of 20,000 per volt. Five ranges are provided for A.C. and D.C. voltages, the highest being 1,000 volts and the lowest 2.5 volts. The most sensitive current range is 100 microvolts at full-scale reading.

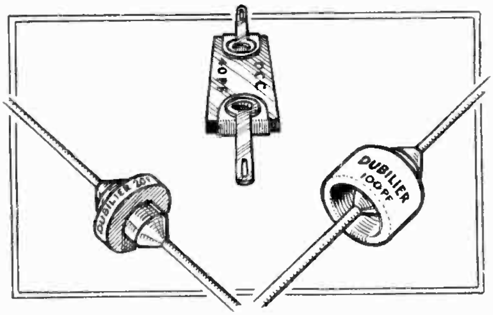
The latest Model 7 Avometer, which has 46 separate ranges, was shown by the Automatic Coil Winder and Electrical Equipment Company. In addition to its excep-



Weston Super Sensitive Analyzer.

tionally wide application a feature of interest regarding this instrument is the inclusion of an overload cut-out in place of a fuse for protection of the meter unit.

There were several new valve testers shown this year; one, the Mullard Master Test Board is of special interest in that perforated cards are used to make the necessary internal changes in the instrument for testing valves. Test cards for all types of valve in general use are available as well as cards for converting it into a test set for voltage, current, resistance and capacity measurements.

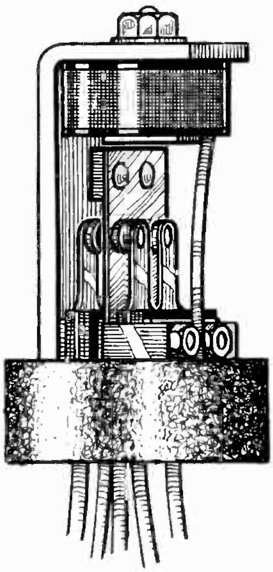


Dubilier ceramic and metallised mica condensers.

In regard to components it was noticed that several new all-wave coil units have appeared this year, also that quite a number of firms are taking an active part in the development of special components for use in television sets.

Mains transformers, condensers, valve-holders and connectors in various forms for operating at high A.C. and D.C. potential were also well in evidence.

In addition to showing a variety of fixed condensers of this kind Dubilier had a full range of the new ceramic dielectric condensers, the special features of which are low-temperature coefficient, stability under all conditions of use and the high accuracy in values that can be obtained in manufacture. They are made in the form of discs, cups and tubes. Capacities of from 2 to 1,200 m-mfds. are available in this pattern.



Construction of the new Bulgin electronic self-rectifying H.T. vibrator.

Ceramic dielectric condensers in the form of discs and cups of similar size were shown also by T.C.C. They are intended for a maximum working potential of 500 volts D.C. and they have an insulation resistance of 5,000 megohms.

Another item of special interest was the vibrator-rectifier device for obtaining H.T. from an L.T. accumulator. The new Bulgin models are claimed to give at least 1,500 hours trouble-free service and they are designed to handle 15 watts. Used in conjunction with a transformer the 6-volt model develops 4 volts A.C. across the primary, which with the synchronous-rectifier type, can be stepped up to 250 volts. Full-wave rectification is provided. Vibrators for 4, 6 and 12 volts are now available.

The Industry

USEFUL information on the applications of metal rectifiers to the power supply systems of transmitters and receivers is contained in a new publication entitled "Westinghouse Rectifiers for Telecommunications." Copies are obtainable from the Westinghouse, Brake & Signal Co., Ltd., 82, York Road, King's Cross, London, N.1.

The Physical Society announces that the annual Craftsmanship and Draughtsmanship Competition will be held as usual in conjunction with the Society's January exhibition.

Among exhibits of wireless interest at the Engineering and Marine Exhibition, Olympia, which closes on October 2nd, are two Marconi transmitters, together with a highly selective all-wave marine receiver and the latest auto-alarm apparatus produced by the same firm. Gambrell Radio Communications is showing direction-finding apparatus, the G.R.C. Auto-Alarm Type 25 and two complete radio-telegraphic installations as well as lifeboat equipment, etc.

"Characteristic Constants of H.F. Pentodes"

IN the above article by Dr. Strutt, published in our last issue, in Table 1 on page 483, the active value of $R(M\Omega)$ for the valve AF3 at 230 metres should be 12 and not 1.2 as shown. On page 485 there appear, in the first column, two equations. In each of these 10^{-6} should read 10^{-16}, thus giving $C = 0.0031 - 0.0075 . 10^{-16} (2\pi f)^2$ and $C = 0.0024 - 0.0059 . 10^{-16} (2\pi f)^2$.

A Thermionic Wattmeter

By Raymond J. Wey, A.M.I.R.E.

(Concluded from page 495 of last issue)

6. Calibration with Sinusoidal Input

It was decided to calibrate the valve on sinusoidal waveform before checking the method for the elimination of errors due to harmonics. The bias of grid 1 was set to 9.36 volts negative, which allows a voltage swing of ± 8.6 volts to be accepted, grid current starting at about -0.8 volts. A bias larger than -10.4 cannot be used without reduction of the peak input voltage below the maximum of 9.6 volts possible with this bias, as the potential of grid 1 must not swing below point M (20 volts negative with respect to the cathode). Examination of the $e_4 - i_a$ characteristics in Fig. 1 shows that a reasonably straight portion, with good slope, occurs at about 4.7 volts negative bias. At lower values of bias the slope increases but slightly, whilst the anode current increases rapidly. At the selected values of bias the steady anode current was 2 mA.

The test results are plotted in Fig. 5, which shows the response in micro-amperes per (volt R.M.S.)², *i.e.*,

$$A = \frac{I}{E_1'E_4'} = \frac{2I}{E_1E_4}$$

where A = response in micro-amps/(volt R.M.S.)²

E_1' = R.M.S. voltage at grid 1.

E_4' = R.M.S. voltage at grid 4.

The tests were made over a range of values of E_4', with various ratios of $\frac{E_1'}{E_4'}$ or $\frac{R_1 + R_2}{R_2}$. As would be anticipated, at large values of input voltage errors are produced due to the departure of the actual characteristics from the form assumed in equation 1, but it will be seen that the error is not greater than 2.5% when $E_4' < 1.4$ V and $E_1' < 2.8$ V (curve *B*.) The response tends towards a constant value of 103.3 micro-amps/(volt R.M.S.)² at low values of input, when the effect of curvature becomes negligible.

In general, when using thermionic valves as a basis of measurement it is difficult to obtain a much greater accuracy than 1%, unless all potentials are very carefully controlled and frequent calibrations performed. In the present case, where the result depends upon a multiplicity of electrodes being maintained at constant potential, and furthermore, upon the measurement of small differences in anode current, an accuracy of 2.5% can be regarded as reasonable.

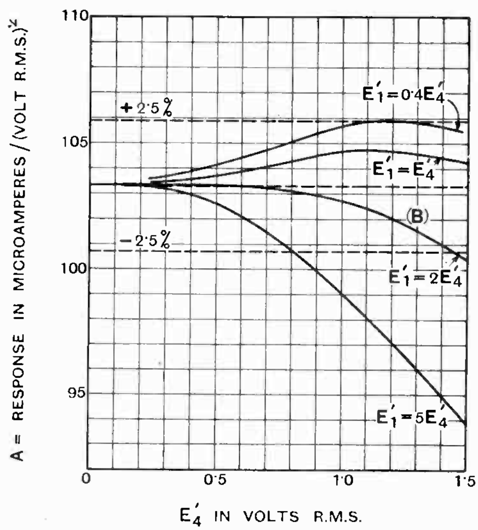


Fig. 5.

The theoretical value of A can be calculated from the static characteristics, and agrees fairly well with the measured mean value of 103.3. Values of constants which give a fairly good approximation to the actual characteristics are as follows :—

$g = 0.94$ mA/V. $a = 0.0067$

$b = 0.0022$ $M = 20$ volts.

$\therefore P = M - 9.36 = 10.64$ volts.

$$A = \frac{2I}{E_1E_4} = \frac{2g\,E_1E_4}{E_1E_4}(a + 2bP)\cos\phi$$

$$= 2g(a + 2bP) \quad \ldots \quad \ldots \quad (8)$$

Substituting the numerical values,

$A = 2 \times 0.94(0.0067 + 2 \times 10.64 \times 0.0022)$

$= 0.1007 = 100.7$ micro-amps/(volt R.M.S)².

7. Effect of Odd Harmonics

It has been shown that provided only odd harmonics are present in the grid input voltages no errors will be caused if the valve characteristics can be truly represented by equation 1. Since in practice this does not hold exactly a certain degree of error would be expected, but this error should definitely

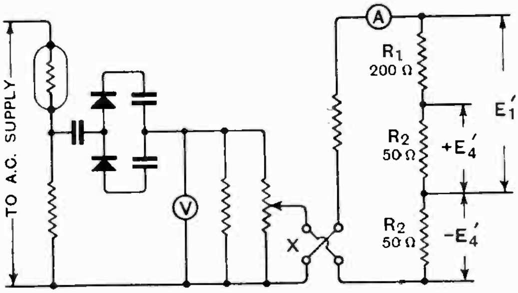


Fig. 6.

be of small magnitude compared with that obtained when even harmonics are present. In order to verify this, a circuit was arranged to produce a waveform rich in odd harmonics, particularly the third, but with little or no even harmonics (*see* Fig. 6). The circuit was found to give about 60% third harmonic, the other odd harmonics not being determined.

To check the absence of even harmonics measurements were made with the switch X, Fig. 6, reversed between successive readings. The difference between these readings was found to be quite small, actually not exceeding one per cent., from which it can be concluded that even harmonics were not present in any appreciable degree. To eliminate this already small effect the mean

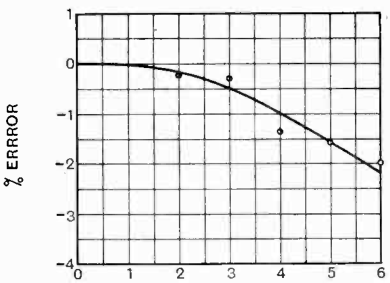


Fig. 7.

of the two determinations was assumed to be the true value (that this assumption is correct will be seen shortly). The results so obtained are shown in Fig. 7, from which it will be evident that odd harmonics have but a negligible effect on accuracy. It should be noted that the error shown in Fig. 7 is the difference between the sinusoidal calibration values and those obtained with harmonics present. In other words, it is an additional error, which must be added to those of Fig. 5 to obtain the total error. It is not serious, however, being about 0.3% when E_1' is 2.5 volts R.M.S., which, due to the presence of the harmonics, corresponded to a peak value of 4.9 volts. These results should be compared with those obtained with even harmonics, described in the next section.

8. Effect of Even Harmonics

The circuit shown in Fig. 8 was now arranged, giving a waveform rich in even harmonics, and especially the second

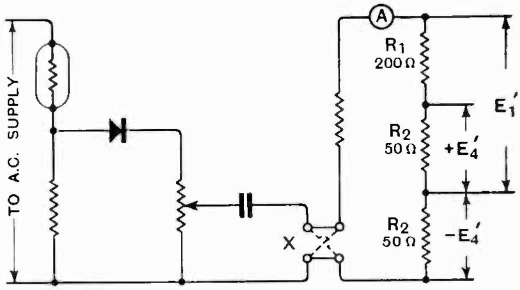


Fig. 8.

harmonic, which had a value of 50% of the fundamental. As would be expected, the response with this distorted waveform differed considerably from that obtained with sinusoidal inputs, the discrepancy increasing with the amplitude of the applied voltages. The results obtained are shown in Fig. 9, in which curve A is the error with the polarity as given in the diagram, Fig. 8, *i.e.*, the positive half-wave having the larger peak value. It will be seen that the error is approximately proportional to the input voltage E_1', in accordance with the conclusions in Section 3. The readings were now repeated with the reversing switch X changed over, thus making the negative half-wave of input voltage to grid 1 of greater magnitude than the positive half-wave. Curve B shows the results obtained, and it will be observed that the errors are of approximately the same magnitude as those given by curve A, but are of opposite sign. The resultant error of the mean of the two sets of tests is shown in curve C, and it is evident that the effect of the even harmonics has been reduced to negligible proportions, in accordance with theory. As in Fig. 7, the errors given in Fig. 9 are the difference between the readings obtained with distorted waveform and sinusoidal

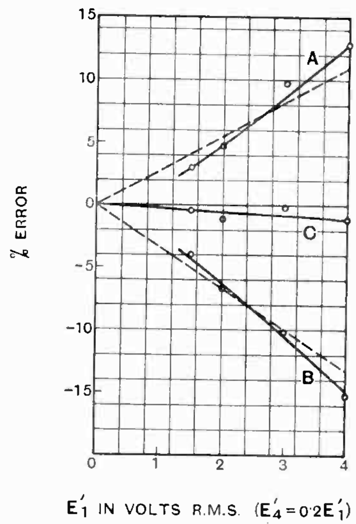


Fig. 9.

waveform. The resultant error is only 0.7% when E_1' is 2.5 volts R.M.S., corresponding to a value of 4.65 volts peak, due to the presence of harmonics.

9. Effect of Power Factor

If the load possesses reactance, the voltage and current will not be in phase, and, furthermore, if harmonics are present, the phase displacements of the harmonics will differ from that of the fundamental. It is evident, however, from the equations that the heptode wattmeter should correctly indicate the power, since this is proportional to $\int e_1e_4$ in any circuit connected as shown in Fig. 4.

It was decided to test the effect of reactance in the load with sinusoidal current only, and by bringing the condenser C into the circuit, and suitably adjusting its value in conjunction with R_1, it was possible to vary the power factor from about 0.25 to unity whilst keeping the impedance constant. A number of tests were made with various values of input voltages, up to $E_1' = 2.5$ volts R.M.S. and $E_4' = 1.0$ volt R.M.S., and in no case was it found that the error exceeded 1%. Typical results are shown in Fig. 10, obtained with constant input voltages of $E_1' = 2.5$ V R.M.S. and $E_4' = 0.32$ V R.M.S., the phase angle varying from zero to about 75°, *i.e.*, a power factor variation of unity to 0.25.

10. Practical Load Circuits

Since the load must be in series with the additional resistance R_2, there is an extra power loss which must be taken into account. Referring to Fig. 11, it will be seen that with this method of connection, the measured power is the sum of the power in the load Z and the loss in R_2. Thus, if W_L is the instantaneous power in the load circuit and i_L the instantaneous current, then

$$W_L = \frac{e_1e_4}{R_2} - i_L^2R_2$$

Normally $i_L^2R_2$ would not be known, but it may be found quite easily by connecting grid 1 to point Y and repeating the reading. In this case

$$W_L = \frac{(e_1e_4)_X - (e_1e_4)_Y}{R_2}$$

where $(e_1e_4)_X$ is the instantaneous volts² input with grid 1 connected to point X and $(e_1e_4)_Y$ the input when this grid is connected

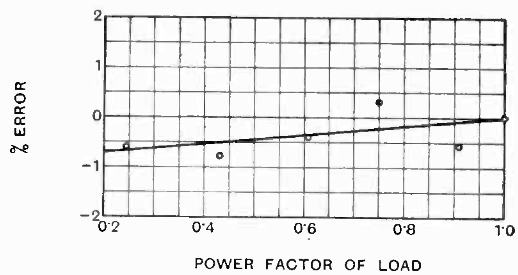


Fig. 10.

to point Y. The foregoing naturally applies to mean values as well as instantaneous values, so that

$$W = \frac{I_X - I_Y}{R_2A} \quad \ldots \quad \ldots \quad (9)$$

where W = power in watts in Z.

I_X = change of anode current obtained with grid 1 connected to X.

I_Y = change of anode current obtained when grid 1 is connected to Y.

A = Change of anode current per (volt R.M.S.)^2 input, measured with sinusoidal waveform and unity power factor.

With grid 1 connected to Y, the wattmeter becomes a square law ammeter, the R.M.S. value of the load current I_L being given by

$$I_L = \frac{1}{R_2}\sqrt{\frac{I_Y}{A}} \quad \ldots \quad \ldots \quad (10)$$

A disadvantage of the simple circuit just dealt with is that the load voltage is limited to that which grid 1 will accept, less the drop over R_2. An obvious solution is the use of a step-down transformer between the load and grid 1. On the other hand, when the available voltage drop across the load and R_2 is too little to enable a reasonable input to be applied to the grids, step-up transformers can be used for both e_1 and e_4. Such an arrangement is normally inapplicable to any frequency above moderate audio-frequency, owing to the phase displacement caused by the transformers.

An alternative means of enabling a higher load voltage to be used is shown in Fig. 12, in which grid 1 is connected to a potential divider consisting of R_3 and R_4 in series across the supply. In this case it is easy to show that

$$W = \frac{I_X}{kAR_2} - I_L{}^2R_2\left(\frac{1}{k} - 2\right)$$

where $$k = \frac{R_4}{R_3 + R_4}$$

This is also, in terms of I_X and I_Y

$$W = \frac{I_X}{kAR_2} - \frac{I_Y}{AR_2}\left(\frac{1}{k} - 2\right) \quad \ldots \quad (11)$$

When $k = 0.5$, the second term is zero, and hence there is no correction for the loss in R_2, or

$$W = \frac{2I_X}{AR_2} \quad \ldots \quad \ldots \quad \ldots \quad (12)$$

A somewhat similar case is dealt with by Dr. Mallet in the article previously mentioned.

It will be observed that in the tests described the grid bias battery B_2 was at an alternating potential with respect to the cathode. This was of no account, however, owing to the low frequency used (50 cycles) and the low circuit resistances R_1 and R_2, of the order of a few hundred ohms only.

When higher frequencies or circuit impedances are used it would be desirable to isolate the grids by means of condensers, and to apply the bias through grid leaks in the usual manner, from a common grid battery at cathode potential. The effect of capacity of this battery to earth is thus

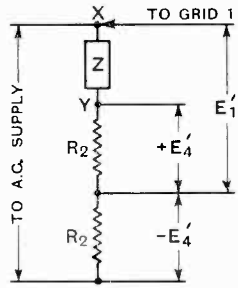


Fig. 11.

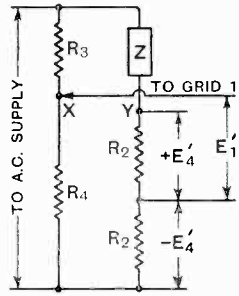


Fig. 12.

avoided, the input capacity of grid 1 now being due to inter-electrode and stray capacities only.

Grids leaks should not be of higher value than necessary to avoid loading the input circuit, or the calibration may be upset due to the presence of grid current or leakage. This may easily be checked by momentarily shorting the grid leak, when no appreciable change of anode current should be observed.

The importance of low resistance in the batteries supplying screened grid current has already been emphasised. This is difficult to ensure unless accumulators are used, but the effect of changes in internal resistance of dry batteries may be minimised by feeding the screening grid through a relatively high resistance, of the order of 20,000 ohms. This will result in an increase of sensitivity of the wattmeter (with the valve used for the tests described this increase of sensitivity amounted to about 30%). When this method is adopted it is essential to use a large by-pass condenser connected between screening grid and cathode, or the calibration will not be independent of frequency. For use down to 50 cycles a capacitance of 10 microfarads is suitable, paper dielectric condensers being necessary since electrolytic condensers pass an appreciable, and variable, leakage current.

Abstracts and References

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For the information of new readers it is pointed out that the length of an abstract is generally no indication of the importance of the work concerned. An important paper in English, in a journal likely to be readily accessible, may be dealt with by a square-bracketed addition to the title, while a paper of similar importance in German or Russian may be given a long abstract. In addition to these factors of difficulty of language and accessibility, the nature of the work has, of course, a great influence on the useful length of the abstract.

PROPAGATION OF WAVES

3588. THE RETURN OF RADIO WAVES FROM THE MIDDLE ATMOSPHERE: I.—R. A. Watson Watt, A. F. Wilkins, & E. G. Bowen. (*Proc. Roy. Soc.*, Series A, 15th July 1937, Vol. 161, No. 905, pp. 181–196.)

A detailed account of work already referred to in 2509 of 1936 and 1270 of 1937. In an appendix, a theoretical discussion of the theory of production of low-level ionisation by thunderstorms is given.

3589. IRREGULARITIES IN THE PROPAGATION OF ULTRA-SHORT WAVES TO TRANSOCEANIC DISTANCES, AND DISTURBANCES OF THE IONOSPHERE [Two Distinct Types, "Dellinger Effect" (Increase in Ionisation) and Decrease in Ionisation (Specially affecting Ultra-Short Waves and accompanied by 12–24 hr Magnetic Storms)].—H. A. G. Hess. (*Funktech. Monatshefte*, July 1937, No. 7, pp. 217–220.)

For previous work by the same writer *see* 2059 of June and 2851 of August. "Strong solar activity, especially individual chromospheric eruptions, always improve the propagation conditions for ultra-short waves. . . . During particularly violent eruptions the phenomenon known as 'Dellinger effect' is observed [occurring only on the sun-lit half of the earth]. On days of pre-eminently good over-sea ultra-short-wave propagation the terrestrial-magnetic report always runs 'Quiet or slightly disturbed' . . . Echo observations on 80 m show, during the night hours, pronounced multiple reflection from the F region, while at the same time the critical frequency of the F layer is very high: these facts clearly point to high ionisation." On the other hand the second type of disturbance, adversely affecting ultra-short-wave propagation (apparently more in the east-west direction than in the north-south: this may be connected with the fact that in the latter direction the minimum wave for reflection seems to be shorter than that for the former direction) appears to be due to a *decrease* in ionisation; 80 m echo observations show weak F reflection, the layer rising sharply to abnormal heights as the phenomenon begins; and the critical frequency for the F layer is always smaller than on ordinary days. Unlike the Dellinger effect (also known as the "dead quarter-of-an-hour") the second effect may last a whole day or even more, and it is always accompanied by a magnetic disturbance, whose magnitude is proportional to that of the ultra-short-wave effect: thus when the magnetic disturbance is very great, waves as long as 16 m are impeded in the east-west direction, whereas for 8 m fading in this direction the magnetic disturbance may be quite small. The origin of this second effect is not yet clear; it appears *not* to be solar eruptions.

3590. THE IONOSPHERE AND RADIO TRANSMISSION [General Notes].—Gilliland, Kirby, Smith, & Reymer. (*Journ. Franklin Inst.*, July 1937, Vol. 224, No. 1, pp. 115–116.) Note on paper referred to in 3591, below.

3591. CHARACTERISTICS OF THE IONOSPHERE AND THEIR APPLICATION TO RADIO TRANSMISSION [1934/1936 Data: Seasonal Variation and Long-Time Increase of Critical Frequencies (Sunspot Cycle): Decrease of Max. Usable Frequency during and after Local Magnetic Disturbance: Dellinger "Fade-Outs": etc.].—Gilliland, Kirby, Smith, & Reymer. (*Proc. Inst. Rad. Eng.*, July 1937, Vol. 25, No. 7, pp. 823–840: *Journ. of Res. of Nat. Bur. of Stds.*, June 1937, Vol. 18, No. 6, pp. 645–667.)

3592. EXTENSION OF NORMAL-INCIDENCE IONOSPHERE MEASUREMENTS TO OBLIQUE-INCIDENCE RADIO TRANSMISSION [Simple and Rapid Graphical Method of obtaining Skip Distances and Limiting Frequencies from Normal-Incidence Measurements].—N. Smith. (*Journ. of Res. of Nat. Bur. of Stds.*, July 1937, Vol. 19, No. 1, pp. 89–94.) Used in preparing data for weekly broadcasts, in interpreting low-layer ionosphere transmission, in supplementing local ionosphere measurements by long-distance transmission observations, etc. *Cf.* 2461 of July, 2862 of August, and 3591, above.

3593. SOLAR ACTIVITY AND SHORT-WAVE PROPAGATION: THE "DELLINGER EFFECT" [Survey, including Numerous Observations in 1936 and 1937 by Author, Ullrich & other German Amateurs, Japanese (Kwasan Observatory) Observers, etc.].—O. Morgenroth. (*Funktech. Monatshefte*, July 1937, No. 7, pp. 211–216.)

3594. THE MAGNETIC DISTURBANCE OF 24TH TO 28TH APRIL 1937 [Reproduction of Records of Magnetic Elements at Niemegk: Discussion of Characteristics: Agreement with Theory of Corpuscles travelling from Sun to Earth].—G. Fanselau. (*Naturwiss.*, 23rd July 1937, Vol. 25, No. 30, pp. 490–492.)

3595. THE PERIODICITY OF IRREGULARITY IN THE EARTH'S ROTATION.—N. Stoyko. (*Comptes Rendus*, 5th July 1937, Vol. 205, No. 1, pp. 79–81.) Continuation of work referred to in 2856 of August.

3596. THE ELECTRICAL STATE OF THE EARTH'S OUTER ATMOSPHERE.—L. V. Berkner. (*Scientific Monthly*, Aug. 1937, Vol. 45, No. 2, pp. 126–141.)

3597. IONIC RECOMBINATION IN THE IONOSPHERE [Validity of Thomson Equation at Low Pressures: Mechanism of Electron Transfer: Limiting Collision Radius: Question of Ionic or Electronic Combination depends on Oxygen Content of Ionosphere].—L. B. Loeb. (*Phys. Review*, 1st July 1937, Series 2, Vol. 52, No. 1, pp. 40–41.) Letter extending the work referred to in 3550 of September. For a correction to the values given in the earlier letter see *Phys. Review*, 15th July 1937, Series 2, Vol. 52, No. 2, p. 136.

3598. THE VARIATIONS IN THE OZONE CONTENT OF THE ATMOSPHERE IN THE NEIGHBOURHOOD OF SHANGHAI [Seasonal Curves, measured by Dobson's Method: Relation to Meteorological Phenomena].—P. Lejay. (*Comptes Rendus*, 2nd Aug. 1937, Vol. 205, No. 5, pp. 307–309.) *See* also 21 of 1935.

3599. SPACE AND SURFACE WAVES IN RADIO PROPAGATION [from Vertical Dipole: Theoretical Results].—K. A. Norton. (*Phys. Review*, 15th July 1937, Series 2, Vol. 52, No. 2, pp. 132–133.)

For previous work by the writer *see* 2538 of 1935 (*cf.* also 442 of 1936) and 14 of January. The present note concerns recent theoretical studies which show that the total radiation field from a vertical dipole over a plane earth may be separated into two components which can be identified as space and surface waves and that "the surface wave is just the 'ground wave' which is the medium for most low and medium frequency radio communication." The surface wave "exists only over an imperfectly conducting earth"; it has an attenuation factor which is "identified with the 'ground wave attenuation factor' which varies first exponentially with the 'numerical distance' and finally, at large distances, inversely as the 'numerical distance.'" This surface wave is found to be similar to the guided wave on a wire.

3600. REFLECTION AND REFRACTION OF ELECTRIC AND MAGNETIC WAVES AT THE PLANE SURFACE BETWEEN TWO MEDIA [General Theoretical Discussion].—P. G. Violet. (*E.N.T.*, June 1937, Vol. 14, No. 6, pp. 210–223.)

The term "electric waves" is here taken to mean the electromagnetic field emitted by an electric dipole or a system of such dipoles, while "magnetic waves" include the field from a coil or frame or combination of several coils or frames. The derivation of the general expressions (eqns. 14) for these fields from Maxwell's fundamental equations, using vector potentials, is given (§ B). The general relations between electric and magnetic emitters are discussed in § C. § D gives the general boundary conditions at a plane surface of separation between two media and discusses the work of other authors on the mode of wave propagation and on the theoretical existence of "surface" waves. The work of the present paper refers to "spatially distributed waves"; the results are stated to be true for receiving as well as for emitting aerials, and a complex ratio of the refractive indices of the two media is chosen. The calculations are actually performed in § E; § F deals with various special cases, including an electric dipole with (a) perpendicular and (b) grazing incidence of the waves, and with special values of the ratio of the refractive indices.

3601. SOME FUNDAMENTAL EXPERIMENTS WITH WAVE GUIDES [Cylinders of Water of 4′ Length and 10″ Diameter: Wavelengths about 2 m: Technique of Measurement and of plotting Configuration of Lines of Force: Good Agreement between Analysis and Experiment].—G. C. Southworth. (*Proc. Inst. Rad. Eng.*, July 1937, Vol. 25, No. 7, pp. 807–822.)

Description and discussion of the early verifying experiments, using water. In the more recent experimental work (2502 of 1936) air-cored guides have been used, but these call for much shorter wavelengths (*e.g.* 30–7.5 cm).

3602. A POWER SCALE FOR THE "INSTANT HEAVISIDION" [Computing Device for Long Transmission Lines].—V. Karapetoff. (*Elec. Engineering*, July 1937, Vol. 56, No. 7, pp. 917–918.)

ATMOSPHERICS AND ATMOSPHERIC ELECTRICITY

3603. PLANES MAKE STATIC [when Flying through Charged Clouds: Interference Not Due to Water Drops or Snow Crystals in Cloud, but to "Charges already gathered on Surface of Plane and discharging through Trailing Edge"].—Hucke. (*Sci. News Letter*, 10th July 1937, Vol. 32, p. 22.)

3604. RAPID VARIATIONS IN THE MAGNETIC FIELD PRODUCED BY LIGHTNING DISCHARGES.—H. Norinder. (*Proc. Phys. Soc.*, 1st July 1937, Vol. 49, Part 4, No. 273, pp. 364–375.)

In these experiments a frame aerial (Fig. 2) and cathode-ray oscillograph (with relay action, Fig. 1) were used to measure the rapid variations in the magnetic field produced by lightning discharges. Typical oscillograms with rapid (Fig. 4) and slow (Fig. 5) base times are given. The current variations in the discharges are calculated under certain conditions. The characteristic properties of individual current pulses (total duration, time intervals between successive partial discharges, etc ; Figs. 6–13) are represented diagrammatically. The results agree with those of earlier work (*e.g.* 1715 of 1936).

3605. THE DISTRIBUTION OF ELECTRICITY IN THUNDERCLOUDS.—G. Simpson & F. J. Scrase. (*Proc. Roy. Soc.*, Series A, 3rd Aug. 1937, Vol. 161, No. 906, pp. 309–352.)

Authors' summary :—A method of obtaining records of the sign of the potential gradient at different heights in thunderclouds is described. The apparatus, which is carried by a sounding balloon, depends for its action on the fact that the potential gradient is often strong enough to cause a point-discharge current in a suitably exposed conductor ; the direction of the current is recorded by a pole-finding device.

The results show that, in general, a thundercloud has a positive charge in the upper layers, a negative charge in the lower part, and very frequently a region of positive charge in the base. This lower region of positive charge is usually found in the neighbourhood of the active centre of a storm and is associated with heavy rain, which is nearly always positively charged. The region of separation of the upper positive charge and the negative charge occurs at levels where the temperature is well below freezing-point, and for this reason it is considered that the generation of the upper charge depends on the presence of ice crystals and not on the presence of water drops. The position of the lower positive charge supports the idea that it is generated by the " breaking-drop " process. [It is also found that " Wilson's influence theory cannot explain the separation of charges found in the upper part of the thunderclouds. . . . The results . . . are not inconsistent with the idea that it is by the action of thunderstorms and shower clouds that the circulation of electricity in the atmosphere is maintained."]

3606. MODEL TESTS ON LIGHTNING STROKES [Criticism of Former Tests, in Light of Latest Knowledge : New Method : Results]. —A. Matthias. (*E.T.Z.*, 12th & 26th Aug. 1937, Vol. 58, Nos. 32 & 34, pp. 881–883 and 928–930.) To be concluded.

3607. RUSSIAN WORK ON LIGHTNING RESEARCH IN THE YEAR 1936.—I. S. Sokolnikov. (*E.T.Z.*, 12th Aug. 1937, Vol. 58, No. 32, pp. 887–888 : long summary only.)

3608. DISTORTION OF TRAVELLING [Lightning-Surge] WAVES BY CORONA.—Skilling & Dykes. (*Elec. Engineering*, July 1937, Vol. 56, No. 7, pp. 850–857.)

3609. CHARACTERISTICS OF THE NEW STATION-TYPE AUTOVALVE LIGHTNING ARRESTER.—W. G. Roman. (*Elec. Engineering*, July 1937, Vol. 56, No. 7, pp. 819–822.)

3610. LIGHTNING PROTECTORS FOR H.T. LINES [particularly the Siemens-Schuckert Cathode-Drop Protector].—J. Mosebach. (*Rev. Gén. de l'Élec.*, 17th July 1937, Vol. 42, No. 3, pp. 75–88.)

3611. THE PROTECTION OF TELEPHONE EQUIPMENT AGAINST ATMOSPHERIC DISCHARGES.—Bogdanovich & Nekrasov. (*Izvestiya Elektroprom. Slab. Toka*, No. 5/6, 1937, pp. 31–38.)

3612. MEASUREMENT OF THE NUCLEAR ABSORPTION OF ELECTRONS BY THE ATMOSPHERE UP TO ABOUT 10^{10} ELECTRON VOLTS.—I. S. Bowen, R. A. Millikan, & H. V. Neher. (*Nature*, 3rd July 1937, Vol. 140, p. 23.)

3613. COEFFICIENT OF COMBINATION BETWEEN SMALL IONS AND LARGE IONS [in Atmosphere : Data : Variation with Temperature and Absolute Humidity of Air : Size of Particle forming Large Ion may vary with Absolute Humidity].—G. R. Wait. (*Phys. Review*, 1st June 1937, Series 2, Vol. 51, No. 11, p. 1025 : abstract only.)

3614. RECOMBINATION OF IONS IN AIR AT HIGH PRESSURES [Measurements].—P. Kraus. (*Ann. der Physik*, Series 5, No. 6, Vol. 29, 1937, pp. 449–472.)

PROPERTIES OF CIRCUITS

3615. RELAXATION, SYNCHRONISATION, AND FREQUENCY DEMULTIPLICATION.—Y. Rocard. (*L'Onde Élec.*, July 1937, Vol. 16, No. 187, pp. 396–413 : Discussion pp. 413–419.)

The writer replaces the equation for relaxation oscillations (eqn. 1 ; resistance curve Fig. 1) assumed by van der Pol by eqn. 3, in which the resistance curve has the form shown in Fig. 2 ; it is linear, rising at a constant rate except for a sudden drop from a positive to an equal negative value at the origin. The steady solution of this equation is found to be represented by a succession of damped half-sinusoids (Fig. 3) ; Fig. 4 shows the variation of amplitude and Fig. 5 the period. Differences between these results and those of van der Pol are pointed out, " to prevent excessive generality being attributed to certain results obtained with models of special oscillators." The physical significance of the writer's oscillator is that " all its self-oscillation capacity is concentrated in the region $\nu = 0$," which might occur approximately in practice with oscillators including hot-cathode discharge tubes. The writer prefers however to characterise the oscillator by the relative proportions of harmonics it contains ; any oscillator may be approximately represented thus if the harmonics are suitably chosen. The harmonics are found by Fourier analysis and are defined by their " assessment " given in eqn. 4. Another completely integrable oscillator (Fig. 6) is shortly discussed in the same way.

The synchronisation of the oscillator given by eqn. 2 by an impressed sinusoidal vibration is discussed mathematically ; the solution (eqn. 7) has the same form as that of the equation without relaxation but has slightly different amplitude and diminished phase. The conditions for a steady state of approximation to the impressed frequency are found; these are limits for the difference between the impressed frequency and the natural frequency of the oscillator. The synchronisation results are all contained in eqn. 15, which shows that (1) if the imposed frequency is equal to the natural frequency of the oscillator, synchronisation takes place for infinitely small amplitudes, while, if non-zero amplitudes are used, the phase of the oscillator also approximates to that of the imposed vibration; (2) if the difference between the imposed and natural frequencies increases, for given amplitude, a point is reached which is the limit of the zone of synchronisation for this amplitude, and at this point the oscillator and the imposed vibration are in phase quadrature; (3) if, *a priori*, $\sin \psi_0 = \pm 1$ (ψ_0 given by eqn. 6), eqn. 15 defines the relation between the impressed amplitude and the frequency difference at the boundaries of the synchronisation region. A numerical example of these relationships is given, with a simplified formula (16) which suffices for practical needs.

Frequency demultiplication is similarly discussed; the conditions for creation of a periodic steady state are found, with an eqn. 19 of significance analogous to that of eqn. 15. It is found that the symmetrical oscillator considered cannot produce demultiplication by *even* multiples of its own frequency. The ratio between the amplitude of the superposed wave necessary for frequency demultiplication by the ratio n and the amplitude required for synchronisation on a frequency $1/n$ times the superposed frequency is determined (top of p. 409). The results are also given in terms of the harmonic "assessment" given by eqn. 4; the significance of this quantity is illustrated by working out the case of a classical oscillator (Fig. 10). The synchronisation and frequency demultiplication regions are illustrated by Fig. 12, for a symmetrical oscillator without even harmonics.

In the discussion, Le Corbeiller points out that the resistance curve (Fig. 2), when differentiated, gives Heaviside's unit function, and refers to previous work of his own (1933 Abstracts, p. 445). He discusses possible resistance curves, their parametric representation and suitability for the study of synchronisation and frequency demultiplication of a continuous system.

3616. GRAPHICS OF NON-LINEAR CIRCUITS [based on Point-by-Point Method of solving Differential Equations].—A. Preisman. (*RCA Review*, July 1937, Vol. 2, No. 1, pp. 124–133: to be contd.)

As an example of the method applied to a non-linear parallel branch, the writer takes the case of a driver valve, of constant plate resistance, driving the grid of a succeeding valve positive.

3617. THE QUESTION OF WEAK-CURRENT RECTIFIERS [Study of Phenomena in Circuits containing Diodes and Screen-Grid Valves].—R. Zenneck. (*Hochf:tech. u. Elek:akus.*, July 1937, Vol. 50, No. 1, pp. 5–18.)

The arrangement here studied theoretically is shown in Fig. 1, the detector being connected in parallel with circuits containing a condenser and a coil respectively. The cases of small and large amplitudes of the current and voltage across the detector are considered in §§ I and II respectively, with theoretical investigations of the effect of the characteristic alone (§ I 1) and the effect of the voltage drops across the external resistances (§ I 2), with the correction factors given by the successive approximations to and differential coefficients in the Taylor series for the characteristic. In the case of large amplitudes (§ II) it is found that "the detector characteristic loses its important rôle in the rectification phenomenon; the h.f. circuit is loaded directly from the d.c. or l.f. circuit, whereby a distinction must be made between carrier wave and sidebands. Distortions occur only when the working line is cut short." Expressions for the correcting factors are found. The method of successive approximation is found not to deal adequately with l.f. phenomena, for which a method due to Ballantine (1929 Abstracts, p. 570) is used.

In § III special questions are discussed, including the variation of h.f. impedance with alternating voltage (§ III 1), the difference between parallel and series connection of the rectifier (§ III 2), and carrier telephony (§ III 3).

3618. FREE OSCILLATIONS OF A RESONANT CIRCUIT LOADED BY A DIODE RECTIFIER [Assumption that Rectifier exerts only Negligible Effect on Resonant Frequency, and acts as Resistance slightly greater than One-Half the Load Resistance, only valid for Constant Input Amplitude: Time Constant of Combined Circuit may be Equal to or Less than That of Circuit alone: Implications for (*e.g.*) Frequency-Response and Demodulation Theory].—F. C. Williams. (*Wireless Engineer*, Aug. 1937, Vol. 14, No. 167, pp. 403–408.)

3619. DISCUSSION ON "AMPLIFICATION LOCI OF RESISTANCE-CAPACITANCE COUPLED AMPLIFIERS."—Seletzky. (*Elec. Engineering*, July 1937, Vol. 56, No. 7, pp. 877–879.) *See* 912 of March.

3620. TRANSMISSION LINES AT VERY HIGH RADIO FREQUENCIES [and the Effect of Radiation Resistance].—Reukema. (*See* 3635.)

3621. THE USE OF COAXIAL AND BALANCED TRANSMISSION LINES IN FILTERS AND WIDE-BAND TRANSFORMERS FOR [Ultra-] HIGH RADIO FREQUENCIES.—Mason & Sykes. (*See* 3671.)

3622. ANALOGY OF MAGNETIC CIRCUIT AND LONG TRANSMISSION LINE.—Ragazzini. (*Elec. Engineering*, Aug. 1937, Vol. 56, No. 8, p. 1063.)

3623. ELECTRICAL SHUNTING CIRCUITS [General Matrix Theory].—H. Piloty. (*E.N.T.*, June 1937, Vol. 14, No. 6, pp. 197–209.)

These "shunting circuits" are reactance circuits with one pair of input terminals and several pairs of output terminals, which separate the input electrical energy into various frequency bands corresponding to the requirements of the circuits connected to the various outputs. The present paper deals with the case of two pairs of output terminals for which the frequency bands are to be "conjugate," *i.e.* together fill up the whole frequency spectrum. One such circuit (due to Ericsson) is shown in Fig. 1; another type has been given by Brandt (2937 of 1936), based on

Cauer's matrix theory of circuits. The purpose of the present writer is to give, if possible, a wider choice of circuits than that given by Brandt, to classify the circuits according to their properties, and to discover the place of the Ericsson shunting circuit in the system. In § II, a discussion of Brandt's circuits of uneven class based on their resistance matrices is given. Shunting circuits of even class are found, with properties intermediate between those of the uneven-class circuits. The latter may also be considered as two filters and a negative reactance connected in series (Fig. 3); their properties are deduced from this circuit, which also leads to the derivation of even-class shunting circuits (§ III) when the two filters are so chosen that the attenuation function of one is the inverse of the impedance of the other (Fig. 5). The connection between the shunting circuits of even and uneven class is discussed (§ IV) from the properties of their matrices. A third kind of shunting circuit, of fractional class, is found in § V; Fig. 9 illustrates the quantities determining it and its resistance and conductance circuits. The new types of shunting circuit are found to demand an increase in the number of circuit elements of only two from class to class, whereas Brandt's circuits of uneven class demanded an increase of eight elements for each higher class. Differential shunting circuits (§ VI) are formed when two similar filters are combined in a differential circuit. The Ericsson circuit is of this type. The position of these circuits with equivalent and dual circuits in the general system is discussed on the matrix theory. Various equivalent circuits are shown diagrammatically. For the writer's paper on "reactance quadripoles" (matrix theory) *see* 2477 of July.

3624. THE ASYMMETRY OF THE DETUNED FILTER DUE TO RETROACTION.—H. Frühauf. (*Hochf: tech. u. Elek:akus.*, July 1937, Vol. 50, No. 1, pp. 29–32.)

Work by Troeltsch & Steinmetz (3357 of 1936), on the production of a band-filter amplifier by detuning the circuits in an h.f. amplifier, assumed that there was no retroaction from the second circuit on the first (Fig. 1). Here the effect of such a retroaction on the propagation constants of the circuit shown in Fig. 2, in particular as regards their asymmetry, is worked out theoretically by a method due to Strecker & Feldtkeller (*E.N.T.*, 1929, p. 93). It is found that the internal capacity of the valve alone suffices to produce too large distortion when the "form value" (Troeltsch & Steinmetz, *loc. cit.*) is greater than 0.5. "The form value is calculated for the detuned filter with retroaction, and the self-excitation condition for this filter is found using the form value and asymmetry."

3625. ON A METHOD OF DESIGNING NEW TYPE FILTERS [Combination of Matsumae-Matsumoto "Doublet" Filter and "Derived-*m*" Type Filter to give Composite Filter or Wave Selector of Very Desirable Characteristics].—S. Matsumae & M. Yoneyama. (*Nippon Elec. Comm. Eng.*, June 1937, No. 6, pp. 145–153.) Removing certain defects of the "doublet" filter (1934 Abstracts, pp. 435–436) but "not surely favourable from an economical standpoint."

3626. SOME METHODS OF IMPEDANCE TRANSFORMATION [Matching Defects of Filter Repeating Coils passing D.C.: the Use of Complex Filter Repeating Coils and of Exponentially Spaced Lines or Uniformly Spaced Lines with Size varying Exponentially].—A. Matsumoto. (*Nippon Elec. Comm. Eng.*, June 1937, No. 6, pp. 122–127.)

3627. A SIX-TERMINAL ELECTRICAL SYSTEM.—A. V. Styblik. (*Izvestiya Elektroprom. Slab. Toka*, No. 4, 1937, pp. 39–44.)

A theoretical investigation of the operation of a network with one pair of input and two pairs of output terminals (such as a transformer with three windings). The analysis given is similar to that normally used in the case of four-terminal networks.

3628. QUADRIPOLE THEORY FOR CIRCUITS OF HIGH-FREQUENCY ENGINEERING [Derivation of Practical H.F. Equations from Line-Telephony Theory: with Examples of Use].—W. Kautter. (*Telefunken*, March 1937, Vol. 18, No. 75, pp. 50–59.)

I: The law of "core resistance" (Kernwiderstand), applicable to all passive quadripoles: with short-circuited secondary the short-circuit current bears the same ratio to the primary applied voltage as the short-circuited current, when the primary is short-circuited, bears to the secondary voltage. II: The counter-action law, when both primary and secondary are acted on simultaneously by one current source. III: A general quadripole equivalent circuit. IV: The input impedance of a quadripole and its dependence on the terminating resistance. V: The delta-connected equivalent circuit of a quadripole. VI: The law of the equivalent current source. VII: General considerations on calculation with circuit diagrams.

3629. GRAPHICAL DETERMINATION OF THE RESULTANT IMPEDANCE OF A.C. IMPEDANCES CONNECTED IN PARALLEL.—P. Böning. (*Hochf:tech. u. Elek:akus.*, July 1937, Vol. 50, No. 1, pp. 32–34.)

The method, which is applicable to the determination of the resultant of three or more impedances (as well as two) connected in parallel, employs an auxiliary circle drawn through the points on the three impedances for which the resultant is required; this gives the polar co-ordinates of the resultant. The geometrical reasoning underlying the method, its use in various special cases, and its extension to more than three impedances, are described.

3630. A LADDER NETWORK THEOREM [with Particular Application to Electric Railway Networks].—J. Riordan. (*Bell S. Tech. Journ.*, July 1937, Vol. 16, No. 3, pp. 303–318.)

TRANSMISSION

3631. THE ENERGY BALANCE OF THE ROTARY MOTION OF THE ELECTRON IN THE MAGNETIC-FIELD VALVE [Investigation with Special "Turbine" Tube, and Application of Results to Split-Anode Magnetrons].—K. Fritz. (*Telefunken*, March 1937, Vol. 18, No. 75, pp. 37–42.)

Adopting the "Cyclotron" principle of electron acceleration, the writer has experimented with a "turbine" valve consisting of two (later four) accelerating electrodes (parts of a cylinder) around a straight coaxial cathode. The accelerating electrodes are connected to an oscillatory circuit into which a voltage of angular frequency ω_0 is induced from an oscillator. A magnetic field parallel to the cathode is so adjusted that the angular frequency ω_e of the electrons emerging from the cathode and rotating under the action of the magnetic field is exactly equal to ω_0. Those electrons which pass through the planes of the anode slits in the correct phase are accelerated. At each revolution they pass twice through the alternating field, thus gaining, from the oscillator, an energy of $2eV_{osc}$, where V_{osc} is the amplitude of the alternating voltage. With increasing energy the electron paths increase their radius, and after n revolutions the electrons reach the anode with the energy $E_e = eV_{init} + n.2eV_{osc}$. In practice n may be several hundreds.

Such is the action when the tube is used as an accelerator, driven by an external oscillator. As an oscillation generator its action is reversed. The electron is shot into the cylindrical space with a velocity corresponding to the high anode d.c. voltage V_a, and, if it is of correct phase, gives up its energy by stages to the a.c. field and thus to the oscillatory circuit. When it has lost practically all its energy, its radius is at its smallest: it finds itself in the middle of the tube. It must now, before it can perform a phase jump (*see* 1736 of 1936) and again follow the magnetic field (taking up energy in the process), be led away by a collector electrode at the centre or side (Fig. 52).

By splitting the anode into four parts, with opposite pairs connected (Fig. 53), the frequency introduced into the associated oscillatory circuit is doubled for the same value of magnetic field, that is for constant ω_e. These tubes and circuits are the subject of various patent applications. The action may be regarded as that of a rotary converter: the phase-correct electron charge, rotating with the angular velocity $\omega_e = \text{const.} \times H$, represents the armature rotating with velocity ω_e. This velocity is determined by the magnetic field, while the initial energy of rotation depends on the d.c. voltage. The split anode acts as the commutator: for n segment-pairs the generated frequency $\omega_0 = n \,.\, \omega_e$. The energy-transfer process, as regards the phase-correct electrons, is clearly seen: the initial energy of an electron is $E_a = eV_a$, and with $2n$ segments the energy given up in one revolution is $2n \,.\, eV_{osc}$, assuming that the a.c. field is predominantly concentrated in the planes of the slits (otherwise the energy given up at each revolution is decreased). After m revolutions the electron is led away by the collector electrode. The difference between the initial and final energies, transferred to the oscillatory circuit, is thus $E_a - E_e = eV_a - m \,.\, 2n \,.\, eV_{osc}$. Under optimum conditions the whole initial energy is transformed into a.c. energy, so that $eV_a = m \,.\, 2n \,.\, eV_{osc}$. These relations apply only to the phase-correct electrons. In the simplest case there would be no phase arrangement in the electrons as they emerge from the cathode: there would then be two groups to be considered. In one of these the electrons are predominantly correct in phase, and the above reasoning applies to this group. In the other the electrons are predominantly of wrong phase: that is, they pass through the planes of the slits in the same sense as the a.c. field obtaining there at the moment, and thus absorb energy from the field. Their path radius therefore increases and they soon land at the anodes. The energy taken from the a.c. field is given by $E_e - E_a = \text{const.} \times (r_a^2 - r_0^2)$, where r_0 is the initial path radius and r_a the anode radius; whereas the energy given up by an electron of the phase-correct group, ending at the centre of the tube ($r = 0$ approx.) is equal to $\text{const.} \times r_0^2$. Since r_a need only be slightly larger than r_0, if the two groups are about equal there can be, without any phase correction, a surplus of energy to be transferred to the oscillatory circuit.

The remainder of the paper deals with the application of these results with the special "turbine" tube to the usual multi-slit magnetron valves with their various regions of different types of oscillation. Under optimum conditions the rotary motion is largely in resonance with the electric alternating field. Neglecting the synchronising action of this field, the calculated values for the optimum conditions come very close to the experimental (*e.g.* 1.75×10^8 and 1.7×10^8, respectively, for the value of the constant).

3632. On the Modulation of Magnetron Oscillators with Auxiliary Electrodes.—H. Uchida. (*Electrotech. Journ.*, Tokyo, Aug. 1937, Vol. 1, No. 3, p. 115.)

If a modulating transformer is placed in the plate circuit of a magnetron there is a tendency for parasitic a.f. oscillations to be produced, owing to the inclination of the plate circuit to develop a negative resistance. This defect can be avoided by the introduction of auxiliary, modulating electrodes symmetrically in the gaps between the two halves of the split anode. The method is free from the limitations of the "end-plate" modulation method, in which the control diminishes if the anode is made long compared with the diameter.

3633. Magnetron Oscillations [Corrections].—Herriger & Hülster. (*Hoch:tech. u. Elek: akus.*, July 1937, Vol. 50, No. 1, p. 35.) Corrections to footnote and to equation in paper referred to in 2499 of July.

3634. Electron Oscillations [at Positive Anode Potentials] of Constant Wavelength.—Nakamura & others. (*See* 3644.)

3635. Transmission Lines at Very High Radio Frequencies [Effect of Radiation Resistance on Selectivity Factor Q and Input Impedance Z_s for Parallel-Wire and Concentric Lines: Analysis and Practical Conclusions as to Design].—L. E. Reukema. (*Elec. Engineering*, Aug. 1937, Vol. 56, No. 8, pp. 1002–1011.)

Thus it is shown that for maximum Q the optimum ratio of spacing to wire-radius for parallel wires is 6.186, and that of outer-conductor-radius to inner-conductor-radius for concentric lines is 4.22, as compared with about 3.6 for both ratios when radiation resistance is neglected. For maximum impedance the corresponding values are 20.96 and 14.3, compared with 8 and 9.2 respectively. Both Q and Z_s for optimum design are both *inversely* proportional to the cube root of the frequency for parallel wires and to the 0.4 power of the frequency for concentric lines, whereas previous analysis showed both *increasing* as the square root of the frequency.

3636. THE FREQUENCY STABILITY OF 100-MEGACYCLE OSCILLATIONS, *and* AN INVESTIGATION OF LONG-LINE FREQUENCY CONTROL FOR ULTRA-HIGH-FREQUENCY TRANSMITTERS.—A. Peterson: E. B. Patterson. (*Proc. Inst. Rad. Eng.*, July 1937, Vol. 25, No. 7, pp. 796–797: p. 803: summaries only.)

(1) Great ability for stabilisation shown by high-Q circuits: relative ineffectiveness of parallel-wire lines attributed to radiation: use of lumped concentric element. (2) Contrary to experience below 30 Mc/s, the radiation resistance of the control line is not negligible in its effect on the Q of the circuit; it is several times as large as other losses.

3637. EMITTER CONTROL BY LONGITUDINAL OSCILLATIONS OF TOURMALIN PLATES.—V. Petržílka. (*Hochf:tech. u. Elek:akus.*, July 1937, Vol. 50, No. 1, pp. 1–5.)

For previous work on oscillations of tourmalin plates *see* 1933 Abstracts, p. 223 (two) and 3184 of 1935. The data of the plates used in the experiments are given (Table 1); data of longitudinal oscillations of circular (§ I) and rectangular (§ II, including quartz plates) are reviewed. The Pierce circuit (Fig. 10) was chosen for the experiments on emitter control; Figs. 11 and 12 show the experimental variation of the anode current and oscillatory current, respectively, with the natural frequency of the oscillating circuit. The temperature coefficient (§ IV) and the attenuation (§ V) of radial oscillations were also measured. The attenuation of radial oscillations was found to be about half that of transverse oscillations.

3638. OPERATING DATA ON THE NEW BEAM POWER TUBES: A TWO-STAGE BEAM TRANSMITTER USING THE RK-47.—G. Grammer. (*QST*, Aug. 1937, Vol. 21, No. 8, pp. 33–36.) For the new beam power valves *see* 3323 of September.

3639. THE DYNATRON OSCILLATOR [Good Wave Form and Frequency Stability both given if L/C Ratio is Low and Grid Bias is Highest Possible to maintain Oscillation: Easy Variation of Frequency given by High L/C Ratio].—J. E. Houldin. (*Wireless Engineer*, Aug. 1937, Vol. 14, No. 167, pp. 422–426.) Arising out of a study of the iron-cored-choke dynatron described by Marchant (173 of January).

3640. AN ARC GENERATOR OF CONSTANT FREQUENCY.—H. Göller. (*Hochf:tech. u. Elek:akus.*, July 1937, Vol. 50, No. 1, pp. 18–29.)

In spite of its several advantages, the arc as a generator of radio frequencies has been superseded by the valve, largely because of the inconstancy of frequency of arc oscillations. The idea underlying the design of the arc generator here described (for frequencies of the order of 8 kc/s) is based on the fact that there is no current in the arc during a certain part of its period; thus, its re-striking might be controlled by voltage impulses from an oscillatory circuit of constant frequency and relatively small power which would pull the arc generator into tune. The action of an ideal arc generator with oscillations of the second kind is first explained on the basis of its fundamental circuit (Fig. 1) and static characteristic (Fig. 2). Experiments were made with a small arc generator (without a magnetic field) and a small valve oscillator (circuit Fig. 7) which, together with the circuit Figs. 8, 13, produced the required impulses. Fig. 14 shows the circuit of the whole arrangement. Oscillograms of the beat phenomena are given, with experiments to test the constancy of the frequency and the range of "pulling-into-tune" (§ IV). A second circuit for pulse production is shown in Fig. 24. Frequency stabilisation in which the arc generator itself provides the stabilising impulses is described in § V (circuit Fig. 27): it gave "a much greater constancy of frequency than when it was not used" (max. variation in 20 seconds 0.038% instead of 0.102%), thanks probably to a "flywheel" action of the circuits "II" and "III."

3641. A VARIABLE AIR CONDENSER WITH ADJUSTABLE COMPENSATION FOR TEMPERATURE [for Use in Receiver or Small Transmitter: Stator as Earthed Electrode].—H. A. Thomas. (*Journ. I.E.E.*, Aug. 1937, Vol. 81, No. 488, pp. 277–281.)

Further development of the work dealt with in 4013 of 1936. The temperature coefficient of capacitance can be adjusted to have any value between + 80 and − 80 parts in a million per deg. C, so that it can be made to compensate for the temperature coefficient of the associated coil, yielding a circuit frequency coefficient of (*e.g.*) 3 in 10^6/deg. for slow rates, or 2 in 10^6/deg. for rapid changes.

3642. THE HIGH-FREQUENCY GAS-FILLED CONDENSER AND ITS FIELD OF APPLICATION.—M. A. Zhilinski. (*Izvestiya Elektroprom. Slab. Toka*, No. 5/6, 1937, pp. 9–16.)

In view of the high cost of mica, work was carried out with an object of developing air condensers of fixed capacity suitable for use in high-power radio transmitters. In order to increase the permissible load it was decided to use these condensers in cases filled with air or some other gas under pressure, and the technical requirements set forward were as follows: (a) wavelength range of 200–600 m; (b) capacity of the order of 1000 cm; (c) working voltage of 4–8 kv and test voltage of 12 kv; (d) refilling of the case with compressed air or gas not more than once a month.

An account is presented of experiments carried out mainly to determine the effect of the pressure of the gas, and of various methods of mechanical construction, on the heating of the condenser and the break-down voltage. A description is also given of a condenser built on the basis of these experiments. This condenser uses aluminium vanes and, operating under a pressure of 6–8 atmospheres, fully meets the conditions specified above. It is suggested that this type of condenser would also be economical for operation on longer waves (up to 1500 m) in equipments where the condensers are continuously loaded to their full voltage capacity, as (for instance) in high-frequency electric furnaces.

3643. MODULATION ON THE ANODE.—Rubin. (*L'Onde Élec.*, July 1937, Vol. 16, No. 187, pp. 420–428.) Concluded from 3278 of September.

RECEPTION

3644. ELECTRON OSCILLATIONS OF CONSTANT WAVELENGTH, AND A SUPER-REGENERATIVE ELECTRONIC AMPLIFYING DETECTOR WITHOUT QUENCHING TUBE.—Nakamura, Shino, & Komaki. (*Nippon Elec. Comm. Eng.*, June 1937, No. 6, pp. 128–134.) The full paper, a summary of which was dealt with in 932 of March.

3645. A 56-Mc/s CONVERTER OF HIGH STABILITY: HIGH-*C* OSCILLATOR AND HIGH-FREQUENCY I.F. FOR RECEPTION OF CRYSTAL-CONTROLLED FIVE-METRE SIGNALS.—B. Goodman. (*QST*, Aug. 1937, Vol. 21, No. 8, pp. 30–32.) The i.f. chosen is 20.5 Mc/s, which obviates image trouble.

3646. RECENT DEVELOPMENTS IN DIVERSITY RECEIVING EQUIPMENT [Improved Over-All Performance, Flexibility of Application to Different Types of Service, Improved Mechanical Design: New Version of Two-Signal Test for Selectivity: etc.]—J. B. Moore. (*RCA Review*, July 1937, Vol. 2, No. 1, pp. 94–116.)

3647. THE QUESTION OF WEAK-CURRENT RECTIFIERS [Detectors: with Small and Large Amplitudes of Current and Voltage].—Zenneck. (*See* 3617.)

3648. INVERSE FEEDBACK: ITS APPLICATION TO RECEIVERS AND AMPLIFIERS [supplying a Loudspeaker: Improvement of Frequency Characteristic, Elimination of Harmonics and Combination Frequencies: Different Effects of Voltage and Current Feedback: etc.].—Tellegen & Henriquez. (*Wireless Engineer*, Aug. 1937, Vol. 14, No. 167, pp. 409–413.)

3649. REDUCTION OF NON-LINEAR DISTORTION BY MEANS OF COMPENSATION [by Preamplifier Valve (with Strong Negative Bias) with Resistance-Capacity Coupling to Output Valve].—(*Alta Frequenza*, Aug. 1937, Vol. 6, No. 8, pp. 534–535.) Summary of article in *Philips Setmakers' Bulletin*.

3650. HIGH-FREQUENCY COILS WITH IRON [Nickel/Iron Alloy] RIBBON CORES AND ADJUSTABLE D.C. MAGNETIC BIAS.—G. Maus. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 18, 1937, pp. 228–230.)

The idea of utilising the fact that the inductance of an iron-cored coil can be varied by altering the magnetic bias is an old one, and has actually been used for the modulation of radio transmitters. In receiving technique, however, according to the present writer the first suggestion is the recent one of Leithäuser & Boucke (2974 of 1936); their plan, using iron powder (which is particularly unsusceptible to d.c. current effects), is only suitable for short-wave reception. To cover the whole of the medium or long broadcast wave-band with one fixed condenser, an inductance variation of 9 : 1 is necessary; the loss angle $R/\omega L$ should be around 2%, and the biasing power should not exceed 2 watts. The core must therefore be made of compact magnetic material with high initial permeability. The total inductance is divided between two equal coils on separate cores, the h.f. windings being connected in series in the same sense, the d.c. windings in series in opposed sense, so that there is no retroaction of the h.f. circuit on to the d.c. circuit. The condition of highly variable permeability combined with great stability is best fulfilled by a nickel/iron alloy of very high " stretch factor " (judged by the decrease in thickness during the final rolling process), in the form of the thinnest ribbon that is mechanically satisfactory, and subjected to a special heat treatment before it is made into cores. A loss reduction (due to a diminution of eddy-current losses) is obtained by reducing the thickness of the ribbon by the action of acid (Fig. 2, curves *a* & *b*). This treatment not only increases the permeability but also decreases the magnetising power required. A further reduction of loss (Fig. 2, curve *c*), is obtained by maintaining a small magnetising current (0.05 A, producing 0.8 oersted) even at the initial frequency; the maximum biasing current required is thus increased slightly, but remains below the required limit. The question whether the variation of inductance shown (for example) in Fig. 3 is really due solely to the adjustment of magnetic bias, or whether it is partly due to a variation of permeability with frequency, is an important one, since only in the first event can the method be used for selective tuning. Using Wolman's formula for the " limiting frequency," below which a core has a permeability practically independent of frequency (1930 Abstracts, p. 228), it is found that for the core in question this frequency is 15 Mc/s, so that over the wave-bands required there is no question of a spurious effect interfering with the tuning action.

3651. VOLUME EXPANSION PROBLEMS [and a New Circuit].—M. C. Pickard. (*Wireless World*, 27th Aug. 1937, Vol. 41, pp. 186–189.)

3652. NEW FEATURES IN BROADCAST RECEIVER DESIGN [Automatic Programme Tuning (Mechanical or Motor-Driven): Automatic Tuning Correction: Band-Spread Circuits: Cabinet Acoustics: etc.].—Carson, Chittick, Cole, & Perry. (*RCA Review*, July 1937, Vol. 2, No. 1, pp. 45–59.)

3653. NEW TUNING INDICATOR TUBES.—(*See* 3696.)

3654. BATTERY PERFORMANCE FROM THE RECTIFIED A.C. POWER SUPPLY [A.V.C. Principle applied to Voltage Regulation for Receivers (*e.g.* with Crystal Filters), Speech Amplifiers, Frequency Meters, Oscillators, etc.]—G. Grammer. (*QST*, Aug. 1937, Vol. 21, No. 8, pp. 14–17.)

Including a practical circuit developed by the writer from a combination of an RCA circuit (for speech amplifiers) and the Bell Laboratories circuit

(Trucksess, 2760 of July). No bias batteries are involved, the constant-voltage properties of an ordinary neon lamp being utilised.

3655. A VARIABLE AIR CONDENSER WITH ADJUSTABLE COMPENSATION FOR TEMPERATURE.—Thomas. (*See* 3641.)

3656. MEASUREMENTS ON BROADCAST RECEIVERS [42 Types of 1935/36: Comparative Values of Sensitivity, Selectivity, and Fidelity, for Single-Circuit, Two-Circuit, Three-Circuit, and Superheterodyne Models].—H. Jungfer & H. Köpke. (*E.T.Z.*, 29th July 1937, Vol. 58, No. 30, pp. 809–813.)

3657. MEASUREMENTS ON BROADCAST RECEIVERS [Technique].—Jungfer & Köpke. (*E.T.Z.*, 29th July 1937, Vol. 58, No. 30, p. 821: summary only.)

3658. OSCILLATORS FOR CIRCUIT ALIGNMENT [in conjunction with Cathode-Ray Tube, for Visual Depiction of Resonance Curves].—O. S. Puckle. (*Wireless World*, 6th Aug. 1937, Vol. 41, pp. 112–114.)

3659. THE USE OF THE CATHODE-RAY TUBE FOR THE EXAMINATION OF RESONANCE CURVES [with Electronic Method of Frequency Sweep].—(*Alta Frequenza*, Aug. 1937, Vol. 6, No. 8, pp. 543–544.) Summary of article in *Philips Setmakers' Bulletin*.

3660. NEW RECEIVER DESIGNS: A PRELIMINARY SURVEY OF THE OLYMPIA SHOW, *and* OLYMPIA SHOW REPORT: A STAND-TO-STAND REPORT OF THE 1937 RADIO EXHIBITION.—(*Wireless World*, 20th Aug. 1937, Vol. 41, pp. 158–164: 27th Aug. 1937, Vol. 41, pp. 207–224.)

3661. GERMAN RADIO EXHIBITION, 1937.—(*Wireless World*, 13th Aug. 1937, Vol. 41, pp. 139–142.)

3662. NOVELTIES IN RECEIVER DESIGN AT THE BERLIN RADIO EXHIBITION, 1937.—J. Gross. (*Radio, B., F. für Alle*, Aug. 1937, No. 186, pp. 113–121.)

3663. THE FOURTEENTH RADIO EXHIBITION, PARIS, 1937 [Comments by a Group of Visitors].—(*L'Onde Élec.*, July 1937, Vol. 16, No. 187, pp. 389–395.)

3664. BROADCAST PROGRAMMES BY CARRIER WAVES OVER THE TELEPHONE NETWORK.—Buchmann. (*See* 3889.)

3665. RADIOTELEPHONE NOISE REDUCTION BY VOICE CONTROL AT RECEIVER [" Noise Reducer " eliminating Noise during Intervals of Speech].—C. C. Taylor. (*Elec. Engineering*, Aug. 1937, Vol. 56, No. 8, pp. 971–974 and 1011.)

3666. RADIO INTERFERENCE FROM STREET RAILWAY SYSTEMS [Experimental Investigation, including Use of Model System in Laboratory].—L. M. Howe. (*Proc. Inst. Rad. Eng.*, June 1937, Vol. 25, No. 6, pp. 708–713.) From the Saskatchewan Power Commission, Canada.

3667. EXPERIMENTAL WORK ON THE INTERFERENCE SUPPRESSION OF A HIGH-TENSION LINE OVER A LIMITED SECTION [a 350-Metre 20 kV Tie-Line in Biedenkopf].—F. Conrad. (*E.T.Z.*, 29th July 1937, Vol. 58, No. 30, pp. 813–817.)

Along the line were the houses of 28 listeners, for all of whom even local reception was hopelessly interfered with. By replacing the line insulators (3-petticoat type) by the most interference-free type (which was found to be of " Vollkern "—solid-core ?—design: no details are given) and by the introduction of rejector circuits at the beginning of the line, outside the switching station, the trouble was so conquered that every listener could receive, " practically free from interference," all the big German stations.

3668. LIABILITY TO INTERFERENCE OF BROADCAST RECEIVER INSTALLATIONS, AND THE EARTHING OF THE AERIAL CARRIER TUBE.—Bergtold. (*See* 3676.)

3669. RESULTS OF THE CISPR EXPERTS' CONFERENCE IN BRUSSELS, 15TH–17TH MARCH 1937 [on Broadcast Interference].—(*E.T.Z.*, 29th July 1937, Vol. 58, No. 30, p. 820.)

3670. ON THE SECONDARY VOLTAGE OF THE HIGH-TENSION MAGNETO.—G. Tahata. (*Electrotech. Journ.*, Tokyo, Aug. 1937, Vol. 1, No. 3, p. 117.)

AERIALS AND AERIAL SYSTEMS

3671. THE USE OF COAXIAL AND BALANCED TRANSMISSION LINES IN FILTERS AND WIDE-BAND TRANSFORMERS FOR [Ultra-] HIGH RADIO FREQUENCIES.—W. P. Mason & R. A. Sykes. (*Bell S. Tech. Journ.*, July 1937, Vol. 16, No. 3, pp. 275–302.)

" The effect of the distributed nature of the elements is taken account of in the design equations, and methods are described for obtaining single-band filters and transformers. Experimental measurements of such filters and transformers are shown. The experimental loss curve is shown of a coaxial filter used for the Provincetown/Green-Harbour short-wave radio circuit, for the purpose of connecting a transmitter and receiver to the same aerial."

3672. TRANSMISSION LINES AT VERY HIGH RADIO FREQUENCIES [and the Effect of Radiation Resistance].—Reukema. (*See* 3635.)

3673. EXPERIMENTS WITH UNDERGROUND ULTRA-HIGH-FREQUENCY ANTENNA FOR AIRPLANE LANDING BEAM.—Diamond & Dunmore. (*See* 3708.)

3674. RECEIVING AERIALS: TYPES BEST SUITED FOR BROADCASTING, SHORT WAVES, AND THE ULTRA-SHORT WAVES.—H. B. Dent. (*Wireless World*, 20th Aug. 1937, Vol. 41, pp. 174–175.)

3675. A NEW ANTENNA KIT DESIGN [Noise-Reducing All-Wave Aerial, with Distribution Transformer for feeding Several Receivers].—W. L. Carlson & V. D. Landon. (*RCA Review*, July 1937, Vol. 2, No. 1, pp. 60–68.)

3676. LIABILITY TO INTERFERENCE OF BROADCAST RECEIVER INSTALLATIONS, AND THE EARTHING OF THE AERIAL CARRIER TUBE [especially of Rod Aerials with Screened Down-Leads].—F. Bergtold. (*E.T.Z.*, 29th July 1937, Vol. 58, No. 30, pp. 817–819.)

Such earthing of the metal carrier tube produces no increase of interference, usually even a decrease, provided that the earthing lead can be kept outside the interference zone. In closely built-over areas, and with high buildings, it is, however, usually impossible so to run the earthing lead, since the zone often extends several metres above the walls of the house and all over the space between the houses. In such a case the disturbances produced in the earthing lead are transmitted capacitively from the carrier tube to the aerial. The problem is dealt with in two parts: first the case where the screened down-lead is directly connected to aerial and to receiver, and secondly where matching transformers are used at each end. In both cases the earthing of the tube is found liable to produce some 30% increase in susceptibility to interference.

Two improvements are suggested: earthing the tube through a protecting spark gap (which will very greatly reduce the capacity between aerial and earth, especially for rod aerials where the rod/tube capacity has to be large for mechanical reasons), and the erection of a circular horizontal counter-balancing capacity or earth-screen (Figs. 10, 11) immediately below the aerial and connected to the earthed tube and to the outside of the screened down-lead. The effect of this screen is to reduce the aerial's capacity to earth, and thus to reduce its susceptibility to interference. Except when such a screen is used, the earthing of the outside of the screened down-lead will as a rule increase interference considerably: in previous diagrams it is therefore shown as un-earthed. If an iron roof under the aerial is available, it may advantageously be used as the screen. This second plan has the advantage of allowing *direct* earthing and decreases the liability to other types of interference.

3677. A MULTIPLE-UNIT STEERABLE ANTENNA FOR SHORT-WAVE RECEPTION [for Increased Reliability of Transatlantic Service: "MUSA" End-On Array using Rotatable Phase Shifters to steer the Vertical Response].—H. T. Friis & C. B. Feldman. (*Proc. Inst. Rad. Eng.*, July 1937, Vol. 25, No. 7, pp. 841–917: *Bell S. Tech. Journ.*, July 1937, Vol. 16, No. 3, pp. 337–419.)

"A system two miles long is believed to be practicable and desirable. It could be expected to perform more consistently better than the three-quarter-mile trial installation [at the Holmdel laboratories] and should yield a signal/noise improvement of 12–13 db referred to one rhombic antenna . . ."

3678. ALTERATIONS TO VDE 0855/1936 "REGULATIONS FOR AERIAL INSTALLATIONS."—Verband Deutscher Elektrotechniker. (*E.T.Z.*, 8th July 1937, Vol. 58, No. 27, pp. 755–756.)

3679. NEW TRANSATLANTIC ANTENNAS [130-Foot Wooden Poles at Riverhead, Long Island, for Short-Wave Aerials].—(*Journ. Franklin Inst.*, July 1937, Vol. 224, No. 1, p. 132: short note only.)

3680. GROUND SYSTEMS AS A FACTOR IN ANTENNA EFFICIENCY [Theoretical and Experimental Investigation of Losses: $\lambda/8$ Aerial practically as Efficient as $\lambda/4$ Aerial: Desirability of Ground System of 120 Buried Radial Wires each $\lambda/2$ in Length: etc.].—G. H. Brown, R. F. Lewis, & J. Epstein. (*Proc. Inst. Rad. Eng.*, June 1937, Vol. 25, No. 6, pp. 753–787.)

3681. THE SHUNT-EXCITED ANTENNA [Vertical Broadcasting Tower with Earthed Base].—J. F. Morrison & P. H. Smith. (*Proc. Inst. Rad. Eng.*, June 1937, Vol. 25, No. 6, pp. 673–696.) *See* 113 of January; *also* 524 of February.

3682. SOME FACTORS IN THE DESIGN OF DIRECTIVE BROADCAST ANTENNA SYSTEMS [Simplified Method of Analysis: Application to Systems of Two Radiators].—W. S. Duttera. (*RCA Review*, July 1937, Vol. 2, No. 1, pp. 81–93.)

3683. RADIATION IMPEDANCE OF T-TYPE BROADCASTING ANTENNA.—M. Korekoda. (*Electrotech. Journ.*, Tokyo, Aug. 1937, Vol. 1, No. 3, pp. 104–108.)

"Up to the present, the radiation impedance of an antenna of this type having a horizontal part has been calculated by Pierce, Moullin [2596 of 1936], and Hara [1934 Abstracts, p. 383]. In the present paper, however, assuming that the current distribution in the vertical and horizontal parts of T-type aerials takes the sinusoidal form," the equations for the self and mutual radiation impedances of the two parts are first deduced, and then the composite radiation impedance which appears at the feeding point is obtained. The values obtained by theoretical calculation are found to agree very closely with actual measurements.

3684. CONSIDERATIONS ON THE PROBLEM OF THE CALCULATION OF COMPLEX AERIALS.—P. Nicolas. (*Bull. de la S.F.R.*, No. 3, Vol. 11, 3rd Quarter 1937, pp. 93–112: in French & English concurrently.)

VALVES AND THERMIONICS

3685. ELECTRON SCATTERING AND THE ACTION OF A COLLECTOR ELECTRODE IN AN ELECTRON SWARM [Calculations applicable to Magnetrons and Positive-Grid Valves: Formation of Virtual Cathode: Expression for Current to Internal Collector with Retarding Field].—E. G. Linder. (*Phys. Review*, 1st June 1937, Series 2, Vol. 51, No. 11, p. 1024: abstract only.)

3686. THE ENERGY BALANCE OF THE ROTARY MOTION OF THE ELECTRON IN THE MAGNETIC-FIELD VALVE.—Fritz. (*See* 3631.)

3687. THE DISTRIBUTION OF POTENTIAL IN SOME THERMIONIC TUBES [Formulae for Coefficients of Capacity in Various Cases].—L. Rosenhead & S. D. Daymond. (*Proc. Roy. Soc.*, Series A, 3rd Aug. 1937, Vol. 161, No. 906, pp. 382–405.)

A triode is considered as a row of rectilinear cylindrical conductors of small circular section between plane or circular anode and cathode. The electrostatic theory of such systems is investigated from fundamental principles, and expressions for the capacity coefficients of the grid or grids and anode are found in the cases of a triode and tetrode for both plane and cylindrical electrodes.

3688. CAPACITIVE CURRENTS IN TRIODE POWER AMPLIFIER VALVES.—M. Mariani. (*Alta Frequenza*, Aug. 1937, Vol. 6, No. 8, pp. 501–515.)

Author's summary :—The various methods proposed for the design calculation of triode power amplifiers do not take into account the capacitive currents which, at the higher frequencies, assume values greater than the useful current, and which ought therefore to be considered in calculating the various circuit elements. On the basis of the simplifying hypotheses generally adopted in calculating power amplifiers, simple expressions are derived for the calculation of these capacitive currents. From these expressions, and their corresponding equivalent circuits, some deductions are made on the influence of the inter-electrode capacities on the input and output circuits, both for the case of phase coincidence between the exciting voltage and the anode counter-voltage and for the case when the phase difference between these two voltages is not zero.

The derived expressions are extended to apply to the estimation of the currents due to parasitic capacities outside the valve, connected with the blocking and leak condensers associated with the valve. The results of calculation are verified experimentally, and an account is given of the method of deriving, by capacity measurements, the empirical values to be introduced into the various formulae.

3689. THE THEORY OF THE SHOT EFFECT : II.—E. N. Rowland. (*Proc. Camb. Phil. Soc.*, July 1937, Vol. 33, Part 3, pp. 344–358.)

For I *see* 534 of February. Calculations are here given of the shot effect when the anode circuit has inductance, the shot effect with finite valve resistance, the probability functions involved, and the shot effect with secondary emission.

3690. APPARATUS FOR DEMONSTRATING THE ACTION OF A TRIODE [using the Westinghouse WL 787 with Fluorescent Anode].—A. Bressi. (*Alta Frequenza*, Aug. 1937, Vol. 6, No. 8, pp. 555–563.)

3691. AN IMPROVED ELECTRICAL TELEGAUGE [using Special Triode with Element Spacing capable of Variation].—W. C. Hall & R. Gunn. (*Phys. Review*, 1st June 1937, Series 2, Vol. 51, No. 11, p. 1027 : abstract only.)

3692. INVESTIGATION OF THE BEHAVIOUR OF A HEXODE [connected for A.F. Amplification : Faithful Amplification over Greater Part of Cycle, but with Very Short Discontinuity, traced to Peculiarity of Grid-Current Characteristic due to Very High-Frequency Self Oscillation in Screen/Cathode Circuit].—H. O. Walker. (*Wireless Engineer*, Aug. 1937, Vol. 14, No. 167, pp. 430–432.)

The analysis applies equally to a pentode in which the suppressor grid lead is brought out. The unusual behaviour of the screen/cathode circuit "would appear to be the principle of the positive-mu oscillator recently described in an American technical journal. In this a pentode is used with an added capacity in the grid circuit. . . It would also appear that the valve could be used as a short-wave oscillator in which the oscillatory circuit contains the inter-electrode capacitance as the capacitance necessary."

3693. NEW COMMERCIAL AMPLIFIER VALVES [for Audio-Frequency Amplifiers : Triodes Type AC 100/101 (Input Stage) and AD 100/101 (Output) : Low Noise, Low Distortion, Constancy of Electrical Properties throughout Long Life].—W. Graffunder, W. Kleen, & H. Rothe. (*Telefunken*, March 1937, Vol. 18, No. 75, pp. 42–50.)

The types 100 and 101 differ only in their valve bases, the 101's having the usual five-pin "European" base. The writers discuss the various types of valve noise and the extent to which they have been cut down by the special design of the AC 100/101. Since the thermal-agitation noise in an ohmic resistance has a similar variation with frequency to that of shot-effect noise, the value of the latter can be represented by the value of an ohmic resistance which, when introduced into the grid circuit, produces the same noise level : *see* Rothe & Plato, 3765 of 1936. The same applies to scintillation noise. For the AC 100/101, in the range 30–20 000 c/s, the total equivalent resistance is 4000–5000 ohms, giving by Nyquist's formula an average shot-plus-scintillation voltage, referred to the grid, of only about 1 μv, which would be swamped by the thermal noise voltage of a circuit containing, for instance, a one-tenth megohm resistance in the grid lead.

"Spontaneous" valve noise, due to the thermal expansion and consequent changes in position of the electrodes, is also avoided by making the electrodes rigidly fixed with respect to each other by ceramic bridges which, however, allow expansion to occur in a longitudinal direction. Hum due to a.c. heating current (magnetic field and induced charges on the grid) is reduced by methods suggested by McNally (1932 Abstracts, pp. 639–640). Microphonic noise is decreased by the above-mentioned bridge construction : the "capacitive analysis" technique (Graffunder & Rothe, 536 of February) was of great service in developing the design of the system.

For the output triode AD 100/101 the most important objective is undistorted output. The round, indirectly heated cathode, oval grid and oval anode used in the AC 100/101 give rise to an inhomogeneity of the field (in front of the hot cathode) produced by the potentials of the various electrodes, and yield a family of characteristics which is perfectly suitable for an input valve working at quite small modulation amplitudes and low a.c. outputs, but which must be improved for an output valve. Hitherto, therefore, an output triode has been given a directly heated filament, which has a logarithmic course of potential between grid and cathode and a consequently more favourable characteristic shape. But for the avoidance of hum with a.c. mains heating an indirectly heated cathode was required for the AD 100/101, and an extensive uniformity of potential field has been obtained by the special " lens " cross-sections given to the electrodes (Fig. 62) and by the use of a grid-type auxiliary anode A_1, internally connected to the true anode A. Only the curved surfaces of the cathode K are oxide coated, and opposite these surfaces are parts of the grid, auxiliary anode and true anode surfaces all having the same centre of curvature.

3694. The New Valves [to be shown at the Olympia Exhibition].—(*Wireless World*, 20th Aug. 1937, Vol. 41, pp. 178–179.)

3695. The New German 18-Watt Output Pentode AL5.—(*Funktech. Monatshefte*, July 1937, No. 7, pp. 227–228.)

In the paper dealt with in 3696, below. This pentode, and the tuning indicator there described, are the only new German valve productions of the new season, thanks to an agreement between the valve manufacturers. The AL5 is a further development of the AL4, whose output it roughly doubles. It has overcome the difficulties of large output (in spite of its small size of diameter 44 mm and over-all height 110 mm) by " the application of electron-optical knowledge and new work on the current-distribution relations: thus it has been possible to improve the ratio between screen-grid and anode currents so that the former is only about 10% of the latter." The grid bias must be obtained by way of a cathode resistance, and ultra-short-wave self-excitation must be suppressed by a damping resistance of 1000 ohms directly in the grid lead. The " klirr " factor (of non-linear distortion) varies from 2.6% for a speech power of 1 watt to 10.5% for a speech power of 9 watts.

3696. New Tuning Indicator Tubes [German Versions of the " Magic Eye ": Types AM2 (for A.C.) and C/EM2 (Universal & Car Receivers): Two Methods of Use (compared with One for Foreign Design) owing to Addition of Grid to Indicator System].—(*Funktech. Monatshefte*, July 1937, No. 7, pp. 226–228.)

3697. New Amateur Tubes [RK-25B, RK-41 (Beam), RK-42, & RK-43 (for Single Dry Cell)].—Raytheon Company. (*QST*, Aug. 1937, Vol. 21, No. 8, p. 96.)

3698. Nickel in the Radio Industry [for Valves (including Methods of Increasing the Thermal Emissivity and for securing Low Grid Emission: Oxide Cathodes, and the Need for Traces of Activating Elements: etc.): Magnetic Alloys: Chemical Properties: Outgassing: etc.].—E. M. Wise. (*Proc. Inst. Rad. Eng.*, June 1937, Vol. 25, No. 6, pp. 714–752.) With 55 literature references, including private communications.

3699. " Batalum," a Barium Getter for Metal Tubes.—E. A. Lederer & D. H. Wamsley. (*RCA Review*, July 1937, Vol 2, No. 1, pp. 117–123.)

3700. Measuring Mutual Conductance [by Single Milliammeter and Calibrated Variable Resistance].—P. D. Tyers. (*Wireless World*, 13th Aug. 1937, Vol. 41, pp. 143–144.)

3701. Secondary-Electron Emission from Complex Surfaces.—Treloar. (*See* 3793.)

3702. The Chief Laws of the Emission of Secondary Electrons from the Surface of Metals.—R. Warnecke. (*Bull. de la S.F.R.*, No. 3, Vol. 11, 3rd Quarter 1937, pp. 61–92: in French & English concurrently.)

3703. Field Emission from Stratified Cathodes (Al–Al Oxide-Cs Oxide) [studied with Electron Microscope: Positive Surface Charge].—H. Mahl. (*Naturwiss.*, 9th July 1937, Vol. 25, No. 28, p. 459.) *See* also Malter, 3419 of 1936.

3704. Surface Migration of Barium [No Evidence of Migration to Opposite Side on Nickel or Tungsten Ribbon].—M. Benjamin & R. O. Jenkins. (*Nature*, 24th July, 1937, Vol. 140, p. 152.) Results contradicting those of Brattain & Becker (1933 Abstracts, p. 330).

3705. Thermionic Approximations to the Gas-Covered Fraction of an Adsorbing Surface, applied to the Temperature Dependence of Oxygenation and Oxidation of a Tungsten Filament.—M. C. Johnson & F. A. Vick. (*Proc. Phys. Soc.*, 1st July 1937, Vol. 49, Part 4, No. 273, pp. 409–418: Discussion p. 418.)

Authors' summary:—A distinction is made between two methods of using thermionic data to estimate for a filament surface the fraction which is covered with oxygen. Conditions are formulated under which either of the two gives approximations to the true fraction defined by concentration of particles in an adsorbed layer. In the method depending upon work functions the necessity for obtaining true instead of apparent thermionic constants for a composite surface is introduced, as these are found to differ widely for oxygenated tungsten. A set of experimental data is analysed by means of the two methods in turn, and empirical graphs are thence obtained representing approximately the temperature variation of the gas content of the surface. The limiting slopes to which these graphs tend in the valid portions of their respective ranges agree with the temperature coefficients of oxidation and oxygen evaporation known from other experiments.

3706. A Study of the Properties of Hydrogen Films on Tungsten by the Method of Contact Potentials.—R. C. L. Bosworth. (*Proc. Camb. Phil. Soc.*, July 1937, Vol. 33, Part 3, pp. 394–402.)

Measurements are described of the work function and thermionic constants of tungsten covered with hydrogen, the covering of the tungsten filament under various conditions in the presence of hydrogen, the condensation coefficient, and the effective dipole moment of each hydrogen atom on the surface.

3707. Contact Potentials for Metals immersed in a Dielectric, and Conduction of Electricity by Liquid Dielectrics [Experiments inconsistent with Thermionic Emission Theory of High Field Phenomena].—H. J. Plumley. (*Phys. Review*, 15th July 1937, Series 2, Vol. 52, No. 2, p. 140.) For this theory *see* 1820 of May: *also* 2985 of August.

DIRECTIONAL WIRELESS

3708. Experiments with Underground Ultra-High-Frequency Antenna for Airplane Landing Beam [Pit Aerial and Transmitter, for Centre of Landing Field (to give Steeper Approach Path and Other Advantages): with Mathematical Analysis and Investigation of Polarisation of Received Wave].—H. Diamond & F. W. Dunmore. (*Journ. of Res. of Nat. Bur. of Stds.*, July 1937, Vol. 19, No. 1, pp. 1–19.)

3709. Note on the Aerials and Radiation Diagrams of Interlocked-Signal Radio Beacons [using Besson's Phase-Inversion Method of Keying].—Y. Rocard: Besson. (*Bull. de la S.F.R.*, No. 2, Vol. 11, 2nd Quarter 1937, pp. 33–60.)

Including a study of the course width for a beacon of four doublets set cross-wise; of systems of aerials giving increased keying depth with large angles; of secondary effects (*e.g.* if, during phase inversion, the intensity is varied in the same rhythm); analysis of the effects of diffraction by obstacles, and a discussion on the reduction of such effects due to obstacles near the receiver and near the transmitter.

3710. The Influence of Re-Radiators on Direction Finding [Decrease of Bearing Error with Increasing Phase Difference between Signal and Disturbing Fields: Compensation of Error on Airship "Hindenburg," s.s. "Europa": "Funkbeschicker," the Telefunken Mechanical Error Compensator (using Metal Templates): etc.].—A. Mainka. (*Funktech. Monatshefte*, July 1937, No. 7, pp. 201–206.)

3711. Small-Vessel Direction Finders.—H. B. Martin. (*RCA Review*, July 1937, Vol. 2, No. 1, pp. 69–80.)

3712. Novel Methods of testing Aircraft Radio Compass [in Laboratory: with Transmission Line stretched across Large Shielded Room].—R. J. Framme. (*Proc. Inst. Rad. Eng.*, June 1937, Vol. 25, No. 6, p. 659: summary only.)

3713. Safety in Aviation [the German State Services and Their Growth in the Last Ten Years].—F. W. Petzel. (*E.T.Z.*, 19th Aug. 1937, Vol. 58, No. 33, pp. 894–898.) Introductory article to the series of papers (*see* below) forming this special number of *E.T.Z.* devoted to the subject of Safety in Aviation.

3714. Central Offices [Telegraphy and Telephony, Pneumatic Tube] of the State Service for Safety in Aviation.—F. Hentschel. (*Ibid.*, pp. 898–901.)

3715. Ground Direction-Finding Stations of the State Service for Safety in Aviation.—W. Robra. (*Ibid.*, pp. 901–904.)

3716. Blind Landing Beacons of the State Service for Safety in Aviation.—H. J. Zetzmann. (*Ibid.*, pp. 904–907.)

3717. Transoceanic Radio Stations of the State Service for Safety in Aviation, Hamburg (Quickborn).—H. Friedrich. (*Ibid.*, pp. 907–909.)

3718. Central Radio Stations of the State Service for Safety in Aviation.—L. Benkert. (*Ibid.*, pp. 909–913.)

3719. The Illumination of Flying Grounds and Routes.—F. Nickel. (*Ibid.*, pp. 913–914.)

3720. Wireless Installations on Commercial Aircraft.—R. Brüger. (*Ibid.*, pp. 915–917.)

3721. Aviation Weather Service.—K. Bringmann. (*Ibid.*, pp. 917–919.)

3722. New Weather-Report Receiving and Control Central Stations of the State Service for Safety in Aviation.—H. J. Zetzmann. (*Ibid.*, p. 920: summary only.)

ACOUSTICS AND AUDIO-FREQUENCIES

3723. On the Disturbing Power of Non-Linear Distortions.—H. J. von Braunmühl & W. Weber. (*Akustische Zeitschr.*, May 1937, Vol. 2, No. 3, pp. 135–147.)

It is concluded that while the ear is extraordinarily sensitive to distortions in pure tones, in natural composite sounds (speech, music, noises) distortions in the transmitting system can be detected only if a "klirr" factor (independent of frequency) of at least 4% is present. If the distortions vary with frequency the deterioration is in general considerably slighter. In the most unfavourable case examined, the critical "klirr" factor reached 6–7%. In the practically important case of a "klirr" factor increasing towards the lower frequencies, the critical value is 20%. But if it is stipulated that no deterioration due to non-linear distortion of speech and music must be perceptible, and it is assumed that pure tones and simple tone mixtures (occurring only very rarely in practice) are to be judged by a direct comparison, then a "klirr" factor not greater than 2% at medium and high frequencies must be striven for. Below 100 c/s a factor of 15% is still permissible.

3724. Remarks on the Subjective, Harmonic Partial Tones described by G. von Békésy.—Lottermoser: Békésy. (*Akustische Zeitschr.*, May 1937, Vol. 2, No. 3, pp. 148–149.)

Lottermoser maintains that Békésy's values are too high by a whole order of magnitude. Békésy replies.

3725. THE CANCELLATION, REINFORCEMENT, AND MEASUREMENT OF SUBJECTIVE TONES.—D. Lewis & M. J. Larsen. (*Proc. Nat. Acad. Sci.*, July 1937, Vol. 23, No. 7, pp. 415–421.)

"As will be shown, a subjective tone that is specifically audible [or not: *see* footnote 1] may be either increased or decreased in loudness by the introduction of a harmonic whose pitch is the same as that of the subjective tone. The phenomenon is undoubtedly due to interference, inasmuch as both the amount and direction of loudness-change vary with the phase of the introduced harmonic." The electrostatic audio-generator (3946 of 1935) was employed.

3726. AN INVESTIGATION OF SUBJECTIVE TONES BY MEANS OF THE STEADY-TONE PHASE EFFECT.—J. D. Trimmer & F. A. Firestone. (*Journ. Acoust. Soc. Am.*, July 1937, Vol. 9, No. 1, pp. 24–29.)

3727. MODERN METHODS OF SOUND ANALYSIS [including Automatic Methods and "Sound Spectroscopy" (Meyer & Thienhaus—2691 of 1935): Comparison].—G. Buchmann. (*Zeitschr. V.D.I.*, 31st July 1937, Vol. 81, No. 31, pp. 915–921.)

3728. RELATION BETWEEN LOUDNESS AND MASKING [and the Effect on the Accuracy of the Authors' Method of calculating the Loudness of a Complex Tone from Its Acoustic Spectrum].—H. Fletcher & W. A. Munson. (*Journ. Acoust. Soc. Am.*, July 1937, Vol. 9, No. 1, pp. 1–10.) *See* 1934 Abstracts, p. 99, l-h column, 3rd abstract.

3729. LOUDNESS MEASUREMENTS: DERIVATION OF A SCALE FOR USE WITH PERSONAL ESTIMATIONS.—W. A. Munson: Fletcher. (*Electrician*, 30th July 1937, Vol. 119, p. 138.) *See* also 3020 of August.

3730. AN EMPIRICAL FORMULA FOR THE LOUDNESS OF A 1000-CYCLE TONE.—H. P. Knauss. (*Journ. Acoust. Soc. Am.*, July 1937, Vol. 9, No. 1, pp. 45–46.)

The formula found shows that for low intensities the loudness (in millisones) is directly proportional to the intensity (in units of 10^{-16} watt per sq. cm), while for high intensities it is proportional to the cube root of the intensity.

3731. NOISE MEASUREMENT: WORK OF THE FIRST INTERNATIONAL ACOUSTICAL CONFERENCE.—(*Electrician*, 13th Aug. 1937, Vol. 119, p. 197.)

3732. TENTATIVE GUIDING LINES FOR SOUND METERS AND RECORDERS.—(*Akustische Zeitschr.*, Jan. 1937, Vol. 2, No. 1, pp. 54–55.)

3733. INVESTIGATIONS ON NEW "SOUND NOZZLES" [Rectifier Nozzle, Bolometer Nozzle, and Bolometer Probe: for Sound Pressure Measurements around 15 Microbars: Suitable for Tests on Resonators].—P. E. Schiller & H. Castelliz. (*Akustische Zeitschr.*, Jan. 1937, Vol. 2, No. 1, pp. 11–17.)

3734. AUDIO-FREQUENCY CURVE TRACER [using Cathode-Ray Tube with Long Afterglow].—W. N. Weeden. (*Wireless World*, 13th Aug. 1937, Vol. 41, pp. 137–138.)

3735. A CHROMATIC STROBOSCOPE [giving Direct Reading (in Musical Scale Notation) of Any Pitch, with Precision greater than That of Ear].—O. L. Railsback. (*Journ. Acoust. Soc. Am.*, July 1937, Vol. 9, No. 1, pp. 37–42.)

3736. THE DYNATRON OSCILLATOR.—Houldin. (*See* 3639.)

3737. AUDIO-FREQUENCY TRANSFORMERS.—Wrathall. (*Wireless Engineer*, Aug. 1937, Vol. 14, No. 167, pp. 414–421.) Conclusion of the paper referred to in 3009 of August.

3738. CLASS B AUDIO DESIGN: A SIMPLIFIED METHOD FOR DETERMINING CORRECT OPERATING CONDITIONS.—E. I. Anderson. (*QST*, Aug. 1937, Vol. 21, No. 8, pp. 43–45 and 98, 100, 102 & 106.)

3739. INVESTIGATION OF THE BEHAVIOUR OF A HEXODE [connected as A.F. Amplifier].—Walker. (*See* 3692.)

3740. CONTRAST ["Dynamik"] AND NOISELESS-RECORDING ["Reinton"] PERFORMANCE OF THE DIFFERENT SYSTEMS OF SOUND-ON-FILM RECORDING.—A. Narath. (*Telefunken*, March, 1937, Vol. 18, No. 75, pp. 59–71.)

Comparison of amplitude (single double-contour track and fourteen double-contour track) and intensity processes, as regards their contrast (defined as the ratio of max. undistorted useful amplitude to background-noise amplitude) and its effective increase by the "noiseless" recording technique.

3741. LARGE-PICTURE SOUND-FILM EQUIPMENT [for Open Air and Indoors: 40–50 Watts enough to fill "Deutschlandhalle" of 200 000 m³].—O. Laass. (*Zeitschr. V.D.I.*, 31st July 1937, Vol. 81, No. 31, p. 922.)

3742. MODERN THEATRE LOUDSPEAKERS AND THEIR DEVELOPMENT.—Flannagan, Wolf, & Jones. (*Bell S. Tech. Journ.*, July 1937, Vol. 16, No. 3, p. 420: summary only.)

3743. PENTODE CONTROL OF DAMPING OF LOUDSPEAKER CONE, ELIMINATING DISTORTION DUE TO INERTIA.—J. R. Warren. (*Proc. Inst. Rad. Eng.*, June 1937, Vol. 25, No. 6, p. 670: in a summary of a Canadian Westinghouse paper entitled "Radio Tube Applications.")

3744. EXTENDING THE AUDIO RANGE OF LOUDSPEAKERS [Improved Low-Frequency Response by Tuned Acoustic Transmission Line coupled to Rear of Loudspeaker].—H. S. Knowles. (*Proc. Inst. Rad. Eng.*, June 1937, Vol. 25, No. 6, p. 661: summary only.) From the Jensen Company.

3745. W. B. "PLANOFLEX" LOUDSPEAKER.—(*Wireless World*, 20th Aug. 1937, Vol. 41, p. 175.)

3746. TRANSIENT RESPONSE [Width of Frequency Response *Not* Sole Factor of Importance].—P. G. A. H. Voigt. (*Wireless World*, 30th July 1937, Vol. 41, pp. 90–92.)

3747. THE SOUND FIELD OF THE PISTON RADIATOR [Theoretical Investigation with Application to the Theory of the Finite Horn (as Radiator and as Receiver, with and without Baffle)].—L. Gutin. (*Tech. Phys. of USSR*, No. 5, Vol. 4, 1937, pp. 404–413: in German.)

3748. THE EFFECT OF TWO ISOLATED FORCES ON THE ELASTIC STABILITY OF A FLAT RECTANGULAR PLATE [Theory].—D. M. A. Leggett. (*Proc. Camb. Phil. Soc.*, July 1937, Vol. 33, Part 3, pp. 325–339.)

3749. THE FREQUENCIES AND NODAL LINES ON CIRCULAR METALLIC PLATES.—Colwell, Friend, & Hardy. (*Phys. Review*, 1st June, 1937, Series 2, Vol. 51, No. 11, p. 1025: abstract only.)

3750. ACOUSTIC MEASUREMENTS ON EDDY STREAMS BEHIND CIRCULAR CYLINDERS AND FLAT PLATES [Eddy Frequencies and Distances, Hydrodynamic Resistance, etc.].—R. Lehnert. (*Physik. Zeitschr.*, 15th July 1937, Vol. 38, No. 13/14, pp. 476–498.)

3751. THE DEFORMATION OF ELASTIC PLATES IN THE CASE OF GIVEN ANALYTICAL CONDITIONS [for General Solution of Differential Equation in Polar Coordinates].—N. Cioranesco. (*Comptes Rendus*, 19th July 1937, Vol. 205, No. 3, pp. 215–217.)

3752. THE MECHANISM OF INTERNAL FRICTION [Transverse Vibrations of Thin Reeds are neither Adiabatic nor Isothermal: Their Relation between Stress and Strain is represented by a Closed Hysteresis Curve].—C. Zener. (*Phys. Review*, 1st June 1937, Series 2, Vol. 51, No. 11, p. 1015: abstract only.)

3753. ON FUNDAMENTAL VIBRATIONS WITH DAMPING INDEPENDENT OF VELOCITY.—H. Neubert. (*Akustische Zeitschr.*, Jan. 1937, Vol. 2, No. 1, pp. 34–37.)

3754. ON FREE VIBRATIONS WITH NON-LINEAR ELASTICITY [Formulae for Computation of Natural Frequency when Restoring Force is Proportional to Any Power of Displacement].—A. Gemant. (*Phil. Mag.*, Aug. 1937, Series 7, Vol. 24, No. 160, pp. 272–281.)

3755. COMPLETE [General] EQUATIONS FOR THE EQUILIBRIUM OF THIN ELASTIC SHELLS.—F. Odqvist. (*Comptes Rendus*, 26th July 1937, Vol. 205, No. 4, pp. 271–273.)

3756. THE DEVELOPMENT OF NEW GRAMOPHONE RECORDING HEADS AND PICK-UPS [Reed (clamped at One End) and "Four-Pole" Type Recorders: Pick-Up (Pressure 30 gm, Restoring Force 5–6 gm) with Permanent Needle: All without Artificial Damping and for Frequency Range 40–10 000 c/s: Special Pick-Up for Wax Records, for monitoring Recording Process].—H. Bartels & E. Severin. (*Telefunken*, March 1937, Vol. 18, No. 75, pp. 27–37.)

3757. CRYSTAL PICK-UP [" Bending " Type (" Bieger ") using Composite Rochelle Salt Crystal Plate 1 mm Thick, with Needle-Movement applied at Narrow Free End: High E.M.F. and Light Weight: Other Advantages].—(*E.T.Z.*, 29th July 1937, Vol. 58, No. 30, p. 823.) An anonymous paragraph.

3758. RECENT IMPROVEMENTS IN CRYSTAL PICK-UP DEVICES.—J. R. Bird. (*Proc. Inst. Rad. Eng.*, June 1937, Vol. 25, No. 6, p. 660: summary only.)

Max. response is obtained at lower frequency end of spectrum (reverse of crystal microphone): tracking error reduced to 2.4° by offset head (with straight arm may be as much as 22°): mechanical couplings between needle chuck and crystal: Rochelle salt crystal shunted by resistance above 10 megohms behaves as pure capacitance up to its resonant point and as pure resistance above this.

3759. THE SPONTANEOUS RESISTANCE FLUCTUATIONS IN CARBON MICROPHONES.—E. Waetzmann & G. Kretschmer. (*Akustische Zeitschr.*, March 1937, Vol. 2, No. 2, pp. 57–61.) Further confirmation of the work dealt with in 3448 of 1936.

3760. DISTORTION IN THE L.F. CONDENSER MICROPHONE.—W. Ernsthausen. (*Arch. f. Elektrot.*, 20th July 1937, Vol. 31, No. 7, pp. 487–494.)

The l.f. condenser microphone and the elements to which it is connected (Fig. 1) are discussed as a whole. The differential equation for the circuit is solved by the assumption of a power-series solution; this leads to curves (Fig. 2) for the " klirr " factor as a function of frequency. In the investigation of linear distortions (§ 2) the effect of the electrode form (electrodes used, Fig. 4) on the frequency curve was measured with the microphone shown in Fig. 3, with a high-tension membrane; the results are shown in Fig. 5. It is found that the frequency curve depends largely on the ratio of the air space between the membrane and the opposite electrode to the effective electrode surface. A new electrode (No. 7, Fig. 4) was developed (frequency curves Fig. 6) with small holes arranged concentrically. An optimum depth was found for the holes, depending on the particular microphone used.

3761. MODE OF ACTION, NATURAL OSCILLATION, AND DAMPING OF OPEN CYLINDRICAL RESONANCE CHAMBERS IN FRONT OF MICROPHONE DIAPHRAGMS.—G. H. Domsch. (*Akustische Zeitschr.*, Jan. 1937, Vol. 2, No. 1, pp. 18–21.)

3762. ON THE POSSIBILITY OF INCREASING THE OUTPUT OF AN ELECTRO-MAGNETIC TELEPHONE RECEIVER BY MEANS OF A RATIONALLY DESIGNED EAR-PIECE.—A. G. El'snits & A. A. Kozlyaninova. (*Izvestiya Elektroprom. Slab. Toka*, No. 5/6, 1937, pp. 38–43.)

A theoretical investigation in which the geometrical dimensions and physical properties of the human ear are taken into account, leading to the examination of an electrical circuit equivalent to the " telephone-receiver/ear " system.

3763. Scientific Research applied to the Telephone Transmitter and Receiver.—E. H. Colpitts. (*Bell S. Tech. Journ.*, July 1937, Vol. 16, No. 3, pp. 251–274.)

3764. A Measure and the Limit of the Quality of Telephone Receivers [and Possibility of Improvement].—K. Kobayasi. (*Nippon Elec. Comm. Eng.*, June 1937, No. 6, pp. 114–118.)

" . . . . the quality of telephone receivers can reasonably be measured with the resonance frequency f_0 and pressure p_0, shown in Fig. 2." "It is impossible to realise a telephone receiver of quality higher than 46.4 db by any means so long as the clamped steel diaphragm is used. This statement may sound somewhat remarkable," but is supported by argument. The only method of improvement is to make the ratio $a/\sqrt{m}$ as large as possible, a being effective area of diaphragm and m the equivalent mass of the vibrating system. *See* 3765, below.

3765. A High Quality Telephone Receiver [with Armature and Light Corrugated Silk Diaphragm].—H. Ikeda. (*Nippon Elec. Comm. Eng.*, June 1937, No. 6, pp. 119–121.)

From Kobayasi's work (3764, above) it follows that the only way of improving the quality of a simple clamped diaphragm receiver is to increase $a/\sqrt{m}$, but that this ratio is limited by the fact that the diaphragm is charged with two functions—the transformation of electrical to mechanical power and the radiation of sound power. To improve quality, therefore, these two functions should be separated. Experiments on composite structures have led to the construction of silk diaphragms impregnated with a special varnish and suitably corrugated. The new telephones have a quality ranging from 43.2 to 46.2 db, which approaches the theoretical limit of 46.4 db for clamped steel diaphragms and exceeds the limit practically attainable, estimated by Kobayasi at 37.6 db.

3766. Acoustic Measuring Methods, with Particular Attention to Measurements on Telephone Receivers.—H. Panzerbieter. (*E.T.Z.*, 8th & 15th July 1937, Vol. 58, Nos. 27 & 28, pp. 735–738 and 765–766.)

3767. Volume Expansion Problems [and a New Circuit].—M. C. Pickard. (*Wireless World*, 27th Aug. 1937, Vol. 41, pp. 186–189.)

3768. Recent Progress in Speech and Music Transmission [14th Berlin Radio Exhibition, 1937.]—E. Thienhaus. (*Zeitschr. V.D.I.*, Nos. 29 & 31, Vol. 81, 1937, pp. 855–861 and 905–913.) With 119 literature references.

3769. The Development of "Distant Conducting" [leading to Erich Fischer's Demonstration, in Berlin, of his System of Conductor & Orchestra in One Hall, and Vocal & Instrumental Soloists (with Auxiliary—"Formal"—Conductor) in Another, perhaps in a Different Town].—H. Draeger. (*Funktech. Monatshefte*, July 1937, No. 7, pp. 229–230.)

3770. The Hammond Organ [with 91 Electro-Magnetic Tone-Wheel Generators: Almost Unlimited Range of Tone Colours by adding Harmonics to the Pure Tones].—W. Baggally. (*Wireless World*, 13th Aug. 1937, Vol. 41, pp. 134–136.)

3771. Magnetic Generation of a Group of Harmonics [Description and Analysis].—Peterson, Manley, & Wrathall. (*Elec. Engineering*, Aug. 1937, Vol. 56, No. 8, pp. 995–1001.)

3772. Violin Intonation.—P. C. Greene. (*Journ. Acoust. Soc. Am.*, July 1937, Vol. 9, No. 1, pp. 43–44.)

3773. Frequency Response Curves of Violins.—H. Meinel. (*Journ. Acoust. Soc. Am.*, July 1937, Vol. 9, No. 1, pp. 51–52: long summary of *Akustische Zeitschr.* paper.)

3774. Practical Tests for Determining the Accuracy of Pianoforte Tuning.—W. B. White. (*Journ. Acoust. Soc. Am.*, July 1937, Vol. 9, No. 1, pp. 47–50.)

3775. The Influence of the Material of Metal Organ Pipes on Their Tone.—W. Lottermoser. (*Akustische Zeitschr.*, May 1937, Vol. 2, No. 3, pp. 129–134.)

3776. An Equipment for the Artificial Production of Noise of Different Intensities and Frequency Spectra.—A. G. El'snits & M. Yd. Gol'din. (*Izvestiya Elektroprom. Slab. Toka*, No. 4, 1937, pp. 32–38.) For laboratory investigation of the effect of interfering noise on the reception of speech.

3777. The Transmission of Air-Borne Sound by Composite Partitions [with Approximate Formulae and Working Rules].—C. J. Morreau. (*Engineering*, 13th Aug. 1937, Vol. 144, p. 192.)

3778. Experiments on the Conduction of Sound through Solids ["Sound Bridges" formed by Solid Connections between the Air-Spaced Components of a Composite Wall: Alternative Ways of Behaviour].—E. Meyer. (*Akustische Zeitschr.*, March 1937, Vol. 2, No. 2, pp. 72–75.)

3779. On an Asymptotic Behaviour of Forced Plate Oscillations at High Frequencies [Theory and Experimental Confirmation: Application to Sound Transmission through Single Walls].—A. Schoch. (*Akustische Zeitschr.*, May 1937, Vol. 2, No. 3, pp. 113–128.)

3780. Long-Distance Communication System on Non-Loaded Cable.—S. Matsumae. (*Nippon Elec. Comm. Eng.*, June 1937, No. 6, pp. 85–99.)

3781. American Tentative Standard Acoustical Terminology.—H. A. Frederick. (*Journ. Acoust. Soc. Am.*, July 1937, Vol. 9, No. 1, pp. 60–71.)

3782. Theoretical and Experimental Comparison of Measurements of the Threshold of Hearing.—E. Waetzmann & L. Keibs. (*Journ. Acoust. Soc. Am.*, July 1937, Vol. 9, No. 1, pp. 52–53: long summary of *Akustische Zeitschr.* paper.)

3783. Proposed Specifications for Audiometers for General Diagnostic Purposes.—(*Journ. Acoust. Soc. Am.*, July 1937, Vol. 9, No. 1, pp. 72–73.)

3784. A Physical Analysis of the Dead-Beat Mechanism of the Auditory Ossicles [investigated with Model].—O. Stuhlman. (*Phys. Review*, 1st June 1937, Series 2, Vol. 51, No. 11, p. 1026: abstract only.)

3785. The Dependence of Hearing Impairment on Sound Intensity.—J. C. Steinberg & M. B. Gardner. (*Journ. Acoust. Soc. Am.*, July 1937, Vol. 9, No. 1, pp. 11–23.)

3786. The Spectral Constitution of the Long and Short Vowels.—O. Vierling & F. Sennheiser. (*Akustische Zeitschr.*, March 1937, Vol. 2, No. 2, pp. 93–106.)

3787. A Study of the Effect of Frequency and Temperature on the Velocity of Ultrasonic Waves in Gases.—G. W. Warner. (*Journ. Acoust. Soc. Am.*, July 1937, Vol. 9, No. 1, pp. 30–36.)

PHOTOTELEGRAPHY AND TELEVISION

3788. The Brightness of Outdoor Scenes and its Relation to Television Transmission [Average Brightness ranges from Nearly Zero to over 1000 Candles/Sq.Ft: Anything above 15 Candles/Sq.Ft. satisfactory for Iconoscope: Ives's Work on Local Conditions (Smoke, etc.): Specially Sensitive Iconoscopes made by Silver-Evaporation Sensitisation Process: Illumination on Mosaic may be Too Strong as well as Too Weak: etc.].—H. Iams, R. B. Janes, & W. H. Hickok. (*Proc. Inst. Rad. Eng.*, Aug. 1937, Vol. 25, No. 8, pp. 1034–1047.)

3789. Television Pickup Tubes with Cathode-Ray Beam Scanning [Experiments with Cathode Ray (with Secondary Electrons from Electron Gun specially Suppressed) releasing Secondary Electrons from Light-Sensitive (including Selenium-Sensitised), Heat-Sensitive, and Electron-Sensitive Targets].—H. Iams & A. Rose. (*Proc. Inst. Rad. Eng.*, Aug. 1937, Vol. 25, No. 8, pp. 1048–1070.)

3790. Theory and Performance of the Iconoscope [Standard Models give Excellent Pictures with 2½–6 Millilumens/Sq.Cm on Mosaic, in spite of Over-All Efficiency of only 5–10%: Experimental Models with Efficiencies as high as 50%: Experimental Signal-Multiplier Iconoscopes: Experimental Image-Multiplier Iconoscopes (Sensitivity 10 times greater than Standard): etc.].—V. K. Zworykin, G. A. Morton, & L. E. Flory. (*Proc. Inst. Rad. Eng.*, Aug. 1937, Vol. 25, No. 8, pp. 1071–1092.)

3791. A New Electron Camera: First Details of a Recent Development combining the Principles of the [Farnsworth] Image Dissector and the [Zworykin] Iconoscope.—Lubszynski & Rodda. (*Television*, Aug. 1937, Vol. 10, No. 114, pp. 467–468.)

3792. Photocells with Secondary-Emission Amplification.—W. Kluge, O. Beyer, & H. Steyskal. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 18, 1937, pp. 219–228.)

From the AEG laboratories. One of the guiding lines of the writers' investigations was to keep, in the complex construction of the electron-multiplier photocell, the highly sensitive photocathode arrived at in the construction of the simpler ordinary photocell. Thus they have succeeded in attaining, in their multiplier cells, a sensitivity of 15–30 μA/lumen for their primary cathodes (*see* Kollath, 2584 of July). A second object held in view was to keep the voltages employed as low as possible: that is, with a fixed total voltage to obtain as high a multiplication as possible, by concentrating on getting a high efficiency per stage instead of using a large number of stages. For the writers believe that in many practical cases objection will be taken to voltages exceeding 1000 volts such as are required by multipliers of more than about 8 stages. They also believe that the magnetic multiplier will be less popular than the electrostatic type, because of the extra space and weight associated with the necessary magnet. The fact that, other things being equal, the multiplication factor is always greater for a solid bombarded electrode than for a bombarded grid ("Prallgitter") does little to affect such a preference, for although this higher multiplication factor is clearly seen by a comparison of Fig. 1 and Fig. 8, nevertheless the curves of Fig. 3 show the superior relative spectral sensitivity of the bombarded-grid multiplier compared with the magnetic type with its solid electrodes. This is because "the process of manufacture and the use of silver sheet as the carrier metal for the photocathode does not allow the high current sensitivity usual in modern photocells to be attained: the primary cathode as a rule shows a sensitivity barely exceeding 8–12 μA/lumen."

The writers have therefore concentrated on the bombarded-grid multiplier. Earlier types of these (Weiss, 3496 of 1936: *see* also 1470 of April) had the disadvantage of requiring either electrostatic focusing, by auxiliary ring electrodes (Fig. 4), or magnetic (Fig. 5); such arrangements are quite practicable for laboratory purposes but are inconvenient for to-day's commercial requirements. The writers have succeeded in obtaining the necessary focusing by means of the concentrating action of wall charges. Fig. 6 shows how the various grid surfaces are extended so as to fill the entire cross-section of the cylindrical glass tube *R*, each grid being separated from its neighbour by glass distance-rings *D*. The leads to the grids run along the outside of the tube *R* and through holes to the grids. The whole system is built into the photocell bulb *B*, whose end portion *A* contains the photocathode layer, covering the whole of its rounded surface except for a circular window *F*. The photocurrent multiplication occurs in the same way as in the earlier types of Figs. 4 & 5, but the focusing of the electrons and their directing from grid to grid is accomplished by the wall charges which form on the inner surfaces of the distance-rings *D*. For stabilisation of the conditions it is advisable to earth one point of the arrangement, preferably the cathode. The finished 8-stage multiplier (Fig. 7) is of particularly rigid construction, and tests have shown that the addition of a magnetic focusing coil causes hardly any increase of the multiplying action.

The paper ends with the description of an entirely different type of multiplier—a small two-stage device with solid secondary electrodes and without any kind of focusing. It is a development of the scheme described by Görlich (248 of 1936) and by Iams & Salzberg (1545 of 1935) which had the defect that a large number of the primary electrons, especially those from the zone *a–b* (Fig. 13) escaped multiplication by flying direct to the rod-anode *A*. This the writers avoid by the introduction of a semi-cylindrical screen *S* protecting the anode, and the finished cell (Fig. 16) gives an over-all current sensitivity of 150–200 μA/lumen for a total voltage of 500 volts. The rather high voltage compared with that of a good gas-filled photocell is balanced by two advantages, namely constancy of amplification for different light-impulse frequencies and low background noise. Under suitable conditions the new cell also gives a greater constancy with time.

3793. SECONDARY-ELECTRON EMISSION FROM COMPLEX SURFACES.—L. R. G. Treloar. (*Proc. Phys. Soc.*, 1st July 1937, Vol. 49, Part 4, No. 273, pp. 392–407: Discussion p. 408.)

Author's summary:—The secondary emission from metals on whose surfaces foreign substances (*e.g.* electropositive metals) have been deposited to various thicknesses up to a few atomic layers has been studied. It is shown experimentally [for method *see* 2620 of 1936] that for sufficiently thin films of the contaminant the secondary emission for a given base metal depends only on the work function of the surface, and not at all on the nature of the contaminant. The form and magnitude of the variation of secondary emission with work function agree with those calculated from the energy-distribution of secondary electrons. From a study of thicker films information is obtained concerning the mean depth of liberation of secondary electrons. The significance of the results in connection with more complex secondary-emitting materials is discussed.

3794. EFFECT OF BASE METAL CRYSTALS ON PHOTOELECTRIC EMISSION [from (Ag)–Cs_2O–Cs Surface: Electron-Microscopic Investigation].—Y. Moriya. (*Electrotech. Journ.*, Tokyo, Aug. 1937, Vol. 1, No. 3, p. 118.)

For previous work *see* 3077 of August. Among the effects observed were that the electron emission is specially great at the boundaries of the individual crystal grains and that the boundaries become clearer as the wavelength of the light is decreased from 6000 to 3000 or 4000 Angstroms; leading to the conclusion that the electron-emitting substance exists in greater quantities at the boundaries than in the crystal surface, and that there is a preponderance of such substance, having high work function, at these boundaries. The effect of rotation of the electric vector was also examined.

3795. MULTIPLIER PHOTOCELLS TYPES ML AND MS.—Baird Company. (*Electrician*, 6th Aug. 1937, Vol. 119, pp. 162–163.)

3796. IMPROVEMENTS IN SYSTEMS FOR THE VOLTAGE SUPPLY FOR [Secondary-Emission] PHOTO-ELECTRIC CELLS.—Bathélémy. (French Pat. 811 387, pub. 13.4.1937: *Rev. Gén. de l'Élec.*, 26th June 1937, Vol. 41, pp. 207–208D.) Using the amplified line-changing signals, transformed, rectified, and filtered.

3797. THE TIME-LAG IN GAS-FILLED PHOTO-ELECTRIC CELLS [Measurements agreeing with Value calculated from Positive Ion Mobility].—A. M. Skellett. (*Phys. Review*, 1st June 1937, Series 2, Vol. 51, No. 11, p. 1026: abstract only.)

3798. IMPROVEMENT OF QUALITY OF TELEVISION RECEPTION BY ALTERNATE HORIZONTAL AND VERTICAL SCANNING, USING ELECTRONIC COMMUTATION.—Denisov. (*See* 3845.)

3799. METHODS OF TWO-WAY [Alternate Horizontal and Vertical] SCANNING IN TELEVISION.—V. G. Denisov. (*Tech. Phys. of USSR*, No. 5, Vol. 4, 1937, pp. 383–403: in English.)

"Images obtained by one-way and two-way scanning are compared. The advantages of the second technique are discussed in connection with the possibility of high-quality television transmission with short [as distinct from ultra-short] waves. Devices for scanning in two perpendicular directions, as developed by T. Smith [Br. Pat. 347 435 of 1930] and J. Ryftin, are discussed [no specific publication of the latter's proposal is cited, but his analysis of the influence of different parameters on the image quality is quoted from: *see* 1524 & 2719 of 1935]. The author then describes a mechanical [two synchronised semi-spiral discs] and an electronic two-way scanning device worked out by him . . ." [*see* also 3798, above]. It is claimed that the quality of the images is increased by 20–30%.

3800. IMPROVEMENTS IN THE USE OF AN ELECTRIC ARC [*e.g.* Tungsten in Hydrogen] AS LUMINOUS SOURCE FOR TELEVISION RECEIVERS.—Siemens & Halske. (French Pat. 810 969, pub. 3.4.1937: *Rev. Gén. de l'Élec.*, 26th June 1937, Vol. 41, pp. 206–207D.)

3801. TELEVISION RECEIVERS: PART II.—Espley & Edwards. (*G.E.C. Journ.*, Aug. 1937, Vol. 8, No. 3, pp. 229–236.) Final part of the paper referred to in 3041 of August.

3802. DEVELOPMENT OF THE PROJECTION KINESCOPE [for 18" × 24" Pictures], *and* HIGH-CURRENT ELECTRON GUN FOR PROJECTION KINESCOPES [based on "First Crossover" Theory: on 10 kV, Beam Currents of 1.5–2 mA easily concentrated into 300-Micron Spot].—V. K. Zworykin & W. H. Painter: R. R. Law. (*Proc. Inst. Rad. Eng.*, Aug. 1937, Vol. 25, No. 8, pp. 937–953: pp. 954–976.)

3803. THEORETICAL LIMITATIONS OF CATHODE-RAY TUBES [Maximum Current Density in Beam $= I_0(E_2e/kT + 1) \sin^2 \phi$].—D. B. Langmuir. (*Proc. Inst. Rad. Eng.*, Aug. 1937, Vol. 25, No. 8, pp. 977–991.)

Aberrations may reduce the current density below this value. The total voltage is usually limited by practical considerations, and no great gain can be expected from reduction of cathode temperature T. "Two major points of attack upon the problem of producing more intense electron beams are, therefore, indicated; namely the development of cathode surfaces from which higher current densities can be drawn at a given temperature, and the development of focusing fields which can handle beams of wider angle without attenuation."

3804. TELEVISION PROJECTION WITH THE CATHODE-RAY TUBE: AN ACCOUNT OF SOME RECENT R.C.A. DEVELOPMENTS.—(*Television*, Aug. 1937, Vol. 10, No. 114, pp. 457–459.)

3805. THE TELEFUNKEN TELEVISION PROJECTION RECEIVER, 1936.—K. Diels & G. Wendt. (*Telefunken*, March 1937, Vol. 18, No. 75, pp. 23–27.)

3806. PROJECTION WITH CATHODE-RAY TUBES: AN ACCOUNT OF SOME RECENT ITALIAN DEVELOPMENTS BY THE SAFAR COMPANY [Metal, Quartz, and Ceramic Tubes].—A. Castellani. (*Television*, July 1937, Vol. 10, No. 113, pp. 413–414.)

3807. A CIRCUIT FOR STUDYING KINESCOPE RESOLUTION [by Special, Very "Tight," Synchronisation of Deflection- and Grid-Signal-Frequencies to give Black and White Chessboard Patterns].—C. E. Burnett. (*Proc. Inst. Rad. Eng.*, Aug. 1937, Vol. 25, No. 8, pp. 992–1011.)

3808. MINIATURE TELEVISION: THE POSSIBILITIES OF SMALL RECEIVERS [using the RCA Miniature Cathode-Ray Tube] AND CONSEQUENT REDUCTION IN COST.—(*Television*, Aug. & Sept. 1937, Vol. 10, Nos. 114 & 115, pp. 456 & 459 and 523–524 & 528.)

3809. TELEVISION—SCANNING AND SYNCHRONISING; DETAILS OF A SYNC SEPARATOR AND PULSE-SHAPING CIRCUIT [giving Perfect Synchronisation even when Signal/Noise Ratio is Low and during Heavy Interference causing Trouble to Conventional Circuits].—P. D. Tyers. (*Wireless World*, 6th Aug. 1937, Vol. 41, pp. 115–118.)

3810. THE WIDTH OF THE FREQUENCY BAND IN THE SCANNING OF TELEVISION PICTURES [Wrongness of Former Method of reckoning Band Width by Frame and Line Numbers and Number of "Elements" in Line: Width governed by Rapidity of Succession of Changes from Light to Dark and *vice versa*: Effect of Spot Size].—F. Raeck. (*Funktech. Monatshefte*, July 1937, No. 7, Supp. pp. 57–58.)

3811. TELEVISION TRANSMITTERS OPERATING AT HIGH POWERS AND ULTRA-HIGH FREQUENCIES [and Their Radical Departures from Usual Conventions].—J. W. Conklin & H. E. Gihring. (*RCA Review*, July 1937, Vol. 2, No. 1, pp. 30–44.)

3812. TELEVISION IN GREAT BRITAIN.—N. Ashbridge. (*Proc. Inst. Rad. Eng.*, June 1937, Vol. 25, No. 6, pp. 697–707.)

3813. THE LONDON TELEVISION STATION, ALEXANDRA PALACE.—BBC. (At Patent Office Library, London: Cat. No. 77 569: 36 pp.)

3814. TELEVISION RECEPTION AT 80 MILES [Rugby, from Alexandra Palace].—(*Electrician*, 6th Aug. 1937, Vol. 119, p. 156: summary only.)

3815. TELEVISION RECEIVERS AND CATHODE-RAY GEAR, *and* TELEVISION AT THE OLYMPIA EXHIBITION [Items in Stand-to-Stand Guide].—(*Wireless World*, 20th Aug. 1937, Vol. 41, pp. 170–171: 27th Aug. 1937, Vol. 41, pp. 207–224.)

3816. TELEVISION RELAYS FOR MODERN FLATS [at Arlington House, Piccadilly].—(*Television*, July 1937, Vol. 10, No. 113, pp. 399–400.)

3817. TELEVISION AT THE GERMAN RADIO EXHIBITION, *and* BRITISH AND GERMAN TELEVISION: IDEALS AND IDEAS.—Anon: L. M. Gander. (*Wireless World*, 13th Aug. 1937, Vol. 41, p. 142: pp. 145–146.)

3818. THE TELEVISION DISPLAY OF THE GERMAN IMPERIAL POST OFFICE AT THE INTERNATIONAL EXHIBITION, PARIS 1937 [Television of Films, Open-Air Scenes: Television Conversations].—(*E.N.T.*, June 1937, Vol. 14, No. 6, p. 223: short note only.)

3819. THE NEW STANDARDISATION OF GERMAN TELEVISION BROADCASTING [Change-Over from 180-Line Sequential to 441-Line Interlaced Scanning].—F. Banneitz. (*Funktech. Monatshefte*, July 1937, No. 7, Supp. pp. 53–54.)

3820. PROGRESS IN TELEVISION TECHNIQUE.—(*Radio, B., F. für Alle*, July 1937, No. 185, Supp. pp. 78–96.) Being Chapter 8 of *Fortschritte der Funktechnik II*.

3821. DEVELOPMENT, PRESENT POSITION, AND LIMITS OF TELEVISION [Address to the Hauptversammlung Deutscher Naturforscher und Ärzte, Dresden, Sept. 1936].—F. Schröter. (*Telefunken*, March 1937, Vol. 18, No. 75, pp. 5–18.)

3822. TELEVISION DURING THE OLYMPIC GAMES.—W. Federmann. (*Telefunken*, March 1937, Vol. 18, No. 75, pp. 18–23.)

3823. THE MIHALY-TRAUB SYSTEM.—(*Television*, June 1937, Vol. 10, No. 112, pp. 324–328.)

3824. A NOVEL SCHEME FOR TELEVISION IN COLOURS [Combination of "Kodacolor" Film Principle and Existing Television Technique].—V. A. Babits. (*Television*, Aug. 1937, Vol. 10, No. 114, p. 480.)

3825. TELEVISION STUDIO DESIGN.—R. M. Morris & R. E. Shelby. (*RCA Review*, July 1937, Vol. 2, No. 1, pp. 14–29.)

3826. AN OSCILLOGRAPH FOR TELEVISION DEVELOPMENT [with Circuits particularly designed to transmit Transient Phenomena (of Both Types) without Distortion].—A. C. Stocker. (*Proc. Inst. Rad. Eng.*, Aug. 1937, Vol. 25, No. 8, pp. 1012–1033.)

"Suitable for sine-wave tests at any frequency between about 10 cycles and 2 megacycles. It will faithfully reproduce any wave shape in the frequency band between 30 cycles and 50 kilocycles, and will reproduce any but the very sharpest wave shapes to about 300 kilocycles."

3827. CONCENTRIC HIGH-FREQUENCY CABLE [Strong and Flexible, using Minimum Amount of Copper].—AEG. (French Pat. 810 604, pub. 24.3.1937: *Rev. Gén. de l'Élec.*, 26th June 1937, Vol. 41, p. 205D.)

MEASUREMENTS AND STANDARDS

3828. MEASURING METHODS AND APPARATUS FOR FREQUENCIES BETWEEN 30 AND 60 MEGACYCLES PER SECOND [using Thermogalvanometer and Rohde Diode: Importance of Screening and Arrangement: Calibration: etc.].—H. Lennartz & K. Koschmieder. (*Funktech. Monatshefte*, July 1937, No. 7, pp. 221–225.) The Rohde diode (*see*, for example, 1931 Abstracts, p. 393) is found to have a capacity of 0.7 pF (1 picofarad = 10^{-12} farad).

3829. POWER MEASUREMENT WITH THE CATHODE-RAY OSCILLOGRAPH.—H. J. Mohr. (*Arch. f. Elektrot.*, 20th July 1937, Vol. 31, No. 7, pp. 442–456.)

The measurement of power (or the product of voltage and current in a circuit) as a function of time (1) by the loop oscillograph and (2) in general is first discussed. The direct multiplication of current and voltage is possible in the cathode-ray oscillograph with a combination of electric and magnetic fields (it is shown in § B that the use of electric fields alone is impracticable). The electrode arrangement is shown in Fig. 2 and the principle of the measurement theoretically explained. Calculations of the measuring system are given in § B II; eqn. 15 gives the final series expression for the deviation of the spot, of which the first term gives the direct measurement of power. The succeeding terms give the distortion, which can be kept sufficiently small. A numerical estimate of the limiting frequency is given.

Experiments with a gas-filled hot-cathode tube (Fig. 4) are described in detail in § C I, and with an ion tube (Figs. 15, 16) in § C II. It is concluded that the cathode-ray oscillograph is superior to the loop oscillograph as an instrument for power measurement as regards frequency variation up to 10^6 c/s. Its disadvantages are that the magnitude of the permissible measuring voltage is limited and must have a definite ratio to the anode voltage of the cathode-ray tube; the deflections obtained are also so small that they are of the same order of magnitude as the unavoidable errors of the apparatus. Suggestions for reducing the latter disadvantage are made; the former is connected with the principle of the measurement and imposes a marked limitation on the practical use of the method.

3830. MEASURING R.F. POWER WITH A [Photographic] EXPOSURE METER.—Hannah. (*QST*, Aug. 1937, Vol. 21, No. 8, p. 51.)

3831. MEASUREMENTS ON BROADCAST RECEIVERS.—Jungfer & Köpke. (*See* 3656 & 3657.)

3832. MEASURING MUTUAL CONDUCTANCE [by Single Milliammeter and Calibrated Variable Resistance].—P. D. Tyers. (*Wireless World*, 13th Aug. 1937, Vol. 41, pp. 143–144.)

3833. DISCUSSION ON "CALORIMETRIC MEASUREMENT OF DIELECTRIC LOSSES IN SOLIDS."—Race & Leonard. (*Elec. Engineering*, July 1937, Vol. 56, No. 7, pp. 890–893.) *See* 1081 of March.

3834. NEW A.C. BRIDGE FOR ACCURATE MEASUREMENT OF SMALL DIELECTRIC LOSSES.—H. J. Mau. (*Arch. f. Elektrot.*, 20th July 1937, Vol. 31, No. 7, pp. 473–487.)

The sensitivity of Wheatstone-type bridges is first discussed from fundamental principles. The "adjustment value" of a bridge (Fig. 1) is introduced as a measure of the sensitivity; it is defined as the ratio, to the deflection of the measuring instrument, of the change in the impedance of the quantity to be measured relative to the quantity itself. For measurements of small loss angles, this "adjustment value" is equivalent to the loss angle of the material under test which would give a deflection of 1 mm on the measuring instrument. A formula is deduced (eqns. 4, 6) giving the "adjustment value" in terms of the magnitudes of the elements composing the bridge. The Schering bridge (Fig. 2) and the four-capacity bridge (Fig. 3) are discussed numerically, with the zero galvanometer (Fig. 4) to be used for the measuring instrument. The necessary screening is discussed in § II; a screened bridge with earthed auxiliary branch (after K. W. Wagner) is shown in Fig. 5.

The new bridge circuit here developed (Fig. 6) needs no high-voltage condenser in the auxiliary circuit. Both the high-voltage transformer and the screen are earthed; the voltage drop in the lower arms of the bridge is very high. The circuit and its vector diagram (Fig. 7) are described in detail, with the low- and high-voltage condensers (§ III; Figs. 8–10) with loss-angles smaller than 10^{-6}. The causes of disturbance are discussed in § IV; the voltage variations have the same effect as if a disturbing bridge (equivalent circuit Fig. 11) were superposed on the measuring bridge. The effects of alternating electric and magnetic fields and condenser losses are described. The complete bridge circuit is shown in Fig. 14; its adjustment and the determination of its "adjustment value" are discussed, with measurements on various substances (glass, crystalline quartz, an air condenser, benzol), for which curves are given.

3835. THE BALANCE CONDITIONS OF A.C. BRIDGES WITH MUTUAL INDUCTANCES.—K. Potthoff. (*E.T.Z.*, 22nd July 1937, Vol. 58, No. 29, pp. 793–794.)

3836. Multi-Range A.C. and D.C. Volt-Ammeters.—Ya. S. Averbuch. (*Izvestiya Elektroprom. Slab. Toka*, Nos. 3 & 4, 1937, pp. 58–63 and 60–62.) Conditions are determined enabling a universal meter to be used for measurements over a number of ranges with two scales only. Circuits satisfying these conditions are discussed and a typical meter is described.

3837. A Gas-Relay Operated Frequency Meter [based on the Wynn-Williams "Scale of Two" Counter Principle: Independent of Wave Form and suitable for Frequencies from Lowest to Some Kilocycles/Second].—E. J. B. Willey. (*Wireless Engineer*, Aug. 1937, Vol. 14, No. 167, pp. 433–434.)

3838. Emitter Control by Longitudinal Oscillations of Tourmalin Plates.—Petržílka. (*See* 3637.)

3839. The Theory of the Self-Excitation of a Piezo-Quartz System with Anode Stabilisation.—G. A. K'yandski. (*Izvestiya Elektroprom. Slab. Toka*, No. 5/6, 1937, pp. 1–5.)

A theoretical discussion is presented of the operation of a circuit in which the crystal is connected between the anode and the grid of the oscillator valve (Fig. 1). From an examination of an equivalent circuit (Fig. 2) an equation (6) is derived determining the conditions for self-excitation, and it appears that the back coupling in this system is effected through the grid/filament capacity of the valve. A general equation (9) determining the frequency of the oscillating circuit is also derived, and methods are indicated for solving it in terms of the natural frequency of the tuned anode circuit (11), the natural frequency of the equivalent crystal circuit (13), and the coupling coefficient between these two circuits (15). The solution so obtained is reduced to simpler forms (25 & 26) and it is stated that when the simplified formula (26) was applied to the example given by Vigoureux (1930 Abstracts, p. 518) the calculated frequency was 390 000 c/s, while according to Vigoureux it should be 389 014 c/s.

3840. The Design of Multi-Layer Inductance Coils.—N. M. Goltzman. (*Izvestiya Elektroprom. Slab. Toka*, No. 4, 1937, pp. 20–23.)

A method is proposed for designing a multi-layer cylindrical coil with optimum dimensions, *i.e.* using a wire of a given diameter, to obtain the required value of self inductance with the lowest possible ohmic resistance and the minimum weight of wire. Starting with the Korndörfer formula for the self-inductance of cylindrical coils, an expression (5) is derived determining the resistance R of the coil in terms of the thickness b and length l of the winding, and it is shown that for the minimum R (and weight) of the winding b should be equal to l. It is also shown that R is a minimum when $D/2(b + l) = 1$ (where D is the mean diameter of the winding). From these conditions the optimum values of n (number of turns), D, b, and l are found. Methods are also indicated for determining the section of the coil which it is necessary to tap off in order to obtain the required value of self inductance. It is stated that the discrepancy between the calculated and experimental results is of the order of 2% to 5%.

3841. Graphical Determination of the Resultant Impedance of A.C. Impedances connected in Parallel.—Böning. (*See* 3629.)

3842. Standardisation in Science [Symbols and Units: the "Siemens," the "Gauss," and the "Oersted": etc.]—G.W.O.H: Wallot. (*Wireless Engineer*, Aug. 1937, Vol. 14, No. 167, pp. 401–402.) Editorial prompted by an address by Wallot.

SUBSIDIARY APPARATUS AND MATERIALS

3843. Circuit for Cathode-Ray Tubes: a New Soft Time-Base Circuit [with Quick Flyback (Grid made Positive during Discharge) and Higher Anode Voltage without Cathode Disintegration].—Chard. (*Wireless Engineer*, Aug. 1937, Vol. 14, No. 167, pp. 427–429.)

The two points mentioned above combine to provide a bigger time-sweep voltage, sufficient for use with high-vacuum cathode-ray tubes.

3844. Relaxation, Synchronisation, and Frequency Demultiplication.—Rocard. (*See* 3615.)

3845. Electronic Commutation and Its Application in Apparatus employing Cathode-Ray Tubes.—V. G. Denisov. (*Izvestiya Elektroprom. Slab. Toka*, No. 5/6, 1937, pp. 24–30.)

A description is given of a device developed by the author which enables oscillograms relating to two different oscillating circuits to be obtained simultaneously on the screen of a cathode-ray oscillograph. The device (Fig. 5) consists essentially of a push-pull oscillator blocking alternately, during each half of the cycle, one of the two "commutator" valves. The anodes of these valves are connected to one pair of oscillograph plates, while the other pair serves as a time base. If outputs from two circuits oscillating at a frequency twice the frequency of the push-pull oscillator are applied to the grids of the commutator valves, two separate oscillograms will be obtained on the screen of the oscillograph. The operation of the device is discussed and various applications suggested. One of these is the alternate transmission of horizontally and vertically scanned frames in television. This would improve the quality of the received image without an increase in the number of transmitted elements: *see* 3799, above.

3846. Discussion on "Electronic Transient Visualisers" [using Cathode-Ray Oscillographs].—Reich. (*Elec. Engineering*, July 1937, Vol. 56, No. 7, pp. 873–875.) *See* 1107 of March.

3847. THE TECHNIQUE INVOLVED IN INVESTIGATIONS ON INVOLUNTARY TRANSIENT PHENOMENA [including Two- and Three-Element Oscillographs (Split Ray): Fog-Free Trapping Device: Kipp Relays: Automatic Electro-Magnetic Oscillograph].—Kasai. (*Electrotech. Journ.*, Tokyo, Aug. 1937, Vol. 1, No. 3, pp. 78–88.)

3848. A MAGNETIC ELECTRON MICROSCOPE OF SIMPLE DESIGN.—McMillen & Scott. (*Review Scient. Instr.*, Aug. 1937, Vol. 8, No. 8, pp. 288–290.)

3849. GAUSS'S APPROXIMATION FOR THE GENERAL SYSTEMS OF ELECTRONIC OPTICS [Theory of Electron Trajectories].—Cotte. (*Comptes Rendus*, 12th July 1937, Vol. 205, No. 2, pp. 129–131.)

3850. THE FOCUSING OF CORPUSCULAR BEAMS BY CIRCULAR DEVIATION IN A TRANSVERSE MAGNETIC FIELD [Theory: Proposed Arrangements for Study of Energy, Mass, etc.].—Cartan. (*Comptes Rendus*, 12th July 1937, Vol. 205, No. 2, pp. 126–129.)

3851. MAGNETIC FOCUSING OF ION BEAMS [Experimental Test of Theory of Effect, on Focus Position, of Angle of Incidence of Beam on Magnetic Field: Satisfactory Agreement].—Straus: Herzog. (*Phys. Review*, 15th July 1937, Series 2, Vol. 52, No. 2, pp. 128–130.) For the theory in question *see* Herzog, 1934 Abstracts, p. 570.

3852. A STABLE SOURCE OF FOCUSED IONS.—Smith & Scott. (*Phys. Review*, 1st June 1937, Series 2, Vol. 51, No. 11, p. 1025: abstract only.) Modification of the source already referred to in 2786 of 1936.

3853. HIGH POTENTIAL APPARATUS FOR NUCLEAR DISINTEGRATION EXPERIMENTS [Million-Volt Transformer: Focused Ion Beam].—Crane. (*Phys. Review*, 1st July 1937, Series 2, Vol. 52, No. 1, pp. 11–17.)

3854. DESTRUCTION BY PRESSURE [Grinding] OF PHOSPHORESCENT PROPERTIES OF MATERIALS [Zinc and Strontium Sulphide: Measurements of Decrease in Phosphorescence with Amount of Grinding: a Phosphorescent Centre is Not a Place of Least Resistance of the Material to Pressure].—Riehl & Ortmann. (*Ann. der Physik*, Series 5, No. 6, Vol. 29, 1937, pp. 556–568.)

3855. THE MANUFACTURE OF HIGH OHMIC RESISTANCES BY THE METHOD OF CATHODE SPUTTERING.—Ust'yanov. (*Izvestiya Elektroprom. Slab. Toka*, No. 5/6, 1937, pp. 48–51.)

A description is given of the manufacturing technique evolved to increase the stability of platinum resistances prepared by the method of cathode sputtering. After a spiral layer of platinum has been deposited on a glass bar, the latter is mounted in a glass tube which is then evacuated down to 10^{-5}mm Hg and kept for one hour at a temperature of 450°C in the presence of P_2O_5. A current is then passed through the resistance for 18 to 25 hours, reaching a maximum of 4 watts for 4 to 6 hours. Resistances up to 10^7 ohms were so prepared; their capacities and inductances did not exceed 0.1 cm and 20 cm respectively. In addition to a detailed description of various stages of the manufacture, curves are given showing the effect of vacuum and electric-current treatment on the resistance of the platinum layer.

3856. CONTROLLED CATHODE SPUTTERING [Measurements relating to Cathode Disintegration in Gaseous Discharges: Amount and Rate of Sputtering, etc.]—Timoshenko. (*Nature*, 10th July 1937, Vol. 140, p. 67.)

3857. MERCURY VAPOUR GRID-CONTROLLED TUBES; THEIR ELECTRIC CONTROL BY A PHASE-SHIFTING NETWORK: I [Equations for Voltage/Current Relations of Apparatus involving Grid for Phase-Shifting Method: Circle Diagram giving Amplitude and Phase of Grid Potential: General Equations for Application: Experimental Confirmation].—Strelzoff. (*Journ. Franklin Inst.*, July 1937, Vol. 224, No. 1, pp. 55–75.)

3858. THE DESIGN OF THERMIONIC RECTIFIERS.—Rabinovich. (*Izvestiya Elektroprom. Slab. Toka*, No. 4, 1937, pp. 38–44.)

A method is proposed based on the use of the "rectification characteristics," *i.e.* curves showing the relationship between the d.c. component of the anode voltage and the average value of the current flowing through the rectifier, for a constant a.c. anode-voltage component. Both single and poly-phase rectifiers are discussed.

3859. THE SELENIUM RECTIFIER.—Kipphan. (*Elec. Communication*, July 1937, Vol. 16, No. 1, pp. 21–29.)

3860. RIPPLE ELIMINATOR [for Rectified Currents: Usual High-Frequency Suppressors (Low-Pass Filters), used as Ripple Eliminators, do Not stop A.C. Harmonics from flowing through A.C. Side: Use of "Harmonic Wave Absorber": Application to Sparkless Interruption of Inductive Circuits].—Nukiyama, Hashimoto, & Sugi. (*Nippon Elec. Comm. Eng.*, June 1937, No. 6, pp. 135–144.)

3861. BATTERY PERFORMANCE FROM THE RECTIFIED A.C. POWER SUPPLY [A.V.C. Principle].—Grammer. (*See* 3654.)

3862. THE THYRATRON VOLTAGE REGULATOR [for Alternator supplying Radio Transmitter: Tirrill System, with Thyratrons in Output Circuit of Exciter].—Voskresenski. (*Izvestiya Elektroprom. Slab. Toka*, Nos. 5/6, 1937, pp. 44–47.)

3863. A TYPE OF HIGH POTENTIAL BATTERY WHICH COMBINES EXTREME LIGHTNESS WITH LONG SHELF LIFE.—Ramsey. (*Phys. Review*, 1st June 1937, Series 2, Vol. 51, No. 11, p. 1028: abstract only.)

3864. SOME PRIMARY BATTERIES WITH ALUMINIUM ELECTRODES.—Brull. (*La Ricerca Scient.*, 15th/30th June 1937, Series 2, 8th Year, Vol. 1, No. 11/12, pp. 525–527.)

3865. New Vibrator-Type Plate Supplies for Storage-Battery Operation [" Vibrapack " Units].—P. R. Mallory Company. (*QST*, Aug. 1937, Vol. 21, No. 8, pp. 52 and 82.)

3866. The " Genemotor " [Power Generator for Two-Way Police Systems].—De Soto & Goodman. (*See* 3891.)

3867. High-Frequency Gas-Filled Condensers for High-Power Radio Transmitters.—Zhilinski. (*See* 3642.)

3868. Variation of Resistance and Power Factor of Glass Condensers with Radio-Frequencies [76 to 8250 kc/s: Measurements: Resistance varies Inversely as Frequency and Inversely as Capacity: Resistance due chiefly to Dielectric Losses: Part of Dielectric Absorption due to Polar Orientation].—Fletcher. (*Phil. Mag.*, Aug. 1937, Series 7, Vol. 24, No. 160, pp. 319–324.)

3869. A Variable Air Condenser with Adjustable Compensation for Temperature.—Thomas. (*See* 3641.)

3870. Capacitor Requirement Analysis, *and* Electrolytic Capacitors and Their Applications [and the Two Types of Charging Curves and Their Special Advantages for Specific Purposes].—Peck: Robinson. (*Proc. Inst. Rad. Eng.*, June 1937, Vol. 25, No. 6, p. 662: p. 663: summaries only.)

3871. Electrolytic Condensers [Short Survey, including the " Eloxal " Process].—(*Zeitschr. V.D.I.*, 31st July 1937, Vol. 81, No. 31, pp. 913–914.)

3872. Anodic Protection of Aluminium and Its Alloys: Characteristics and Applications.—Afferni. (*L'Elettrotec.*, 25th July 1937, Vol. 24, No. 14, pp. 437–439.)

3873. Contact Potentials for Metals immersed in a Dielectric, and Conduction of Electricity by Liquid Dielectrics.—Plumley. (*See* 3707.)

3874. The Temperature Stability of Condenser Paper.—Walter & Chelyustkina. (*Izvestiya Elektroprom. Slab. Toka*, No. 4, 1937, pp. 54–59.) An experimental investigation of the effect, on the tensile strength of condenser paper, of heating in air, vacuum, paraffin, and halowax (*see* 3167 of 1936).

3875. Superstyrex: the Use of Styrol as an Insulator.—Scott. (*Elec. Communication*, July 1937, Vol. 16, No. 1, pp. 51–55.)

3876. Components and Accessories [to be shown at the Olympia Exhibition].—(*Wireless World*, 20th Aug. 1937, Vol. 41, pp. 180–184.)

3877. The Design of Transformers and Inductance Coils with Iron Cores.—Starik. (*Izvestiya Elektroprom. Slab. Toka*, No. 5/6, 1937, pp. 5–9.)

A method is proposed for determining the constants of a transformer or coil starting from a fixed relationship between the various dimensions of the iron core. The optimum shape of the core is also discussed.

3878. High-Frequency Coils with Iron Ribbon Cores and Adjustable D.C. Magnetic Bias.—Maus. (*See* 3650.)

3879. Magnetic Materials and Their Application to Loudspeaker Design [particularly Nipermag].—Conwell. (*Proc. Inst. Rad. Eng.*, June 1937, Vol. 25, No. 6, pp. 665–666: summary only.)

3880. Magnetic Quality of Nickel Wire as Influenced by the Surface [Magnetisation Curves for Wires heated in Hydrogen and then cooled: Magnetic Characteristic depends on Diameter].—Wall. (*Nature*, 7th Aug. 1937, Vol. 140, p. 238.) *See* also 3157 of August.

3881. Low Flux Density A.C. Losses in 35 Permalloy Sheet [Properties of Hysteresis, Eddy Current and Residual Losses: Variation with Frequency does not agree with Classical Theory].—Legg. (*Phys. Review*, 1st June 1937, Series 2, Vol. 51, No. 11, p. 1009: abstract only.)

3882. Nickel in the Radio Industry.—Wise. (*See* 3698.)

3883. An X-Ray Study of the Ar_3 and Ac_3 Points for Pure Fe and Fe/Ni Alloys.—Smith & Davey. (*Phys. Review*, 1st June 1937, Series 2, Vol. 51, No. 11, p. 1010: abstract only.)

3884. Magnetic Interaction and Resultant Anisotropy in Unstrained Ferromagnetic Crystals [Theory].—McKeehan. (*Phys. Review*, 1st July 1937, Series 2, Vol. 52, No. 1, pp. 18–30.)

3885. Magnetic Properties of Alloys of Iron with Ruthenium and Osmium [Curie and Transition Points for Varying Proportions of Metals].—Fallot. (*Comptes Rendus*, 19th July 1937, Vol. 205, No. 3, pp. 227–230.)

3886. A New Photoelectric Hysteresigraph.—Edgar. (*Elec. Engineering*, July 1937, Vol. 56, No. 7, pp. 805–809.)

3887. An Apparatus for Accelerated Cinematography [Simple and Cheap Rotating-Disc Apparatus using Photographic Plates].—Bronn & Alexandrow. (*Tech. Phys. of USSR*, No. 5, Vol. 4, 1937, pp. 370–376: in English.)

3888. A Curve Tracer for Two, Three, or Four Variables.—Awender & Tombs. (*Review Scient. Instr.*, Aug. 1937, Vol. 8, No. 8, pp. 274–278.)

STATIONS, DESIGN AND OPERATION

3889. The Provision to Subscribers of Broadcast Programmes over Lines by means of Carrier Waves [Radio Relay Services over Telephone Network]. — Buchmann. (*E.T.Z.*, 29th July 1937, Vol. 58, No. 30, pp. 822–823.)

Summary of a *Siemens-Zeitschrift* paper. The relay service system which is most satisfactory both commercially and technically is that using long-wave carriers (150–300 kc/s) over the existing telephone network, giving 3 to 5 alternative programmes: the German experimental service at present uses 155, 220 and 250 kc/s. For a limit of 5 km from the local exchange, a signal strength sufficiently above the background noise (*e.g.* 25 mv for each carrier over cable and 100 mv over line) can be produced with at most a few watts. For greater distances a suitably placed intermediate repeater is desirable, to avoid the necessity for inconveniently large inputs.

3890. ULTRA-SHORT-WAVE COMMUNICATION [including the Single-Channel Barcelona/Majorca and Nine-Channel Scotland/Ireland Links: Comparative Utility of Ultra-Short and Micro-Waves: etc.].—Ullrich. (*Elec. Communication*, July 1937, Vol. 16, No. 1, pp. 64–86.)

3891. A UNIT-STYLE PORTABLE STATION: "GENEMOTOR"-POWERED 'PHONE-C.W. ASSEMBLY WITH SUPERHET RECEIVER AND 35-WATT 6L6 TRANSMITTER.—De Soto & Goodman. (*QST*, Aug. 1937, Vol. 21, No. 8, pp. 20–25 and 82.) The Genemotor combination (designed primarily for 2-way police systems) is driven off a 6-volt battery and gives 50 mA at 250 v (for receiver and modulator) and 100 mA at 350 v (for transmitter).

3892. THE RADIOTELEGRAPHIC CENTRE OF ADDIS ABBABA.—Zambon. (*Alta Frequenza*, Aug. 1937, Vol. 6, No. 8, pp. 516–529: to be contd.)

3893. STANDARD FREQUENCY AND OTHER SERVICES BROADCAST BY THE NATIONAL BUREAU OF STANDARDS [from WWV].—Bureau of Standards. (*Proc. Inst. Rad. Eng.*, July 1937, Vol. 25, No. 7, pp. 793–796.) *See* also 3172 of August.

3894. A SURVEY OF MARINE RADIO PROGRESS, WITH SPECIAL REFERENCE TO R.M.S. "QUEEN MARY."—Loring, McPherson, & McAllister. (*Journ. I.E.E.*, Aug. 1937, Vol. 81, No. 488, pp. 183–218.) The full paper referred to in 3174 of August.

3895. DETAILS OF THE EMERGENCY COMMUNICATION PLAN [U.S. Navy Plan for Co-operation between Naval Communication Reserve Stations and Red Cross Chapters].—Lee. (*QST*, Aug. 1937, Vol. 21, No. 8, pp. 27–29.)

3896. THE VODAS [in the Interconnection of Telephone Systems by Long Radiotelephone Links].—Wright. (*Elec. Engineering*, Aug. 1937, Vol. 56, No. 8, pp. 1012–1017.)

GENERAL PHYSICAL ARTICLES

3897.—CONTEMPORARY ADVANCES IN PHYSICS: XXXI—SPINNING ATOMS AND SPINNING ELECTRONS.—Darrow. (*Bell S. Tech. Journ.*, July 1937, Vol. 16, No. 3, pp. 319–336.)

3898. RECENT WORK IN NUCLEAR PHYSICS AND QUANTUM DYNAMICS: I—THE PRIMARY PARTICLES OF MATTER.—Hill. (*Review Scient. Instr.*, Aug. 1937, Vol. 8, No. 8, pp. 269–273.)

3899. DETERMINATION OF ELECTRONIC CHARGE BY THE OIL-DROP METHOD [using New Oil which minimises Various Errors].—Ishida, Fukushima, & Suetsugu. (*Nature*, 3rd July 1937, Vol. 140, p. 29.)

3900. LIGHT SIGNALS ON MOVING BODIES AS MEASURED BY TRANSPORTED RODS AND CLOCKS [in connection with Michelson-Morley Experiment].—Ives. (*Journ. Opt. Soc. Am.*, July 1937, Vol. 27, No. 7, pp. 263–273.)

MISCELLANEOUS

3901. THE DEATH OF GUGLIELMO MARCONI.—Vallauri. (*Alta Frequenza*, Aug. 1937, Vol. 6, No. 8, pp. 497–500.)

3902. GUGLIELMO MARCONI.—G.W.O.H. (*Wireless Engineer*, Sept. 1937, Vol. 14, No. 168, pp. 465–466: Editorial.)

3903. "BEHANDLUNG VON SCHWINGUNGSAUFGABEN [Oscillation Problems] MIT KOMPLEXEN AMPLITUDEN UND MIT VEKTOREN" [Book Review].—Möller. (*E.T.Z.*, 12th Aug. 1937 Vol. 58, No. 32, p. 891.) This second edition includes new sections on eddy currents, Lecher systems, band filters, etc.

3904. "THÉORIE ET PRATIQUE DES CIRCUITS FONDAMENTAUX DE LA T.S.F." [Applications of the Symbolic Method: Book Review].—Quinet. (*Wireless Engineer*, Sept. 1937, Vol. 14, No. 168, p. 477.)

3905. A NEW APPROACH TO THE HERMITE POLYNOMIALS [Application of Symbolic Operator Methods].—Condon & Greenwood. (*Phil. Mag.*, Aug. 1937, Series 7, Vol. 24, No. 160, pp. 281–287.)

3906. SOME PROPERTIES OF BESSEL FUNCTION ZEROS DERIVED FROM THE WAVE FUNCTIONS FOR A PARTICLE IN AN ENCLOSURE.—Bell. (*Phil. Mag.*, Aug. 1937, Series 7, Vol. 24, No. 160, pp. 299–304.)

3907. A METHOD OF SUMMATION, VALID ALMOST EVERYWHERE, FOR FOURIER SERIES OF CONTINUOUS FUNCTIONS.—Salem. (*Comptes Rendus*, 5th July 1937, Vol. 205, No. 1, pp. 14–16.)

3908. "DIE ZYLINDERFUNKTIONEN UND IHRE ANWENDUNGEN" [Book Review].—Weyrich. (*Zeitschr. f. tech. Phys.*, No. 8, Vol. 18, 1937, p. 238.)

3909. SOME SERIES AND INTEGRALS FOR THE ASSOCIATED LEGENDRE FUNCTIONS OF THE FIRST KIND, REGARDED AS FUNCTIONS OF THEIR ORDERS.—MacRobert. (*Phil. Mag.*, Aug. 1937, Series 7, Vol. 24, No. 160, pp. 223–227.) *See* also 2461 of 1936.

3910. On the Determination of an Integral $\left[\int_0^\infty \{\epsilon^{-px^2}/(1+x^2)\}dx\right]$.—Tonks. (*Phil. Mag.*, July 1937, Series 7, Vol. 24, No. 159, pp. 206–207.)

3911. On the Variation Calculation of Eigen Values [Expression for Lower Bound of Eigen Value associated with Differential System, enabling Estimate of Accuracy of Approximation to Least Eigen Value to be made].—Newing. (*Phil. Mag.*, July 1937, Series 7, Vol. 24, No. 159, pp. 114–127.)

3912. A Method for the Numerical or Mechanical Solution of Certain Types of Partial Differential Equations [Use of the Differential Analyser: Approximation by the Use of Finite Intervals in One Variable and Exact Integration in Other Variable: Subsequent Correction for Leading Error Term]—Hartree & Womersley. (*Proc. Roy. Soc.*, Series A, 3rd Aug. 1937, Vol. 161, No. 906, pp. 353–366.)

3913. Some Differential Equations involving Three-Term Recursion Formulas [Method of Solution of Spheroidal, Lamé, and Generalised Spheroidal Equations].—Fisher. (*Phil. Mag.*, Aug. 1937, Series 7, Vol. 24, No. 160, pp. 245–256.)

3914. On the Solution of Systems of Linear Equations by Successive Approximations.—Cesari. (*La Ricerca Scient.*, 15th/30th June 1937, Series 2, 8th Year, Vol. 1, No. 11/12, pp. 512–522.)

3915. Linear Dependence Charts [Simple Theory of General Type of Chart of which Alignment Charts are a Special Case].—Chao. (*Science Reports of Nat. Tsing Hua Univ.*, Series A, April 1937, Vol. 4, No. 1, pp. 5–19: in English.)

3916. On the Construction of Mechanised Nomograms.—Frank. (*Automatics & Telemechanics* [in Russian], No. 6, 1936, pp. 77–84.)

3917. Trihornometry: a New Chapter of Conformal Geometry.—Kasner. (*Proc. Nat. Acad. Sci.*, June 1937, Vol. 23, No. 6, pp. 337–341.)

3918. Note on the Maximum Correlation Coefficient between Two Series whose Values have been Determined at Equal Intervals [Formulae for Fractional Advance or Lag giving Maximum Correlation and for Maximum Correlation Coefficient].—Morrison. (*Phil. Mag.*, Aug. 1937, Series 7, Vol. 24, No. 160, pp. 240–245.)

3919. Statistical Technique as a Tool in Industry.—Dudding. (*G.E.C. Journ.*, Aug. 1937, Vol. 8, No. 3, pp. 206–215.)

3920. Dynamic Symmetry in Radio Design.—Eddy. (*Rad. Engineering*, June & July 1937, Vol. 17, Nos. 6 & 7, pp. 5–6 & 29 and 7–9: to be contd.)

3921. Scientific Research in Various Countries: I—Belgium.—(*Recherches et Inventions*, July/Aug. 1937, No. 271, pp. 147–158.)

3922. RCA Research and Development [from 1919 to 1937].—(*Electronics*, Aug. 1937, Vol. 10, No. 8, Supp. pp. 1–16.)

3923. Science and Society.—Sarnoff. (*RCA Review*, July 1937, Vol. 2, No. 1, pp. 3–13.)

3924. "Elektrotechnische Berichte" and "Literaturkartei Elektrotechnik" [Abstracts and References Services under VDE Auspices].—Verband Deutscher Elektrotechniker. (*E.T.Z.*, 22nd July 1937, Vol. 58, No. 29, pp. 801–802 and 806.)

It is estimated that the over-lapping between *Elektrotechnische Berichte* and the old-established *Physikalische Berichte* will amount only to about one-fifth of the total contents. Unlike the *Literaturkartei*, which gives short (say 50-word) indications of the contents of each paper, monograph, etc., the new *Berichte* will try as far as possible to make it unnecessary for the reader to read the original. On the other hand, subscribers to the *Literaturkartei* are given certain facilities for obtaining photo-copies of the original papers, and also translations.

3925. Conference of Authors and Readers of "*The Journal of Technical Physics*" (Russian), "*Technical Physics of the USSR*," and "*The Journal of Experimental and Theoretical Physics*" (Russian).—(*Tech. Phys. of USSR*, No. 3, Vol. 4, 1937, pp. 256–258: in English.)

3926. "Lehrbuch [Text Book] der Hochfrequenztechnik" [Book Review].—Vilbig. (*Zeitschr. V.D.I.*, 5th June 1937, Vol. 81, No. 23, pp. 675–676.)

3927. "Preparation of Scientific and Technical Papers: 3rd Edition" [Book Review].—Trelease & Yule. (*Science Progress*, July 1937, Vol. 32, No. 125, p. 201.)

3928. "Telecommunications" [Economics and Regulation: Book Review].—Herring & Gross. (*Electronics*, May 1937, Vol. 10, No. 5, p. 51.)

3929. The Development of Electrotechnics in 1936/1937.—VDE. (*E.T.Z.*, 5th Aug. 1937, Vol. 58, No. 31, pp. 834–860.) With sections on insulating materials, radio, television, interference between communication and power lines, electro-acoustics, etc.

3930. New Receiver Designs: a Preliminary Survey of the Olympia Show, *and* Olympia Show Report: a Stand-to-Stand Report of the 1937 Radio Exhibition.—(*Wireless World*, 20th Aug. 1937, Vol. 41, pp. 158–164: 27th Aug. 1937, Vol. 41, pp. 207–224.)

3931. German Radio Exhibition [17th Berlin Exhibition].—(*Wireless World*, 13th Aug. 1937, Vol. 41, pp. 139–142.)

3932. The Latin-American Expedition of the Telefunken Company.—(*Telefunken*, March 1937, Vol. 18, No. 75, pp. 71–75.)

3933. DISCUSSION ON "SEALED-OFF IGNITRONS FOR WELDING CONTROL."—Packard & Hutchings. (*Elec. Engineering*, July 1937, Vol. 56, No. 7, pp. 875–877.) *See* 1638 of April.

3934. ON MAXIMUM EFFICIENCY IN THE HEATING OF STEEL BY [High-Frequency] INDUCTION.—Vlasov. (*Journ. of Tech. Phys.* [in Russian], No. 4, Vol. 7, 1937, pp. 380–392.)

3935. SURGE METER FOR WELDING MEASUREMENT [Rectifier/Condenser Circuit with High-Resistance Voltmeter].—Weiller. (*Electronics*, May 1937, Vol. 10, No. 5, p. 43.)

3936. THYRATRON CONTROL EQUIPMENT FOR RESISTANCE WELDINGS: PART II—TIMING AND HEAT CONTROL.—Palmer. (*Gen. Elec. Review*, July 1937, Vol. 40, No. 7, pp. 321–325: to be contd.) For Part I *see* 3217 of August.

3937. MAGNETIC METHOD FOR MEASURING THE THICKNESS OF NICKEL COATINGS ON NON-MAGNETIC BASE METALS.—Brenner. (*Journ. of Res. of Nat. Bur. of Stds.*, May 1937, Vol. 18, No. 5, pp. 565–583.)

3938. CONSTRUCTION AND PROPERTIES OF THE MANGANIN-RESISTANCE PRESSURE GAUGE.—Adam, Goranson, & Gibson. (*Review Scient. Instr.*, July 1937, Vol. 8, No. 7, pp. 230–235.)

3939. THE EFFECT OF ELASTIC STRAINS ON THERMO-ELECTRIC FORCES [and Its Possible Use for the Inertialess Measurement of Internal Strains].—Lichtenberger. (*E.T.Z.*, 24th June 1937, Vol. 58, No. 25, p. 694: summary only.)

3940. A METHOD FOR DETERMINING ICE/WATER RELATIONSHIPS BY MEASUREMENTS OF DIELECTRIC CONSTANT CHANGES [at 1.8 Mc/s by Change in Condenser Capacity].—Alexander & Shaw. (*Nature*, 26th June 1937, Vol. 139, pp. 1109–1110.)

3941. TWO NEW METHODS OF TAKING INDICATOR DIAGRAMS OF HIGH-SPEED PISTON ENGINES.—Watzinger & Larsen. (*Zeitschr. V.D.I.*, 28th Aug. 1937, Vol. 81, No. 35, pp. 1011–1012.)

3942. MEASUREMENT OF FLEXURAL VIBRATIONS IN [the Crankshaft of] A DIESEL ENGINE.—Ernst. (*Zeitschr. V.D.I.*, 5th June 1937, Vol. 81, No. 23, pp. 672–673.) Using a high-frequency coupling method.

3943. PROTECTION OF BURIED METALLIC CABLES AND PIPES AGAINST ELECTROLYTIC CORROSION [particularly by the "Electronic Filter" Method].—Guillot. (*Rev. Gén. de l'Élec.*, 19th June 1937, Vol. 41, No. 25, pp. 795–800.) By coating with a non-corrodable conducting substance such as graphited rubber.

3944. APPLICATIONS OF PHOTOGRAPHY TO SCIENTIFIC AND TECHNICAL PROBLEMS.—Bloch. (*Journ. Roy. Soc. Arts*, 28th May 1937, Vol. 85, pp. 651–672.)

3945. PRACTICAL APPLICATIONS OF X-RAY ANALYSIS TO THE TESTING OF MATERIALS [*e.g.* Nickel Tube for Oxide Cathodes].—Burgers. (*Philips Tech. Review*, Jan., March, & May 1937, Vol. 2, Nos. 1, 3, 5: pp. 29–31, 93–95, and 156–158.) Continued from Vol. 1.

3946. THE METALLO PROBE [Electronic Device for studying Cause of Fractures in New Concrete Highways].—Barger. (*Proc. Inst. Rad. Eng.*, June 1937, Vol. 25, No. 6, pp. 668–669: summary only.)

3947. AN IMPROVED ELECTRICAL TELEGAUGE [using Special Triode with Element Spacing capable of Variation].—Hall & Gunn. (*Phys. Review*, 1st June 1937, Series 2, Vol. 51, No. 11, p. 1027: abstract only.)

3948. ELECTRO-MAGNETIC STRAIN PICK-UP UNIT.—Bleakney. (*Engineer*, 6th Aug. 1937, Vol. 164, p. 163.)

3949. MECHANICAL AMPLIFIER WITH A MAGNIFICATION OF MORE THAN 1000: APPLICATION TO THE RECORDING OF THE VISCOUS DEFORMATION OF METALS AT HIGH TEMPERATURES.—Chevenard & Joumier. (*Génie Civil*, 7th Aug. 1937, Vol. 111, pp. 133–134.)

3950. RADIO TECHNIQUE IN THE SERVICE OF GEOLOGY AND MINING (RADIO GEOLOGY).—(*Radio, B., F. für Alle*, Aug. 1937, No. 186, Supp. pp. 97–112.) Being Chapter 9 of *Fortschritte der Funktechnik II*.

3951. RADIO DEVICE LOCATES UNDERGROUND PIPE LINES [Transmitter & Receiver: Presence of Metal Object increases Signal in Receiver].—Fisher. (*Journ. Franklin Inst.*, July 1937, Vol. 224, No. 1, pp. 131–132: note on paper in *American Gas Journal*, Vol. 146, No. 4.)

3952. DISCUSSION ON "CURRENTS AND POTENTIALS ALONG LEAKY GROUND-RETURN CONDUCTORS."—Sunde. (*Elec. Engineering*, July 1937, Vol. 56, No. 7, pp. 887–889.) *See* 2025 of May.

3953. CARRIER TELEPHONE AND TELEGRAPH SYSTEMS IN AUSTRALIA.—Hayes. (*Journ. Inst. Eng. Australia*, May 1937, Vol. 9, No. 5, pp. 195–202.)

3954. THE ADAPTATION OF HIGH-TENSION ELECTRIC NETWORKS TO THE USE OF HIGH-FREQUENCY CARRIER CURRENTS.—Carbenay. (*Ann. des Postes, T. et T.*, June & July 1937, Vol. 26, Nos. 6 & 7, pp. 533–539 and 585–593.)

3955. RECENT PROGRESS IN THE SELECTIVE PROTECTION OF HIGH-TENSION POWER LINES BY CARRIER CURRENT SYSTEMS.—Cahen. (*Bull. Soc. franç. des Élec.*, July 1937, Vol. 7, No. 79, pp. 725–765.)

3956. TERMINOLOGY IN TELEMECHANICS AND AUTOMATICS.—Solodovnikov. (*Automatics & Telemechanics* [in Russian], No. 6, 1936, pp. 85–88.)

3957. RELAXATION CIRCUIT MEASURES RADIANT ENERGY [Flashing Frequency of Neon Tube varied by Illumination, presumably owing to Photoelectrical Activity of Electrodes].—Stager. (*Electronics*, July 1937, Vol. 10, No. 7, pp. 29 and 52, 53.) For the writer's previous work on relaxation oscillation circuits *see* 1933 Abstracts, p. 112, l-h column.

3958. "MEASUREMENT OF RADIANT ENERGY" [Book Review].—Forsythe (Edited by). (*Electronics*, Aug. 1937, Vol. 10, No. 8, p. 32.) Including a chapter by Koller on the measurement of spectral radiation by the photoelectric cell.

3959. A PHOTOELECTRIC METHOD FOR TRACING CURRENT WAVE FORMS [Description of Circuit of Photoelectric Timing Arrangement for obtaining Point-by-Point Plots of Periodically Varying Currents].—Huxford. (*Phys. Review*, 1st June 1937, Series 2, Vol. 51, No. 11, p. 1010: abstract only.)

3960. A PORTABLE PHOTOTUBE UNIT USING AN RCA 954 TUBE [as Amplifier: Input Resistance raised from 10^8 to 10^{13} Ohms by Special Use of Its Grids and by Low Voltages].—Gabus & Pool. (*Review Scient. Instr.*, June 1937, Vol. 8, No. 6, pp. 196–198.)

3961. A HIGH-SPEED HIGH-PRECISION MICROPHOTOMETER, *and* A NEW RECORDING MICROPHOTOMETER.—Vincent & Sawyer: Knorr & Albers. (*Journ. Opt. Soc. Am.*, May 1937, Vol. 27, No. 5, pp. 193–197: *Review Scient. Instr.*, June 1937, Vol. 8, No. 6, pp. 183–184.)

3962. HETEROCHROME PRECISION PHOTOMETRY BY THE USE OF THERMOCOUPLES AND COMBINATION FILTER.—König. (*Helvet. Phys. Acta*, Fasc. 3, Vol. 10, 1937, pp. 165–181: in German.)

3963. PHOTOELECTRIC COMPARATOR [with Circuit Diagram].—Roure, Quevron, & Gense. (*Comptes Rendus*, 12th July 1937, Vol. 205, No. 2, pp. 131–133.)

3964. A COMPENSATING CIRCUIT FOR BLOCKING-LAYER PHOTOELECTRIC CELLS [*e.g.* for measuring Transmission or Reflectance of Light from a Sample].—Brice. (*Review Scient. Instr.*, Aug. 1937, Vol. 8, No. 8, pp. 279–285.)

3965. PORTABLE TRANSPARENCY METER USING PHOTOX CELL.—Westinghouse Company. (*Electronics*, July 1937, Vol. 10, No. 7, p. 28.)

3966. THE LIGHT-SENSITIVE CELL [Selenium Barrier-Layer Cell].—Mighell. (*Gen. Elec. Review*, Aug. 1937, Vol. 40, No. 8, pp. 372–275.)

3967. PHOTOELECTRIC PHOTOMETER ["Photelometer," for Chemical Analysis, etc.].—(*Electronics*, Aug. 1937, Vol. 10, No. 8, pp. 54 and 56.)

3968. THE PHOTOELECTRIC MEASUREMENT OF THE DIURNAL VARIATIONS IN DAYLIGHT IN TEMPERATE AND TROPICAL REGIONS.—Atkins, Ball, & Poole. (*Proc. Roy. Soc.*, Series A, 15th June 1937, Vol. 160, No. 903, pp. 526–539.)

3969. ULTRA-VIOLET ENERGY IN DAYLIGHT—A TWO-YEAR RECORD [with Description of Integrating Ultra-Violet Meter: Experimental Curves of Ultra-Violet Energy: Physiological Effects].—Luckiesh, Taylor, & Kerr. (*Journ. Franklin Inst.*, June 1937, Vol. 223, pp. 699–714.)

3970. PHOTOTUBE CONTROLS PUNCH PRESS [for Protection of Operator], *and* PHOTOTUBES CONTROL COCOA REFINING PLANT.—(*Electronics*, July 1937, Vol. 10, No. 7, pp. 21–23: p. 53.)

3971. PHOTOELECTRICALLY - CONTROLLED CANDY WRAPPER MACHINE.—Hall. (*Electronics*, Aug. 1937, Vol. 10, No. 8, p. 18.)

3972. IMPROVED FORM OF AUTOMATIC [Photoelectric] TESTING DEVICE FOR WATT-HOUR METERS.—Takata. (*Electrotech. Journ.*, Tokyo, Aug. 1937, Vol. 1, No. 3, pp. 115–117.)

3973. METHODS FOR THE DETERMINATION OF THE VELOCITY OF PROJECTILES [Short Survey, including Piezo-Indicator].—Teichmann. (*E.T.Z.*, 10th June 1937, Vol. 58, No. 23, pp. 627–628.)

3974. A NEW TYPE OF PERMANENT POLARISATION OF DIELECTRICS [Photoelectrets, produced by Light, compared with Thermoelectrets produced by Heat].—Nadjakoff. (*Comptes Rendus*, 21st June 1937, Vol. 204, No. 25, pp. 1865–1866.)

3975. THE INFLUENCE OF WAVELENGTH ON GENETIC EFFECTS OF X-RAYS.—Fricke & Demerec. (*Proc. Nat. Acad. Sci.*, June 1937, Vol. 23, No. 6, pp. 320–327.)

3976. EMISSION OF X-RAYS BY VACUUM TUBES [Electrodeless or with Single Nickel Electrode] OF VERY SMALL DIMENSIONS UNDER A HIGH-FREQUENCY CURRENT [of Wavelength 200 m].—Maillet. (*Comptes Rendus*, 19th July 1937, Vol. 205, No. 3, pp. 231–234.)

3977. THE "ABSOLUTE" CARDIOGRAM [and Its Derivation from a Time-Marked "Triogram"].—Hollmann. (*Zeitschr. f. Instrumentenkunde*, No. 7, Vol. 57, 1937, pp. 285–295.) Further development of the work referred to in 3587 of September.

3978. PHYSIOLOGICAL EVALUATION OF SHOCK [Vibration, Jerks] MEASUREMENTS.—Meister. (*Journ. Acoust. Soc. Am.*, July 1937, Vol. 9, No. 1, pp. 53–54: long summary only.)

3979. THE RÔLE OF ELECTROTECHNICS IN THE ANALYSIS AND INTERPRETATION OF THE FUNCTIONING OF THE NERVOUS SYSTEM.—Monnier. (*Bull. Soc. franç. des Élec.*, July 1937, Vol. 7, No. 79, pp. 681–702.)

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. A selection of abstracts from patents issued in the U.S.A. is also included, and these bear a seven-figure serial number.

AERIALS AND AERIAL SYSTEMS

464 075.—Directional combination of a frame aerial and an open aerial designed to eliminate "night effect."

Telefunken Co. Convention date (Germany) 7th August, 1935.

464 443.—Short-wave transmitting aerial having a total impedance over a range of frequencies equal to its resistance at resonance.

A. D. Blomlein; E. C. Cork; and J. L. Pawsey. Application dates 19th October, 1935 and *10th July,* 1936.

464 825.—High-frequency transmission line for feeding a short-wave wireless or television aerial.

E. C. Cork and J. L. Pawsey. Application dates 22nd October, 1935 and *25th May,* 1936.

466 020.—Aerial arrangement suitable for receiving at will either short-wave television or the normal B.B.C. programmes.

The General Electric Co. and D. C. Espley. Application date 14th November, 1935.

TRANSMISSION CIRCUITS AND APPARATUS

464 977.—Electrical transmission line for a wide band of frequencies embodying an electron discharge device.

W. S. Percival. Application dates 24th July and 17th December, 1935.

465 613.—Modulating circuit in which the cathodes of the valves are heated by currents of greater frequency than the highest signal frequency.

Marconi's W.T. Co. and N. H. Clough. Application date 9th November, 1935.

RECEPTION CIRCUITS AND APPARATUS

465 333.—Wireless receiver in which interfering signals are eliminated by means of two detectors having different time-constants.

N. V. Philips Co. Convention date (Germany) 26th October, 1935.

465 442.—Wavelength and station-indicator for a wireless set, comprising two rotary members arranged one within the other.

Minerva-Radio, W. Wohleber & Co. Convention dates (Austria) 27th June and 16th July, 1935.

465 593.—Means for maintaining a constant mutual capacity between the elements of a variable high frequency coupling in a wireless receiver.

P. D. Tyers. Application date 3rd October, 1935.

465 703.—Wireless receiver in which a single control knob is made to effect various independent adjustments according to whether it is rotated or moved laterally.

N. V. Philips Co. Convention date (Germany) 19th August, 1935.

467 637.—System of permeability tuning in a wireless receiver.

Johnson Laboratories Inc. (assignees of W. A. Schaper). Convention date (U.S.A.) 26th June, 1935.

VALVES AND THERMIONICS

465 763.—Cathode-ray tube in which the electrodes and a focusing coil are all mounted on a single support of ceramic material.

N. V. Philips Co. Convention date (Germany) 14th October, 1935.

468 185.—Ultra short-wave oscillator in which a beam of electrons is swung over a series of collecting electrodes.

P. M. G. Toulon. Convention date (France) 13th November, 1935.

DIRECTIONAL WIRELESS

465 022.—Wireless method of "spotting" the presence of aircraft and other moving bodies in an area under supervision.

Telefunken Co. Convention date (Germany) 19th August, 1935.

465 587.—Transformer coupling for giving "sense" determination in a directional aerial of the Bellini-Tosi type.

Panstwowe Zaklady Radio Co. Convention date (Poland) 8th August, 1934.

466 241.—Wireless navigation system in which two overlapping beams are used to mark out a desired course, and the pick-up signals are fed to a "sluggish" indicator of the hot-wire type so as to give a steady reading.

The Telefunken Co. Convention date (Germany) 16th August, 1935.

TELEVISION AND PHOTOTELEGRAPHY

463 896.—Regulating the focus of the electron stream as it moves over the surface of a screen which is set at an angle to the main axis of a cathode-ray tube.

P. T. Farnsworth. Application date 28th February, 1936.

463 967.—Correcting for "background" illumination when transmitting a picture by television.

Marconi's W.T. Co. (assignees of A. V. Bedford). Convention date (U.S.A.) 26th October, 1934.

463 971.—Time-base circuit for television in which the synchronising impulses appear in the cathode circuit of a valve in reversed polarity to the picture signals in the anode circuit.

Baird Television and L. R. Merdler. Application dates 8th, 23rd, and 29th October, 1935.

464 049.—Interlaced scanning systems for use with "film" television.

Radio-Akt. D. S. Loewe. Convention date (Germany) 11th October, 1934.

464 064.—Cathode-ray tube for television with a back-coupling connection which is effective over a wide range of frequencies.

E. Michaelis. Convention date (Germany), 22nd June, 1935.

464 286.—Combined sound and television receiver designed to work on slightly-separated carriers.

Marconi's W.T. Co. (assignees of C. D. Kentner.) Convention date (U.S.A.) 31st October, 1934.

464 553.—Stabilizing or preventing "flicker" in television receivers operated from electric supply mains.

Radio-Akt. D. S. Loewe. Convention date (Germany) 25th July, 1935.

464 637.—Cathode-ray tube provided with a compact magnetic deflection system designed to produce a strictly linear traverse of the electron stream.

Fernse H. Akt. Convention dates (Germany) 19th October, 1934 and 28th February, 1935.

464 831.—Method of preventing trapezoidal distortion when using rotating-disc scanners in television.

Radio-Akt. D. S. Loewe. Convention dates (Germany) 25th October and 6th November, 1934.

464 946—Method of separating two or more groups of synchronising impulses from the picture signals in a television receiver.

The General Electric Co. and D. C. Espley. Application date 6th February, 1936.

464 979.—Amplifying a wide band of frequencies, such as are used in television, by a method which involves a preliminary stage of modulation.

Baird Television and P. W. Willans. Application date 23rd October, 1935.

465 118.—Method of increasing or modifying the fidelity of voltage amplifiers in television scanning circuits.

The British Thomson-Houston Co. and D. J. Mynall. Application date 30th October, 1935.

465 147.—Saw-toothed oscillation-generator suitable either for straight or interlaced scanning and designed to be either self-operative or dependent upon the action of synchronising impulses.

Baird Television and D. M. Johnstone. Application date 5th November, 1935.

465 276.—Super-regenerative amplifier for television signals, in which the quenching frequency coincides with the "flyback" period of the scanning stroke.

Baird Television and D. M. Johnstone. Application date, 4th November, 1935.

465 631.—Television system in which picture signals of high contrast but small detail and superposed upon signals showing small contrast but greater detail.

P. T. Farnsworth. Application date 13th January, 1936.

465 755.—Television scanning system in which a rectangular area is converted into a trapezoid.

Radio-Akt. D. S. Loewe. Convention date (Germany) 26th January, 1935.

465 790.—Method of making fine apertures in a scanning disc used for television.

The General Electric Co.; H. W. B. Gardner; and D. T. Russell. Application date 14th November, 1935.

465 892.—Time-base circuit for a cathode-ray tube in which both the oscillator and tube operating voltages are tapped off from a common source of supply.

Baird Television and L. R. Merdler. Application date 16th November, 1935.

466 124.—Means for eliminating interference from a short-wave set used for receiving television.

Radio-Akt. D. S. Loewe. Convention date (Germany) 24th November, 1934.

466 508.—Method of emphasising the effect of the bright margin, used as a starting line, in television transmitters.

Radio-Akt. D. S. Loewe. Convention date (Germany), 1st December, 1934.

466 545.—Method of rectifying the picture-modulated intermediate-frequency output in a superhet receiver for television.

E. Michaelis. Convention date (Germany) 26th September, 1935.

466 866.—Means for adjusting a cathode-ray receiver so as to handle television programmes sent out with different scanning-line frequencies.

Marconi's W.T. Co. and A. A. Linsell. Application date 3rd December, 1935.

SUBSIDIARY APPARATUS AND MATERIALS

464 386.—Single microphone designed to give the same effect as a combined ribbon and pressure-gradient type of instrument.

Electrical Research Products Inc. Convention date (U.S.A.) 11th July, 1936.

464 418.—Loud speaker designed to produce the same effect as an exponential horn combined with a cone.

The British Thomson-Houston Co. and W. A. Bocock. Application date 17th October, 1935.

464 894.—Piezo-electric crystal cut so that it will oscillate freely at only one "contour" frequency, and with a substantially zero temperature coefficient.

Marconi's W.T. Co. (assignees of S. A. Bokovoy) Convention date (U.S.A.) 30th September, 1935.

465 441.—Preventing "cabinet resonance" in a loud speaker attached to a wireless set.

Philco Radio & Television Corp. Convention date (U.S.A.) 17th June, 1935.

465 746.—Varying the inductance of a screened tuning coil by means of a short-circuiting ring attached to the lid of the screening case.

Telefunken Co. Convention date (Germany) 13th November, 1934.

466 031.—Electrically-controlled "light" valve operated by changes in the "adhesion" attraction between bodies in optical contact.

Marconi's W.T. Co.; L. M. Myers; and E. F. Goodenough. Application date 20th November, 1935.