WIRELESS ENGINEER

THE JOURNAL OF RADIO RESEARCH & PROGRESS

AUGUST 1947

VOL. XXIV.   TWO SHILLINGS AND SIXPENCE - - No. 287

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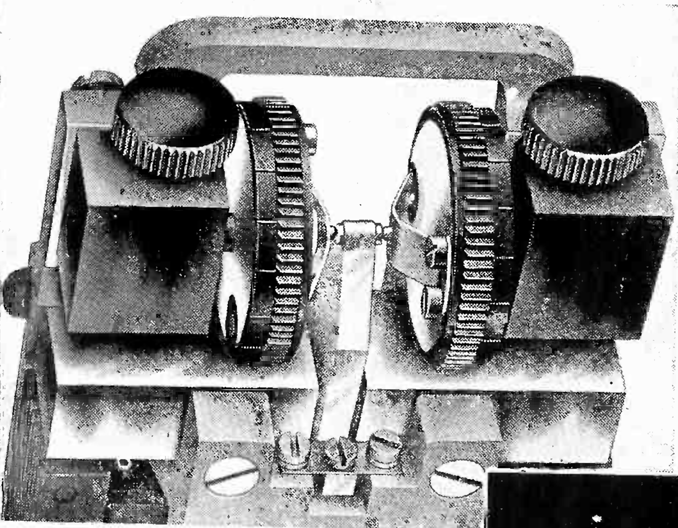

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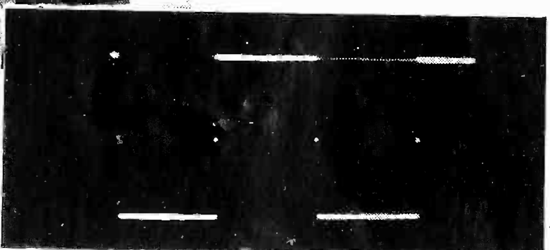
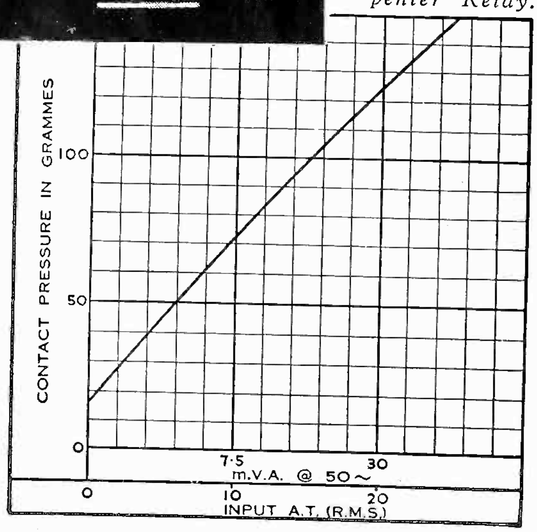
● (Above) *Contact mechanism of Relay showing damped compliant mountings of side contacts.*



● (Right) *Unretouched photograph (3 sec. exposure) of oscillogram showing contact performance of Relay in special adjustment for a measuring circuit; coil input 18 AT (25 mVA) at 50 c/s.*

(Below) *Graph showing contact pressures developed at 50c/s against mVA and ampere turns input for type 3E Carpenter Relay.*



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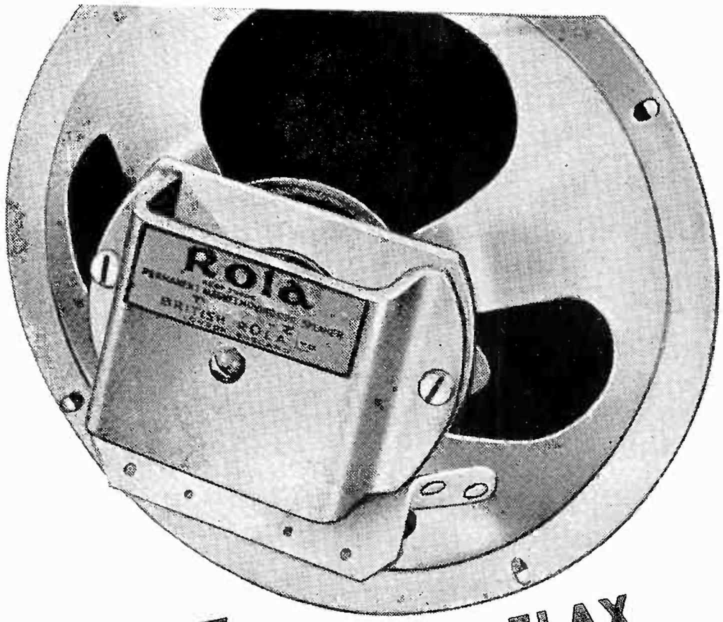
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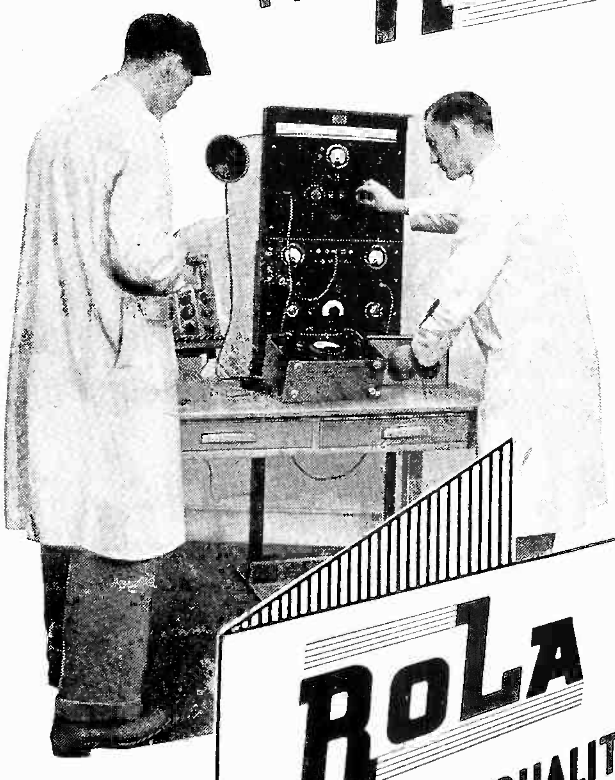

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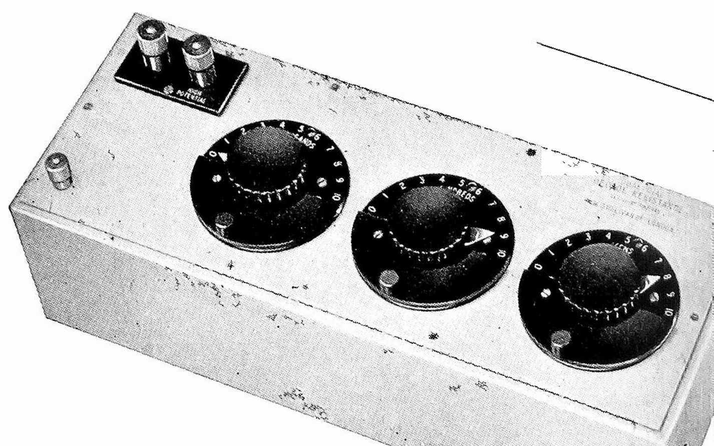

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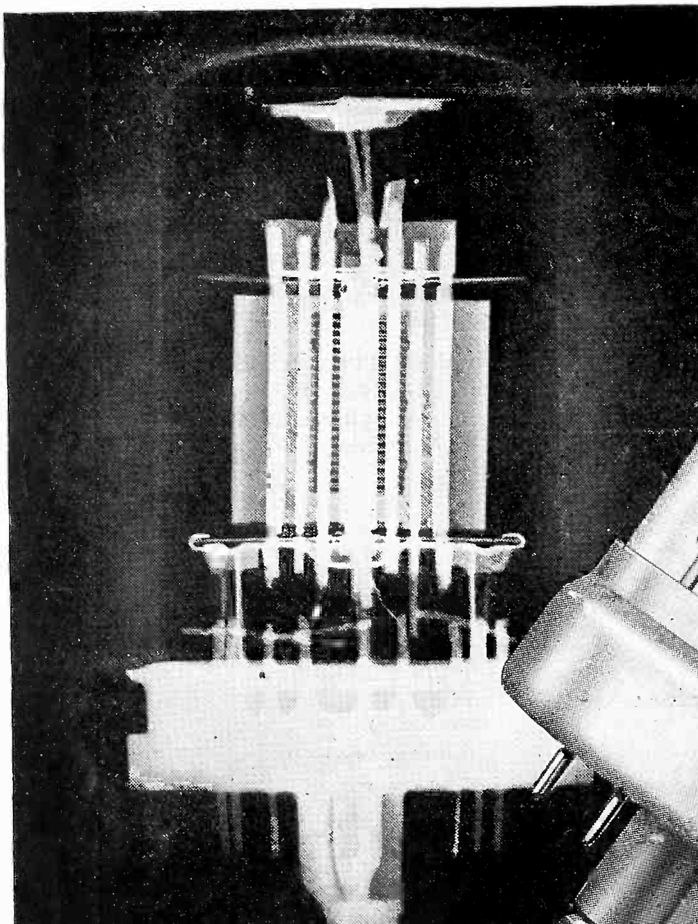

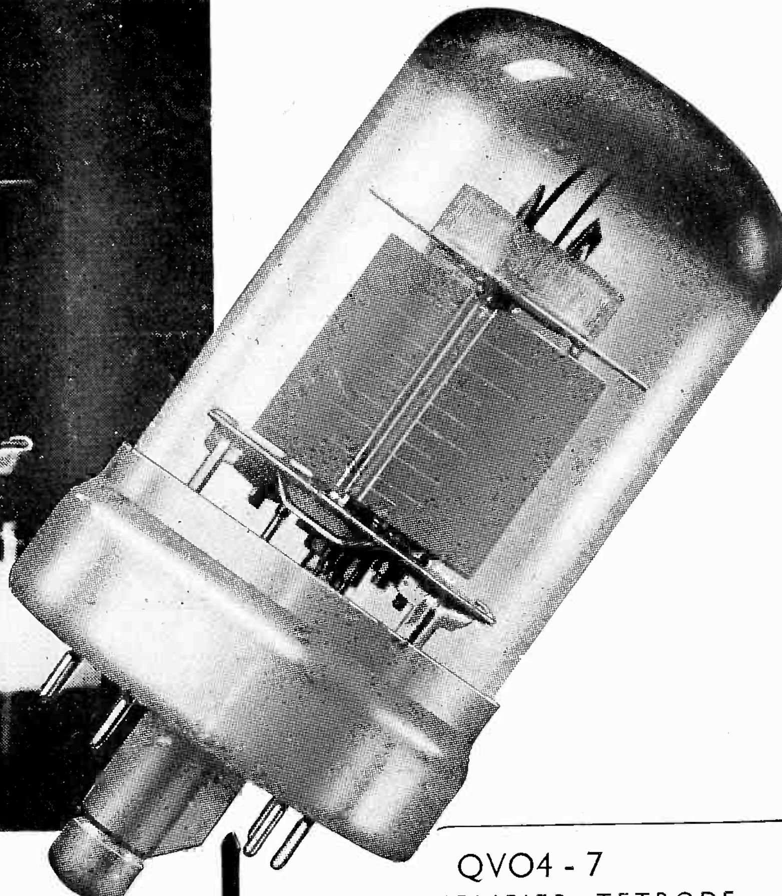

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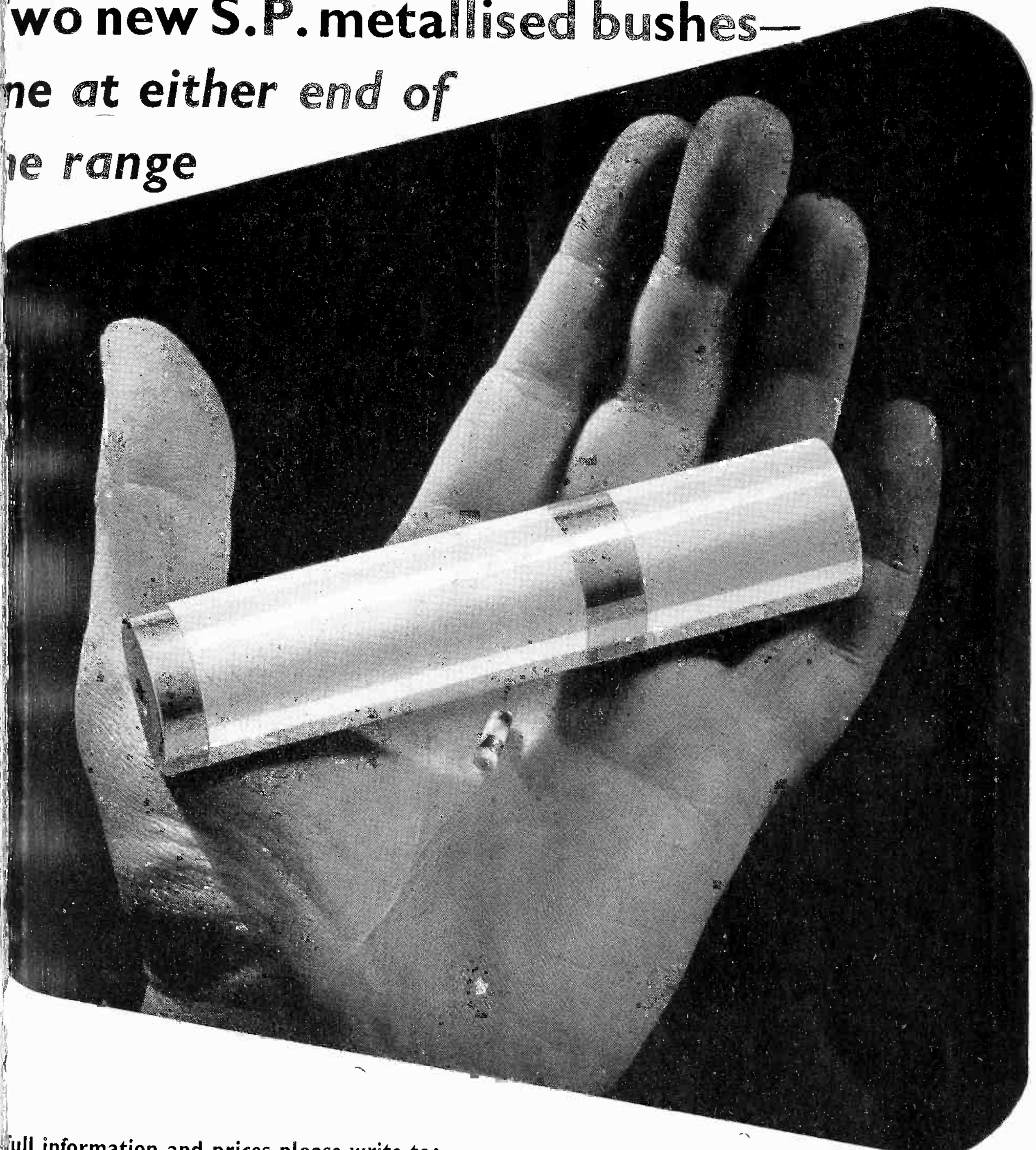

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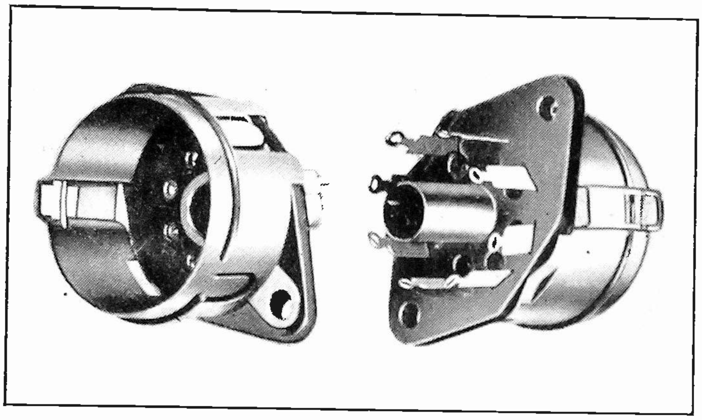

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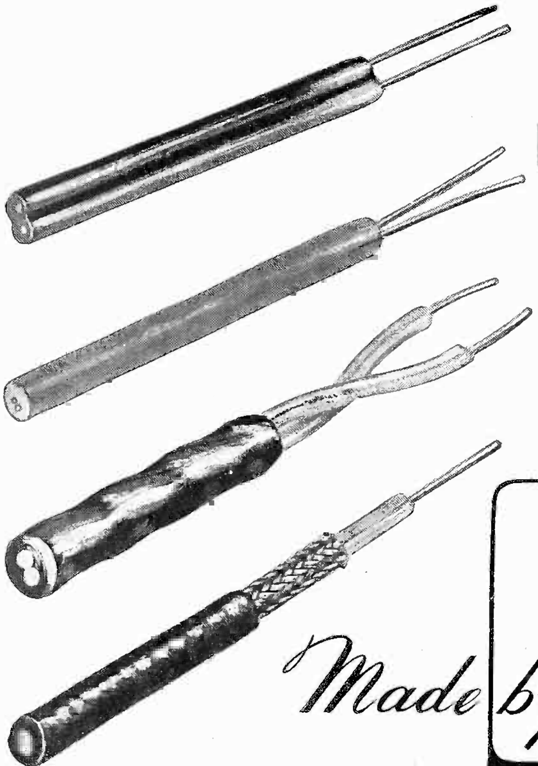

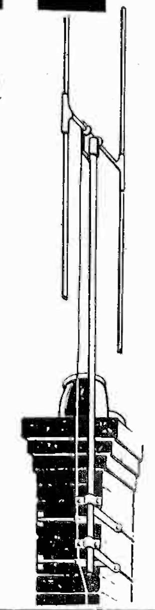

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EDITORIAL

Where was the Telephone Invented?

FOR over seventy years there has been discussion as to who invented the telephone and even within the last month we have received a long letter from one of his descendants claiming that the honour really belongs to Alexander Bain, well-known as the inventor of the electric clock and of the chemical telegraph. This claim seems to be based on some family tradition and is probably due to the fact that the words telegraph and telephone were used in rather a confused way in the early days. This is brought out very clearly in Kelvin's report on the Philadelphia Centennial Exhibition, where he heard "to be, or not to be" on the electric *telegraph* and referred to an electric *telephone* sending four messages simultaneously on the Morse code.

Very few people now have any doubts as to the justification for regarding Alexander Graham Bell as the inventor of the telephone, but we have, within the last few weeks, received two letters from Canada suggesting that in the recent celebrations of the centenary of Bell's birth, too much credit was given to Boston and too little to Brantford as the birthplace of the telephone. It was to Brantford in Ontario that Bell's father and mother went from London in 1870, hoping that the climate would be beneficial to the health of Alexander Graham, whose two brothers had recently died of tuberculosis and whose own health was causing grave anxiety. There on Tutela Heights the family settled and there Bell's father and mother lived until 1881 when they followed their—by that time, celebrated—son to Washington. At Brantford Bell's health rapidly improved and he took a post in Boston, but he spent his holidays at Brantford and discussed his ideas with his father.

The experimental work and realization of the invention was carried out in Boston, but then when he returned to Brantford he carried out transmission experiments between Brantford and neighbouring towns. In 1916 a tablet was unveiled at 109, Court Street, Boston, with the inscription "Here the telephone was born June 2, 1875." In 1917 a monument was unveiled at Brantford "To commemorate the invention of the telephone by Alexander Graham Bell, in Brantford in 1874." Bell was present at the ceremony and naturally did his best to justify the claims of Brantford. He said "Brantford became my thinking place; here the telephone was invented; the first draft of the patent specification prepared; the proper relation of the parts of a telephone to enable it to be used on long lines, worked out; and the first transmission of the human voice over miles of telegraph line actually accomplished. Here also the first public demonstration of this result was given to the world. I think, therefore, that Brantford is fully justified in considering itself as integrally associated with the development of the telephone."

The long distance transmission referred to was on August 10, 1876, when by arrangement with the Dominion Telegraph Company he established one-way communication between Brantford and a neighbouring town of Paris, really only 8 miles away, via Toronto, a distance of 136 miles; this was certainly the first long distance telephone call in the world, but it was only one way and the reply was by telegraph. The first two-way long distance transmission was in the United States. On another occasion Bell said "It so happens that the telephone was invented in Canada at Tutela Heights, during my visit to my father and mother in 1874; but the first telephone was made in Boston in 1875, and all the early experiments were made there up to the time of the Centennial Exposition at Philadelphia. Thus the telephone was conceived in Brantford, reduced to practice in Boston, and became known to the world at the Centennial Exposition in Philadelphia."

Bell's father kept a diary, and during the Christmas holidays in 1874 there are such entries as: "Dec. 27. Long talk on multiple telegraphy and speech transmission. Al. sanguine." "Dec. 29. Talking half the night—motor and telephone." It was in Boston in the following June that, during experiments with the multiple telegraph, the slight mishap occurred that led to the construction overnight of Bell's first telephone. Where the telephone was invented depends entirely on the meaning attached to the word "invention." Long talks and discussions of schemes, however enthusiastic, can hardly be regarded as invention, and there was no suggestion of a patent specification until after the incident at Boston, for we have Bell's own statement that he drew up the first draft of the telephone patent specification at Brantford in September or October of 1875.

G.W.O.H.

CONCENTRIC LINE*

Critical Wavelength of the Higher Modes

By H. Bondi and S. Kuhn

IN normal practice, the field in a concentric-line feeder is entirely in a plane transverse to the axis. With the use of very short waves there arises the possibility of other modes in a concentric line. When this happens there will, in general, be a complicated system of standing waves in the line, and in many applications this is undesirable. The purpose of this note† is to give curves showing, for any dimensions of the line, the critical wavelengths at which these modes occur.

The higher modes are similar to those in a circular waveguide and fall into two classes, the E-modes and the H-modes. In an E-mode the electric field has a longitudinal component, but the magnetic field is wholly transverse; in an H-mode the magnetic field has a longitudinal component, but the electric field is wholly transverse. They are further classified according to half the number of nodes encountered in the field in a full revolution round the axis and the number of nodes encountered in the longitudinal or tangential electric field in going radially from one conductor to the other (actually one plus the latter). Thus an H_{11} mode has two nodes in going round a full revolution and no nodes of tangential electric field in going radially from one conductor to the other.

We consider a concentric line filled with a uniform dielectric of dielectric constant ϵ and unit permeability, referred to vacuum. In the free dielectric waves of frequency f are propagated with a wavelength λ_e given by

$$\lambda_e = c/f\sqrt{\epsilon} = \lambda_0/\sqrt{\epsilon},$$

where c is the velocity of light in vacuo, viz., 3×10^{10} cm/sec, and λ_0 is the wavelength in vacuo. While the wavelength of the normal mode of propagation in the concentric line is also λ_e, the wavelength λ_g of any higher mode is greater than this, and is given by the formula

$$\frac{1}{\lambda_g^2} = \frac{1}{\lambda_e^2} - \frac{1}{\lambda_{cr}^2}$$

where λ_{cr} is a length characteristic of the

* MS. accepted by the Editor, June 1946.

†Based on Admiralty Signal Establishment Report M.423 of May 1942.

concentric line, which depends only on its dimensions and not on the nature of the dielectric. The critical frequency f_{cr} below which no propagation in this mode is possible is related to λ_{cr} by the formula

$$f_{cr} = c/(\lambda_{cr}\sqrt{\epsilon})\ ;$$

in other words, λ_{cr} is the wavelength in the free dielectric of waves of the critical frequency, whereas in free space their wavelength is $\lambda_{cr}\sqrt{\epsilon}$. It will be seen that, compared with a vacuum in the concentric line, the presence of dielectric decreases the critical frequency by a factor $1/\sqrt{\epsilon}$.

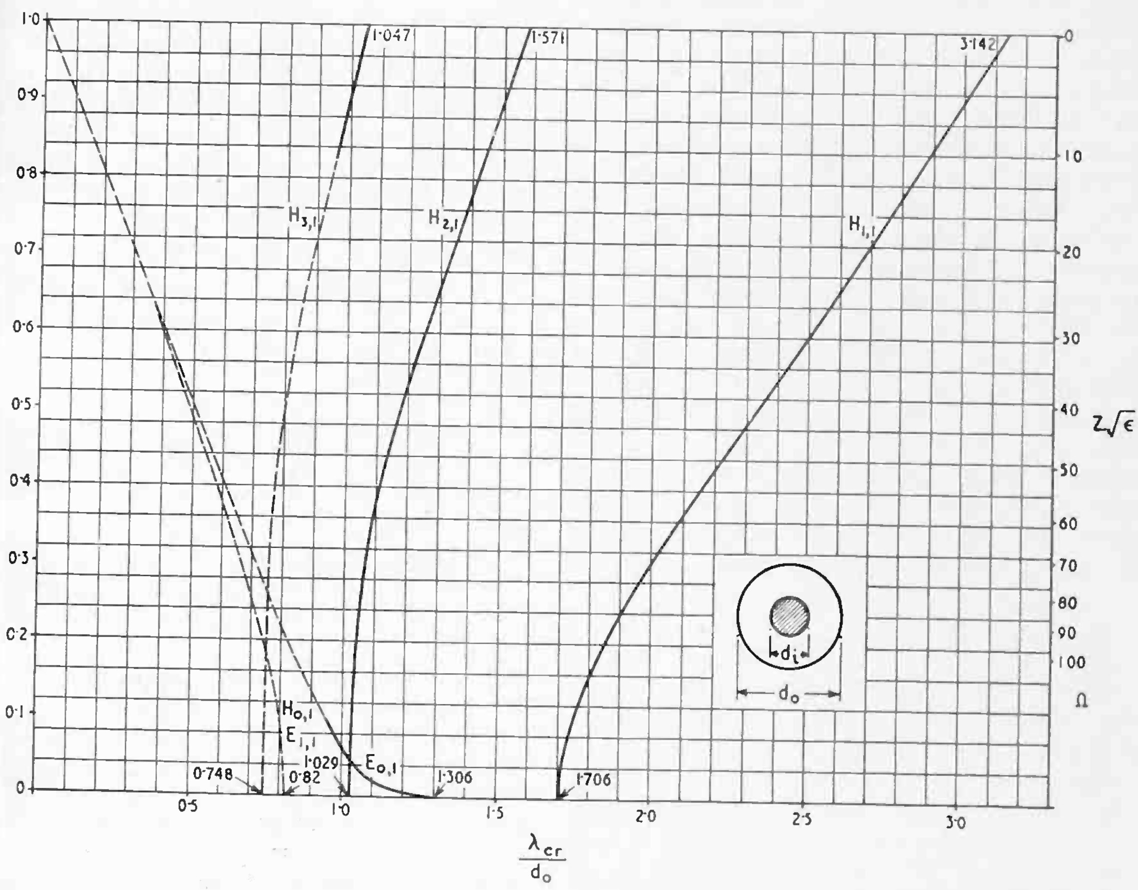
The normal mode does not fall into this classification, but for convenience it can be referred to as either the E_{00} or the H_{00} mode. It can exist at all wavelengths and its critical wavelength can be regarded as infinite.

The accompanying curves show, for the first few modes, the ratio λ_{cr}/d_0 of the critical wavelength (in free dielectric) to the outer diameter, plotted against the ratio d_i/d_0 of the diameters (or, equivalently against $Z\sqrt{\epsilon}$, Z being the characteristic impedance of the line for its normal mode).

They can also be used to determine the critical diameter for a given wavelength λ_e in the free dielectric and a given characteristic impedance, by interpreting λ_{cr}/d_0 as λ_e/d_{0cr}.

As the wavelength is diminished, the first new mode to appear in any concentric line is the H_{11} mode.

It will be seen that, to a very good approximation, the critical wavelength of this mode is equal to the mean circumference of the inner and outer conductors. This rule is deviated from by less than 3 per cent if the inner diameter is not less than a twelfth of the outer diameter, and the maximum deviation is 8·8 per cent.



Critical wavelengths of higher modes in a concentric line.

The work described in this paper was carried out in the Admiralty Signal Establishment and the paper is published with the approval of the Board of Admiralty.

STABILIZING DIRECT-VOLTAGE SUPPLIES*

By J. W. Hughes, B.Sc., Ph.D., A.Inst.P.
(*University College, Cardiff*)

SUMMARY.—A graphical method of assessing the performance of the gas-discharge tube stabilizer circuit is described, and a means of ensuring that the tube "strikes" with low supply voltages is indicated.

1. Introduction

THE h.t. voltage for electronic equipment is usually obtained by using a valve rectifier supplied from a.c. mains, or directly from d.c. mains. In both cases the voltage is subject to random variations from its nominal value because of changes of load on the mains, and it is often desirable to stabilize the h.t. voltage supply, particularly that for instruments of the laboratory type. Various circuits giving an h.t. voltage relatively independent of variations in the supply voltage are described in the literature [1, 2, 3, 4, 5]; the simplest of them makes use of the property possessed by the gas-discharge tube of carrying a large range of direct current with a comparatively small variation of the voltage between its anode and cathode. In the standard circuit [1,2] of Fig. 1 the voltage V_2 applied to the load is that existing across such a "stabilizer tube," and a series resistance r between it and the supply limits the current I_3 in the tube to a value

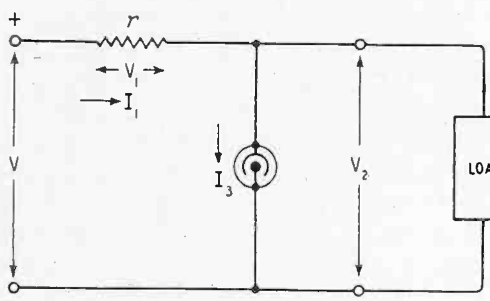


Fig. 1. *The basic stabilizer circuit.*

below its safe maximum. In this paper a graphical method of assessing, for various values of r, the degree of stabilization obtained with respect to input voltage variations and changes of load current is discussed; a simple method of ensuring that the stabilizer tube "strikes" when the supply voltage V is below the striking voltag is also described.

*MS. accepted by the Editor, October 1946.

2. The General Problem

In order to deal with the stabilizin properties of the circuit of Fig. 1, th graphical solution of a more general circui problem will first be obtained. The circui is shown in Fig. 2. The three circuit element (a), (b), (c), are all supposed non-linear, s that the relation between voltage an current for any one of them is represente by a curve, and not by a straight line, an the voltage V available depends on th

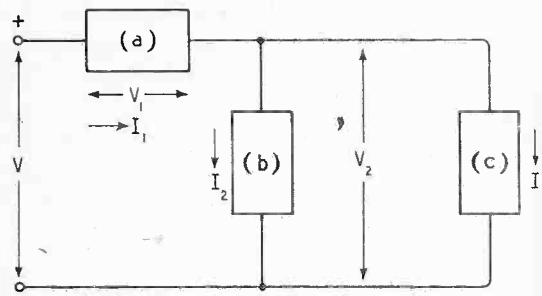


Fig. 2. *Generalized voltage stabilizer.*

current I_1. The values assumed by V V_1, V_2, I_1, I_2, and I_3 are required.

The graphical solution of the problem is in dicated in Fig. 3. Curve I shows the relatio between V_2 and I_3; curve II, obtained b adding to the ordinates of curve I the value of I_2 for the corresponding values of V shows the relation between V_2 and $(I_2 + I$ $= I_1$. Curve III represents the variatio of V with I_1, and IV, obtained by sub tracting from V the values of V_1 for variou values of I_1, represents the variation c $(V-V_1)$ with I_1. Curves II and IV intersec at A where $(V - V_1) = V_2$. Its ordinat gives the current I_1, made up of AB (I and BC (I_3), and DE gives the value of V made up of DA (V_2) and AE (V_1).

If now the $V—I_1$ curve takes up a ne position because of a change in suppl voltage, the effect on the position of A, and hence on the distribution of voltage and current in the circuit, is readily assessed. It is also clear that disconnection of the element drawing the current I_2 brings the point A to F, the point of intersection of curves I and IV.

Though the problem does not arise in the present considerations, it is worth noting that the method is easily extended to the cases in which there are further elements in parallel with either (b) and (c), or with (a). In the first of these, the I_1—V_2 curve is obtained by extending the above procedure; in the second, the curve relating V_1 to I_1 is first obtained in a similar way, the value of V_1 is found as before, and the currents in the elements in parallel with (a) are obtained from the curves used to construct the $I_1 — V_1$ curve. The method of solution here outlined appears to have some advantage over that given by Harnwell[6] for solving a similar type of problem in which only one of the elements is non-linear.

3. Circuit Design and Action

3.1 *Data required.*

In the circuit of Fig. 1, the elements (a), (b), (c) of Fig. 2 are replaced by the resistance r, the load and the stabilizer tube, respectively. The method of Section 2 will be applied to find the value of r appropriate to a given load and the supply voltage available, and to assess the degree of stabilization achieved by the circuit under

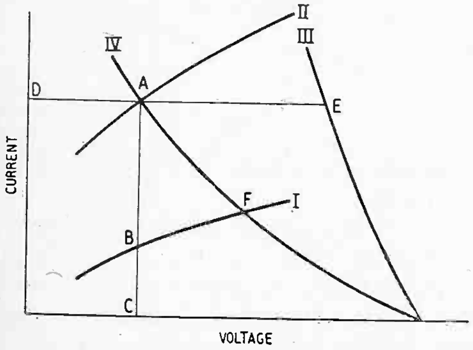


Fig. 3. *Graphical solution of the general three-element circuit.*

different conditions. Two types of direct voltage supply will be considered. In the first of these the d.c. mains are used, and it is assumed that the supply voltage V is independent of the current I_1 drawn from it. In the second type the supply is derived from a rectifier system, and the variation of V with I_1 is taken into account. The following characteristics will be supposed available, either from previous experiment or from manufacturers' data:

(a) *Stabilizer Tube:* variation of voltage V_2 with current I_3, maximum safe current, minimum current required to maintain the struck condition, and striking voltage.

(b) *Supply:* nominal voltage, and extreme departures from the nominal value; variation of direct voltage V with current I_1 when derived from a rectifier.

(c) *Load:* current drawn at the stabilized

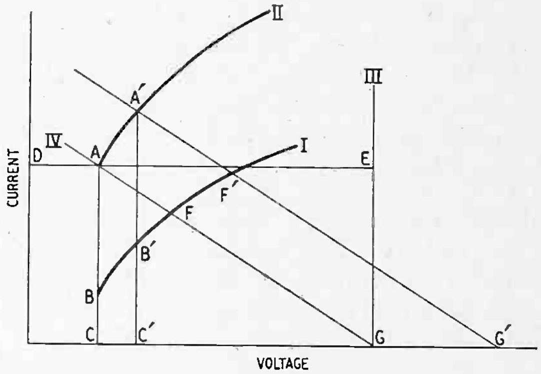


Fig. 4. *Determination of conditions for a d.c. mains input supply.*

voltage V_2, its small variation with the (small) variations in V_2 arising from changes in the supply voltage V, and the limits between which the current may be expected to vary owing to the addition to, or removal from, the system of items of equipment.

3.2 *Graphical procedure (d.c. mains supply).*

The highest permissible value of r, the series resistor, is that which, with the supply voltage at its lowest and the load current at its maximum, just avoids making the stabilizer voltage and current fall below the minimum values needed to maintain conduction. Fig. 4 shows the procedure for determining this value of r. It will be shown below that

(a) a lower value of r, with the same load current, will give worse stabilization,

(b) if the load current is decreased below the maximum, the behaviour of the system using the chosen value of r is easily assessed, and that the degree of stabilization then obtained differs little from that available when the maximum current is being taken.

Thus the highest permissible value of r

gives best operation, and in the subsequent discussion it will be assumed that this value is being used.

As in Fig. 3, curve I represents the stabilizer characteristic (I_3—V_2); curve II is obtained by adding to curve I the currents I_2 corresponding to the various voltages V_2 across the load. The ordinate through B, the point corresponding to minimum stabilizer voltage and current, meets curve II in A, the ordinate of which gives the total current I_1 for the voltage corresponding to A. If G represents the lowest supply voltage, the vertical line through G (III) corresponds to curve III of Fig. 3, and the straight line GA corresponds to curve IV. The horizontal line AE through A, meeting curve III in E, thus gives the voltage drop required in r at the current I_1 corresponding to A, and r is given by AE/EG, the reciprocal of the slope of GA.

If G′ corresponds to the highest supply voltage, the relation between V_2 and I_1 at this voltage is now known, since r has been found; it is represented by the line through G′ parallel to GA, meeting curve II in A′. Then the ordinate A′C′, meeting curve I in B′, gives the total current I_1 now flowing, made up of B′C′ (I_3) and B′A′ (I_2), and the abscissa at C′ gives the new stabilized voltage. A similar procedure gives I_2 and I_3 at the nominal supply voltage.

3.3 *Further deductions.*

The diagram also illustrates certain other points:

(a) When the maximum value of r has been chosen for a given maximum load current, the behaviour of the stabilizer voltage for a smaller load current is indicated by the point of intersection with GA and G′A′ of a line drawn in the same way as curve II. Since this line will usually lie between curves I and II, and will have a slope rather less than that of I, it follows that

(i) the limits between which V_2 varies are higher in absolute value than before,

(ii) the limits are somewhat further apart than before. Since curves I and II are almost parallel in practice, this has little effect on the degree of stabilization obtained.

(b) If the load is removed altogether, making I_2 zero, the new limits of stabilized voltage and stabilizer current are given by the points F and F′ where GA and G′A′ cut curve I. Now the highest stabilizer current occurs when there is maximum supply voltage and zero load current. It is thus immediately evident whether this exceeds the maximum safe current for the stabilizer; methods of reducing this current are considered in Section 5.2 below.

(c) If a value of r below the maximum is chosen, then

(i) GA and G′A′ will have a greater slope, and the horizontal separation of A and A′ will be further increased, so that the degree of stabilization obtained will not be as good as with maximum r,

(ii) the current limits for the stabilizer tube are both higher than before, and overloading occurs more readily.

(d) The greater the difference between the minimum stabilized voltage and the minimum supply voltage, the smaller is the variation of stabilized voltage with a given supply fluctuation GG′, since GA and G′A′ will then be more nearly horizontal and the horizontal separation between A and A′ for a given value of GG′ will decrease.

(e) The smaller the maximum load current for which the circuit is designed, the better is the stabilization achieved; for under these conditions the line II has a smaller vertical displacement from I, GA and G′A′ are more nearly horizontal, and the point A′ is again nearer A.

(d) and (e) both lead to the conclusion that stabilization is best when the load current is small and the nominal supply voltage is high. Under these circumstances the power consumed in the load is small compared with that dissipated in the stabilizer tube and the resistance r, so that stability of voltage is obtained at the expense of economy in consumption.

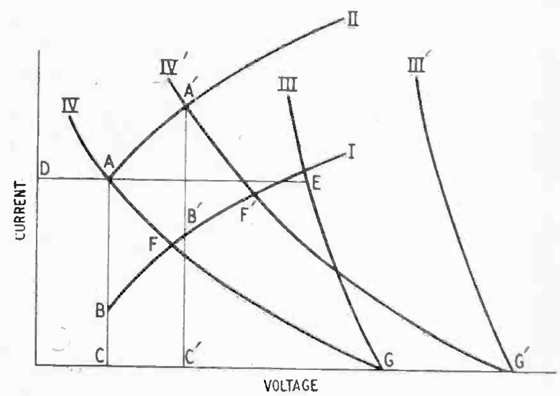


Fig. 5. *Conditions for an a.c. mains supply.*

3.4 *A.C. mains supply.*

The procedure of 3.2 for determining r now requires some slight modification, since the direct voltage V available at the terminals of the rectifier system varies considerably with the current I_1 drawn from it. Fig. 4 is altered as follows :

Curve III becomes the I_1—V curve for the rectifier circuit for the minimum a.c. voltage input ; the point E is found, and the value of r is deduced, as before. The line GA becomes the curve obtained by plotting $(V-rI_1)$ against I_1, and G′A′ is replaced in the same way by using III′, the I_1—V curve for maximum a.c. voltage input. Fig. 5 illustrates the resulting diagram, from which the degree of stabilization and the stabilizer current are obtained as in Section 3.2. The remarks made in 3.3 apply equally to this case.

3.5 *Non-linear element in place of r.*

It is possible to use a non-linear element in place of r if its current-voltage characteristic is such that it makes curve IV of Fig. 3 pass through the points G and A. The effect on the stabilizing properties of the circuit depends on the shape of the characteristic, as shown in Figs. 6 (a) and (b). If it is convex upwards (Fig. 6 (a), tungsten filament lamp[7]) then variations in the supply voltage produce smaller changes in the stabilized voltage than they would if the appropriate resistor were used. On the other hand, variations due to diminution of load are larger than with the resistor. If the curve is concave upwards (Fig. 6 (b), thyrite and similar materials[7]) these results are interchanged, and stabilization against change of load is better, and against change of supply voltage is worse, than when a resistor is used.

4. Stabilizer Striking

In order to obtain the stabilizing action it is essential that after switching on, the voltage applied to the stabilizer tube shall momentarily exceed the striking voltage so that conduction is ensured. It is usually necessary to modify the circuit of Fig. 1 to achieve this ; the changes required are next considered.

If the character of the load is such that full load current is taken as soon as its H.T supply is switched on, it is unlikely that the load voltage will at any time exceed the striking voltage. Since r, V, and the I_1—V characteristic are known, a graphical determination of the resulting load voltage is easily carried out by the method of Section 3.3 (b). If it does not, a switch can be incorporated into the circuit so that the load can be added after the mains voltage has been applied to strike the stabilizer tube ; the initial stabilizer overload which may occur need only be momentary. Where the load current is mainly that taken by indirectly-heated valves, the necessary action is obtained by switching on their heaters at the same time as the mains supply.

When the nominal d.c. mains voltage is below the striking voltage the use of a switch is clearly inadequate. To produce a voltage which will cause striking, the resistance r is replaced by an inductance L, with its resistance made up to r with a suitable series resistor, and a capacitor C is connected in parallel with the stabilizer tube and the load. It is shown in the Appendix that when the d.c. supply is switched on, the voltage across C surges above the mains voltage

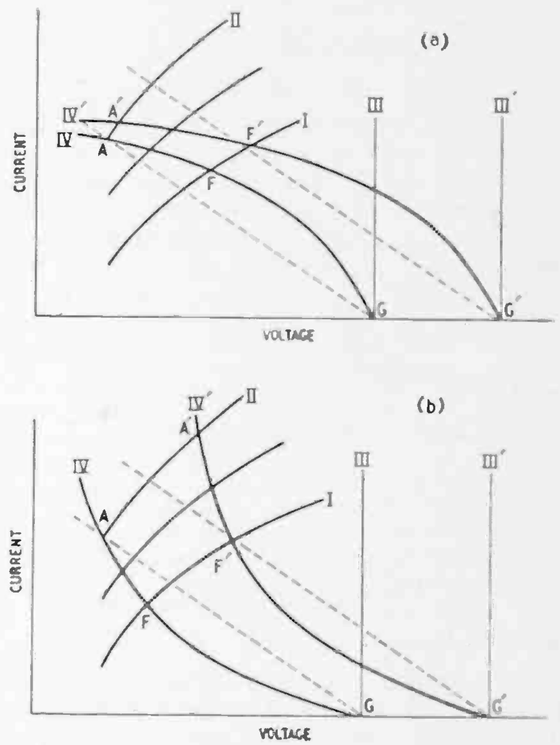


Fig. 6. *Effects of using non-linear series resistances. At (a) the resistor is a tungsten filament lamp and at (b) it is thyrite or similar material.*

by an amount which is sufficient to strike the stabilizer, even when the full load is also connected, and that standard rectifier filter components may be used for L and C. The inductance-capacitance combination also assists in smoothing any "ripple" which may be present on the main supply.

In rectifier circuits the "no-load" voltage is often high enough to ensure striking, so that the load-switching arrangement may be used. Alternatively, the last *LC* combination in the filter circuit of the rectifier can be modified by adding resistance, obtaining its value by using for Curve III of Fig. 5 the voltage-current relation across the capacitor preceding the combination. A switch which applies the h.t. to the rectifier after its heater has reached working temperature will then give the same conditions as with d.c. mains. Such a switch may readily be placed in the lead between h.t. negative and the centre-tap of the rectifier transformer in a full-wave circuit. Where the load is of the valve type in which the heaters reach their working temperature some seconds after that of the rectifier, no switching becomes necessary.

5. Other Considerations

5.1. *Choice of stabilizer tube.*

The stabilizer tube chosen for a particular application will depend on the voltage of the source, the normal load current, and the degree of stabilization required, and the conclusions of Section 3.3 have to be taken into account. Table I indicates some of the types of tube available for currents likely to be used.

TABLE I Voltage-Stabilizer Tube Data

Designation	Running voltage	Current range	Approximate striking voltage
1. Cossor S130 ...	115-135 V	75 mA (max)	180 V
2. R.C.A. VR75-30	75 V	5-30 mA	—
3. R.C.A. VR105-30	105 V	5-30 mA	—
4. R.C.A. VR150-30	150 V	5-30 mA	—
5. R.C.A. 874 ...	90 V	5-30 mA	120 V

Since tubes of different types can be used in series, it is evident that combinations of them can be chosen to stabilize d.c. supplies whose nominal voltages cover a considerable range without having too large a difference between stabilized and nominal supply voltages.

5.2. *Safeguarding the stabilizer tube.*

It was noted in Section 3.3 (b) that a large reduction in load current might give an excessive stabilizer current. There are two methods of overcoming this difficulty. The total current drawn from the source can be maintained at its proper value without increase in stabilizer current by switching in an appropriate "dummy" load" in parallel with the main load. This can be further elaborated by having a suitable variable resistor for the dummy load, with a control calibrated so that it can be set appropriately when the equipment which forms the load is changed. The stabilizing properties of the arrangement with respect to supply voltage variations are then much the same for any load current in the range used.

A better scheme is to introduce additional resistance in series with r (or to vary r by a calibrated control) when the load current is decreased. This has the effect of accommodating the design of r to the appropriate load current, and, as shown in Section 3.3 (c), some increase in the degree of stabilization obtained is achieved by this. Since the power dissipation in the dummy load is eliminated, and that in the resistor is diminished, this arrangement decreases unwanted power consumption, whereas the first increases it.

5.3. *Some experimental results*

By way of illustration of the degree of stabilization obtainable with a comparatively small difference between stabilized voltage and nominal supply voltage, some results obtained by the procedure of Sections 3.2, 3.4, and 3.5, and checked experimentally, will be quoted. They also indicate that a value of stabilized voltage very suitable for many purposes can be obtained from d.c. mains voltages which are sometimes available, especially from lightly-loaded heavy-duty mercury-arc rectifiers, or from low-power rectifier arrangements working from a transformer secondary of about 250 V r.m.s.

The experimental procedure was as follows :—

The voltage V_2 was measured to the nearest 0.5 V with a 200 : 1 resistance potential divider and a laboratory potentiometer of the normal type. With the supply voltage at a given minimum, the resistance and the load were varied until the required load current and the minimum stabilizer current were flowing. The value of r was then noted, and the effects of changes of load current and supply voltage were investigated, and compared with those deduced

TABLE II. Experimental Results.

Stabilizer tubes :—two Cossor S.130 in series ; striking voltage 278V.

Expt. No	Nature of supply	I_2 (mA)	I_3 (mA)		V_2 (V)		r (ohms)	
			Obs.	Calc.	Obs.	Calc.	Obs.	Calc.
(i)	250 V d.c. ...	60	15	15	237.6	237.8	160	162
		30	50	47	237.2	237.5		
		0	73	68	238.6	238.8		
	260 V d.c. ...	60	79	70	239.2	239.0		
(ii)	250 V d.c. ...	30	15	15	237.8	237.8	270	271
		0	48	46	237.2	237.4		
	260 V d.c. ...	30	56	52	237.5	237.6		
		0	78	76	239.5	239.5		
(iii)	260 V d.c. ...	60	15	15	238.0	237.8	300	296
		30	49	46	237.2	237.5		
		0	74	71	239.0	239.0		
	270 V d.c. ...	60	53	50	237.6	237.6		
		30	77	74	239.4	239.2		
(iv)	260 V d.c. ...	30	15	15	237.9	237.8	500	493
		0	47	45	237.3	237.4		
	270 V d.c. ...	30	39	36	237.2	237.4		
		0	66	64	238.2	238.4		
(v)	Rectified ... 225 V a.c. ...	60	15	15	238.2	237.8	820	830
		30	46	45	237.7	237.5		
		0	75	74	239.1	239.3		
	Rectified ... 235 V a.c. ...	60	25	23	237.6	237.6		
		30	55	53	238.0	237.6		
		0	83	82	240.0	240.0		
(vi)	251.5 V d.c. ...	60	15	15	237.9	237.7	40 W, 200 V metal filament lamp used in place of r.	
		30	45	48	237.4	237.7		
		0	75	74	239.0	239.3		
	261.5 V d.c. ...	60	30	32	237.2	237.4		
		30	60	61	237.9	238.2		
		0	87	89	240.2	240.6		
	271.5 V d.c. ...	60	40	40	237.9	237.4		
		30	68	70	238.6	238.8		

theoretically, with the results shown in Table II. When r was replaced by a 40-W lamp, the supply voltage was adjusted to give the above conditions, and the voltage thus obtained was taken as the minimum for the purpose of the experiment. Since the stabilizer tube characteristic proved slightly concave towards the high-voltage side, it is not surprising that the stabilized voltages vary in both directions from those obtained with the initial conditions. Within the limits of error imposed by the conditions of the experiment and the graphical work, the results show good agreement between theory and experiment.

APPENDIX

Establishment of the results quoted in 4.2

It will be assumed that the load behaves like a resistance R, and that the value of the inductance L is independent of the current in it. Then with the previous notation, we have that (before the stabilizer strikes)

$$V = V_2 + ri_1 + L\frac{di_1}{dt} \quad \ldots \quad (1)$$

$$i_1 = C\frac{dV_2}{dt} + \frac{V_2}{R} \quad \ldots \quad (2)$$

with the initial conditions $V_2 = \frac{dV_2}{dt} = 0$ at t = 0.

Solving for V_2, we obtain

$$V_2 = \frac{V}{1 + r/R}\left[1 + \frac{2\omega_2}{(4\omega_2^2 - \omega_1^2)^{\frac{1}{2}}} \cdot e^{\frac{-\omega_1 t}{2}} \sin\left\{\frac{(4\omega_2^2 - \omega_1^2)^{\frac{1}{2}}}{2} \cdot t + \phi\right\}\right] \quad (3)$$

where $\omega_1 = \frac{1}{CR} + \frac{r}{L}$, $\omega_2^2 = \frac{1}{LC}\left(1 + \frac{r}{R}\right)$, $\cos\phi = \frac{\omega_1}{2\omega_2}$, $(0 < \phi < \pi/2)$ and it is assumed that $4\omega_2^2 > \omega_1^2$.

Thus V_2 executes a damped oscillation about its final steady value $V\Big/\left(1 + \frac{r}{R}\right)$ with period $T = 4\pi/(4\omega_2^2 - \omega_1^2)^{\frac{1}{2}}$.

The greatest positive value of V_2 is reached

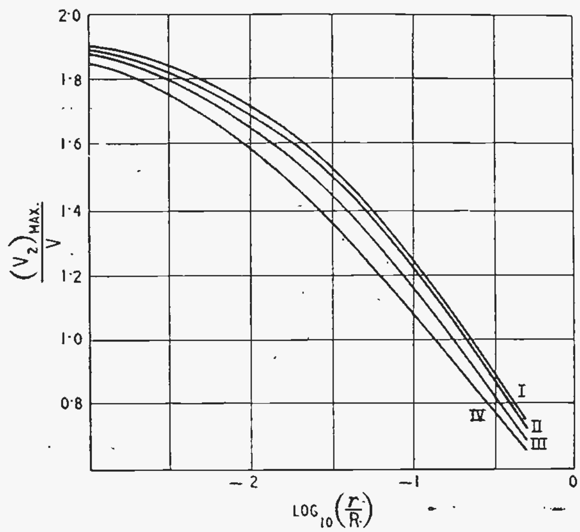


Fig. 7. *Relation between $(V_2)_{max}/V$ and r/R for different values of k ; I, k=1 ; II, k=1/2 or 2 ; III, k=1/4 or 4 ; IV, k=1/8 or 8.*

during the first upward rise of voltage after switching on, and is given by

$$\left(V_2\right)_{max} = \frac{V}{1 + r/R}\left[1 + \exp.\left\{-\pi\omega_1(4\omega_2^2 - \omega_1^2)^{-\frac{1}{2}}\right\}\right] \quad (4)$$

Substituting for ω_1 and ω_2, and writing

$$\frac{L}{C} = k \cdot r \cdot R \quad \ldots \quad (5)$$

equation (4) becomes

$$\left(V_2\right)_{max} = \frac{V}{1 + r/R}\left[1 + \exp.\left\{\pi\left(\frac{4k}{(1 + k)^2}\left(1 + \frac{R}{r}\right) - 1\right)^{-\frac{1}{2}}\right\}\right] \quad \ldots \quad (6)$$

For given values of V, r, and R, it is evident from (6) that to obtain the maximum value of V_2 it is necessary to make $k = 1$; i.e., to have

$$\frac{L}{C} = r \cdot R \quad \ldots \quad (7)$$

To find whether the stabilizer tube will strike under any given set of conditions, the curves showing the relation between $(V_2)_{max}/V$ and r/R for various values of k may be used. These may be computed from (6), and are shown in Fig. 7. As long as the value of r/R is such that the ordinate to the appropriate curve exceeds the ratio (striking voltage)/V, striking will occur.

As an example, using the figures of Table II, for the 250-V d.c. supply the ratio is $\frac{278}{250} = 1.112$. From Fig. 7, the maximum values of r/R for which striking will occur are as follows :—

k	1	$\frac{1}{2}$ or 2	$\frac{1}{4}$ or 4	$\frac{1}{8}$ or 8
r/R	0.16	0.15	0.14	0.13

The choice of values for L and C is evidently a wide one in this case, since, from the first line of Table II, $r = 162\ \Omega$, $V_2 = 237.8$ V, $I_2 = 60$ mA, giving $R = 3960\ \Omega$, and $r/R = 0.041$, well within the above limits. From (7), a value of $L/C = 162 \times 3960$ and (say) $L = 10$ H, $C = 15.6\ \mu$F gives maximum upward surge ; but the wide variations permissible in the value of L/C imply that normal rectifier filter components will in general be adequate to ensure striking. Individual cases may be treated in a similar way.

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ELECTRO-ENCEPHALOGRAPH AMPLIFIER*

By Denis L. Johnston, B.Sc.(Eng.)

SUMMARY.—An amplifier with frequency response of 0.15–10,000 c/s is described, it requires a 15-μV peak-to-peak input signal for full output drive, and operates on a.c. supplies without batteries by an extension of the technique of electronically-stabilized power-supply circuits. The overall mains-frequency hum signal is equivalent to less than 0.5-μV peak-to-peak input signal. Four channels of amplification and an ink-writing recorder are assembled in a compact equipment for electro-encephalography. Some special properties and unusual circuit arrangements of differential amplifiers are discussed. Critical balancing adjustments have been eliminated by the use of degenerative circuits.

1. General Description.

1.1. *Discussion of Requirements*

A VERY complete survey of the medical and instrumental practice in electro-encephalography (e.e.g.) has been given by Parr and Grey Walter,[1] and designs of special amplifiers described by a number of authors[2–9]. It has always been found necessary to use batteries for the high-tension supply to the earlier stages, and frequently for the heater supplies also.

The frequency range required for the graphic recording of brain potentials is at least 0.3–70 c/s. The lower limit is commonly set by problems of amplifier stability, and the upper limit by the available direct-writing recorders. As mains-supply frequencies fall within this range it is not easy to attain a sufficiently low hum level. Electro-encephalographic potentials are not reproduced satisfactorily if extraneous noise and hum exceeds a level equivalent to about 2-μV peak-to-peak input signal.

In certain equipments[5] mains-frequency components have been eliminated by a low-pass filter, but this solution is hardly adequate with 60-c/s supplies, and with 50-c/s supplies a cut-off placed at about 40 c/s obscures important components of the e.e.g. potential waveforms. An alternative approach has been the use of carrier frequency and chopper-type amplifiers[10–13], but this method introduces a higher level of noise.

It is usual to use accumulators or other batteries to supply or stabilize the voltage to the heaters of valves in early stages in order to reduce drift in the amplifier. In the equipment to be described such batteries are eliminated. This self-contained equipment does not require the special screening and spacing previously necessary in clinical use[14], and no attention has to be paid to the maintenance of accumulators and dry batteries.

1.2. *Mechanical Arrangement*

It was found possible to arrange the amplifier and power-unit chassis in close

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proximity without appreciable induction of mains-frequency voltages. The chassis are to the dimensions of the 19-inch standard rack and are mounted in a steel cabinet 40 inches high fitted with castors. A rear door carries the power units, and when this is lowered the valves of all chassis are easily reached (Fig. 1). The complete equipment incorporates four channels of amplification in two two-channel units.

Access to wiring and components of the amplifiers is obtained by opening the hinged front panels of the chassis (Fig. 2). Figure 3 shows the complete electro-encephalograph equipment in use: a section of the cabinet side lifts to form a working desk that is level with the recorder set in the top of the cabinet of Fig. 4, which shows the first experimental model.

It was necessary to take some precautions against microphony from vibration of the motor driving the paper tape for the recorder. The motor and paper drive unit are mounted on rubber anti-vibration units, and the critical stages of the amplifier are on rubber-mounted subchassis. The "click" springs on rotary switches are adjusted to be only strong enough for correct location.

1.3. *Electrical Arrangement*

Differential-input amplifiers are employed in electro-encephalography because the potential to be observed is that between two points on the scalp rather than between one

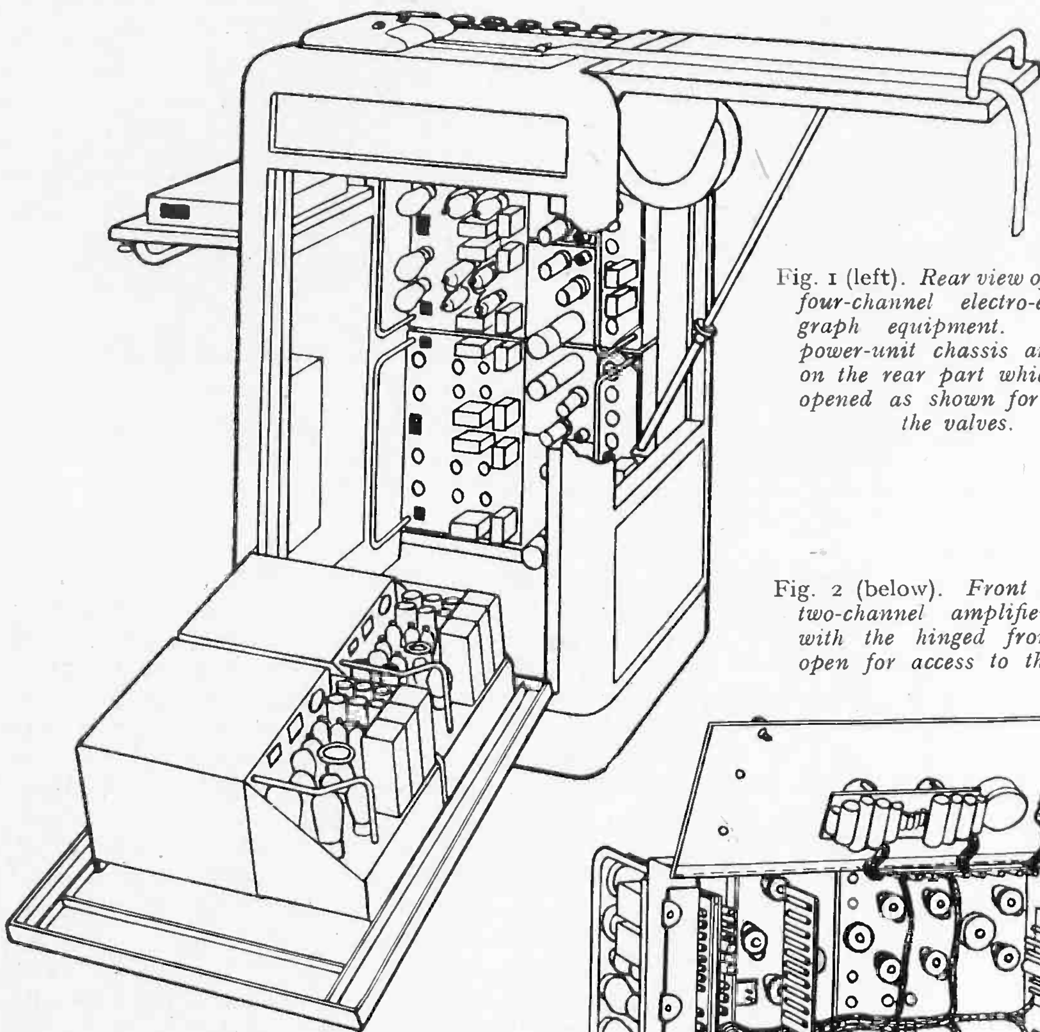


Fig. 1 (left). *Rear view of complete four-channel electro-encephalograph equipment. The two power-unit chassis are carried on the rear part which can be opened as shown for access to the valves.*

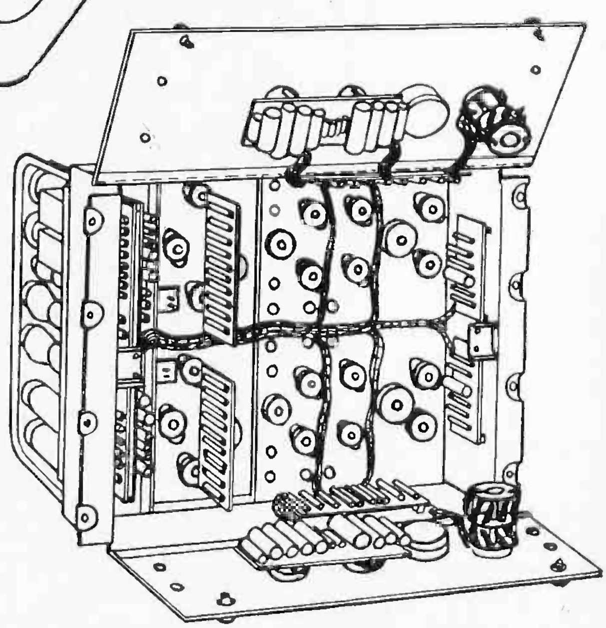
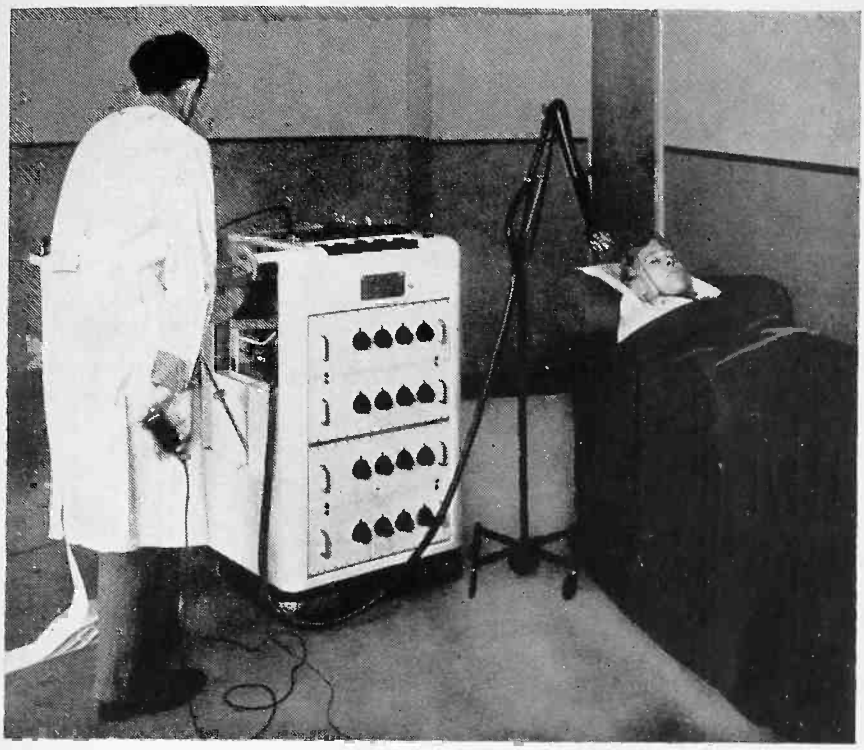


Fig. 2 (below). *Front view of a two-channel amplifier chassis with the hinged front panels open for access to the wiring.*



first stage is provided by the dynamic anode impedance of a pentode.

As the early stages have to be push-pull and a push-pull output is desired, it is convenient to make the amplifier push-pull throughout. This confers certain advantages and it facilitates the provision of gain controls which are placed differentially across anode or cathode loads. The high-frequency response control is a

Fig. 3. *Experimental model of electro-encephalograph in use.*

point and an arbitrary "earth." These special requirements are explained by Parr and Grey Walter[1] and others[15–17]. The screening of the patient from external electrical interference is made very much easier if the differential amplifiers can discriminate against in-phase inputs; i.e., potentials appearing equally between each point on the scalp and earth.

In the present design it has been possible without critical adjustment to obtain a discrimination of as high as 3,000 : 1 between the amplification of differential and of in-phase input signals, by using a cascade of coupled-cathode push-pull stages of amplification. For maximum effect the cathode-coupling load at the

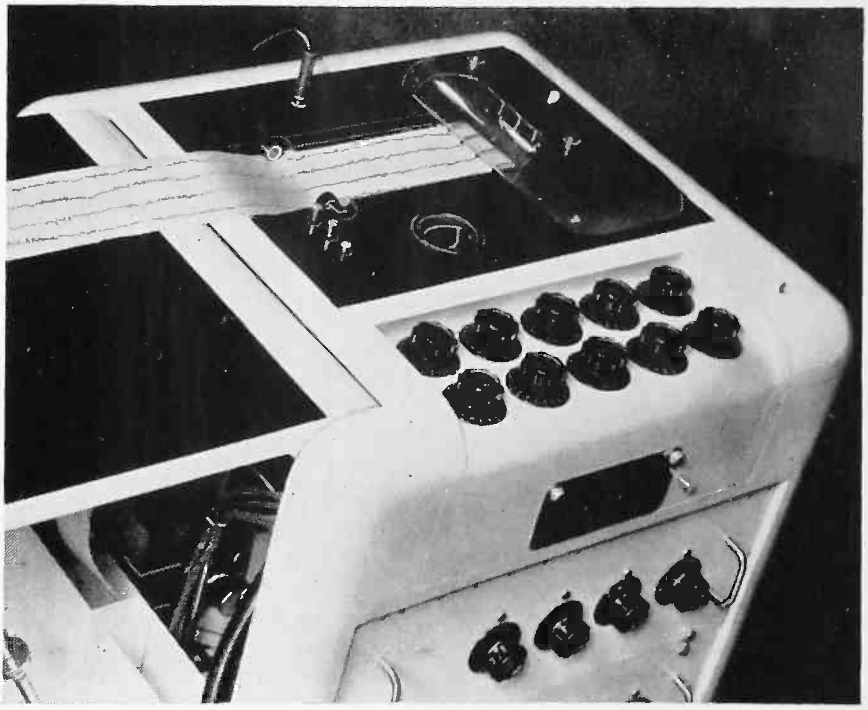


Fig. 4. *Recorder and head-electrode selector switches in desk-top of complete equipment.*

switched differential capacitor and the low-frequency control a pair of switched series coupling capacitors.

It has been pointed out by Dawson[18] that the reproduction of electro-cardiograph and electro-encephalograph waveforms can be seriously modified by the phase shift in several capacitor-coupled stages. A direct-current amplifier is not satisfactory because relatively large and slowly-changing muscle potentials would mask the desired record. The ideal amplifier has one capacitor-coupled stage. In the present design, of the four interstage couplings, two are direct. The small number of capacitor couplings is of assistance in obtaining the relatively long time constant of one second, without the use of unusually large coupling capacitors and grid leaks.

A schematic circuit of the amplifier is given in Fig. 5.

A high degree of stabilization is required of the power-supply circuits and for the sake of economy in a multichannel equipment one power unit is arranged to supply a pair of amplifier channels.

The high-tension supply must duplicate the characteristics of a dry-battery that is insulated and "floating" to earth. A block schematic of the stabilizer arrangements is shown in Fig. 6. For the h.t. supply two stages of a conventional electronic-stabilizer circuit are used in series, and a third stage of stabilization causes the h.t. supply to "float" at a definite potential to earth. These last two stages are not on the power unit chassis but are located physically adjacent to the input stages of the amplifier chassis.

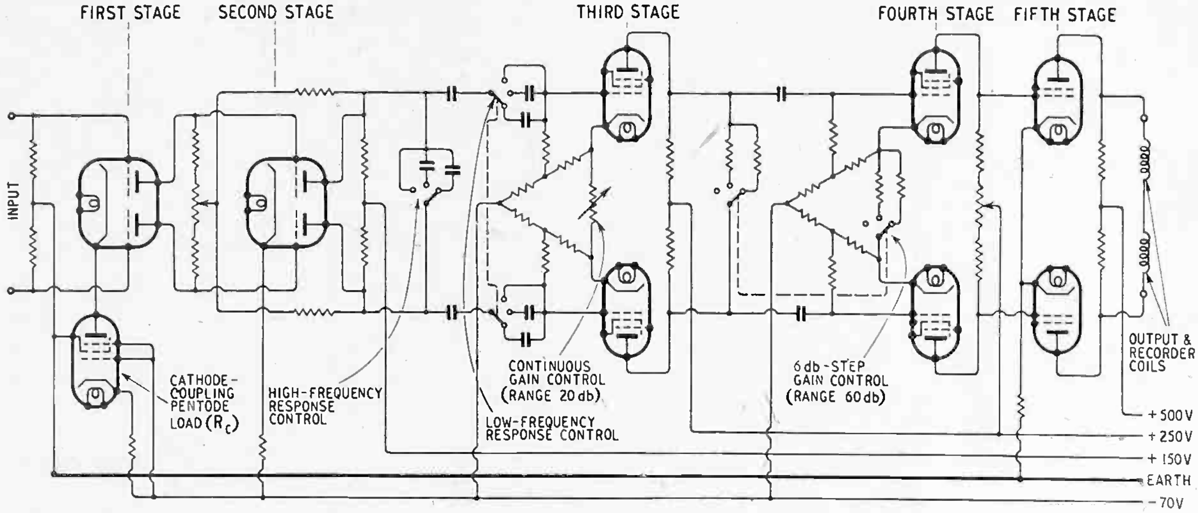


Fig. 5. *Simplified basic circuit of complete differential amplifier.*

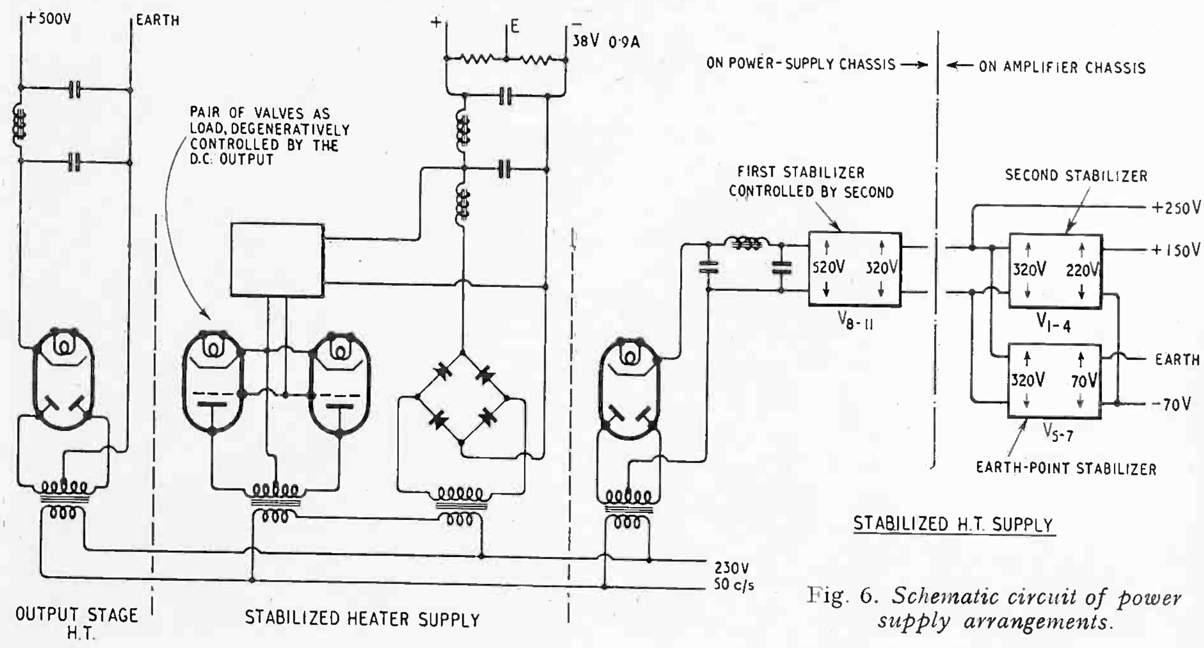


Fig. 6. *Schematic circuit of power supply arrangements.*

Controlled voltage for the heater supply to the critical stages is derived from an electronic a.c. stabilizer followed by a metal rectifier and smoothing circuit. Current for the output stage of the amplifier is supplied by a rectifier and smoothing circuit without stabilization.

2. Amplifier Circuit

2.1. *Input Stages*

2.1.1. *Coupled-cathode differential amplifiers*

The term "coupled-cathode differential amplifier" is used here rather than the customary term "cathode-coupled" as the latter suggests inter-stage coupling, and we wish to imply a coupling between the cathodes of a pair of valves forming a single push-pull stage as shown in Fig. 7(*a*). The amplification of this stage to push-pull signals is: (taken differentially)

$$M' = \frac{\mu \, . \, R_L}{r_a + R_L}$$

and the amplification to in-phase signals: (taken at either anode load)

$$\overline{M} = \frac{\mu \, . R_L}{r_a + R_L + 2R_c(\mu + 1)}$$

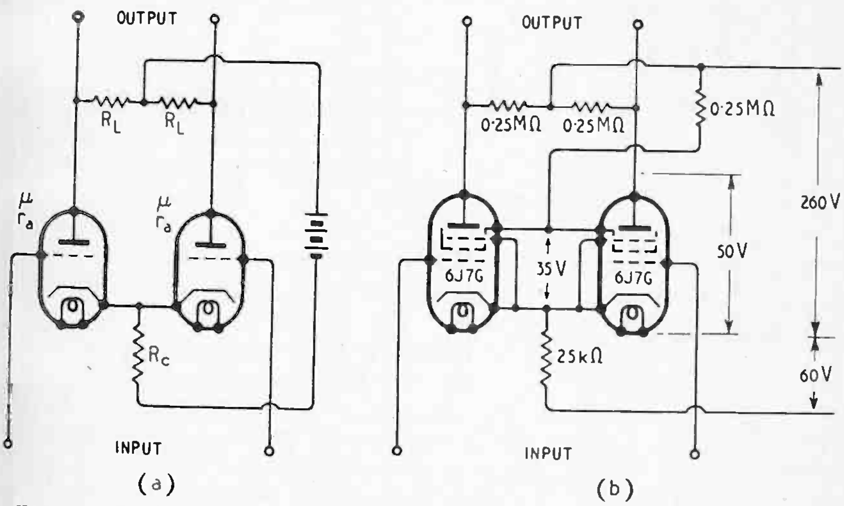


Fig. 7. *Coupled-cathode amplifier stage (a) and practical circuit with values for 6J7G pentode valves (b).*

For an amplifier using 6J7G pentodes with the circuit of Fig. 7(*b*) the values of amplification M' and $\overline{M}$ are respectively 140 and 5. If the valves are connected as triodes the amplifications are respectively 16 and 4.

We see that the discrimination factor F is given by :—

$$F = \frac{M'}{\overline{M}} = \frac{r_a + R_L + 2R_c(\mu + 1)}{\mu \, . \, R_L}$$

and in the above circuits the value is 28 for the pentodes and 4 for the triodes.

When the amplifier is employed as a phase

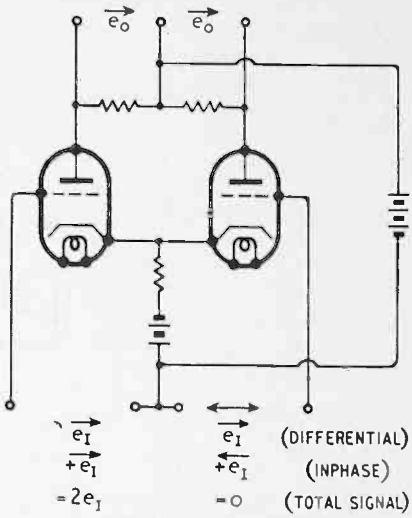


Fig. 8. *Self-balanced phase invertor.*

invertor (Fig. 8) the signal between one grid and earth is zero and the input is applied between the other grid and earth. This is the equivalent of superposing a push-pull signal of $2e$ across the pair of grids, and a signal of e in-phase between each grid and earth.

D is :

$$D = \frac{\text{In-phase signal output}}{\text{Push-pull signal output}} = \frac{\mu \, . \, R_L}{r_a + R_L + 2R_c(\mu + 1)}$$

Thus the inversion defect in a degenerative phase-invertor is the reciprocal of the discrimination factor to in-phase signals.

Balanced phase-invertors and composite balanced and degenerate circuits are in common use: various means are adopted for balancing out the phase inversion defect, but they are appropriate only to constant-input circuit conditions and for this reason are unsuitable in the detection of brain potentials.

The differential amplifier circuit was first applied by a number of independent workers between 1936 and 1938[3,19–24]. Offner pointed out the high stability possible with the circuit, and Goldberg has recently contributed the use of a pentode valve as the coupling inpedance[4]. The coupled-cathode circuit has been analysed and discussed by a number of the above and by other workers[26,27]. Special applications such as oscillator circuits have been described recently[28–32] and the earlier work that was carried out with balanced-differential circuits has been summarized by Penick[61] and others[34–37].

Miller used twin-triode valves in a coupled-cathode amplifier to obtain a high degree of stability in what was functionally a single-sided amplifier[39]. Here one half of the twin triode was regarded as the amplifier and the other half treated as a degenerative stabilizer, the circuit having the form shown in Fig. 9.

This form of circuit can similarly improve the stability of a differential amplifier, and

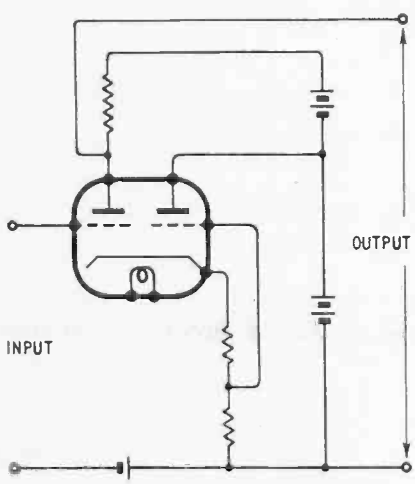
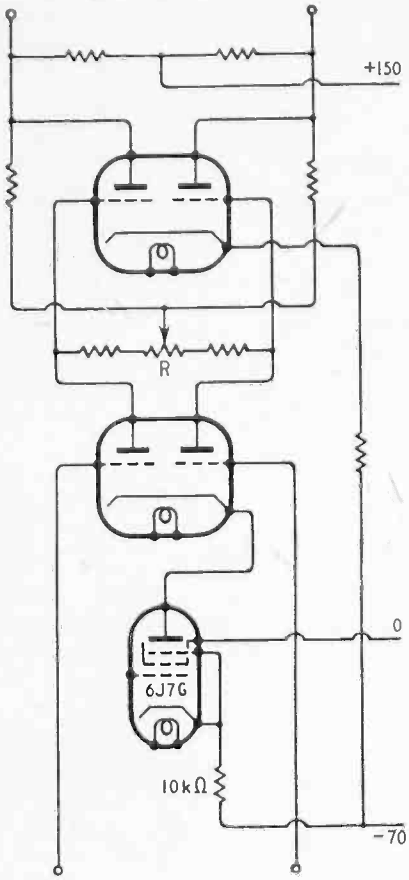
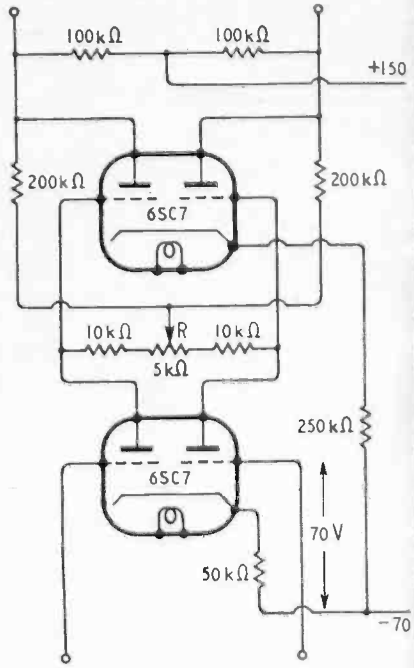


Fig. 9. *Basic circuit of Miller's amplifier.*

for the performance required of the present design, its use was found essential, both for the low-level stages of amplification and for the electronic-stabilizer circuits. The circuit discriminates against variations in high-tension supply and heater voltage just as it rejects in-phase grid voltages.



(a)



(b)

Fig. 10. *Direct-coupled pair of input stages, with pentode as cathode-coupling load at first stage* (*a*), *and the corresponding circuit employing a resistor as cathode-coupling load* (*b*).

2.1.2. *Differential Input Circuit.*

The discrimination factor of the amplifie shown in Fig. 7(*b*) is 28. If it is backed u by a following stage that also possesses high rejection factor, the overall rejection i higher than that of a single stage. In th present equipment the first two stages are direct coupled and triodes are used [Fig. 10(*a*)] A high degree of negative feedback o in-phase voltage is applied, principally t minimize the effect of h.t. variations. A limitation in cascaded direct-couple amplifiers is the available high-tensio voltage. In Fig. 10(*b*) employing 6SC triodes a discrimination factor of 69 i obtained when the cathode load is 50,00 ohms and the p.d. across the load is 70 volts It is uneconomical to increase the discrimina tion factor substantially by increasing th cathode-load resistor, but it is possible t use a pentode in this position as in Fig. 10(*a*) With a 6J7G pentode a dynamic impedanc of 5 MΩ is obtained with this same potential drop of 70 V. The value of the dynamic impedance r'_a for a pentode with self-bias is given by $r'_a = r_a + (\mu + 1)R'_c$ approximately: it is reduced by about 10 per cent in the 6J7G by the mutual conductance between the screen grid and anode.

The discrimination factor is increased in proportion to the value of the cathode load. If adjustments are made to compensate for the inequalities of characteristics in a pair of valves with differential input and output, it is possible to realise a factor of 100,000 : 1; using components of commercial tolerance 3,000: 1 is obtained in the circuit of Fig. 10(*a*) without further adjustment.

The performance can be improved further by taking feedback to the load-valve grid[60] as shown in Fig. 11 for this case of triodes, but in the circuit adopted this was not done because readjustment becomes necessary when valves are changed.

The limit of performance of the differential amplifier is reached when the level of the in-phase signal is high enough to swing the valve characteristic outside the linear range: intermodulation then occurs between the in-phase and the push-pull components. This limiting level can be raised by applying negative feedback individually to each valve (Fig. 12).

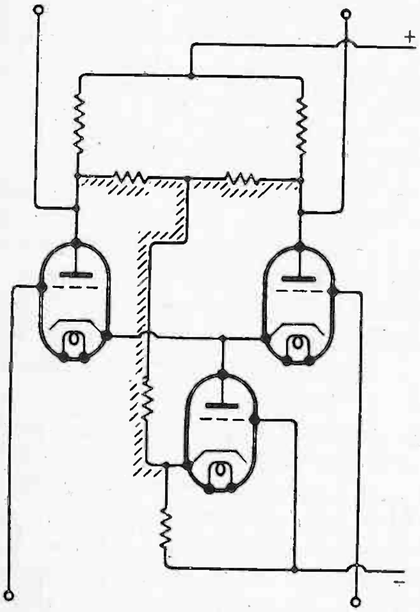


Fig. 11. *Differential input amplifier with feedback (cross-hatched) to grid of valve serving as dynamic cathode load.*

2.1.3. *Differential Amplifier with Floating H.T. Supply.*

The differential amplifier is intended to work with its input grids at about earth potential, and when an h.t. battery is used, an earth tap must be provided at a suitable potential between the negative and positive poles. An earth point can be taken on a potentiometer connected across the battery, but the impedance will be relatively high and careful screening against electrical interference is then necessary. This difficulty will also arise with a mains-derived power supply, and the method of overcoming it is described in Section 3.1.1.

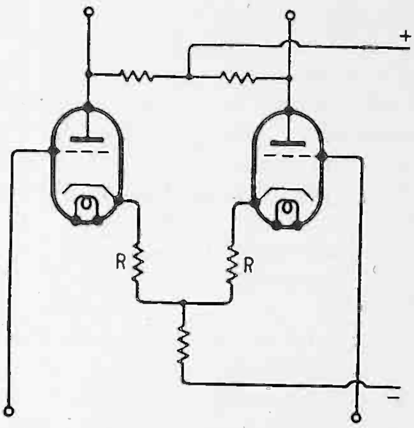


Fig. 12. *Differential input circuit for high signal levels.*

2.1.4. *Valve and Circuit Noise at Very Low Frequencies.*

The chief sources of spurious output voltages will be:

(*a*) Thermal agitation noise of the input circuit.

(*b*) Shot-effect noise of the first stage valves.

(*c*) Noise due to space charge variations of a random nature, and variations induced by changes in heater current.

(*d*) Modulation at the several electrodes of valves in the early stages due to fluctuations in high-tension voltage.

(*e*) Other causes, such as mechanical vibration and electromagnetic and electrostatic induction.

In a differential amplifier a source peculiar to one side of the amplifier will be amplified as a differential signal: as Pratt[40] has pointed out, the application of negative feedback has no effect on the equivalent input noise of an amplifier.

The relative importance of the several sources of noise will depend upon the frequency range and the bandwidth of the amplifier. The first two are the main sources of noise in radio-frequency amplifiers and they have received a good deal of attention: useful reviews are given by Pearson[41], Thompson[42] and others[5,43].

At very low sub-audible frequencies, circuit and shot noise is not high because the bandwidth is small, and the greater part of the fluctuations appear to originate at the cathode space charge, and fall below about 10 c/s. These effects are least in large triodes of low amplification factor. The

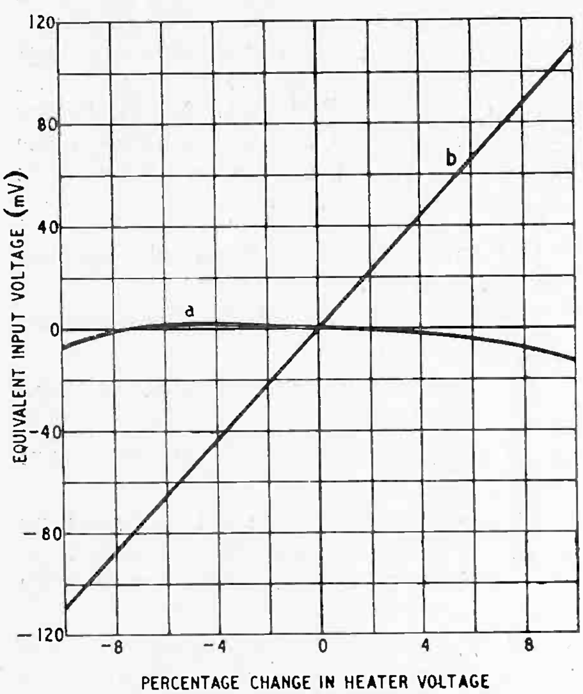


Fig. 13. *Fluctuation due to changes in heater voltage; (a) in Miller's circuit, and (b) in conventional single-sided amplifier.*

condition of the space charge depends to some extent upon the heater current, and consequently the heater supply must be stablized in sensitive low-frequency amplifiers: the performance of indirectly-heated valves is better than directly-heated types in this respect because of the thermal inertia of the indirectly-heated cathode.

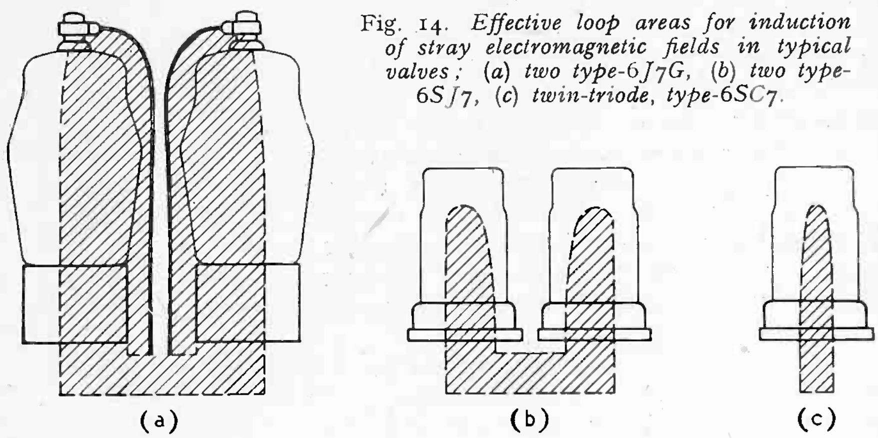


Fig. 14. *Effective loop areas for induction of stray electromagnetic fields in typical valves; (a) two type-6J7G, (b) two type-6SJ7, (c) twin-triode, type-6SC7.*

Thompson gives an expression for thermal agitation hoise in a circuit of resistance R $e = \sqrt{1.6 \times 10^{-20} \times R \times \Delta f}$ where Δf is the bandwidth. The shot effect noise can be represented by an equivalent noise resistance R_{eq}, which for a triode is given approximately by $R_{eq} = 2.5/g_m$, and which for a type 6SC7 twin triode valve is 1900 ohms. The value for a pentode valve of similar type is usually about ten times higher, and for this reason triodes are used for the input stages of the present design. The input circuit resistance in e.e.g. work is usually of the order of 10,000 chms. The bandwidth of an electro-encephalograph working into a mechanical recorder may be 60 c/s, and for an equivalent circuit resistance of 10,000 ohms, the thermal-noise voltage will be about 0.3 microvolt peak-to-peak.

The noise level observed at low frequencies with a good selected specimen of the 6SC7 type valve is of the order of 1.5 microvolts peak-to-peak. This valve is used for the reasons given in the next section, because it is the only type available with a physically common cathode. The single triode MH40[45] is a type of valve known to have a noise value about half the above figure but did not meet all the requirements of a self-contained equipment. There is little published information on low-frequency noise, but Roess[46] has given some useful data taken at very narrow bandwidths in connection with infra-red spectroscopy.

Miller[39] has shown the reduction in drift with change in heater voltage that can be realised by using a balanced-cathode circuit, in the curve (*a*) of Fig. 13 reproduced from his paper: (*b*) is the performance of a conventional amplifier. The improvement is greatest when the valve used is a twin-triode with a cathode physically common to both triode sections (such as the R.C.A. 12SC7 or 6SC7). As might be expected, the changes in cathode conditions due to variation in heater current are then more nearly equal in the two sections than they would be in individual valves, and being equal the in-phase discrimination of the amplifier comes into effect when such valves are applied in differential circuits.

Some work on these lines was done a few years ago by Brentano[35,36] with a valve designed so that the two triode sections received emission from substantially the same area of the filament. An American miniature indirectly-heated double triode, the 6J6, has a flat cathode with the triode sections on either side,[25]. Unfortunately specimens of these two types of valves have not been available for trial, for they are the only other known types particularly suited to the present application.

2.1.5. *Electromagnetic and Electrostatic Induction*

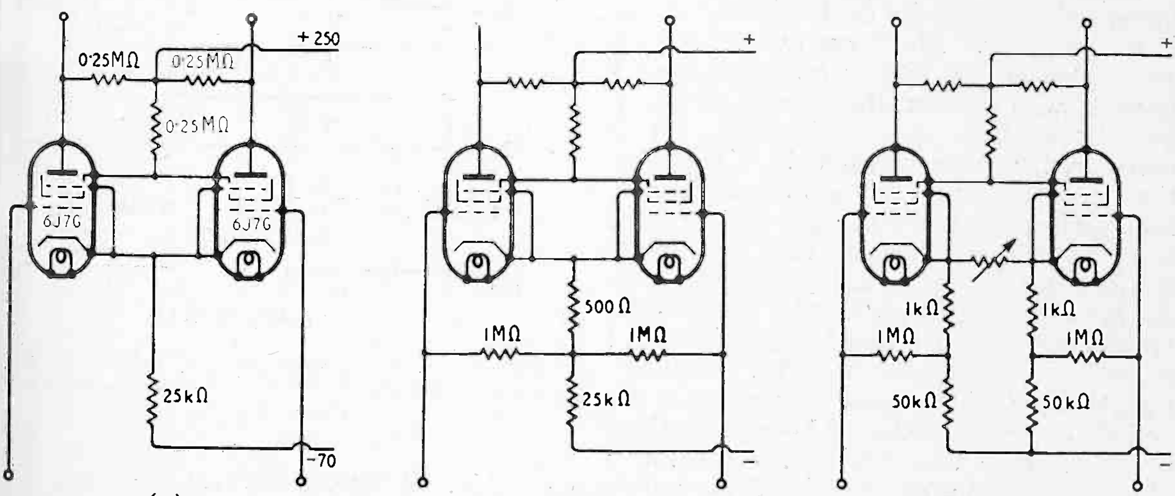
At low signal levels differential pickup of electromagnetic fields is experienced within the circuit wiring. It can be reduced by keeping at a minimum the area of pickup loop formed by the differential circuit, and by a degree of magnetic screening. Magnetic induction can be minimized by choosing the most suitable valves. The worst arrangement is a pair of top-grid pentodes, where the pickup loop area is large. Fig. 14(*a*) represents a pair of 6J7G valves; the loop area is about 60 square cm for valves and circuit wiring. In an alternating field of one gauss (peak) the voltage picked up at 50 c/s would be 30 microvolts (peak).

An under-grid valve such as the 6SJ7 is better Fig. 14(*b*), the loop area being about 15 square cm. The best valve available is the 6SC7: the two triode sections are above one another on the same vertical axis and the total area between the pair of grid leads and wiring is about 3 square cm. This type of valve is enclosed in a ferrous envelope and there is considerable magnetic screening, particularly when the valve holder is fitted in an enclosed steel chassis.

Electrostatic induction is not troublesome in the present instance since all wiring to the first two stages is screened by the chassis, and input cables are screened and fitted to screened plugs and sockets. Pairs of signal leads are run close together in the amplifier in order that the pickup shall be as nearly as possible equal on each lead and so be rejected by the differential amplifier.

2.1.6. *Other Causes of Spurious Fluctuation*

The insulation resistance between heater and cathode in small indirectly-heated valves may not be very much greater than the order of one megohm. In a single-cathode twin-triode circuit the effect of heater-cathode leakage is reduced considerably because the voltage due to leakage is common to each side of the amplifier. In a sensitive input



(a) (b) (c)

Fig. 15. (*a*) *Basic circuit for 3rd and 4th stages;* (*b*) *circuit with self-bias connections; and* (*c*) *alternative self-bias circuit with cathode gain control.*

circuit leakage current is reduced by arranging that the cathode-heater potential difference is small: this is analogous to the use of a guard electrode in measurement technique.

Grid leaks are connected at the input of the amplifier. The value is one megohm, and as this is rather high for a wire-wound

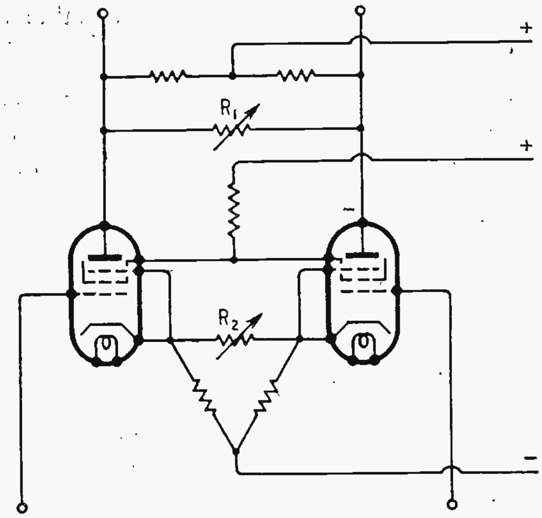


Fig. 16. *Differential gain control in anode load circuit R_1 and in cathode load circuit R_2.*

component, cracked-carbon film resistors are used. It is essential that the grid current be of very low order of magnitude or there will be generation of noise in the resistors. The other resistors in the first two stages are such values that wire-wound components can be used in every case.

Only a proportion of commercial valves are found to be suitable for use in the first stages of the amplifier. About one quarter show a noise level of less than 2 microvolts peak-to-peak while about the same proportion may be as high as 20 microvolts. It is necessary to reject such valves in this application and also any that show low cathode insulation resistance, abnormal grid current, and inequalities between the two triode sections exceeding about ± 10 per cent. An initial ageing of about 100 hours under rated operating conditions is carried out; it has been found that, after this treatment, the characteristics remain very constant for periods of several thousand hours, and there is no evidence that noise or other faults become worse during the life of the valve. The initial ageing is important for any valves that are in directly-coupled circuits: during the first few hours the base voltage of the grid characteristic appears to shift, making it impossible to set up the circuit properly.

Microphony gives very little trouble in valves of modern construction, and the all-metal type 6SC7 is especially good in this respect. The complete equipment must be struck with a fairly heavy blow to produce a substantial deflexion on the recorder when the amplifiers are working at maximum sensitivity.

The natural frequencies of valve structures fall in the range 100–10,000 c/s. Resiliently mounted sub-chassis are employed for the early stages of the equipment. They are fitted with small rubber-metal bonded units of nominal loading one pound. The natural frequency of the sub-panel assembly is thereby reduced to the range 1–10 c/s to which frequencies the valve structures present relatively high stiffness.

A resiliently mounted assembly will have a natural frequency given by the expression $f = \sqrt{10/h}$ c/s, where h is the deflection of the mountings in inches due to the weight of the

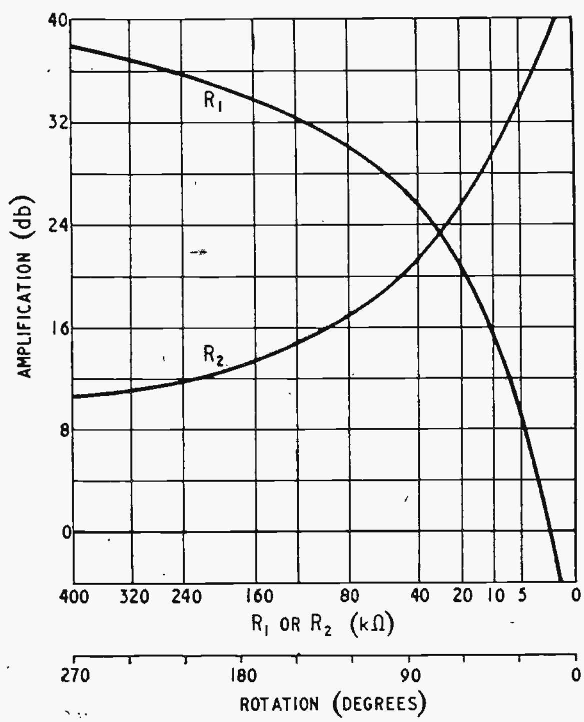


Fig. 17. *Law of gain controls of tapered track when used in anode circuit R_1 and in cathode circuit R_2.*

assembly. A typical rubber mounting for one pound load may have a deflection of about 1/8 inch, corresponding to a natural frequency when loaded of 9 c/s.

2.2 *Intermediate Stages*

2.2.1 *Basic Circuit*

The third and fourth stages of the amplifier contribute the major part of the total voltage gain of over 140 db, the gain per stage being rather more than 40 db. Type 6J7G pentodes are employed in the circuit of Fig. 15(*a*). The anode current is approximately 0.7 mA which is lower than usual practice but provides about the optimum ratio of gain to overall high-tension voltage. Self bias can be applied in this circuit as in Fig. 15(*b*) or (*c*) with no appreciable loss of amplification.

Pairs of ganged controls are undesirable for practical reasons. In a differential amplifier gain controls acting on the anode and on the cathode circuits can be placed differentially as in Fig. 16. The anode control R_1 increases amplification with ncrease of resistance. At the cathode, amplification increases as the variable resistor R_2 is reduced in value, the law for the case of the circuit Fig. 16 being given in Fig. 17. The shape is improved by the use of a 5 : 1 linear taper track control.

In the present design a continuously variable gain control is required: by placing it as a cathode-coupling control, it is possible to use a wire-wound component. In the position differentially across the anodes a considerably higher value of resistance is required, and it is then necessary to use the rather less desirable composition track type of component. This type of gain control was first reported by Jofeh[38].

The cathode and anode attenuation control circuits are delta networks, and their relation to the more familiar circuit arrangement is easily demonstrated by using the star-delta transformation theorem as shown in Fig. 18 (*a*) and (*b*). A simpler means of estimating the amplification to differential signals is to assume that the cathode or anode load effective to differential signals is

$\frac{1}{2} . R_2$ in parallel with R_1 at the anode and
$\frac{1}{2} . R_4$ in parallel with R_3 at the cathode

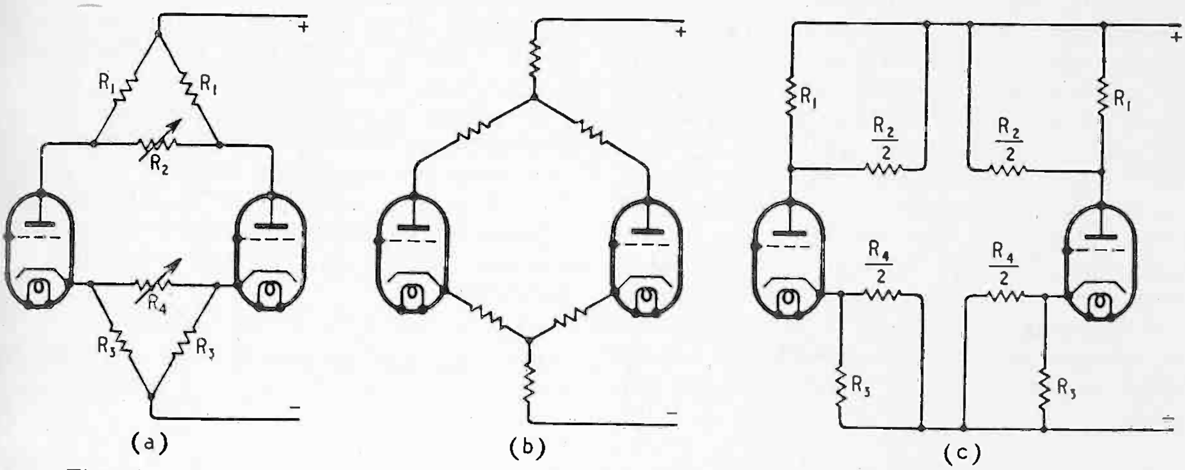


Fig. 18. *Differential gain controls at anode and cathode represented as "delta" networks* (*a*), *and as "stars"* (*b*). *The equivalent circuit of differential loads to push-pull signals* (*c*).

as in Fig. 18(*c*). This follows from the fact that with a push-pull signal the mid-points of R_2 and R_4 are at zero signal potential relative to the negative pole, and so are effectively connected together and to the negative pole. The anode and cathode gain

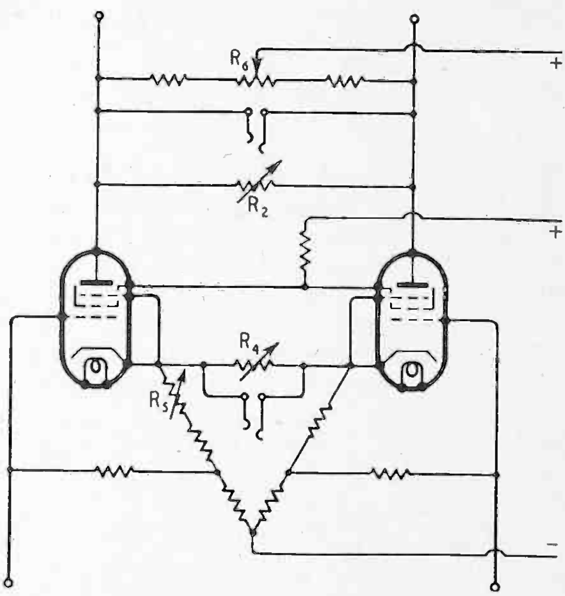


Fig. 19. *Static balancing controls R_5 at cathode and R_6 at anode, with cathode and anode test jacks.*

controls are independent of one another. Amplification of in-phase signals is constant for any position of the cathode control, and will vary with the value of the anode differential resistor.

An undesirable surge voltage occurs as the differential control is operated, in either the anode or cathode positions, when the potentials of the pair of valves at these points are not statically in balance at their direct current values. The cathode potentials are made exactly equal by including a pre-set variable resistor of small value R_5 (Fig. 19) as part of the self-bias load for one valve. It is adjusted for zero cathode p.d. when R_4 is in its position of maximum resistance. This adjustment requires attention only at very long intervals of time, or when valves are changed: to facilitate the adjustment of R_5 and R_6 small tests jacks are provided at these points for the connection of a meter with sensitivity of the order of 20,000 Ω/v.

The present amplifier design requires a continuous attenuation control of 20-db range, and a variable control with 6-db steps and a total range of 60 db. This exceeds the amplification of any one stage and to avoid using a screened attenuator the 60-db control is distributed over two stages of the amplifier. The 6-db steps are taken alternatively from the anode circuit of the third stage, Fig. 5, and the cathode circuit of the fourth stage, and the continuous control is at the cathode of the third stage. The resistor manufacturers' preferred series of component values is a logarithmic one, and some economy was effected by using the ± 10 per cent series to obtain the component values for the 6-db steps (the effective anode load is halved or doubled at each step).

(*To be concluded*).

References will appear at the end of the last instalment.

FILTER DESIGN TABLES BASED ON PREFERRED NUMBERS*

Band-pass Filters

By H. Jefferson, M.A., A.Inst.P., A.M.I.E.E.

In this paper tables are given for the design of constant-k band-pass filters having preferred values of capacitance. The method by which this result is reached has already been described.[1] As before, the values in the tables are those of the ladder network elements and where single sections are used the actual element values used are those given in Fig. 1. L_{1k}, L_{2k}, C_{1k} and C_{2k} are the values obtained from the tables, and are approximations to

$$L_{1k} = R/\pi(f_2-f_1)$$
$$L_{2k} = (f_2-f_1)R/4\pi f_1 f_2$$
$$C_{1k} = (f_2-f_1)/4\pi f_1 f_2 R$$
$$C_{2k} = 1/\pi(f_2-f_1)R$$

Where f_1, f_2 are the cut-off frequencies and R is the impedance. These expressions take a more convenient form if we write $(f_2-f_1) = f_b$, the band-width, and $(f_1 f_2)^{\frac{1}{2}} = f_m$, the geometric mid-band frequency. Then

$$L_{1k} = R/\pi f_b \qquad C_{1k} = f_b/4\pi f_m^2 R$$
$$L_{2k} = f_b R/4\pi f_m^2 \qquad C_{2k} = 1/\pi f_b R.$$

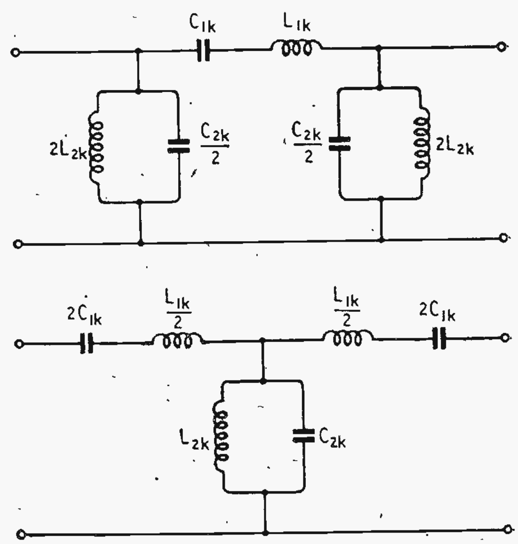


Fig. 1. *Constant-k band-pass filter sections.*

*MS. accepted by the Editor, August 1946.

It will be seen that L_{1k} and C_{2k} are the same as for a low-pass filter of the same impedance R and cut-off frequency f_b. Thus the tables already published[2] may be used to determine these two element values.

We also have

$$4\pi^2 f_m^2 \, L_{1k} C_{1k} = 1$$

and $4\pi^2 f_m^2 \, L_{2k} C_{2k} = 1.$

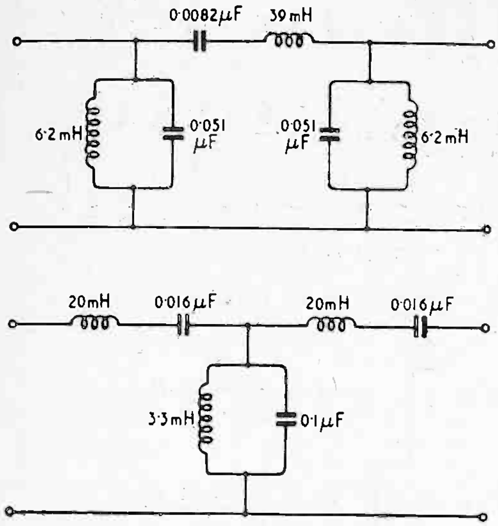


Fig. 2. *The component values of the example discussed in the text are marked on the π- and T-sections.*

Having determined L_{1k} and C_{2k} from the low-pass filter tables[2] the tables which follow can be used to determine C_{1k} and L_{2k}. Table I gives the geometric mid-band frequency f_m; this table may only be used when f_1 and f_2 are in the same decade. If f_2 is in the next decade to f_1, the value of f_m derived from Table I is taken in the top row of the supplementary table, and the true value of f_m read off below.

The values of L_{1k} and C_{2k} are obtained from the low-pass filter tables. Table II is a coarse table which enables an approximate value to be obtained for C_{1k} and L_{2k}. Table III enables the significant figures to be determined. Any practical filter will involve the use of either $2X$ or $X/2$, where

TABLE I

GEOMETRICAL MID-BAND FREQUENCY $fm = (f_1 f_2)^{1/2}$

CUT-OFF FREQUENCY f_2

CUT-OFF FREQUENCY f_1	10	11	12	13	15	16	18	20	22	24	27	30	33	36	39	43	47	51	56	62	68	75	82	91	100
10	10		11		12		13		15		16		18		20		22		24		27		30		33
11		11		12		13		15		16		18		20		22		24		27		30		33	
12	11		12		13		15		16		18		20		22		24		27		30		33		36
13		12		13		15		16		18		20		22		24		27		30		33		36	
15	12		13		15		16		18		20		22		24		27		30		33		36		39
16		13		15		16		18		20		22		24		27		30		33		36		39	
18	13		15		16		18		20		22		24		27		30		33		36		39		43
20		15		16		18		20		22		24		27		30		33		36		39		43	
22	15		16		18		20		22		24		27		30		33		36		39		43		47
24		16		18		20		22		24		27		30		33		36		39		43		47	
27	16		18		20		22		24		27		30		33		36		39		43		47		51
30		18		20		22		24		27		30		33		36		39		43		47		51	
33	18		20		22		24		27		30		33		36		39		43		47		51		56
36		20		22		24		27		30		33		36		39		43		47		51		56	
39	20		22		24		27		30		33		36		39		43		47		51		56		62
43		22		24		27		30		33		36		39		43		47		51		56		62	
47	22		24		27		30		33		36		39		43		47		51		56		62		68
51		24		27		30		33		36		39		43		47		51		56		62		68	
56	24		27		30		33		36		39		43		47		51		56		62		68		75
62		27		30		33		36		39		43		47		51		56		62		68		75	
68	27		30		33		36		39		43		47		51		56		62		68		75		82
75		30		33		36		39		43		47		51		56		62		68		75		82	
82	30		33		36		39		43		47		51		56		62		68		75		82		91
91		33		36		39		43		47		51		56		62		68		75		82		91	
100	33		36		39		43		47		51		56		62		68		75		82		91		100

SUPPLEMENTARY TABLE FOR USE WHEN f_1 and f_2 ARE NOT IN THE SAME DECADE

10	11	12	13	15	16	18	20	22	24	27	30	33	35	39	43	47	51	56	62	68	75	82	91	100
33	36	39	43	47	51	56	62	68	75	82	91	10	11	12	13	15	16	18	20	22	24	27	30	33

TABLE II

INDUCTANCE OR CAPACITANCE OF BAND-PASS FILTER

INDUCTANCE		CAPACITANCE μμF 1	3.3	10	33	100	330	1 000	μF 0.0033	0.01	0.033	0.1	0.33	1	3.3	10	
μH	1	5 100	3 000	1 600	910	510	300	160	91	51	30	16	9.1	5.1	3.0	1.6	Mc/s
	3.3	3 000	1 600	910	510	300	160	91	51	30	16	9.1	5.1	3.0	1.6	910	
	10	1 600	910	510	300	160	91	51	30	16	9.1	5.1	3.0	1.6	910	510	
	33	910	510	300	160	91	51	30	16	9.1	5.1	3.0	1.6	910	510	300	
	100	510	300	160	91	51	30	16	9.1	5.1	3.0	1.6	910	510	300	160	kc/s
	330	300	160	91	51	30	16	9.1	5.1	3.0	1.6	910	510	300	160	91	
	1 000	160	91	51	30	16	9.1	5.1	3.0	1.6	910	510	300	160	91	51	
mH	0.0033	91	51	30	16	9.1	5.1	3.0	1.6	910	510	300	160	91	51	30	
	0.01	51	30	16	9.1	5.1	3.0	1.6	910	510	300	160	91	51	30	16	
	0.033	30	16	9.1	5.1	3.0	1.6	910	510	300	160	91	51	30	16	9 100	
	0.1	16	9.1	5.1	3.0	1.6	910	510	300	160	91	51	30	16	9 100	5 100	
	0.33	9.1	5.1	3.0	1.6	910	510	300	160	91	51	30	16	9 100	5 100	3 000	
	1	5.1	3.0	1.6	910	510	300	160	91	51	30	16	9 100	5 100	3 000	1 600	
	3.3	3.0	1.6	910	510	300	160	91	51	30	16	9 100	5 100	3 000	1 600	910	
	10	1.6	910	510	300	160	91	51	30	16	9 100	5 100	3 000	1 600	910	510	c/s
	33	910	510	300	160	91	51	30	16	9 100	5 100	3 000	1 600	910	510	300	
	100	510	300	160	91	51	30	16	9 100	5 100	3 000	1 600	910	510	300	160	
	330	300	160	91	51	30	16	9 100	5 100	3 000	1 600	910	510	300	160	91	
H	1	160	91	51	30	16	9 100	5 100	3 000	1 600	910	510	300	160	91	51	
	3.3	91	51	30	16	9 100	5 100	3 000	1 600	910	510	300	160	91	51	30	
	10	51	30	16	9 100	5 100	3 000	1 600	900	510	300	160	91	51	30	16	
	33	30	16	9 100	5 100	3 000	1 600	910	510	300	160	91	51	30	16	9.1	
	100	16	9 100	5 100	3 000	1 600	910	510	300	160	91	51	30	16	9.1	5.1	

TABLE III

SIGNIFICANT FIGURES FOR INDUCTANCE OR CAPACITANCE OF BAND-PASS FILTER

MID-BAND FREQUENCY f_m

CAPACITANCE OR INDUCTANCE	10	11	12	13	15	16	18	20	22	24	27	30	33	36	39	43	47	51	56	62	68	75	82	91	100
10	27	22	18	15	12	10	82	68	56	47	39	33	27	22	18	15	12	10	82	68	56	47	39	33	27
11	24	20	16	13	11	91	75	62	51	43	36	30	24	20	16	13	11	91	75	62	51	43	36	30	24
12	22	18	15	12	10	82	68	56	47	39	33	27	22	18	15	12	10	82	68	56	47	39	33	27	22
13	20	16	13	11	91	75	62	51	43	36	30	24	20	16	13	11	91	75	62	51	43	36	30	24	20
15	18	15	12	10	82	68	56	47	39	33	27	22	18	15	12	10	82	68	56	47	39	33	27	22	18
16	16	13	11	91	75	62	51	43	36	30	24	20	16	13	11	91	75	62	51	43	36	30	24	20	16
18	15	12	10	82	68	56	47	39	33	27	22	18	15	12	10	82	68	56	47	39	33	27	22	18	15
20	13	11	91	75	62	51	43	36	30	24	20	16	13	11	91	75	62	51	43	36	30	24	20	16	13
22	12	10	82	68	56	47	39	33	27	22	18	15	12	10	82	68	56	47	39	33	27	22	18	15	12
24	11	91	75	62	51	43	36	30	24	20	16	13	11	91	75	62	51	43	36	30	24	20	16	13	11
27	10	82	68	56	47	39	33	27	22	18	15	12	10	82	68	56	47	39	33	27	22	18	15	12	10
30	91	75	62	51	43	36	30	24	20	16	13	11	91	75	62	51	43	36	30	24	20	16	13	11	91
33	82	68	56	47	39	33	27	22	18	15	12	10	82	68	56	47	39	33	27	22	18	15	12	10	82
36	75	62	51	43	36	30	24	20	16	13	11	91	75	62	51	43	36	30	24	20	16	13	11	91	75
39	68	56	47	39	33	27	22	18	15	12	10	82	68	56	47	39	33	27	22	18	15	12	10	82	68
43	62	51	43	36	30	24	20	16	13	11	91	75	62	51	43	36	30	24	20	16	13	11	91	75	62
47	56	47	39	33	27	22	18	15	12	10	82	68	56	47	39	33	27	22	18	15	12	10	82	68	56
51	51	43	36	30	24	20	16	13	11	91	75	62	51	43	36	30	24	20	16	13	11	91	75	62	51
56	47	39	33	27	22	18	15	12	10	82	68	56	47	39	33	27	22	18	15	12	10	82	68	56	47
62	43	36	30	24	20	16	13	11	91	75	62	51	43	36	30	24	20	16	13	11	91	75	62	51	43
68	39	33	27	22	18	15	12	10	82	68	56	47	39	33	27	22	18	15	12	10	82	68	56	47	39
75	36	30	24	20	16	13	11	91	75	62	51	43	36	30	24	20	16	13	11	91	75	62	51	43	36
82	33	27	22	18	15	12	10	82	68	56	47	39	33	27	22	18	15	12	10	82	68	56	47	39	33
91	30	24	20	16	13	11	91	75	62	51	43	36	30	24	20	16	13	11	91	75	62	51	43	36	30
100	27	22	18	15	12	10	82	68	56	47	39	33	27	22	18	15	12	10	82	68	56	47	39	33	27

X is L or C, and tables showing the preferred values for these quantities have already been published[2].

As an example of the use of the tables, let us consider a band-pass filter of 620 ohms impedance and cut-off frequencies 7 000 c/s and 12 000 c/s.

The band-width is 5 000 c/s, giving as the nearest preferred value 5 100 c/s. For this we have already seen that

$$L_{1k} = 39 \text{ mH}.$$
$$C_{2k} = 0.1 \mu\text{F}.$$

From Table I we read off the intersection of the preferred cut-off frequencies 6 800 c/s and 12 000 c/s as 30, but as the cut-off frequencies are in different decades we must go to the supplementary table, obtaining $f_m = 9\,100$ c/s.

Looking down the 0.1-μF column of Table II we find that 9 100 c/s corresponds to an inductance $L_{2k} = 3.3$ mH. Looking along the 33-mH row we find that 9 100 c/s corresponds to a capacitance of 0.01 μF, while 100 mH gives a capacitance of 0.0033 μF. Turning to Table III, we obtain the significant figure 82, so that $C_{1k} = 0.0082$ μF. The physical forms for a single section are shown in Fig. 2.

REFERENCES

1 "Preferred Numbers and Filter Design," *Wireless Engineer*, October 1945.

2 "Filter Design Tables Based on Preferred Numbers—Low-Pass Filters," *Wireless Engineer*, January 1946.

3 "Filter Design Tables Based on Preferred Numbers—High-Pass Filters," *Wireless Engineer*, July 1946.

BOOK REVIEWS

Radar Engineering.

By Donald G. Fink. Pp. 644, with 471 diagrams. McGraw-Hill Publishing Co., Ltd., Aldwych House, London, W.C.2. Price 35s.

Intensive wartime research resulted in vast stores of information on radar, which became very unevenly distributed because of security needs. Mr. Fink's object has been to provide in one volume a review of the whole subject. In doing so he has wisely given prime attention to basic principles, rather than to filling up the book with the endless details of particular systems, which would only have confused the reader approaching the subject for the first time, and obscured the essentials. The author has, in fact, given considerable details of only four sets of equipment, selected to illustrate techniques in the 200, 600, 3,000, and 10,000 Mc/s bands. They are all U.S. Army ground systems, which is perhaps slightly unfortunate in that present-day development is concerned primarily with marine applications. These are hardly mentioned in the book, nor, incidentally, is the "cheese" aerial, which is probably the most important type to-day. Nevertheless, the examples do between them cover a very wide range of technique.

Although the term "radar" is used by the author in its strictest sense, excluding similar systems which do not depend on involuntary echoes, his treatment of the many branches of radio science brought into prominence by radar—such as pulse generation and transmission, waveguides and resonant cavities, and the beaming and propagation of decimetre and centimetre waves—makes much of his teaching applicable not only to pseudo-radar but also to modern developments in television and communications.

The subject-matter is logically and clearly arranged, and concisely expressed, and an unusually full index is provided. References are few because few were available at the time of writing, and the book is by plan self-sufficient. Some of the diagrams (e.g., Figs. 316 and 323) are on too small a scale for comfort; the former, a half-page circuit diagram, includes ten more-or-less complicated waveform pictures, each 0.17 sq cm in area. But with few exceptions the many illustrations are good.

An otherwise commendable work is marred by its elementary sections on circuit principles, notably Secs. 34–37. These purport to explain the current waveforms resulting from voltage pulses, and vice versa; the pulses being derived from generators having respectively zero and infinite internal impedance, applied to circuits containing pure L, C and R, separately and in combination. Many of these cases would not in any event be particularly helpful to the student of radar. For example, a voltage pulse is applied to an inductive circuit having zero resistance. During the pulse the current is quite understandably shown as growing at a uniform rate, E/L. At the end of the pulse the generator is effectively a dead short, with no e.m.f. That being so, it is rather surprising to find that the current is decreasing at the same rate as it grew, apparently without giving rise to any e.m.f. of self-induction; and when it reaches zero it knows it is home and the uniform decay abruptly stops.

With L and R in series, the voltage across the two is shown as dying away exponentially, although the current through them is constant; this phenomenon is matched by a decaying current in parallel C and R with constant terminal voltage. The climax is reached with an incredibly involved description of what is said to happen when a voltage pulse is applied to L and R in parallel. These influences unfortunately crop up elsewhere, as in Fig. 216, where the voltage-current relations in a sawtooth generator appear to be at variance with $e = Ldi/dt$.

Happily this is not the general standard, though no doubt the people who operated the main radar defence system of the British Isles from 1938 to 1945 will deplore the unqualified assertion that beaming is essential to radar. And in the next edition it might be as well to guard against a reasonable impression (from p. 299) that the minimum range of a radar corresponds to pulse duration plus at least several microseconds, for in current practice the determining period is commonly as brief as 0.3 μsec inclusive of pulse. It might also be of interest to trace the career of Mr. Eccles-Jordan! ("The direct-coupled multivibrator . . . is often referred to by his name," p. 330).

M. G. S.

The Metre-Kilogram-Second System of Electrical Units.

By R. K. Sas and F. B. Pidduck. Pp. 60. Methuen & Co., Ltd., 36, Essex Street, London, W.C.2. Price 4s.

This is one of a series of monographs on physical subjects "intended to supply readers of average scientific attainment with a compact statement of the modern position in each subject." It is a pity that no indication is given of the qualifications of the authors to write such a book; Pidduck we know, but who is Sas? The subject is an important one because, as is mentioned in the introduction, many books on physics in the United States are now written in the m.k.s. system. The authors say that three lines of thought are involved in the discussion, viz., the inconvenience of the present three systems of units, the question whether B and H are of the same nature, and the question of rationalization. The title of the new system is somewhat misleading, for if it were merely a matter of using metres and kilogrammes instead of centimetres and grammes, the only change in any unit would be a power of ten. It is not merely a matter of replacing c.g.s. by m.k.s., but of replacing both c.g.s. (electrostatic) and c.g.s. (electromagnetic) by m.k.s. (what ?)

The authors are physicists rather than electrical engineers and an indication of the world in which they move is given by their statement that the microfarad has long been in use, and "now more often the millimicrofarad mμF = 10^{-9} F and the picofarad pF = 10^{-12} F." Section 5 of the book is headed "Tribulations of the Student" and we think it peculiarly appropriate. We read "dimensions in the electrostatic system are $m_{\frac{1}{2}}l^{\frac{3}{2}}t^{-1}$ and in the electromagnetic system $m^{\frac{1}{2}}l^{\frac{1}{2}}$." As charge had been mentioned several lines back it is presumably to charge that these dimensions refer, but the student will be mystified by the change from $m_{\frac{1}{2}}$ to $m^{\frac{1}{2}}$. Further on in this section it is stated that "the electrical intensity just outside a conductor is $4\pi\sigma S$" which, if S, as we suspect, signifies surface area, is certainly calculated to add to the tribulations of the student. What Section 7 on "Pulse and Aperture" has to do with the matter it is difficult to see. We are told that "electricians use f as little and ω as much as possible", a statement which we very much doubt, and that "the frequency is measured in cycles"; it is measured in cycles per second, even if the "per second" is often omitted in stating the frequency. They then make the almost incredible proposal to call the unit of ω a pulse (p) so that "50 c = 314 p." They are obviously quite unaware that the term pulsatance is obsolescent and has been banished from the British Standards Glossary. An alternating current of 50 cycles per second may perhaps be regarded as having 50 or 100 pulses per second; it certainly has not 314. Surely *angular frequency* is preferable in every way. In this same section they denote "the divergence of **u** by ∇**u** and the curl of **u** by $\triangle \times$ **u**." This change from ∇ to $\triangle$ is presumably a printer's error.

It is in Section 8 on Magnetostatics that the tribulations of the student will really begin. Instead of a unit pole being one that repels a similar pole 1 cm away with a force of 1 dyne, it is now one that repels a similar one 1 metre away *in vacuo* with a force of $1/4\pi\mu_0$ newtons where $\mu_0 = 4\pi/10^7 = 1.257 \times 10^{-6}$. The first question that will occur to any reader is whether this is the same unit pole differently defined or a new unit pole, and the reader is left to find out for himself. As a matter of fact, the strength of this new unit pole is about 8 million times that of the classical unit pole. The authors then perpetrate an inexcusable blunder for they take the ampere-turn per metre as the unit of magnetic intensity and call it an *oersted*. One cannot take a name that has been given by international agreement to a certain unit and give it to another unit. One can call a new unit of force a *newton* but certainly not a *dyne*. The statement that "the earth's horizontal component in England is about 15 Oe" is quite inexcusable. This section concludes with the statement that "since flex (*sic*) and pole strength are equal in the m.k.s. system, we can measure pole strength in Wb/m²." Wb stands for webers but webers per square metre is a measure of B and not of pole strength. There are several more sections dealing with resistance, electromagnetic induction, electrons and the quantum theory, and the book concludes with a list of formulae. In this list we notice "Tension in electromagnetic induction $U = -d\Phi/dt$ where Φ is the total magnetic flux." This strange use of the word tension occurs also in Section 12. We also have "Frequency of electric oscillations $\omega = 1/(LC)^{\frac{1}{2}}$ p," where p stands for pulse.

On p. 53 it is stated that "the unit of magnetic intensity is the *oersted* or $4\pi\mu_0$ times the magnetic intensity at a point 1 m from a unit pole" where μ_0 is the space permeability. Now it is difficult to see how the ratio between two different values of magnetic intensity can be anything but a mere number; it cannot involve the permeability of space. Correctly stated, the oersted, as misused by the authors, is simply $16\pi^2/10^7$ times the value of H 1 metre away from the m.k.s. unit pole *in vacuo* and not, be it specially noted, in a medium of unit permeability. In this rationalized m.k.s. system the permeability of a vacuum is $4\pi/10^7$.

Any student who is still an undergraduate and whose education has been based on the classical systems of units would be very ill advised to look inside this book, for it could lead to nothing but confusion. At a later stage he can please himself.

G. W. O. H.

Second Year Radio Technology

By W. H. Date, B.Sc., A.M.I.E.E. Pp. 222 x ix, 155 diagrams. Published by Longmans, Green & Co., Paternoster Row, London, E.C.4. Price 7s. 6d.

The author presupposes a knowledge of the basic principles of electric and magnetic circuits and covers elementary radio technology on this basis. Starting with capacitance, inductance and resonant circuits, he goes on to discuss radiation and valves in elementary terms. The use of valves as detectors, amplifiers and oscillators is then dealt with and the book concludes with chapters on direction finding, the superheterodyne and r.f. measuring instruments.

In any elementary book of this nature, the greatest difficulty confronting the author is to achieve accuracy and clarity. If extreme accuracy is aimed at statements are apt to be so hedged about by qualifying clauses that clarity suffers and, if clarity is made the target, there is a danger that the reader takes as of general application statements that are really only true in particular cases. The author succeeds fairly well in avoiding both extremes but in some cases there is danger of giving his readers false impressions.

When treating coupled resonant circuits he omits all reference to circuit resistance and he derives a formula for bandwidth based on the peak separation of resistanceless circuits. There is no indication that the peak separation is affected by resistance nor that, in practice, bandwidth is not usually measured by peak separation but by the difference of frequency between the two points on the resonance curve at which the response bears some definite relation—usually 3 db—to the response at the midband frequency.

In dealing with aerial coupling the author is guilty of several mis-statements of fact. With an inductively loaded aerial he says "If the circuit has a high Q factor the impedance offered to neighbouring unwanted frequencies will be high." In fact, the impedance away from resonance is nearly independent of Q, but the resonance impedance is lower the higher the Q. He should have said that by increasing the current at the resonance frequency the current at neighbouring frequencies is relatively reduced.

With a parallel tuning capacitor he says that the voltage across the coil is Q times the e.m.f. induced in the aerial. It is not; it is $\frac{C_a}{C+C_a}$ Q times where C_a and C are the aerial and tuning capacitances respectively.

When treating the circuit in which the aerial is connected to a coil coupled to the tuned circuit proper—the most widely used one in present-day receivers—the author makes some very surprising statements. He says "The effect of the capacitance of the aerial on the tuning circuit is obviated . . ."; "The resistance of the tuning circuit now consists of that of the coil L." He ignores completely the fact that the resistance and reactance of the aerial circuit are reflected into the tuned secondary in an amount dependent on the degree of coupling and that they affect the Q and the tuning of the circuit.

W. T. C.

CORRESPONDENCE

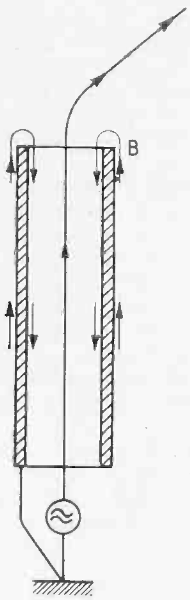
Letters of technical interest are always welcome. In publishing such communications the Editors do not necessarily endorse any technical or general statements which they may contain.

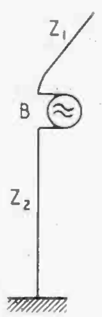
Partially-Screened Open Aerials

To the Editor " Wireless Engineer."

SIR,—I beg leave to query the fundamental concepts of the article on this subject by Mr. Burgess which appeared in your number of May last.

I believe it is essential to consider the two faces of the screening separately (always provided that the thickness of the screening is much greater than the depth of penetration corresponding to the working frequency) since the internal face forms, together with the central conductor, a balanced co-axial feeder; while the external face together with the prolongation of the aerial acts as the actual aerial, being fed from the co-axial feeder at the point B.





(Left.) *The two faces of the screening.*

(Right.) *Symbolic form of actual aerial.*

It is therefore evident that the screening also acts as a collector of the electric field if the aerial is used for reception.

If this exception be admitted, the calculations may be carried out as stated by Mr. Burgess in his article, and a first approximation may be obtained by comparing the various lengths to lines of differing impedance.

A. COLINO.

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Madrid.

Doppler Effect in Propagation.

To the Editor, " Wireless Engineer."

SIR,—In the article on the " Doppler Effect in Propagation," by Mr. H. V. Griffiths, in the June 1947, issue of *Wireless Engineer*, emphasis is laid on the difference between the classical values of the frequency shift according to whether the source is moving towards the observer or the observer towards the source. If, however, this difference were real it would be possible to distinguish states of absolute rest or motion by the measurement of the frequency shift. However the relativity principle states that this is impossible and that, quite generally, observations made in two frames of reference in uniform relative motion can only determine their *relative* velocity.

From the equations of special relativity giving the transformation from one frame of reference to another it is readily shown that the ratio of the observed frequency f_0 to the source frequency f_s when they are in uniform relative motion towards each other with velocity v is given by

$$\frac{f_0}{f_s} = \sqrt{\frac{c+v}{c-v}}$$

(See, e.g., J. H. Jeans " Electricity and Magnetism," 5th Edition, p. 609.) There is thus no question of motion of the source and observer relative to the " ether " but only of their motion relative to each other. In the case of sound waves the problem is different since the medium propagating the waves is in this case material and therefore the terms " rest " and " motion " can be given an absolute meaning.

The difference between the classical values of the frequency ratio (given by the author's equations 1 and 2) and the correct value given above is negligible in the radio problem discussed. However, it seemed worth while to raise the matter especially as several well-known text books on optics still give the classical values and discuss their difference as though it were real.

At the end of the article it is stated that $\Delta H/\Delta l$ is difficult to calculate whereas in fact from simple geometrical considerations it is seen to be equal to sec β which for the numerical examples given is equal to 3.5 in the two-hop case and 3.0 in the three-hop case; the values given by the author are rather low.

R. E. BURGESS.

National Physical Laboratory,
Teddington, Middx.

To the Editor, " Wireless Engineer."

SIR,—I was astonished to read in the article by H. V. Griffiths in the June issue that the Doppler effect gives observed frequencies which depend upon the *absolute* velocity of the source and observer, not just upon the relative velocity between them, a statement upon which the author laid particular stress. This statement recalls the age of classical physics when many experimenters tried to measure the absolute velocity of the earth in " ether." All experiments, notably those of Michelson and Morley, have proved the principle of the special theory of relativity that absolute motion has no meaning.

According to Griffiths, if the earth E were moving with a velocity v_E, a light-emitting star S with v_S (both v_E and v_S approaching along the line ES), then the frequency observed at the earth is

$$f = f_S \frac{c + v_E}{c - v_S}$$

Let $k = f_S/f$ = source freq./observed freq., then $k(c + v_E) = c - v_S$, and $v_S + kv_E = c(1 - k)$. Relative velocity of the star as observed from the earth $= v_E + v_S = (1 - k)(c + v_E)$.
(Applying the classical addition of velocities). This depends upon the absolute velocity of the earth in " ether."

The difficulty may be easily overcome by the application of the special theory of relativity, in particular the Lorentz transformation between coordinate systems moving relatively at a uniform velocity.

Let us have two coordinate systems, one C is fixed to the earth, and the other C' is fixed to the star. Let C move relative to C' at a velocity v in the X direction. The Z axis is taken perpendicular to the plane defined by the X axis and the line ES. The symbols f and f_S will be changed into f' and f to suit the new notation. The line ES makes an angle α with the X direction.

The phase of the light in system C is

$$\left(e^{2\pi jf}\left(t - \frac{X\cos\alpha + Y\sin\alpha}{c}\right)\right).$$

That in C' is $\left(e^{2\pi jf'}\left(t' - \frac{X'\cos\alpha' + Y'\sin\alpha'}{c}\right)\right)$. The phase should be invariant in both systems, hence

$$f\left(t - \frac{X\cos\alpha + Y\sin\alpha}{c}\right) = f'\left(t' - \frac{X'\cos\alpha' + Y'\sin\alpha'}{c}\right)$$

On applying the laws of transformation of X, Y, Z, t into X', Y', Z', t', we get

$$f' = f\frac{1 - \beta\cos\alpha}{\sqrt{1-\beta^2}} \qquad \text{where } \beta = \frac{v}{c}$$

$$\text{and } \tan\alpha' = \frac{\sin\alpha\sqrt{1-\beta^2}}{\cos\alpha - \beta}$$

When $\alpha = 0$ then $f' = f\sqrt{\frac{1-\beta}{1+\beta}}$ and $\alpha' = 0$

If $\beta \ll 1$ then $f' = f(1 - \beta)$, an approximation which coincides with both formulae given by Griffiths for speeds small compared with c, independent of any absolute motion. If $v = c$, $\beta = 1$ and f/f' = observed freq./source freq. $= \infty$, independent of any absolute motion, not once ∞ and once 2 according to which system is the one fixed in space.

If $\alpha = 90°$ (relative motion perpendicular to ES) then $f' = f\frac{1}{\sqrt{1-\beta^2}}$, and $\tan\alpha' = -\sqrt{\frac{1}{\beta^2} - 1}$.

Of course the relativity calculation of the Doppler effect was well known long ago.[1] I write this just to draw attention to the fact.

F. S. ATIYA.

Federal Institute of Technology,
Zürich.

[1] W. Pauli, Jun., "Relativitätstheorie."

To the Editor, "Wireless Engineer."

SIR,—The article by H. V. Griffiths[1] on the Doppler Effect on Propagation is of interest from two points of view, the application of the effect to a study of the movements of the reflecting layers, and its influence on the accuracy of comparing the frequencies of distant standards. From both points of view a complete record of frequency throughout the period of observation would be more useful than the average value. When this manifestation of the Doppler Effect was first noticed[2] it was found that the frequency of the received signal was steady for long periods but was subject to large variations for relatively short periods. From the nature of the observations it was decided that for the purpose of comparing the distant standards it was better to ignore the large variations, which could only be caused by rapid fluctuations in the conditions of propagation, and it was estimated that the result of the comparison was then accurate to $\pm$ 2 parts in 10^8. This could not be checked at the time because the frequency of the standard used was not known with the necessary accuracy, but was confirmed by a series of comparisons carried out in 1938. Mr. Griffiths does not give the results of his recent measurements in detail and it is therefore not possible to say whether some of the deviations could justifiably be neglected for the purpose of frequency comparison. It would be interesting to know if appreciable errors arise when the received signal gives steady uniform beats with the local standard, that is, if the reflecting layers move uniformly for long periods of time, or whether large movements are always associated with unsteady conditions of reception and a variable frequency as my earlier experiments suggested.

L. ESSEN.

National Physical Laboratory,
Teddington, Middx.

[1] H. V. Griffiths. "Doppler Effect in Propagation." *Wireless Engineer*, Vol. XXIV, p. 162, June 1947.

[2] L. Essen. "International Frequency Comparisons by Means of Standard Radio Frequency Emissions." *Proc. Roy. Soc.*, April, 1935, A.149, p. 506.

Permeability of Dust Cores

To the Editor, "Wireless Engineer."

SIR,—One or two remarks in Dr. Friedlaender's letter in your June issue seem to call for a reply and I would offer the following comments :—

(1) It was not explicitly stated in my letter (February, 1947) that slabs of dimension ratio, 10 : 2 : 1 had been observed, but that permeability curves based on these dimensions gave an approximately true picture of the behaviour of the higher permeability cores. Some particles that have been examined do approach these relative dimensions, but it will of course be appreciated that some of the flattening in such cases might have occurred prior to pressing. In most cases the ratio is smaller.

(2) There are many factors, including those mentioned by Dr. Friedlaender, which contribute to the value of effective permeability of a dust core. Particles in alloy cores are often of irregular outline and a rigid mathematical treatment is hardly practicable. The case in which some of the insulation becomes trapped without seriously impeding the flux was catered for to some extent in my curve (2) for truncated cubic particles.

(3) My permeability figures for alloy powder cores, pressed with no insulation are almost certainly of the right order since they were obtained with commercial powders and separate cross-checks on the a.c. and d.c. methods of measurement were carried out. The fact that the permeability of such cores is not the same as the permeability of the metal was implied in my quoting the two values of 1000 and 3000 for cores with considerable air-spaces and with few air-spaces respectively.

P. R. BARDELL.

G.E.C. Research Laboratories,
Wembley.

WIRELESS PATENTS

A Summary of Recently Accepted Specifications

The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

AERIALS AND AERIAL SYSTEMS

582 328.—Waveguide with a slotted end-wall which serves as a dipole to radiate a beam of energy.

The British Thomson-Houston Co. (communicated by the General Electric Co.). Application date 2nd November, 1943.

DIRECTIONAL AND NAVIGATIONAL SYSTEMS

581 201.—Frequency-indicating device, particularly for radiolocation, wherein the signal is passed through two electrical paths which introduce a frequency, phase, or amplitude distortion the sum and difference of which are applied in quadrature to a c.r. oscilloscope.

Standard Telephones and Cables Ltd. and C. W. Earp. Application date 21st April, 1942.

581 561.—Pulse-generating circuit, with means for rapidly damping the oscillations to facilitate close-range observations in radiolocation.

A. D. Blumlein and E. L. C. White. Application dates 17th June, 1940, and 23rd January, 1941.

581 568.—Radiolocation equipment of the "triggered" or i.f.f. type in which a variable delay is introduced before re-transmission, to baffle unauthorized receivers.

Standard Telephones and Cables Ltd. and B. B. Jacobsen. Application date 14th November, 1941.

581 570.—Rotating compass beacon in which two overlapping beams form an equi-signal line, along which a masking signal becomes zero and a bearing signal is heard.

W. A. S. Butement and L. H. Bedford. Application date 28th January, 1944.

581 602.—Navigational system in which a given course is steered by maintaining a constant time-interval between the pulsed signals received from two or more spaced transmitters.

R. J. Dippy. Application date 23rd December, 1942.

581 603.—Control and synchronization of master and satellite stations radiating pulsed signals which form a navigational lattice in space.

R. J. Dippy. Application date 23rd December, 1942.

581 920.—Radiolocation system utilizing a modulated carrier-wave and two or more spaced pick-up devices feeding a cathode-ray indicator.

A. D. Blumlein and L. C. White. Application date 20th July and 3rd November, 1939.

581 980.—Radiolocation equipment to facilitate the rapid alignment of a searchlight projector on a moving target.

J. D. Cockcroft, D. R. Chick, W. S. Eastwood and A. J. H. Oxford. Application date 11th December, 1942.

581 982.—Radiolocation apparatus in which a super-regenerative oscillator serves both as a transmitter and receiver, the quenching-frequency indicating the echo-time of the exploring signal.

A. C. Cossor, Ltd. and F. R. W. Strafford. Application date 30th December, 1942.

581 989.—Radiolocation apparatus in which a "gate" switch operated at the pulsing frequency serves to prevent jamming of the set by c.w. waves.

J. D. Cockcroft and A. J. H. Oxford. Application date 17th September, 1943.

581 996.—Radiolocation apparatus in which a periodic control-voltage allows the echo-signals from a selected target to be distinguished from other echo-signals.

J. D. Cockcroft, D. R. Chick, W. S. Eastwood and A. J. H. Oxford. Application date 11th December, 1942.

581 998.—Radiolocation aerial-system comprising four units grouped around a common axis and a common coupling-ring for constantly rotating the lobe of maximum directivity.

J. D. Cockcroft, D. R. Chick, W. S. Eastwood and A. J. H. Oxford. Application date 11th December, 1942.

582 171.—Radiolocation equipment for indicating to each of a pair of pursuit craft which of the two is nearer to a common target or pursued craft.

Standard Telephones and Cables, Ltd., P. K. Chatterjea and L. W. Houghton. Application date 17th July, 1942.

582 325.—Radiolocation system in which the echo-signals are received by three different aerial systems to give coordinated indications of the distance, bearing, and elevation of the reflecting body or target.

J. D. Cockcroft and P. E. Pollard. Application date 24th March, 1942.

582 360.—Impulse-generator for controlling the fly-back stroke of the cathode-ray indicator in radiolocation equipment.

Marconi's W.T. Co., Ltd., R. J. Kemp and D. J. Fewings. Application date 28th May, 1940.

582 403.—Radiolocation indicator in which the time-base makes several sweeps between successive pulses in order to provide an open zigzag scale.

Marconi's W.T. Co., Ltd., R. J. Kemp and D. J. Fewings. Application date 28th May, 1940.

582 419.—Radiolocation equipment, particularly for following the movement of surface craft at sea, the range being shown against a spiral time-base on one c.r. tube, and the bearing on a linear time-base on a separate tube.

J. D. Cockcroft, J. Ashhead, E. Coop, A. E. Kempton, P. G. Forsyth and B. Newsam. Application date 30th June, 1943.

582 434.—Generating pulses, say for radiolocation, by means of a self-blocking oscillator valve, and an associated column of liquid of variable length, backed by a pair of piezoelectric crystals.

Scophony, Ltd. and A. F. H. Thomson. Application date 15th May, 1944.

582 466.—Overlapping-beam approach-path and blind-landing system, in which provision is also made for a one-way telephone channel between ground and air.
Standard Telephones and Cables, Ltd. and H. P. Williams. Application date 16th May, 1944.

582 493.—Radiolocation equipment, particularly for detecting ships and low-flying aircraft, in which the direction of exploration is constantly varied over a given angle.
J. D. Cockcroft, J. Ashmead, W. S. Eastwood, A. J. H. Oxford, A. F. H. Thomson and W. A. S. Butement. Application date 4th December, 1942.

582 503.—Radiolocation apparatus in which a variable-range strobing voltage is applied to search-out and isolate a selected echo-signal from other interfering signals: applicable to aircraft-interception.
F. C. Williams, E. L. C. White and D. Blumlein (legal representative of A. D. Blumlein). Applica-date 15th October, 1943.

582 708.—Radiolocation system of the variable-frequency type in which the beat-frequency, normally produced is converted into a pure sine wave.
Standard Telephones and Cables, Ltd. and C. W. Earp. Application date 3rd April, 1942.

582 755.—Radio beacon comprising a pair of non-directional aerials, mounted on a common rotating base, and energized through phase-shifting and switching circuits.
Soc. Anon des Industries Radio-Electriques S.A.D.I.R. Convention date (France), 29th May, 1941.

582 768.—Mechanical and electronic switching devices for a waveguide feeding, say, several aerials in succession, as in radiolocation.
Marconi W.T. Co., Ltd. (assignees of W. D. Hershberger). Convention date (U.S.A.) 25th February, 1943.

582 850.—Pulse-generating circuit, say for radiolocation, in which a modulating voltage is applied by discharging a capacitance storage network through triggered spark-gaps.
The British Thomson-Houston Co., Ltd. (communicated by the General Electric Co.). Application date, 8th November, 1943.

RECEIVING CIRCUITS AND APPARATUS

581 913.—Super-regenerative circuit, with a variable quenching-control, particularly for receiving television or pulse-modulated signals.
The British Thomson-Houston Co., Ltd. Convention date (U.S.A.) 3rd February, 1943.

581 976.—Mixing circuit for a superheterodyne receiver in which a crystal rectifier is coupled to a waveguide through coaxial-line elements.
E. C. Cork, M. Bowman-Manifold, F. H. Gale and R. Blythen. Application date 1st September, 1942.

582 127.—Tuning arrangement for a receiver of the "panoramic" type where the whole of a selected wave-band is scanned, the signals being recorded against the time-base of a c.r. tube.
H. Whalley, C. W. Miller and Metropolitan-Vickers Electrical Co., Ltd. Application date 8th September, 1941.

582 128.—Switch-tuning for a multi-waveband receiver of the "panoramic" type.
J. M. Dodds and Metropolitan-Vickers Electrical Co., Ltd. Application date 8th September, 1941.

582 131.—Tuning arrangement for a multi-waveband receiver of the "panoramic" type.
G. J. Scoles, H. Whalley and Metropolitan-Vickers Electrical Co. Ltd. Application date 8th November, 1941.

582 617.—Means for reducing "shot noise" in an electronic resonator, used say as a velocity-modulation mixer in a superheterodyne receiver.
W. S. Percival. Application date 25th July, 1941.

TRANSMITTING CIRCUITS AND APPARATUS

581 984.—Concentric line impedance transformer in which the effective length of a right-angled stub is controlled by a sliding piston.
Sperry Gyroscope Inc. (assignees of W. W. Hansen and J. R. Woodyard). Convention date (U.S.A.) 17th May, 1941.

582 088.—Means for neutralizing the undesired secondary waves that are generated at a bend or angle in a wave-guide.
E. C. Cork and M. Bowman-Manifold. Application date 14th August, 1942.

582 585.—Automatic tuning-control for a radio-transmitter wherein a tuning reactance is regulated, through a motor, by the phase-difference between input and output voltages.
Marconi's W. T. Co. Ltd. (assignees of O. B. Cunningham, H. Sussman and S. Gubin). Convention date (U.S.A.) 29th March, 1943.

582 757.—The use of localized plates and like impedance-varying elements to prevent undesired reflection-effects when energy flows through a waveguide containing sections with different dielectric-constants.
The British Thomson-Houston Co. Ltd. Convention date (U.S.A.) 16th April, 1942.

582 766.—Intercommunication set comprising a super-regenerative detector which serves (a) to receive frequency or amplitude modulated signals and (b) to generate a carrier-wave for f.m. outgoing signals.
Marconi's W. T. Co. Ltd. (assignees of M. G. Crosby). Convention date (U.S.A.) 15th February, 1943.

582 795.—Transmitter circuit in which the anode-cathode paths of two valves are in series resonance with a crystal driver, one of the valves serving as an amplifier, modulator, and start-stop switch.
D. L. Hings. Application date 23rd July, 1942.

SIGNALLING SYSTEMS OF DISTINCTIYE TYPE

582 100.—System for translating amplitude-modulated signals into equivalent time-modulated pulses.
Standard Telephones and Cables Ltd. (assignees of D. D. Greig). Convention date (U.S.A.) 30th April, 1943.

582 146.—Triggered pentode oscillator-circuit for generating trains of pulses of constant amplitude throughout each repetition-period.
Standard Telephones and Cables Ltd. (assignees of L. A. de Rosa). Convention date (U.S.A.) 30th November, 1942.

582 709.—System of pulsed signalling wherein secrecy is secured by the use of an amplitude-modulated masking-wave, which is removed at the receiving end (addition to 580 843).

Standard Telephones and Cables Ltd., P. K. Chatterjea and L. W. Houghton. Application date 23rd October, 1942.

582 798.—Secret signalling system in which a carrier-wave is frequency-modulated both by the desired signal and by a distorting wave, the latter being removed at the receiving end.

The British Thomson-Houston Co. Ltd. (communicated by the General Electric Co.). Application date 25th November, 1943.

CONSTRUCTION OF ELECTRONIC-DISCHARGE DEVICES

581 895.—Reflecting electrode for a rhumbatron resonator adapted to accommodate a wide variation of the biasing potential.

A. F. Pearce. Application date 16th December, 1941.

582 021.—Reducing interelectrode capacitance in short-wave amplifiers of the kind in which the grid and anode leads consist of disks extending through the glass bulb.

Standard Telephones and Cables Ltd. (assignees of P. G. Chevigny). Convention date (U.S.A.) 24th December, 1942.

582 162.—Cathode construction designed to reduce the electron transit-time in a short-wave valve.

The M-O Valve Co. Ltd. and G. W. Warren. Application date 13th March, 1940.

582 171.—Oscillation-generator of the velocity-modulation type comprising a variable-mu control grid to facilitate tuning adjustment.

Standard Telephones and Cables Ltd. and R. G. Roach. Application date 8th May, 1942.

582 222.—Short-wave oscillator valve in which the coupled circuits consist of telescopic transmission-line elements mounted on a common axis.

The British Thomson-Houston Co. Ltd. (communicated by the General Electric Co.). Application date 25th May, 1944.

582 318.—Short-wave oscillator-unit comprising a valve mounted inside a pair of inter-coupled transmission-line elements.

Standard Telephones and Cables Ltd. (communicated by International Standard Electric Corporation). Application date 21st September, 1944.

582 484.—Velocity-modulation tube in which the rims of the resonator-elements are " chiselled " to minimize the effect of secondary emission.

The British Thomason-Houston Co. Ltd. and C. J. Milner. Application date 29th October, 1941.

582 487.—Velocity-modulation devices in which the tuning of the resonator elements is controlled by a differential screw mechanism.

The British Thomson-Houston Co. Ltd. and W. J. Scott. Application date 22nd December, 1941.

582 618.—Construction and arrangement of the filament and grid wires, to minimize " hum " in a valve intended to be driven from an a.c. source.

Standard Telephones and Cables Ltd. and A. J. Maddock. Application date 26th July, 1941.

582 935.—Construction and arrangement of the resonant cavities in an oscillation-generator utilizing velocity-modulation.

Standard Telephones and Cables Ltd., J. H. Fremlin and J. Foster. Application date 19th September, 1941.

582 936.—Resonant-cavity device, particularly for generating ultra-high frequencies, consisting of a stack of apertured plates (divided out of 582 935).

Standard Telephones and Cables Ltd., J. H. Fremlin and J. Foster. Application date 19th September, 1941.

583 024.—Preventing electronic damping effects in velocity-modulation and other electron-beam devices.

Standard Telephones and Cables Ltd. and S. G. Tomlin. Application date 2nd May, 1941.

583 041.—Construction and sealing of electron discharge devices and spark-gaps, where the envelope is made of ceramic material.

The British Thomson-Houston Co. Ltd. and H. de B. Knight. Application date 10th November, 1943.

583 180.—Screw-type tuning adjustment for the cavity-resonator of an electron-discharge device of the velocity-modulation type.

Standard Telephones and Cables Ltd., J. H. Fremlin and S. G. Tomlin. Application date 6th December, 1943.

583 213.—Construction and spacing of the electrode system of a Klystron oscillation-generator, designed to combine easy starting with high operating efficiency.

Standard Telephones and Cables Ltd. and J. H. Fremlin. Application date 12th December, 1941.

583 214.—Electrode construction and arrangement for a discharge device of the velocity-modulating type, particularly where only one cavity-resonator is used.

Standard Telephones and Cables Ltd., J. H. Fremlin and C. Strachey. Application date 12th December, 1941.

584 051.—Construction and arrangement of wire-gauze radiating members forming part of the cooling system of a transmitting valve.

Standard Telephones and Cables Ltd. and A. S. Wade. Application date 23rd November, 1944.

SUBSIDIARY APPARATUS AND MATERIALS

582 018.—Phase-reversing amplifier for obtaining a variable output proportional to the difference between two variable potentials, applicable to calculating-apparatus.

A. C. Cossor Ltd. and L. Jofeh, Application date 12th May, 1944.

583 246.—Frequency-changer stages, with coupling networks, for analyzing a complex wave or for calibrating a wide range of frequencies.

Standard Telephones and Cables Ltd. and C. T. Daly. Application date 14th July, 1944.

583 553.—Pentode valve circuit including a regenerative diode switch on the control-grid for developing a square-shaped wave-form at predetermined times.

F. C. Williams. Application date 2nd October, 1944.

ABSTRACTS AND REFERENCES

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

The abstracts are classified in accordance with the Universal Decimal Classification. They are arranged within broad subject sections in the order of the U.D.C. numbers, except that notices of book reviews are placed at the ends of the sections. The abbreviations of the titles of journals are taken from the World List of Scientific Periodicals. Titles that do not appear in this List are abbreviated in a style conforming to the World List practice.

ACOUSTICS AND AUDIO FREQUENCIES

5 : 534 2306

References to Contemporary Papers on Acoustics.—A. Taber Jones. (*J. acoust. Soc. Amer.*, Jan. 1947, Vol. 19, No. 1, pp. 263–277.)

4 2307

Program of the Thirty-Second Meeting of the Acoustical Society of America.—(*J. acoust. Soc. Amer.*, Jan. 1947, Vol. 19, No. 1, pp. 283–293.) Brief summaries are given of papers read. These include: The Propagation of Underwater Sound at Low Frequencies as a Function of the Acoustic Properties of the Bottom, by J. M. Ide, R. F. Post & W. J. Fry. Measurement Conditions influencing the Front-to-Back Discrimination of an Underwater Hydrophone, by L. N. Miller. An Acoustic Lens for Underwater Sound, by R. Herr. Ultrasonic Lenses and Transmission Plates, by P. J. Ernst. Surface Reflection of Short Ultrasonic Pulses in the Ocean, by R. J. Urick & H. L. Saxton. Reflection of Sound from the Sea Surface, by L. N. Liebermann. Reflection of Sound from Rough Surfaces, by P. G. Bergmann. Supersonic Radar Trainers, by C. E. Hunter, Jr. Attenuation of Sound in Water, by A. Wilson & L. N. Liebermann. Convex Wood Splays for Broadcast and Motion Picture Studios, by M. Rettinger. Disk Recording Studio Acoustics, by . Y. Dunbar & L. Green, Jr. Review of Criteria for Studio Design, by G. M. Nixon & H. M. Gurin. A System for Reducing Scratch in Record Reproduction, by R. W. Carlisle. A Method of Reducing Amplitude Distortion in Engraving Lateral Electrical Transcriptions, by C. E. Harrison. On the Absolute Calibration of Phonograph Test Records by means of Light Patterns, by W. Wathen-Dunn. Some Factors influencing the Choice of a Medium for Magnetic Recording, by L. C. Holmes. Design Problems on Magnetic Recording Equipment, by S. J. Begun. Some Physical Aspects of Magnetic Recording, by O. Kornei. Wow Meter, by W. W. Hansen. Master Wire Recorder, by J. S. Boyers & R. E. Zenner. Mechano-Electronic Transducer, by H. F. Olson.

534.133 — 621.396.611.21.016.2 2308

High Intensity Ultrasonics: The Power Output of a Piezoelectric Quartz Crystal.—Epstein, Andersen & Harden. (*See* 2442.)

534.22 2309

Wavelength of Sound.—B. W. Henvis. (*Electronics*, March 1947, Vol. 20, No. 3, pp. 134, 136.) A table of the velocity of sound in various solids, liquids and gases, with an abac from which the wavelength can be found for any frequency from 10 c/s to 100 Mc/s.

534.24 : 551.510.52 2310

Sound Echoes from the Atmosphere.—(*Bell Lab. Rec.*, Feb. 1947, Vol. 25, No. 2, pp. 75–77.) For a more detailed account of sodar see 330 of February.

534.321.9.001.8 2311

Ultrasonics, a New Tool.—(*Electronics*, March 1947, Vol. 20, No. 3, pp. 100..104.) A short account of the application of supersonic methods to problems of emulsification, catalysis, chemical reactions, gels, degassing of liquids, physiology and homogenizing processes.

534.321.9.001.8 2312

Ultrasonic Garage-Door Opener.—B. A. Andrews. (*Electronics*, March 1947, Vol. 20, No. 3, pp. 116–118.) Uses a 25-kc/s vacuum-type whistle on the car and a 5-valve amplifier, with limiter and discriminator, to operate a relay in the circuit of the motor operating the door.

534.846 2313

Room Acoustics.—A. Moles. (*Radio franç.*, 1947, No. 4, pp. 13–22.) A compromise is usually necessary between reverberation time, power and speech intelligibility. The elimination of interferences can often be achieved by tests carried out on scale models, and by the judicious use of absorbing or scattering materials.

534.862.1 **2314**
Design of Recording Studios for Speech and Music.—G. M. Nixon & J. Volkmann. (*Tele-Tech*, Feb. 1947, Vol. 6, No. 2, pp. 37–39.) Description of a N.B.C. studio designed to obtain a diffuse sound field, thus reducing the importance of reverberation time.

534.862.4 **2315**
Perfect v. Pleasing Reproduction — Discussion.—G. F. Redgrave : F. Slater : B. C. Sewell : F. Duerden : J. Moir. (*Electronic Engng*, April 1947, Vol. 19, No. 230, pp. 115–116.) Comments on 1185 of April and a reply by the author.

534.88 **2316**
Submarine Detection by Sonar.—A. C. Keller. (*Bell Lab. Rec.*, Feb. 1947, Vol. 25, No. 2, pp. 55–60.)

621.395.623.7 **2317**
The Distribution of Acoustic Power.—L. Chrétien. (*T.S.F. pour Tous*, March–May 1947, Vol. 23, Nos. 221–223, pp. 55–59, 70–74 & 97–99.) A discussion of (*a*) voltage and power amplification using triodes, tetrodes or pentodes, (*b*) output transformer characteristics and matching of loudspeaker impedance for optimum performance, and (*c*) simple measurements on transformers and loudspeakers. To be continued.

621.395.623.73 **2318**
High Efficiency Loud Speaker.—(*Tele-Tech*, Feb. 1947, Vol. 6, No. 2, pp. 63, 131.) A 15-W unit for naval use, shock and blast proof and undamaged by deep submersion.

621.395.625.3 **2319**
Wire Recording. A Review of Recent Developments and Applications.—(*Electrician*, 11th April 1947, Vol. 138, No. 3591, pp. 935–936.) Summary of a lecture on " Developments in Magnetic Recording " given by P. T. Hobson to the British Sound Recording Association.

621.395.625.3 **2320**
Magnetophon Recorders.—(*Wireless World*, April 1947, Vol. 53, No. 4, p. 128.) A description of processes involved in manufacturing the tape. Extracted from a British Intelligence Objectives Sub-Committee report. For other abstracts on the magnetophon see 2463 of 1946 and back references.

621.395.625.3 **2321**
New Magnetic Recorder.—(*Wireless World*, March 1947, Vol. 53, No. 3, p. 88.) Another account of the instrument described in *Tele-Tech*, Jan. 1947, Vol. 6, No. 1, pp. 88–89 and 1832 of June.

621.395.625.6 **2322**
Magnetic Sound for Amateur Movies.—(*Electronics*, March 1947, Vol. 20, No. 3, pp. 140, 158.) A fine-grain magnetic coating along one or both edges of the film is unaffected by photographic solutions. The same head is used for recording and reproducing ; it is pressed by a spring against the film while the film rides on a flywheel stabilizer.

AERIALS AND TRANSMISSION LINES

621.315[.211.2+.22 **2323**
Mineral-Insulated Metal-Sheathed Conductors.—F. W. Tomlinson & H. M. Wright. (*J. Instn elect. Engrs*, Part II, Feb. 1947, Vol. 94, No. 37, pp. 84–91.) Discussion on 12 of January.

621.315.687 **2324**
Cable Terminations.—D. B. Irving. (*J. Instn elect. Engrs*, Part II, Feb. 1947, Vol. 94, No. 37, p. 91.) Discussion on 3360 of 1945.

621.392.029.64 + 537.291 **2325**
Generalization of Certain Results relative to the Interaction of Progressive Guided Waves and an Electronic Beam.—P. Lapostolle. (*C. R. Acad. Sci., Paris*, 17th March 1947, Vol. 224, No. 11, pp. 814–816.) Results have previously been given for waves having symmetry of order zero in a guide without loss (1999 and 2003 of July). These are extended to symmetry of order n and to guides with loss.

621.392.029.64 **2326**
On the Theory of Excitation of Waveguides.—G. V. Kisun'ko. (*Bull. Acad. Sci. U.R.S.S., sér. phys.*, 1946, Vol. 10, No. 2, pp. 217–224. In Russian.) Calculations of the electromagnetic field in a waveguide are usually based on various simplifying assumptions with regard to the form and distribution of the exciting conductors, distribution of currents in such conductors, shape of the cross-section of the waveguide, etc. The problem is here considered more generally and the field is determined in an ideally conducting cylindrical waveguide of any arbitrary cross-section when the currents in the exciting conductors can be represented by any arbitrary function of coordinates and time. The cases of (*a*) an infinitely long waveguide and (*b*) a waveguide closed at one end by a conducting wall, are considered separately.

621.392.029.64 : 534.1 **2327**
The Interaction of Oscillating Systems with Distributed Parameters.—Krasnooshkin. (*See* 2386.)

621.392.029.64.018.14+621.392.029.64.091 **2328**
Attenuation and Q Factors in Wave Guides.—A. G. Clavier. (*Elect. Commun.*, Dec. 1946, Vol. 23, No. 4, pp. 436–444.) A theoretical paper which introduces the concepts of attenuation per unit length and Q factor as applied to a coaxial line. The argument is generalized to cover the relation between the " attenuation per unit length for each wave structure propagated at a definite velocity in a wave guide, and . . . [the] Q factor for a section of guide used as a resonant cavity." For earlier work see 1177 of 1943.

621.392.3 : 621.317.382.08 **2329**
R.F. Generator Load.—Leslie. (*See* 2493.)

621.392.43 : 621.396[.397].62 **2330**
Transmission Line Systems for F.M. and Television Home Receivers.—C. Spear. (*Radio News*, Feb. 1947, Vol. 37, No. 2, pp. 44–46 . . 140.) Matching methods for various aerials.

621.396.67 **2331**
Recent Developments of the Theory of the Aerial : Part 1.—É. Roubine. (*Rev. tech. Comp. franç. Thomson-Houston*, Dec. 1946, No. 6, pp. 5–25.) A presentation, in as elementary a manner as possible, of recent attempts to solve the aerial problem. See also 2012 of July and 2332 below.

621.396.67 **2332**
Recent Theories of the Aerial : Part 3.—É. Roubine. (*Onde élect.*, March 1947, Vol. 27, No. 240, pp. 104–118.) An outline of the theory of

Schelkunoff, discussing the 'interior' and 'exterior' solutions, their combination on the Σ sphere, formulae for the current distribution and input impedance and also aerials of arbitrary section. The elements of Hallén's theory are presented. For parts 1 & 2 see 2012 of July. To be continued.

621.396.67 2333

Concerning Hallén's Integral Equation for Cylindrical Antennas.—S. A. Schelkunoff. (*Proc. Inst. Radio Engrs, W. & E.*, March 1947, Vol. 35, No. 3, pp. 282–283.) Discussion of 851 of 1946. S. Hershfield compares the experimental results of D. D. King (3684 of 1946) and of Brown & Woodward (2207 of 1945) with results calculated from the formulae of R. King & D. Middleton (2141 of 1946) and those of Schelkunoff. R. King, in reply, points out the difficulties of making any such comparison without more precise knowledge of the apparatus and methods used in obtaining the experimental results.

21.396.67 2334

Square Loops for Frequency-Modulated Broadcasting at 88-108 Megacycles.—R. F. Lewis. (*Elect. Commun.*, Dec. 1946, Vol. 23, No. 4, pp. 415–425.) practical version of one of the aerial systems escribed in 1180 of 1946 (Kandoian). The installation of the system is discussed. Its advantages clude (*a*) horizontal polar diagram circular to db, (*b*) low overall impedance, (*c*) gain increase by tacking', (*d*) ease of construction.

1.396.671 : 538.3 2335

Physical Interpretation of Electromagnetic Radiation from an Antenna.—R. W. P. King. (*Phys. Rev.*, 15th Jan. 1947, Vol. 71, No. 2, p. 134.) mmary of Amer. Phys. Soc. paper. A discussion the conclusions which follow from the erroneous sumptions that the axial distribution of current a cylindrical aerial is sinusoidal and that the ynting vector is a true measure of the direction d magnitude of 'energy flow' at every point in ace.

.396.677 2336

An Inexpensive 4-Element Array.—V. C. Hale. *dio News*, Feb. 1947, Vol. 37, No. 2, pp. 47 . . 82.) structional details of a high-gain beam.

.396.677 2337

On the Theory of Directional Radiation with abolic Reflectors.—F. Lüdi. (*Helv. phys. Acta*, Sept. 1944, Vol. 17, No. 5, pp. 374–388. In man.) Using Kirchhoff's diffraction formula the ation patterns in the vertical and horizontal nes are derived when the focus is in the plane he aperture. The field intensity gain is found e $8R/3\lambda$, R being the aperture radius, compared n $2.85\ R/\lambda$ given by Darbord's theory (1932 tracts, p. 346). Comparison is made with the and the saw-tooth aerial; the latter simple em of wires gives the same performance as a or.

396.67 2338

ntennae — An Introduction to Their Theory. k Review]—J. Aharoni. Oxford University s, 265 pp., 25s. (*Wireless Engr*, April 1947, 24, No. 283, p. 122.) The treatment throughout ased on the work of Hallén, Ryder, King, ison, Gray and Schelkunoff. A considerable vledge of mathematics is assumed, especially of r algebra.

CIRCUITS AND CIRCUIT ELEMENTS

538.3 : 621.396.694 2339

On the Helix Circuit used in the Progressive Wave Valve.—É. Roubine. (*C. R. Acad. Sci., Paris*, 14th April 1947, Vol. 224, No. 15, pp. 1101–1102.) An explicit formula, involving the modified Bessel function of the second kind of zero order, is given for the axial component (E_z) of the electric field. The formula shows that the field is propagated axially with the reduced velocity $v \sin \alpha$, where v is the velocity of electromagnetic waves in free space and α is the angle of the helix. The amplitude of E_z has a maximum value for a certain frequency and a particular value of α See also 2340 below.

538.3 : 621.396.694 2340

On the Helix Circuit used in the Progressive Wave Valve.—É. Roubine. (*C. R. Acad. Sci., Paris*, 21st April 1947, Vol. 224, No. 16, pp. 1149–1151.) Replacing the helix by a uniform current distribution on the surface of the cylinder on which the helix is traced, a solution is obtained for the equivalent transmission line, with simple formulae for the power transported, the characteristic impedance and the distributed inductance and capacitance. See also 2339 above.

549.514.51 : 534.133] + 621.396.611.21.012.8 2341

Calculation of the Equivalent Constants of a Quartz Plate in Plane Shear Vibration (Type CT, DT).—G. Dumesnil. (*Onde élect.*, Feb. 1947, Vol. 27, No. 239, pp. 42–44.) The equivalent circuits for bars in longitudinal vibration and plates in thickness shear are well known. For a plate in plane shear an expression is found for the equivalent impedance similar to that for thickness vibrations, so that, whatever the frequency, the plate can be treated as a line with distributed constants. Near the resonance frequency the impedance can be considered as a self-inductance L in series with a capacitance. L depends only on the thickness and is proportional to it. Calculated values of L for CT and DT cuts are in good agreement with experimental values.

621.314.2 : 621.392.52 2342

The Design of Tuned Transformers.—F. G. Clifford. (*Electronic Engng*, March & April 1947, Vol. 19, Nos. 229 & 230, pp. 83–90 & 117–123.) Three methods are discussed which have proved particularly useful. These are (*a*) to transform the circuit until it has the same configuration as a ladder filter of which the design data are known, (*b*) to evolve design data from a consideration of the impedances presented by one pair of terminals when the other pair is (i) open-circuited and (ii) short-circuited, (*c*) to apply Bartlett's bisection theorem and thereby determine the equivalent symmetrical lattice network for which the design data may be found simply. The last method is a simplification of method (*b*) but is applicable only to tuned transformers which are equivalent to a symmetrical T- or π- section. Examples of the applications of these three methods are given. Design data and characteristics of a number of useful types of low-pass, high-pass and band-pass transformers are tabulated.

621.314.23.042.14.017.31 2343

An Approximate Theory of Eddy-Current Loss in Transformer Cores excited by Sine Wave or by

Random Noise.—D. Middleton. (*Proc. Inst. Radio Engrs, W. & E.*, March 1947, Vol. 35, No. 3, pp. 270–281.) The field equations governing the distribution of electric and magnetic fields in thin rectangular laminae are solved with certain approximations. Curves and formulae are thereby obtained showing the variation in the skin depth and mean eddy current loss with variation in frequency and lamination thickness for both current and voltage-fed transformers.

621.316.86 2344

On the Mechanism of Voltage-Dependent Resistors.—A. Braun & G. Busch. (*Helv. phys. Acta*, 24th Oct. 1942, Vol. 15, No. 6, pp. 571–612. In German.) Two effects are important in explaining the nonlinear current-voltage characteristic and the hysteresis loop of granular carborundum: (*a*) passage of electrons through impurity layers to positions of higher electric field strength and (*b*) temperature dependence of the conductivity of the impurity layers. These effects are confirmed by experiment and serve as a basis for a theory of the characteristic.

621.317.755.087.35 : 578.088.7 2345

A New 4-Way or 6-Way Electronic Commutator.—M. Bladier. (*Radio en France*, 1947, No. 3, pp. 8–14.) Describes, with circuit diagram, a device enabling four (or six) electrical effects to be observed simultaneously on a single c.r.o. The device has proved useful in electro-encephalography.

621.318.572 : 621.317.761 2346

A Pulse Counter Circuit and Its Adaptation as a Frequency Meter.—R. Lemas. (*Télévis. franç.*, March 1947, No. 23, Supplement *Électronique*, pp. 4–5, 17.) The pulses, of any shape or amplitude, are used to derive a series of pulses of the same recurrence frequency and of uniform shape and amplitude. This is done by means of a capacitor connected to the anode of a thyratron and charged from a constant voltage d.c. source through a suitable resistance. Each pulse triggers the thyratron and thus causes partial discharge of the capacitor through a milliammeter in the thyratron cathode lead. The milliammeter has a highly damped movement, and integrates these partial discharges; its deflection is directly proportional to the pulse recurrence frequency. Methods are given for calculating the capacitance for various frequency ranges and also an appropriate value for the resistor. A complete circuit diagram is given for a 3-range instrument for pulse recurrence frequencies up to 100, 1 000 and 10 000 per sec respectively, the ranges being determined by the capacitor in use. With a relatively high value of the time constant of the charging circuit, the linear relation between milliammeter deflection and pulse recurrence frequency no longer holds. Such an arrangement has certain advantages, since it tends to keep the percentage error of frequency measurement constant.

For frequency measurement of sine waves, rectangular waves are derived and used to produce a series of positive and negative pulses, which are applied to the counter circuit. This only responds to the positive pulses and hence registers the correct sine-wave frequency. Practical circuit details are given.

621.319.4 : 621.315.59 : 621.315.616.92 2347

The Effect of Semiconducting Liquids on the Dielectric Properties of Cellulose Insulation.—Clark. (*See* 2458.)

621.392.52.015.33 2348

Transient Response of Filters.—E. T. Emms. (*Wireless Engr*, April 1947, Vol. 24, No. 283, pp. 126–127.) Reply to the letters of Belevitch and Thomson (2035 of July) agreeing with their conclusions. See also 662 of March and back references.

621.394/.397].645 2349

Cathode-Follower Circuit using Screen-Grid Valves.—E.M.I. Laboratories. (*Electronic Engng*, March 1947, Vol. 19, No. 229, p. 97.) A description of a circuit arrangement using a screen-grid valve as a cathode-follower repeater, with reduced loss of signal transfer.

621.395.623 : 578.088.7 2350

A Simplified Encephalophone.—M. Conrad & B. L. Pacella. (*Science*, 21st Feb. 1947, Vol. 105, No. 2721, p. 216.) A simplified adaptor which converts the varying l.f. voltages observed with an electro-encephalograph into variations in the pitch of an audible tone.

621.396.61 : 517.512.2 2351

Fourier Transform Analysis.—M. M. Levy. (*J. Brit. Instn Radio Engrs*, Dec. 1946, Vol. 6, No. 6, pp. 228–246.) A study of the properties of Fourier transforms with examples of applications to a wide variety of radio problems. A new notation is used. See also 3651 of 1946.

621.396.611.21 2352

On the Resonant Frequencies of *n*-Meshed Tuned Circuits.—P. Parzen. (*Proc. Inst. Radio Engrs, W. & E.*, March 1947, Vol. 35, No. 3, pp. 284–285.) The fact that multiplication of all the inductances (self and mutual) and capacitances by factors of A^2 and B^2 respectively divides the resonant frequency by AB is proved for n-meshed coupled tuned circuits and applied to the predimensioning of quartz oscillating crystals.

621.396.611.3 2353

RC Coupling.—(*Wireless World*, April 1947, Vol. 53, No. 4, p. 131.) Data for the design of couplings for pulse and saw-tooth waves.

621.396.611.4 2354

Natural Frequencies of E-Type of a Capacitance-Loaded Cylindrical Resonator.—F. Lüdi. (*Helv. phys. Acta*, 2nd Nov. 1944, Vol. 17, No. 6, pp. 429–436. In German.)

621.396.615 2355

Phase-Shift Oscillators.—P. G. M. Dawe & A. S. Gladwin. (*Wireless Engr*, April 1947, Vol. 24, No. 283, pp. 125–126.) The resistance-reactance network associated with a phase-shift oscillator is usually considered to form an aperiodically damped system, so that no oscillatory current can occur. It is pointed out that the response of such a circuit to a transient input involves voltage reversals, having the character of a heavily damped oscillation.

621.396.615 2356

Three-Phase RC Oscillator for Radio and Audio

Frequencies.—H. Rakshit & K. K. Bhattacharyya. (*Indian J. Phys.*, Oct. 1946, Vol. 20, No. 5, pp. 171–186.) Regenerative feedback from the output to the input of a 3-stage amplifier enables either audio or radio frequencies to be generated, depending on circuit arrangements. Theory is confirmed by experiment. See also 1796 of 1946.

621.396.615 : 621.396.619.16 2357
Pulse Modulated Oscillator.—A. Easton. (*Electronics*, March 1947, Vol. 20, No. 3, pp. 124–129.) A pulsed resonant circuit giving a damped wave train is combined with a keyed oscillator that builds up oscillations, thus obtaining a pulsed oscillator generating a wave train of constant amplitude.

621.396.615.029.5 2358
H.F. Beat-Frequency Oscillator.—R. Aschen & M. Lafargue. (*T.S.F. pour Tous*, March 1947, Vol. 23, No. 221, pp. 52–54.) Part 1 of another account of 1709 of June.

621.396.615.029.6 : 621.397.62 2359
The 6C5 and 54 Mc/s.—H. Pinot. (*Télévis. Franç.*, Feb. 1947, No. 22, p. 19.) Details of an oscillator suitable for testing the sound channel in television receivers.

621.396.615.14.012.2 2360
Q Circles—A Means of Analysis of Resonant Microwave Systems: Part 1.—W. Altar. (*Proc. Inst. Radio Engrs, W. & E.*, April 1947, Vol. 35, No. 4, pp. 355–361.) A new circle diagram is given for magnetrons and similar resonant systems with an isolated single resonant mode. The diagram is drawn in terms of complex reflection coefficients, the values of which are obtained by standing-wave measurements in the outgoing line. A theoretical discussion will be given later.

621.396.615.17 : 621.316.729 2361
On the Synchronization of Valve Generators.—. Samulon. (*Helv. phys. Acta*, 5th Aug. 1941, Vol. 14, No. 4, pp. 281–306. In German.) A discussion of synchronization by an external a.c. potential, particularly for the case where the applied potential has a frequency close to a harmonic of the fundamental frequency of the generator. A solution is given of the phase-balance equation for the back-coupled generator with tuned anode circuit. A reference was given in 3322 of 1943.

621.396.615.17 : 621.317.733 2362
On a Bridge Circuit for Relaxation Oscillations.— Zickendraht. (*Helv. phys. Acta*, 12th July 1944, Vol. 17, No. 4, pp. 234–235. In German.) A bridge using two resistances and two thyratrons gives powerful oscillations whose waveform may be adjusted to provide a 'saw-tooth' timebase.

621.396.616 : 621.396.662.2.076.2 2363
Precision Master Oscillators.—T. A. Hunter. (*Tele-Tech*, Feb. 1947, Vol. 6, No. 2, pp. 71–73..126.) Permeability-tuned and sealed units of stability equivalent to that of a crystal-controlled oscillator.

621.396.621 : 621.396.619.11 2364
The "Synchrodyne": A New Type of Radio Receiver for A.M. Signals.—D. G. Tucker. (*Electronic Engng*, March 1947, Vol. 19, No. 229, pp. 76.) A description of a process of demodulation whereby the incoming signal is modulated with a frequency equal to its own carrier frequency. The modulation-frequency output of the wanted signa is then obtained correctly and all other signals become high frequencies relative to the modulation frequency and can be separated by means of a low-pass filter in the output circuit.

621.396.621 : 621.396.619.13 2365
Designing an F.M. Receiver: Part 1.—T. Roddam. (*Wireless World*, April 1947, Vol. 53, No. 4, pp. 143–145.) Discusses principles of design of the mixer and i.f. stages.

621.396.622.71 : 621.396.813 2366
Distortion in Diode Detectors.—R. A. Lampitt. (*Electronic Engng*, March 1947, Vol. 19, No. 229, pp. 94–96.) The cause of the distortion introduced by the use of an a.f. amplifier immediately following a diode detector is discussed and two remedies are outlined.

621.396.645 : 518.4 2367
Graphical Analysis of Cathode-Biased Degenerative Amplifiers.—W. A. Huber. (*Proc. Inst. Radio Engrs, W. & E.*, March 1947, Vol. 35, No. 3, pp. 265–269.) A method by which it is possible to predict the performance of cathode-follower and anode-resistance-loaded, cathode-degenerative triode amplifiers.

621.396.645 : 621.396.621.029.6 2368
I.F. Amplifier for High Gain F.M. Receiver.—D. W. Martin. (*Tele-Tech*, Feb. 1947, Vol. 6, No. 2, pp. 60–62.) High sensitivity and selectivity in a v.h.f. communications receiver is obtained with a new circuit.

621.396.645.029.3 2369
A.C.-D.C. Audio Amplifier.—G. Eannarino. (*Radio News*, Feb. 1947, Vol. 37, No. 2, pp. 40–41.) Full circuit details of a four-valve audio amplifier giving 8 W output with 10% distortion over the range 40–15 000 c/s. No transformers are used iu an a.c./d.c. selenium-rectifier power supply.

621.396.645 2370
Balanced Amplifiers.—F. F. Offner. (*Proc. Inst. Radio Engrs, W. & E.*, March 1947, Vol. 35, No. 3, pp. 306–310.) The addition of in-phase feedback to push-pull impedance-coupled amplifiers gives definite advantages. Circuits are given for various applications of such amplifiers.

621.396.645.36.078 2371
Automatic Gain Adjusting Amplifier.—D. E. Maxwell. (*Tele-Tech*, Feb. 1947, Vol. 6, No. 2, pp. 34–36, 128.) A push-pull amplifier. The controlled variable negative feedback is preceded by a signal-frequency delay network, so that the controlling bias, derived from the input to the network, is applied before transient peaks can overload the amplifier.

621.396.662.21.042.1 2372
Those Iron-Cored Coils again.—P. K. McElroy. (*Gen. Radio Exp.*, Dec. 1946 & Jan. 1947, Vol. 21, Nos. 7 & 8, pp. 2–8 & 2–8.) The application of the theory developed previously (*ibid.*, March 1942, P. K. McElroy & R. F. Field) is simplified. Part 1 gives an empirical method for determining the maximum storage factor Q of a coil wound on a particular lamination structure, the frequency at which it occurs and the law of variation of inductance with the width of the centre-leg air gap.

Part 2 gives a method for obtaining the effective permeability of a core of ferromagnetic material with centre-leg air gap, taking account of the fringing that occurs at the air gap. Examples of the use of the methods are given.

621.396.662.3 : 537.228.1 2373
Piezoelectric Quartz.—A. V. J. Martin. (*Toute la Radio*, March/April 1947, Vol. 14, No. 114, pp. 107–111.) Various types of crystal filters, using one, two or four crystals are described and their properties compared. Recent developments briefly mentioned include a quartz transformer, using two crystals slices of identical frequency and giving a variable selectivity, with a very high Q. The pass band of such an arrangement can readily be varied from 10 c/s up to 1 000 c/s.

621.396.667 2374
Towards High Fidelity. Expansion Circuits.—Tabard. (*See* 2565.)

621.396.69+621.317.7+621.38 2375
Physical Society Exhibition.—(*See* 2494.)

621.396.69+621.317.7 2376
The R.C.M.F. [Radio Component Manufacturers' Federation] **Exhibition.**—(*Electronic Engng*, April 1947, Vol. 19, No. 230, pp. 131–132.) A review of some of the test instruments and radio components shown at the 1947 Exhibition. See also 2055 of July.

621.396.69 2377
The 1947 National Salon of Radio Components and Accessories.—G. Giniaux. (*TSF pour Tous*, March–May 1947, Vol. 23, Nos. 221–223, pp. 49–51, 83–90 & 111–112.) A review of some of the novelties exhibited, including coils, fixed and variable capacitors, tuning units, switches, microphones, loudspeakers, meters, etc.

621.396.69 2378
After the [Paris] **Components Exhibition.**—" A Visitor". (*Radio en France*, 1947, No. 3, pp. 4–7.) A review of some of the novelties at the exhibition.

621.396.692.011.2.012.3 2379
Resistances in Parallel.—G. S. Lowey. (*Elect. Times*, 6th Feb. 1947, Vol. 111, No. 2885, p. 165.) A simple graphical method of determining the resultant of any number of resistances in parallel.

621.396.694.012.8 2380
Circuit Conventions. The Valve " Equivalent Generator ".—" Cathode Ray ". (*Wireless World*, April 1947, Vol. 53, No. 4, pp. 129–130.) An attempt to remove the confusion apparent in the valve ' equivalent generator ' principle regarding directions of the voltages and currents.

621.397.62.018.078.3 2381
Automatic Frequency-Phase Control in TV Receivers.—Wright. (*See* 2599.)

621.392.52 2382
Electric Filters. [Book Review]—T. H. Turney. Pitman & Sons, London, 170 pp., 25s. (*Elect. Rev., Lond.*, 28th March 1947, Vol. 140, No. 3618, p. 480.)

GENERAL PHYSICS

53.081 2383
On Unities [units] **and Dimensions : Part 3.**—H. B. Dorgelo & J. A. Schouten. (*Proc. Acad. Sci. Amst.*, April 1946, Vol. 49, No. 4, pp. 393–403. In English.) Conclusion of 1392 of May. Preference expressed for the rationalized system of Giorgi with m, l, t and q.

530.145 2384
Quantum Theory of Electromagnetic Fields : Part 1.—P. Suquet. (*Télévis. franç.*, Feb. 1947, No. 22, Supplement *Électronique*, pp. 1–3.) Preliminary mathematics and general principles.

530.145.6 2385
On the Polarization of Electron Waves.—A. Sokolow. (*J. Phys., U.S.S.R.*, 1945, Vol. 9, No. 5, pp. 363–372.) The polarization is investigated for reflection from a potential barrier and for scattering by a force centre possessing electrical charge and magnetic moment. The scattering is treated by means of Dirac's perturbation theory.

534.1 : 621.392.029.64 2386
The Interaction of Oscillating Systems with Distributed Parameters.—P. Krasnooshkin. (*J. Phys., U.S.S.R.*, 1945, Vol. 9, No. 5, pp. 439–446.) A theoretical treatment of the waves travelling in a set of one-dimensional systems such as parallel strings with force and inertia couplings. Application is made to waveguides and to parallel Lecher systems coupled by inductance coils distributed along their length.

535.13+538.3 2387
An Extension of Fresnel's Formulae.—R. Mercier. (*Helv. phys. Acta*, 24th Oct. 1942, Vol. 15, No. 6, pp. 515–518. In French.) The electric intensities of the waves reflected and transmitted by a plane boundary between two media are related to the ratios of the refractive indices and of the wave resistances. The effect of difference of permeability is discussed.

535.13 2388
Quasi-Optical Links : Models of Ellipsoids [of diffraction] **and Spatial Aerials with Experimental Results.**—Dreyfus-Graf. (*See* 2545.)

535.312.2 2389
Optical Theory of the Corner Reflector.—R. C. Spencer. (*Phys. Rev.*, 15th Jan. 1947, Vol. 71, No. 2, p. 134.) Summary of Amer. Phys. Soc. paper. Experimental results with a corner made from three glass mirrors are presented graphically and discussed. The analysis of the effect of errors of perpendicularity of adjacent sides, as treated by G. A. Van Lear, Jr, is extended and applied to both triangular and square corners.

2390
535.343+621.396.11.029.64] : [546.212+546.212.02
Interpretation of the Microwave Absorption of HDO at 1.3 Centimeters.—G. W. King & R. M. Hainer. (*Phys. Rev.*, 15th Jan. 1947, Vol. 71, No. 2, p. 135.) Summary of Amer. Phys. Soc. paper.

537.291 2391
Energy Distribution and Stability of Electrons in Electric Fields.—H. Fröhlich. (*Proc. roy. Soc. A*, 25th Feb. 1947, Vol. 188, No. 1015, pp. 532–541.) On the usual assumption that electrons are scattered

by the lattice vibrations only, a stationary state cannot be reached. Stationary conditions can probably be obtained by considering also collisions between electrons. For very small electron density, electron collisions are negligible. In this case the possibility of reaching stationary conditions depends on the behaviour of electrons whose energy is large enough to ionize, or excite ions of, the lattice.

537.291 : 621.396.615.141.2 **2392**
Electron Trajectories in a Plane Single-Anode Magnetron — A General Result.—Brillouin. (*See* 2632.)

537.311.2 **2393**
What is Ohm's Law?—"First-Year Lecturer": C. Turnbull. (*Elect. Rev., Lond.*, 7th March 1947, Vol. 140, Nos. 3613/3615, pp. 349–350.) Comment on 1063 of April.

537.5 **2394**
A Proposed Detector for High Energy Electrons and Mesons.—I. A. Getting. (*Phys. Rev.*, 15th Jan. 1947, Vol. 71, No. 2, pp. 123–124.) Depends on the emission of visual radiation by a charged particle moving at constant speed in a medium where the phase velocity of the light is smaller than the velocity of the particle.

The visual radiation produced in a cone of Lucite or Plexiglass, along the axis of which the electrons or mesons are incident, is detected by focusing it to a photo-multiplier to which is connected a video amplifier.

537.523.5 **2395**
On the Current Density in the Initial Stages of an Arc.—R. Holm. (*Ark. Mat. Astr. Fys.*, 7th March 1947, Vol. 34, Part 1, Section B, No. 8, 7 pp. In German.) Current densities of the order of 10^4 A/cm² may occur within times of the order of 10^{-4} sec, with much greater densities immediately after striking.

537.523.5 **2396**
On the Mechanism of Arc Discharge.—O. P. Semenova. (*C. R. Acad. Sci. U.R.S.S.*, 30th March 1946, Vol. 51, No. 9, pp. 683–686. In English.) The effective ionization potential is determined not by the principal component of the arc gas, as is usually assumed, but by the component having the lowest ionization potential, even though present in a comparatively small quantity. Experimental confirmation of this is described.

537.525 : 621.385.18 **2397**
Effect of Direct-Current Potential on Initiation of Radiofrequency Discharge.—A. A. Varela. (*Phys. Rev.*, 15th Jan. 1947, Vol. 71, No. 2, pp. 124–125.) An explanation of the failure to improve the speed of initiation of the discharge in a gaseous discharge switch for radar duplexing by the application of a d.c. potential less than that required to initiate the discharge.

537.525.3 **2398**
The Development of Discharge Paths of an Impulse Corona.—V. Hey & S. Zayentz. (*J. Phys., U.S.S.R.*, 1945, Vol. 9, No. 5, pp. 413–418.)

537.525.3 **2399**
The Investigation of the Impulse Corona in a Cloud Chamber.—V. Hey & S. Zayentz. (*J. Phys., U.S.S.R.*, 1945, Vol. 9, No. 5, pp. 405–412.)

537.525.5 + 621.396.822] : 621.385 **2400**
Effects of Magnetic Field on Oscillations and Noise in Hot-Cathode Arcs.—J. D. Cobine & C. J. Gallagher. (*J. appl. Phys.*, Jan. 1947, Vol. 18, No. 1, pp. 110–116.) Application of a transverse magnetic field is shown to produce two new effects, suppression of the oscillations and radical alteration of the noise spectrum. See also 3266 and 3267 of 1946.

537.525.5 + 621.396.822] : 621.385 **2401**
Noise in Gas Tubes.—J. D. Cobine & C. J. Gallagher. (*Electronics*, March 1947, Vol. 20, No. 3, pp. 144 . . 198.) Noise characteristics are tabulated for a number of hot-cathode discharge tubes and are compared with the shot noise of a diode for two different currents and a 3 000-Ω load resistance. The shape of the noise spectrum is determined by the valve geometry. See also 3266 and 3267 of 1946, 1406 of May, and 2400 above.

537.531 **2402**
Radiation of a Uniformly Moving Electron due to Its Transition from One Medium into Another.—I. Frank & V. Ginsburg. (*J. Phys., U.S.S.R.*, 1945, Vol. 9, No. 5, pp. 353–362.) "The intensity, polarization and angular distribution of the radiation are calculated as functions of the dielectric constants and conductivities of the two media."

537.533.8 **2403**
The Velocity Distribution of Secondary Electrons for Various Emitters.—A. Kadyshevich. (*J. Phys., U.S.S.R.*, 1945, Vol. 9, No. 5, pp. 431–435.) Investigates the dependence on the velocity of the primary electrons and on the energy parameters of the emitter.

537.533.8 **2404**
On the Measurement of the Depth of Generation of the Secondary Electrons in Metals.—A. Kadyshevich. (*J. Phys., U.S.S.R.*, 1945, Vol. 9, No. 5, pp. 436–438.)

537.539 + 621.315.61.015.5 **2405**
On the Theory of Dielectric Breakdown in Solids.—H. Fröhlich. (*Proc. roy. Soc. A*, 25th Feb. 1947, Vol. 188, No. 1015, pp. 521–532.) The theory previously developed is found to be correct only below a critical temperture T_c, above which the density of electrons (in strong fields) is so high that mutual collisions between electrons are more frequent than collisions between electrons and the lattice vibrations. In strong external fields this leads to an equilibrium distribution of the electrons at an electronic temperature T which is higher than the lattice temperature. Equilibrium can only be obtained if the field is below a critical value F^*. For stronger fields the electronic temperature T rises steadily until the crystal breaks down. F^* decreases exponentially with increasing lattice temperature. The theory now accounts for the rise of dielectric strength with temperature at low temperatures and for its decrease at high temperatures. It also shows why influences which tend to increase the dielectric strength at low temperatures (e.g., admixture of foreign atoms) tend to decrease it in the high-temperature region. The increase of electronic temperature with the field strength F leads, for $F < F^*$, to an increase of electronic conductivity with F which is calculated quantitatively. See also 1787 of 1943 and 2979 of 1944.

537.56 : 538.6 2406
Production of H.F. Energy by an Ionized Gas in the Presence of a Magnetic Field.—J. Denisse & J. L. Steinberg. (*C. R. Acad. Sci., Paris*, 3rd March 1947, Vol. 224, No. 9, pp. 646–648.) The tubes used contained pure nitrogen at various pressures ; in some cases they had tungsten filament cathodes and in others aluminium electrodes. A detailed account is given of the effects of magnetic fields of various strengths applied at different points along the tubes.

GEOPHYSICAL AND EXTRATERRESTRIAL PHENOMENA

523.53 : 621.396.82 2407
Whistling Meteors. Audible Radio Reflections from Shooting Stars.—G. R. M. Garratt. (*Wireless World*, April 1947, Vol. 53, No. 4, pp. 141–142.) Chamanlal and Venkataraman have found at Delhi (1607 of 1942) that under favourable conditions meteors give faint heterodyne whistles in a communication receiver. These are attributed to a Döppler effect due to interference of the direct ground waves from the transmitter with the waves reflected from the local area of ionization caused by the passage of the meteor through the atmosphere. The effect is discussed and optimum conditions for its observation are given. See also 916 of 1946.

523.53 "1946.10.09" : 551.510.535 2408
Ionization by Meteoric Bombardment.—J. A. Pierce. (*Phys. Rev.*, 15th Jan. 1947, Vol. 71, No. 2, pp. 88–92.) The meteor shower of October 9–10, 1946, produced intense ionization in the upper atmosphere, from which the energy required to produce an ionospheric layer can be calculated. The necessary power is found to be a few watts per square kilometre, a value comfortably exceeded by the black body radiation of the sun in the region of 1 000 Å.

523.75 2409
The Structure of the Solar Atmosphere.—M. Waldmeier. (*Helv. phys. Acta*, 8th July 1942, Vol. 15, No. 4, pp. 405–422. In German.) A theoretical discussion of the stratification of an atmosphere in radiation equilibrium, with application to the photosphere, sun-spots, the Evershed effect, and the diminution of brightness near the edge of the disk.

523.752 : [551.510.535 + 621.396.812 2410
Eruptions of the Solar Chromosphere and Their Influence on the Ionosphere and on Wave Propagation. Their Effects in Different Regions of the Radio Spectrum.—Bureau. (*See* 2550.)

523.78 "1945.07.09" : 621.396.812 : 551.510.535 2411
Results obtained in observing the Propagation of Radio Waves during the Solar Eclipse of 9th July 1945.—A. A. Grigor'eva. (*Bull. Acad. Sci. U.R.S.S., sér. phys.*, 1946, Vol. 10, No. 3, pp. 253–260. In Russian.) Observations were made at the ionosphere stations near Moscow and Leningrad and short-wave transmissions from Leningrad, Moscow and Kuibisheff (at frequencies of the order of 7 Mc/s) were observed at 22 points in the eclipse zone.

The following main results were obtained. (*a*) During the optical eclipse the critical frequency of the F_2 layer decreased by 14% at Moscow and by 20% at Leningrad. (*b*) The variation of the height of the maximum ionization level remained within the accuracy limits of height measurements. (*c*) At certain periods during the optical eclipse increases of 100% in the field intensity were observed. (*d*) Increases in the audibility, mainly coinciding with field intensity increases, were observed during the optical eclipse. (*e*) In one case a considerable increase in the ionization was observed in Leningrad associated with decreases of the field intensity and audibility at a number of control points. (*f*) Variations of the audibility were observed in the zone of possible influence of the corpuscular eclipse. No corresponding variations were observed outside this zone.

523.78 "1945.07.09" : 621.396.812 : 551.510.535 2412
On the Results of the Ionosphere Measurements made during the Solar Eclipse of 9th July 1945.—N. D. Bulatoff. (*Bull. Acad. Sci. U.R.S.S., sér. phys.*, 1946, Vol. 10, No. 3, pp. 269–274. In Russian.) Observations of the ionosphere were made at stations near Leningrad and Moscow and the field intensities of radio transmitters operating at Leningrad and Moscow (at frequencies from 1.75 to 5.0 Mc/s) were measured at various points.

The following conclusions were reached : (*a*) The decrease in the ionization of the E, F_2 and lower absorbing layers during the passing of the optical shadow of the sun confirms that the main factor in the ionization of all layers is the ultra-violet radiation from the sun. Similar confirmation for the lower layers is given by the sharp increase in the field intensity of radio stations during totality and a corresponding decrease towards the end of the eclipse. (*b*) The absence of the expected effects of the corpuscular eclipse indicates that although the existence of the corpuscular stream under normal conditions is possible, the intensity of the stream is too low to produce observable changes in the ionization. It should be noted that corpuscular eclipses are calculated neglecting the effects of the magnetic field of the earth.

537.591 2413
Absorption of Cosmic Radiation at 2 100 m.—G. Salvini. (*Nuovo Cim.*, 1st Aug. 1946, Vol. 3, No. 4, pp. 283–284.)

537.591 2414
The Intensity Fluctuations in the Hard Component of Cosmic Radiation on the Jungfraujoch (3 500 m above sea level).—H. Wäffler. (*Helv. phys. Acta*, 5th Aug. 1941, Vol. 14, No. 4, pp. 215–256. In German.)

537.591 2415
An Example of Meson Production in Lead.—G. D. Rochester, C. C. Butler & S. K. Runcorn. (*Nature, Lond.*, 15th Feb. 1947, Vol. 159, No. 4033, pp. 227–228.) The two cloud-chamber photographs reproduced suggest that one of the particles emerging from the lead plate is a slow meson.

537.591.15 2416
The Extension of the Shower Theory to Low Energy [levels].—N. Dallaporta & E. Clementel. (*Nuovo Cim.*, 1st Aug. 1946, Vol. 3, No. 4, pp. 235–251. In Italian, with English summary.) Results obtained by an approximation method confirm the great penetration of photons into lead for energies of about 3×10^6 eV.

537.591.15 2417
Auger Showers.—M. M. Mills & R. F. Christy. (*Phys. Rev.*, 15th Feb. 1947, Vol. 71, No. 4, p. 275.) Summary of Amer. Phys. Soc. paper. Examination of Lewis's data on coincident bursts (2889 of 1945; see also 2890 of 1945) shows that if ionization due to electrons is to afford an explanation, "it will probably require initiating electrons of energy $>10^{14}$ eV produced predominantly near the top of the atmosphere and with several electrons having considerable angular spread associated in one event." An alternative possibility that the bursts are due to nuclear disintegrations is being examined.

537.591.5 2418
Production of Mesotrons up to 30 000 Feet at a Magnetic Latitude of 22° North.—P. S. Gill. (*Phys. Rev.*, 15th Jan. 1947, Vol. 71, No. 2, pp. 82–84.) Discovery of a marked hump in the intensity/altitude curve at a pressure of 530 mb.

551.510.535 2419
On the Work of the Ionosphere Bureau of the Institute of Terrestrial Magnetism.—J. V. Leshchinsky & N. V. Pushkov. (*Bull. Acad. Sci. U.R.S.S., sér. phys.*, 1946, Vol. 10, No. 3, pp. 279–280. In Russian.)

551.510.535 2420
Electronic Collisional Frequency in the Upper Atmosphere.—E. F. George. (*Proc. Inst. Radio Engrs, W. & E.*, March 1947, Vol. 35, No. 3, pp. 249–252.) Tables are given showing the collisional frequency as a function of height for night and day conditions, which are thought to represent maximum and minimum values.

551.510.535 : 525.6 2421
Atmospheric Tides in the Ionosphere : Part 1—Solar Tides in the F_2 Region.—D. F. Martyn. (*Proc. roy. Soc. A*, 17th April 1947, Vol. 189, No. 1017, pp. 241–260.) Horizontal winds due to solar tides and the earth's magnetic field cause a vertical component in the velocities of free ions. It is assumed that the velocities decrease with increase of height in the F_2 region. The theory shows that for downward velocities a Chapman region is modified so that the maximum ionization density is reduced, but its height may be above or below the Chapman height, depending on the velocity gradient. Upward velocities lead to increased ionization densities at heights generally above the Chapman height. These results are applied to account for the observed anomalous behaviour of the F_2 region, including the semi-diurnal period, for the existence of which observational evidence is given.

551.510.535 : 535.211 2422
Radiative Equilibrium in the Ionosphere.—R. v. d. R. Woolley. (*Proc. roy. Soc. A*, 17th April 1947, Vol. 189, No. 1017, pp. 218–240.) Molecular and atomic oxygen are the principal ultraviolet absorption agents at heights below and above ... km respectively. Water vapour is the principal infra-red radiator at 100 km, but at 250 km the temperature is controlled by negative ions. At much greater heights the temperature is perhaps controlled by dust particles.

551.510.535 : 621.396.11.029.45 2423
The Oblique Reflexion of Very Long Wireless Waves from the Ionosphere.—Wilkes. (*See* 2548.)

551.593.9 : 535.243 2424
Spectrophotometer Measurements of the Spectrum of the Night Sky (λλ 4 600–3 100).—D. Barbier. (*C. R. Acad. Sci., Paris*, 3rd March 1947, Vol. 224, No. 9, pp. 635–636.) Spectra for wavelengths 3 100–4 600 Å have been obtained at the Haute-Provence observatory at zenith distances of 10° and 80°. Comparison of the spectra taken at the two distances enables the altitude of emission of the bands to be determined. Discussion of the results shows that an appreciable part of the continuous background light comes from the atmosphere. The whole of the measured brightness of the night sky can now be apportioned approximately between spectral rays, bands, zodiacal light extension, and the light of faint stars.

551.594.25 2425
The Electrical Charge on Precipitation at Various Altitudes and Its Relation to Thunderstorms.—R. Gunn. (*Phys. Rev.*, 1st Feb. 1947, Vol. 71, No. 3, pp. 181–186.) The free electrical charges on individual precipitation particles at various altitudes up to 2 600 ft were measured by an induction method. The results are shown graphically and discussed. Electric field measurements showed that the particle charges are largely neutralized by nearby charges. Removal of the neutralizing charge will immediately produce thunderstorm electric fields and potentials.

551.594.5 : 538.691 2426
Experiments on the Aurorae.—K. G. Malmfors. (*Ark. Mat. Astr. Fys.*, 7th March 1947, Vol. 34, Part 1, Section B, No. 1, 8 pp. In English.) An account of experiments to study the motion of charged particles in a magnetic dipole field under the influence of a homogeneous electric field. The results are discussed in relation to Alfvén's theory of magnetic storms and the aurora.

LOCATION AND AIDS TO NAVIGATION

534.88 2427
Submarine Detection by Sonar.—A. C. Keller. (*Bell Lab. Rec.*, Feb. 1947, Vol. 25, No. 2, pp. 55–60.)

621.396.11 2428
On the Coastal Effect in Radio Direction Finding.—E. L. Feinberg. (*Bull. Acad. Sci. U.R.S.S., sér. phys.*, 1946, Vol. 10, No. 2, pp. 196–216. In Russian.) Previous investigations of the phenomenon are briefly reviewed; it is usual to ascribe the effect to the difference in the electrical properties of land and sea and to call it 'coastal refraction'. The author suggests that the actual vertical configuration of the coast also affects the propagation of electromagnetic waves, since it is known, for example, that the difference in the electrical constants of land and sea is greater in the case of a high coast. Accordingly a more general theory is developed in which the effect of the boundary line is taken into account and formulae are derived for different relative positions of the observer and transmitter. The considerable effect of the transitional zone is also demonstrated.

The theory is derived from a general theory of the propagation of radio waves along a non-uniform and uneven surface developed by the author elsewhere (1962 of 1946 and back references). That theory was based on an integral equation first solved by Grünberg (3386 of 1944) and more fully investigated by Fock in *Mathematicheski Sbornik*, 1–2 (1944). In the present paper a method is proposed which makes the solution of the integral equation unnecessary and the problem is reduced to the evaluation of integrals of known functions. This results in a considerable simplification of the necessary calculations.

In conclusion a brief analysis is made of available experimental data, which are in conformity with the theory.

621.396.11 : 621.396.93 **2429**
A New Source of Systematic Error in Radio Navigation Systems requiring the Measurement of the Relative Phases of the Propagated Waves.—K. A. Norton. (*Proc. Inst. Radio Engrs, W. & E.*, March 1947, Vol. 35, No. 3, p. 284.) Accurate navigational fixes can be obtained only when the effective values of ground constants along the propagation path are known accurately. Methods are outlined for correcting range errors due to phase variation.

621.396.7 : 621.396.96 **2430**
The Decca Navigator.—P. Giroud. (*Ann. Radioélect.*, Oct. 1946, Vol. 1, No. 6, pp. 409–433.) For other accounts see 1242 and 3606 of 1946.

621.396.93 : 621.396.677.1 **2431**
The Compensated-Loop Direction Finder.—F. E. Terman & J. M. Pettit. (*Proc. Inst. Radio Engrs, W. & E.*, March 1947, Vol. 35, No. 3, p. 269.) Corrections to 2659 of 1945.

621.396.932 + 621.396.96 **2432**
Radar on the Great Lakes.—N. A. Schorr. (*Radio News*, Feb. 1947, Vol. 37, No. 2, pp. 35–38 . . 147.) A general account of navigational difficulties and recently developed navigation aids. The p.p.i. system is outlined, and essential features are given of six different types of radar installations now operating as test units aboard lake carriers. Research to determine the most efficient system is proceeding.

621.396.933 **2433**
Teleran.—P. Hémardinquer. (*Télévis. franç.*, March 1947, No. 23, pp. 18–19.) A short account of the principles of operation. For a more detailed account see 1546 of 1946.

621.396.933 **2434**
Safety in the Air.—J. A. McGillivray. (*Wireless World*, April 1947, Vol. 53, No. 4, pp. 146–149.) The adoption of a universal standard air navigation system is urged. The advantages and disadvantages of nine existing types of radio aids to navigation are discussed.

621.396.933.1 **2435**
LANAC Two-Signal Navigation System.—(*Tele-Tech*, Feb. 1947, Vol. 6, No. 2, pp. 49–53, 129.) Basic principles of a laminar navigation and anti-collision system. Incorporates challenger and replier units; a different altitude code is used for each 1 000-ft height layer. Position can be obtained with only one beacon. Operation is automatic.

621.396.933.23 : 389.6 **2436**
P.I.C.A.O. recommends C.A.A. Instrument Landing.—H. G. Shea. (*Tele-Tech*, Feb. 1947, Vol. 6, No. 2, pp. 40–43 . . 124.) Condensed specifications for aircraft loran, radar, beacons and landing aids by the Provisional International Civil Aviation Organization. For another account, by D. H. Pain, see *Electronics*, Feb. 1947, Vol. 20, No. 2, pp. 80–83.

621.396.96 : 531.55 **2437**
Navy Fire-Control Radars.—W. M. Kellogg. (*Bell Lab. Rec.*, Feb. 1947, Vol. 25, No. 2, pp. 64–69.) A description of the Mark 3 and Mark 4 radar systems employed largely in the U.S. Navy during the earlier stages of the war. Operation was in the 680–720 Mc/s frequency range, with a pulse power of about 40 kW. Aerials were horizontal cylindrical parabolas fed by a row of dipoles; a gas-switch enabled the same aerial and feeder to be used for transmission and reception. See also 1798–1804 of June.

621.396.96 : 551.594.6 **2438**
Storm Indication by Radio Locators.—V. A. Vvedenski. (*Radio, Moscow*, April 1946, No. 1, pp. 4–8. In Russian.)

621.396.96 : 621.396.621 **2439**
Considerations in the Design of Centimeter-Wave Radar Receivers.—Miller. (*See* 2562.)

MATERIALS AND SUBSIDIARY TECHNIQUES

533.5 **2440**
New Developments in Vacuum Engineering.—R. B. Jacobs & H. F. Zuhr. (*J. appl. Phys.*, Jan. 1947, Vol. 18, No. 1, pp. 34–48.) Methods are described for obtaining vacuum tightness in the K-25 gaseous diffusion plant for the separation of U^{235}. New techniques include the helium hood method for leak detection with the mass spectrometer (2441 below) and the use of calibrated leaks.

533.5 : 539.163.2.08 **2441**
Mass Spectrometer for Leak Detection.—A. O. Nier, C. M. Stevens, A. Hustrulid & T. A. Abbott. (*J. appl. Phys.*, Jan. 1947, Vol. 18, No. 1, pp. 30–33.) A simple low-resolution instrument using helium for leak detection in high vacuum equipment. One part of helium in 200 000 parts of air gives a definite indication on the output meter.

534.133 + 621.396.611.21.016.2 **2442**
High Intensity Ultrasonics: The Power Output of a Piezoelectric Quartz Crystal.—L. F. Epstein, W. M. A. Andersen & L. R. Harden. (*J. acoust. Soc. Amer.*, Jan. 1947, Vol. 19, No. 1, pp. 248–253.) The maximum ultrasonic power density experimentally attained up to the present with a quartz crystal is considerably less than that predicted from the characteristics of quartz. Failure is attributed to dielectric breakdown in the surrounding fluid; if the breakdown voltage gradient of the medium is independent of thickness the maximum power density is independent of frequency, but if the gradient decreases with thickness, the maximum power density increases with frequency. An output of 43 W/cm² has been achieved at 1 000 kc/s.

535.37 **2443**
Decay of Phosphorescence in Cu-Activated ZnS.—H. M. James. (*Phys. Rev.*, 15th Jan. 1947, Vol. 71, No. 2, p. 137.) Summary of Amer. Phys. Soc. paper.

35.376 : 537.226.2 **2444**
Electron Traps and Dielectric Changes in Phos-horescent Solids.—G. F. J. Garlick & A. F. ibson. (*Proc. roy. Soc. A*, 25th Feb. 1947, Vol. 88, No. 1015, pp. 485–509.)

37.228.1 **2445**
Piezoelectric Substances.—M. Bruzau. (*Elect. ommun.*, Dec. 1946, Vol. 23, No. 4, pp. 445–459.) comprehensive review originally published in rench with the title 'Les Substances Piézoélec-iques Synthétiques' in 1940, and including a large bliography. Static and dynamic tests for the etection of piezoelectricity are described and all e known substances are classified in 8 tables ccording to their crystalline structure. Arti-ial crystals are discussed, with particular refer-ce to the properties of Rochelle salt. The various easurements that have been made on the abnormal riations of its dielectric constant and piezo-ectric moduli with temperature are reviewed and e different crystal cuts are described. Other ificial crystals, and the possibility of orienting all crystals to give large piezoelectric slabs, are scussed.

7.228.1 **2446**
The Elastic Behaviour of Rochelle-Type Sub-nces.—W. Bantle & W. Lüdy. (*Helv. phys. a*, 8th July 1942, Vol. 15, No. 4, pp. 325–327. German.)

.228.1 **2447**
he Influence of Temperature on the Dynamic-stic Behaviour of Rochelle-Type Substances.— Lüdy. (*Helv. phys. Acta*, 24th Oct. 1942, . 15, No. 6, pp. 527–552. In German.)

.228.1 **2448**
he Specific Heat of Rochelle-Type Substances. lectric Measurements on KD_2PO_4 Crystals.— Bantle. (*Helv. phys. Acta*, 8th July 1942, . 15, No. 4, pp. 373–404. In German.)

228.1 **2449**
he Inverse Piezoelectric Effect of Rochelle-e KH_2PO_4 Crystals.—A. von Arx & W. Bantle. *v. phys. Acta*, 12th July 1944, Vol. 17, No. 4, 298–318. In German.) Full paper; summary racted in 3643 of 1945.

228.1 **2450**
ectro-Optical Properties of the Rochelle-Type tals KH_2PO_4 and KD_2PO_4.—B. Zwicker & P. rrer. (*Helv. phys. Acta*, 6th Sept. 1944, 17, No. 5, pp. 346–373. In German.) Experi-tal investigation with theoretical discussion of le refraction, the spontaneous Kerr effect, linear electro-optical effect at $T>\theta$, where θ e Curie temperature, electro-optical hysteresis $< \theta$, dielectric constant, anomaly of the specific and 'freezing' of polarization.

228.1 **2451**
electric Measurements on KH_2PO_4 and KH_2AsO_4 Low Temperatures.—G. Busch & E. Ganz. *. phys. Acta*, 15th Aug. 1942, Vol. 15, No. 5, 01–508. In German.) The Curie temperature 3.5°K for KH_2PO_4 and 96.5° K for KH_2AsO_4. een about 75° and 50° K the dielectric con-s fall to very low values and the dielectric eaches a maximum of 3 joules/cm³.

537.311.33 + 621.315.59] : [546.28 + 546.289 **2452**
Measurements of Hall Effect and Resistivity of Germanium and Silicon from 10° to 600° K.—G. L. Pearson & W. Shockley. (*Phys. Rev.*, 15th Jan. 1947, Vol. 71, No. 2, p. 142.) Summary of Amer. Phys. Soc. paper. For *p*-type germanium the logarithm of the Hall coefficient is linear in 1/T°K below 90°K, giving an activation energy of 0.007 eV. For the *n*-type a similar linear relation is found between 17° and 90°K, the activation energy being about the same. "Silicon containing 0.03 atomic per cent boron, has essentially constant resistivity and Hall coefficient below 100°K." These results are discussed. See also 2216 of 1946.

537.311.33 : 537.58 **2453**
Thermal Ionization of Impurity Levels in Semi-Conductors.—B. Goodman, A. W. Lawson & L. I. Schiff. (*Phys. Rev.*, 1st Feb. 1947, Vol. 71, No. 3, pp. 191–194.) The ionization probabilities calcu-lated by the use of a simple Debye model and an Einstein model may play an important part in determining the frequency dependence of the recti-fication efficiency of crystal rectifiers.

538.221 **2454**
Magnetic Spectra of Diverse Materials at Various Frequencies.—V. Arkadiev. (*J. Phys., U.S.S.R.*, 1945, Vol. 9, No. 5, pp. 373–378.)

549.514.51 : 534.133] + 621.396.611.21.012.8 **2455**
Calculation of the Equivalent Constants of a Quartz Plate in Plane Shear Vibration (Type CT, DT).—Dumesnil. (*See* 2341.)

621.314.632 + 537.311.33 **2456**
Photo- and Thermo-Effects in *p*-Type Germanium Rectifiers.—R. Bray & K. Lark-Horovitz. (*Phys. Rev.*, 15th Jan. 1947, Vol. 71, No. 2, pp. 141–142.) Summary of Amer. Phys. Soc. paper. Photo-conductive effects, depending on the particular germanium sample and the metal, leave the forward resistance relatively unchanged, but may so greatly reduce the back resistance as apparently to reverse the rectification. Photo-voltaic effects are ob-served usually in the back direction. Photo-effects approach maximum sensitivity in the near infra-red (about 1.3 μ).

621.314.632 : 546.289 **2457**
Ge-Ge Contacts.—S. Benzer. (*Phys. Rev.*, 15th Jan. 1947, Vol. 71, No. 2, p. 141.) Summary of Amer. Phys. Soc. paper. Germanium crystals of various impurity content in contact with each other produce a rectification series (3628 of 1946—Brattain). Instead of the expected linear current/voltage characteristic, the characteristic observed for both polarities is of the order of the back resist-ance when either piece of the crystal is used with a metal. In both directions the negative resistance at high voltages appears. These effects are dis-cussed.

621.315.59 : 621.315.616.92 : 621.319.4 **2458**
The Effect of Semiconducting Liquids on the Dielectric Properties of Cellulose Insulation.—F. M. Clark. (*Gen. elect. Rev.*, Feb. 1947, Vol. 50, No. 2, pp. 9–17.) The abnormalities met with when cellulose insulation is impregnated with high-loss liquids have been used in the development of a new type of capacitor having a high ratio of capacitance to volume. Such capacitors may be used at

voltages above those at which electrolytic capacitors can be used continuously with safety, and below those at which the usual paper-spaced oil- or askarel-treated capacitors can be used with economy.

621.315.61 : 546.431.823 : 537.228.1 **2459**
Effect of Temperature on the Permittivity of Barium Titanate.—J. H. van Santen & G. H. Jonker. (*Nature, Lond.*, 8th March 1947, Vol 159, No. 4036, pp. 333–334.) Investigation shows that for TiO_2 (rutile), $BaTiO_3$ and titanates with various proportions of Ba and Sr, the permittivity ϵ in the cubic region is accurately represented by the formula $1/\epsilon = \beta(T-C)$, where β is a constant for each material and C is a temperature only slightly different from that corresponding to the maximum value of ϵ. It is concluded that in the temperature region of cubic structures there is no permanent dipole moment.

621.315.612 **2460**
Low Loss Ceramic Dielectric.—H. Thurnauer. (*Tele-Tech*, Feb. 1947, Vol. 6, No. 2, pp. 86–87, 130.) A new material, which has been named AlSiMag 243, can be processed by standard steatite methods. The permittivity is 6.1 and the power factor 3×10^{-4} at 100 Mc/s.

621.318.23 **2461**
Permanent Magnet Design.—D. Hadfield. (*Elect. Times*, 20th & 27th March & 3rd April 1947, Vol. 111, Nos. 2889–2891, pp. 290–294, 323–325 & 357–359.) No rigid formulae for the design of permanent magnets for electrical instruments can be given, since operating conditions, leakage flux, etc., differ very much from one instrument to another. The properties of the various magnetic materials now available are shown graphically and tabulated. The relationship between magnet shape and operating point on the magnetization curve is considered for ring-shaped magnets. Maximum gap flux density for a given volume of magnet material is obtained when the magnet is operating at the $(BH)_{max}$ point of the material of which it is made. General principles are applied to the case of a ring-shaped magnet with soft pole pieces fitted between the ground faces of the gap. Composite magnets, with a block of one of the newer permanent magnet alloys and mild steel side limbs are briefly discussed, and also the question of increasing the sensitivity of an instrument by a new magnet without modification of the movement and other parts. Stabilization is also considered. See also 3371 of 1945.

621.357.6 **2462**
Electroforming. Piece Part Production by Electrodeposition.—E. A. Ollard. (*Metal Ind., Lond.*, 14th Feb. 1947, Vol. 70, No. 7, pp. 126–128.) Conclusion of 1478 of May.

621.395.625.3 **2463**
New Magnetic Recorder.—(*See* 2321.)

621.775.7 **2464**
Powder Metallurgy.—J. W. Lennox. (*Machinery, Lond.*, 3rd April 1947, Vol. 70, No. 1797, pp. 337–344.) An account of production methods for a wide variety of metal parts, including porous bronze bearings, iron dust cores, electrical contacts, hard-metal tools, etc. The advantages and limitations of the process are discussed.

621.785.5 : [669.71 + 669.715 **2465**
Surface Hardening of Aluminium and Its Alloys.—K. G. Robinson & B. W. Mott. (*Metallurgia, Manchr*, Feb. 1947, Vol. 35, No. 208, pp. 201–204.) By careful control of conditions throughout the process, it is possible to obtain a hard copper-rich surface layer of reasonably good uniformity.

621.791.3 : 620.197 **2466**
Soldering Litz Ends.—E. Toth. (*Electronics*, March 1947, Vol. 20, No. 3, pp. 158..166.) An effective method consists of (*a*) burning the silk insulation and wiping off, (*b*) applying a paste of zinc chloride and water and heating with a soldering iron, (*c*) tinning immediately with resin-cored solder. With this method no trace of corrosion was found after equipment had been in service for 18 months in Panama.

621.791.353 : 669.018.21 **2467**
Metallic Joining of Light Alloys : Parts 3 & 4.—(*Light Metals*, March & April 1947, Vol. 10, Nos 110 & 111, pp. 111–120 & 203–209.) Discussion of fluxes for soldering aluminium, theory and practice of hard solders and soldering for light alloys, the mechanical and corrosion properties of soldered joints, American investigations on soft-soldering practices for aluminium and the possibilities of supersonic vibration as an aid to the tinning of aluminium. Though no adequate theory of this last process is yet available, it is thought that the mechanical vibration removes the oxide film from the surface of the metal, so that true metal-to-metal contact is achieved. Practical details are discussed briefly. For a complete account by A. E. Thiemann of this process see *Automobiltechnische Zeitschrift*, 25th Dec. 1942, Vol. 45, No. 24, p. 688, of which an English summary was given in *Light Metals*, 1944, Vol. 7, No. 77, pp. 263–264. For parts 1 & 2 see 2152 of July. To be continued.

666.1 : 621.385.832 **2468**
Gas Heat Speeds Production of Electron Tubes.—(*Glass Ind.*, Feb. 1947, Vol. 28, No. 2, pp. 75–77.) Details of R.C.A. production technique for cathode-ray tubes.

669.28-154.4 **2469**
Ductile Melted Molybdenum.—(*Metal Ind., Lond.*, 7th Feb. 1947, Vol. 70, No. 6, pp. 106, 113.) Molybdenum is melted by an electric arc in vacuo and the resulting casting, after deoxidation with carbon, is sufficiently ductile for hot working.

669.71 + 669.715 **2470**
Aluminium Developments.—S. A. J. Sage. (*Metallurgia, Manchr*, Feb. 1947, Vol. 35, No. 208, pp. 193–196.) A survey of improvements in production methods and of new alloy developments.

669.71 : 6 **2471**
Aluminium 1946.—W. C. Devereux. (*Metallurgia, Manchr*, Feb. 1947, Vol. 35, No. 208, pp. 191–192.) A general review. The Government policy of holding large quantities of secondary stock idle is considered. The need for research and development in the industry is stressed.

669.718.4/.7 **2472**
Metallization with Aluminium.—C. R. Draper. (*Light Metals*, March 1947, Vol. 10, No. 110, pp. 124–160.) "An exhaustive study of all current techniques and equipment for the coating of metallic

nd non-metallic bases with aluminium. Theory nd practice are considered in detail, with particular espect to the scope and economics of various elds of application."

69.718.6 : 621.385 2473
A Substitute for Nickel in Radio Valves.—*Electronic Engng*, April 1947, Vol. 19, No. 230, 123.) The Telefunken Co. have produced a pecially coated aluminium-iron sheet free from nc, whose outstanding characteristic is that the rface changes from normal aluminium brightness a dull dark grey on heating to 600°C in vacuo. his surface is an excellent radiator, comparable ith the blackened surfaces at present used. The etal cannot be used with evaporated cathodes. bstract of "Report on New Vacuum Tube chniques" (Fiat No. 500), published by H. M. ationery Office.

9.5 2474
Materials.—F. A. Freeth. (*J. R. Soc. Arts*, th April 1947, Vol. 95, No. 4740, pp. 333–339. scussion, pp. 339–341.) A general account of properties of polythene, methoxone, plastics d other new materials.

MATHEMATICS

.831 : 535.13 2475
Matrix Representation of Maxwell's Equations.—Baudot. (*C. R. Acad. Sci., Paris*, 10th March 7, Vol. 224, No. 10, pp. 735–737.)

.072 : 537 2476
Tensors and Electricity.—L. Bouthillon. (*Ann. dioélect.*, Oct. 1946, Vol. 1, No. 6, pp. 345–358.) lar, polar, axial and pseudoscalar quantities are ned and the different varieties of tensors to resent them described. The essential elements the tensor calculus are presented, together with original notation based on vector notation. plication of the results to electrostatics and gnetostatics shows that the two Coulomb ories of magnetism, as well as the classic Coulomb ory of electrostatics and Ampère's electrostatic ory can be developed in parallel, with interesting nts of similarity and difference. Maxwell's ations are given in tensor notation and put into most symmetrical form possible.

.512.2 : 621.396.61 2477
ourier Transform Analysis.—Levy. (*See* 2351.)

63 2478
Generalization of Laplace's Transform.—S. Varma. (*Curr. Sci.*, Jan. 1947, Vol. 16, No. 1, 17–18.) A generalization is given on which a calculus is based. Five theorems of this ulus are stated, without proof.

941.9 : 53 2479
New Method for Solving Certain Boundary lems for Equations of Mathematical Physics itting of a Separation of Variables.—G. A. nberg. (*Bull. Acad. Sci. U.R.S.S., sér. phys.*, , Vol. 10, No. 2, pp. 141–168. In Russian.) problems of mathematical physics reducible to ntegration of linear differential equations with rable variables and with linear boundary itions, the well-known Fourier-Lamé method rtial solutions is normally used. This method ly a particular case of a more general and adequate method. As an example, the Laplace equations (1,1) for a rectangle are considered and the method of partial solutions is applied to Dirichlet's problem with boundary conditions (2,1) and (2,2). A complete solution is obtained but complications arise when the method is applied to Neumann's problem with boundary conditions (2,14). Consequently a solution in the form (2,27) is derived and it is emphasized that this is radically different from that obtained by the Fourier-Lamé method. The proposed method is then generalized and applied to the following problems: (*a*) the distribution of current in a uniform conducting cylinder when the current is admitted through a circular electrode AB on one of the ends of the cylinder and taken off from a ring electrode CD on its curved surface (Fig. 3), (*b*) the propagation of electromagnetic and acoustic waves in an infinite straight waveguide with a sectorial cross-section (Fig. 5), and (*c*), as (*a*) but where the cylinder consists of a number of coaxial cylindrical surfaces of different conductivities. An English version was noted in 1838 of June.

518.5 2480
Recent Developments in Calculating Machines.—(*Engineer, Lond.*, 4th April 1947, Vol. 183, No. 4758, p. 292.) Summary of I.E.E. Measurements Section discussion opened by D. R. Hartree. 'Analogue' and 'digital' types of machine were distinguished. The importance of a storage or 'memory' device was stressed. In particular, the I.B.M. automatic sequence-controlled calculator (787 of March and back references), and the ENIAC (462 of February) were briefly mentioned, together with a new American digital machine called EDVAC, which uses mercury vapour delay lines. Automatic indication of error from valve failure cannot yet be fully provided. A central Mathematical Institute will be needed to provide staff to advise on the capabilities of new machines.

518.5 2481
The ENIAC — High-Speed Electronic Calculating Machine.—M. V. Wilkes. (*Electronic Engng*, April 1947, Vol. 19, No. 230, pp. 105–108.) A general description, with photographs and some details of the principles of operation. The apparatus contains about 1 500 relays and 18 000 valves, the power consumption being 150 kW. The basic circuit is the flip-flop; these are arranged in groups of 10 connected in rings so as to give a scale-of-ten counting system. All switching for the operational sequences involved in addition, multiplication, division, etc., is performed by means of pentode gate circuits. All the 2-μs pulses used in the Eniac have their origin in the cycling unit and their progress through the machine is controlled by gate valves. The numbers for the calculations are fed into the machine by means of punched cards of the kind used in the Hollerith accounting equipment. Memory, in the form of a storage device, and an adding machine are provided by units known as accumulators. A special unit carries out multiplication, making use of the method of partial products, the total time required for multiplication being about 14 addition times. Division is effected by repeated subtraction, the operating taking about 140 addition times, addition being performed in about 200 μs. Numbers from tables of functions may be set up in advance by the operator and can be transmitted in pulse form to any part of the

machine when required. Pulse control is also used for selecting the operational sequences and making the necessary inter-unit connections, a 'master programmer' determining the successive routines and the number of times each process is repeated. The importance of such machines is stressed because of their ability to perform long and tedious calculations at high speed. See also 1928 and 2995 of 1946 and 462 of February.

518.5 : 621.3 **2482**
A Relay Computer for General Application.—S. B. Williams. (*Bell Lab. Rec.*, Feb. 1947, Vol. 25, No. 2, pp. 49–54.)

531.31 : 521.4 **2483**
On Nearly Periodic Motions.—F. Loonstra. (*Proc. Acad. Sci. Amst.*, Sept. 1946, Vol. 49, No. 7, pp. 744–751. In French.) A general discussion, with consideration of nearly periodic motions that can be physically realized.

MEASUREMENTS AND TEST GEAR

389.6 : 621.317.36 : 621.396.97(73) **2484**
Standard Frequency Broadcasts.—(*Wireless World*, April 1947, Vol. 53, No. 4, p. 132.) National Bureau of Standards transmissions are now radiated by WWV on four additional frequencies (20, 25, 30 and 35 Mc/s) and include regular warnings of radio propagation disturbances.

620.193.91 : 621.385 **2485**
Tubes Life Tested under Pulsed Operating Conditions.—(*Elect. World, N.Y.*, 8th Feb. 1947, Vol. 127, No. 6, pp. 33–34.) Equipment for life-testing receiving valves gives positive grid pulses, adjustable from 50 to 350 V. Pulse width is 1–25 μs and recurrence frequency 500–2 500 pulses per sec.

621.317.3.011.5 : 621.392.029.64 **2486**
On the Measurement of Dielectric Constant with the Aid of a Waveguide.—G. Fejér & P. Scherrer. (*Helv. phys. Acta*, 20th Jan. 1943, Vol. 15, No. 7, pp. 645–684. In German.) A magnetron oscillator and a rectangular waveguide are used in the band λ 1–3 cm for determining dielectric constant and absorption. A metal disk short-circuits one end of the waveguide and a plate of the material investigated is placed in front of it. The total phase change of the reflected wave is measured and its dependence on the thickness of the plate gives the dielectric characteristics of the material. The theory of the method is given and the advantages of using the H_{01} wave with crystals are explained.

621.317.32 : 578.088.7 **2487**
Method for Measuring High-Frequency Electric Fields and Its Use for Local Short-Wave Dosimetry.—K. S. Lion. (*Helv. phys. Acta*, 20th Feb. 1941, Vol. 14, No. 1, pp. 21–50. In German.) The brightness of the electrodeless discharge in a small gas-filled sphere is proportional to the field strength. The dependence of the brightness on all the factors involved is investigated. A reference was given in 2770 of 1941.

621.317.335 : 621.396.694.032.2 **2488**
Measuring Inter-Electrode Capacitances.—C. H. Young. (*Tele-Tech*, Feb. 1947, Vol. 6, No. 2, pp. 68–70 . . 109.) New bridge, developed for measurement in h.f. valves of capacitances down to 2×10^{-3} pF.

621.317.34 **2489**
A Transmission Measuring Set for 0.1 to 11 c/s.—Bryden. (*See* 2511.)

621.317.341.029.6 **2490**
Attenuation Test Equipment for V.H.F. Transmission Lines.—F. A. Muller & K. Zimmerman. (*Télévis. franç.*, Feb. 1947, No. 22, Supplement *Électronique*, pp. 8–10.) Summary of 982 of 1946.

621.317.361 **2491**
The Identification of Harmonically Related Frequencies.—L. H. Moore. (*Electronic Engng*, April 1947, Vol. 19, No. 230, pp. 134–135.) A method for positive identification of the harmonic frequency with the minimum of apparatus. See also 3010 of 1945 (Anderson).

621.317.372 **2492**
Measurement of Q.—U. Zelbstein. (*Toute la Radio*, March/April 1947, Vol. 14, No. 114, pp. 121–123.) A simple description of indirect and of direct methods of measurement, with circuit diagrams of two *Q*-meters.

621.317.382.08 : 621.392.3 **2493**
R.F. Generator Load.—F. M. Leslie. (*Wireless Engr*, April 1947, Vol. 24, No. 283, pp. 105–108.) Describes the use of a short-circuited concentric transmission line with tap water as dielectric. The input impedance is calculated, and the input power may be found by measuring the temperature ris of the water flowing through the line.

621.317.7 + 621.38 + 621.396.69 **2494**
Physical Society Exhibition.—(*Electrician*, 4th–18th April 1947, Vol. 138, Nos. 3590–3592, pp. 847–849, 937–939 & 1014–1016; *Elect. Times*, 10th April 1947, Vol. 111, No. 2892, pp. 390–395; *Metal Ind., Lond.*, 18th April 1947, Vol. 70, No. 16, pp. 269–271; *Elect. Rev., Lond.*, 11th April 1947, Vol. 140, No. 3620, pp. 559–565; *Wireless Engr*, May 1947, Vol. 24, No. 284, pp. 150–154). Various accounts of the apparatus and equipment exhibited.

621.317.7 + 621.396.69 **2495**
The R.C.M.F. [Radio Component Manufacturers' Federation] **Exhibition.**—(*See* 2376.)

621.317.7 **2496**
Measurement Apparatus at the [Paris] **Components Exhibition.**—(*Toute la Radio*, March/April 1947, Vol. 14, No. 114, pp. 115–116.) A short account, including descriptions of an oscilloscope, valve tester, impedance bridge, resistance and capacitance box, etc.

621.317.7 **2497**
Output Analyser.—P. Bernard. (*Toute la Radio*, March/April 1947, Vol. 14, No. 114, pp. 124–125.) An instrument exhibited at the Paris Components exhibition. It can be used as a wattmeter, a valve voltmeter, a distortion meter or a decibel meter and also permits simple measurement of the useful sensitivity of receivers.

621.317.7 : 621.396.96 **2498**
Test Equipment and Techniques for Airborne-Radar Field Maintenance.—E. A. Blasi & G. C. Schutz. (*Proc. Inst. Radio Engrs, W. & E.*, March 1947, Vol. 35, No. 3, pp. 310–320.) Techniques for measuring frequency, power, receiver sensitivity and performance characteristics of airborne radar equipment are outlined. Test apparatus designed

to carry out these measurements in the field is described with particular mention of 'passive type' instruments not requiring any operating power, such as echo boxes and directional couplers.

621.317.72 : 621.396.813 2499
Distortion Analyzer.—J. T. Goode. (*Radio News*, Feb. 1947, Vol. 37, No. 2, pp. 60–61 . . 144.) Constructional and circuit details.

621.317.725 2500
Stable Voltmeter.—R. W. Gilbert. (*Electronics*, March 1947, Vol. 20, No. 3, pp. 130–133.) By using a plate follower circuit with compound feedback, a conductively coupled instrument of high stability is obtained. Zero drift is discussed and drift factors are given for the four basic degenerating networks.

621.317.733 : 621.316.89 2501
A Bridge Method for the Investigation of Non-linear Resistors.—G. T. Baker. (*Phil. Mag.*, July 1946, Vol. 37, No. 270, pp. 498–502.) R_S ($= V/I$) is termed the steady resistance and R_F ($= \Delta V/\Delta I$) the fluctuation resistance. When $\Delta V/V$ is small, it is shown that for resistors satisfying the relation $V = CI^{\beta}$, $R_F = \beta R_S$, while for the more general equation $V = RI + CI^{\beta}$, $R_F = R + \beta R_S$. R_F and R_S are measured directly on a simple resistance bridge fed by an adjustable d.c. voltage with a small superimposed a.c. voltage which constitutes ΔV. The d.c. balance gives R_S on a suitably calibrated scale and the a.c. balance, with galvanometer cut out and a c.r.o. used as indicator, gives β directly. The method of calibration is fully described, practical bridge details are given and the accuracy of the method is discussed.

621.317.761 : 621.318.572 2502
A Pulse Counter Circuit and Its Adaptation as a Frequency Meter.—Lemas. (*See* 2346.)

621.317.761.078 2503
Description of a New Type of Frequency Meter and Its Application to Power Frequency Control.—Esclangon. (*Bull. Soc. franç. Élect.*, Jan. 1947, Vol. 7, No. 65, pp. 11–20.) Three arms of a Wheatstone bridge are pure resistances and the fourth a series resonant circuit. At the resonant frequency balance is obtained with suitable values of the resistances. For any other frequency an a.c. voltage is developed across one diagonal and is in quadrature with the supply voltage; it can be observed either on a moving-coil electrodynamometer or a rotating-field instrument. The sensitivity is high and accuracy is little affected by harmonics. Simple additions to the instrument adapt it for frequency control.

621.317.761.087 2504
Direct Reading Frequency Meter of High Accuracy up to 100 Mc/s, with Recorder.—L. M. Berman. (*Onde élect.*, March 1947, Vol. 27, No. 240, pp. ...3.) A rack-mounted equipment comprising a wide series of relaxation oscillators controlled by a 100-kc/s quartz crystal and ranging from 10 Mc/s to ... c/s, a corresponding set of selectors and mixers and low-pass filters and valve voltmeters. An incoming frequency gives a series of beat frequencies with successively selected harmonics, the last digit being given by a direct-reading meter. Accuracy ±1 part in 10^6.

621.317.79 : 621.385 2505
A Method of Measuring Grid Primary Emission in Thermionic Valves.—A. H. Hooke. (*Elect. Commun.*, Dec. 1946, Vol. 23, No. 4, pp. 471–478.) Reprint of 1598 of 1946.

621.317.79 : 621.396.62 : 621.396.622.63 2506
Crystal Diode reduces Probe Size.—A. Bein. (*Radio News*, Feb. 1947, Vol. 37, No. 2, pp. 52, 147.) Application to signal tracing of a germanium crystal diode test probe, which indicates difference in modulation or changes in the audio component of the signal. Operates in the frequency band 90 kc/s – 33 Mc/s.

621.317.79 : 621.397.62 2507
Television Synchronizing Signal Generating Units : Part 2.—R. R. Batcher. (*Tele-Tech*, Feb. 1947, Vol. 6, No. 2, pp. 44–48. Correction, p. 127.) Method and equipment for combining picture and synchronizing signals, using the monoscope or image cameras. For part 1, see 1517 of May.

621.39.081 2508
Measurements in Communications.—N. B. Fowler. (*Elect. Engng, N.Y.*, Feb. 1947, Vol. 66, No. 2, pp. 135–140.) Includes a table, arranged for convenient reference, of some of the commoner measurement units and scales used in communication engineering.

621.396.822.08 : 621.396.62 2509
Visual Measurement of Receiver Noise.—Williams. (*See* 2570.)

OTHER APPLICATIONS OF RADIO AND ELECTRONICS

621.317.32 : 578.088.7 2510
Method for Measuring High-Frequency Electric Fields and Its Use for Local Short-Wave Dosimetry.—Lion. (*See* 2487.)

621.317.34 2511
A Transmission Measuring Set for 0.1 to 11 c/s.—J. E. Bryden. (*Electronic Engng*, March & April 1947, Vol. 19, Nos. 229 & 230, pp. 77–81 & 125–130.) A general description of the instrument and its principles of operation, with comprehensive technical details of the circuits. Developed for use with biological and servo apparatus.

621.317.361 : 531.767 2512
Measuring Velocity of V-2 Rockets by Doppler Effect.—J. F. McAllister. (*Tele-Tech*, Feb. 1947, Vol. 6, No. 2, pp. 56–59, 129.) Details of German high velocity measurement technique using a rocket-borne c.w. receiver-transmitter and a heterodyne method for measurement of the change of frequency.

621.317.761.078 2513
Description of a New Type of Frequency Meter and Its Application to Power Frequency Control.—Esclangon. (*See* 2503.)

621.365.5 + 621.365.92 2514
Induction and Dielectric Heating.—K. Pinder. (*Elect. Engng, N.Y.*, Feb. 1947, Vol. 66, No. 2, pp. 149–160.) The fundamental principles are outlined and various general types of operations are described where time, cost, equipment or material

can be saved. The types and sizes of units required in various cases are indicated.

621.365.5 **2515**
Heat Treatment of Highly Conducting Bodies by High-Frequency Eddy Currents.—M. Jouguet. (*Rev. tech. Comp. franç. Thomson-Houston*, Dec. 1946, No. 6, pp. 27–36.) Methods are given for calculating the distribution and power dissipation of eddy currents in a highly conducting solid bounded by any surface of the second degree, when placed in a uniform h.f. field of any orientation. Simplified practical calculations for h.f. furnaces are based on the determination of (*a*) the increase of the effective resistance of the heater winding due to the crucible and (*b*) the decrease of its reactance. The circular section normally used in h.f. furnaces can with advantage be replaced by an oval section. The use of partitions suitably fixed inside the furnace results in lower net and operational costs.

621.365.5 + 621.365.92] : 654 **2516**
Electronic Heating Units show Economy, Speed.—(*Electronic Industr.*, March 1947, Vol. 1, No. 3, pp. 2–3.) Discusses the economics of dielectric and induction heating and gives tables of (*a*) dielectric heating formulae and (*b*) processes in which h.f. heating can be used to reduce cost or increase speed.

621.365.92 : 621.396.662.21.042.15 **2517**
Baking Cores Dielectrically.—J. McElgin. (*Metallurgia, Manchr*, Feb. 1947, Vol. 35, No. 208, pp. 223–224.) With h.f. heating there is perfect control of time and temperature with no under- or overheating. Mass production methods become possible.

621.365.92.029.64 **2518**
Heating with Microwaves.—J. Marcum & T. P. Kinn. (*Electronics*, March 1947, Vol. 20, No. 3, pp. 82–85.) "Suggested methods of utilizing waveguides for applying microwave energy to moving or stationary wires and threads, sheets or irregularly-shaped objects to achieve uniform dielectric heating, and survey of tubes offering possibilities for continuous operation."

621.369.2 **2519**
The Infra-Red Gas Burner.—L. Sanderson. (*Metallurgia, Manchr*, Feb. & March 1947, Vol. 35, Nos. 208 & 209, pp. 187–189 & 239–240.) High rate of heat transmission and low heat loss are claimed. Applications to many branches of industry are described.

621.38 : 6(048) **2520**
Industrial Electronic Equipment Uses.—W. C. White. (*Electronic Industr.*, March 1947, Vol. 1, No. 3, pp. 6–7.) A list of 154 papers, all in English, on industrial applications of electronics and on closely related subjects. For earlier lists see 2655 of 1946, and back references.

621.38.078 **2521**
The Electron Tube as an Element in Industrial Control.—R. R. Batcher. (*Electronic Industr.*, March 1947, Vol. 1, No. 3, pp. 16–17.) A chart giving typical valve circuits for a wide range of control purposes.

621.38.078 **2522**
Process Control by Electronic Instrumentation.—R. R. Batcher. (*Electronic Industr.*, Feb. 1947, Vol. 1, No. 2, pp. 12–13.) A chart illustrating various devices which sense the changes in a variable process and deliver a controlling signal to an electronic system.

621.38.001.8 **2523**
Industrial Applications of Electronic Techniques.—H. A. Thomas. (*Engineer, Lond.*, 21st & 28th March & 4th April 1947, Vol. 183, Nos. 4756, 4757 & 4758, pp. 247–248, 271–272 & 295–297.) Summary of I.E.E. paper. A detailed description, with numerous diagrams, of a wide variety of electronic devices for measurement, industrial instrumentation and control, production, inspection and pro tection. A bibliography of some 60 papers i included.

621.384.6 **2524**
Measurement of Out-of-Phase Magnetic Fields in Betatrons.—W. Bosley, J. D. Craggs & D. H. McEwan. (*Nature, Lond.*, 15th Feb. 1947, Vol. 159, No. 4033, pp. 229–230.) A method for detection and approximate measurement similar to that outlined in 1543 of May.

621.384.6 **2525**
Biased Betatron in Operation.—W. F. Westendorp. (*Phys. Rev.*, 15th Feb. 1947, Vol. 71, No. 4, pp. 271–272.) A schematic cross-section of the machine is given, with a diagram of the principal electrical components of the energizing circuit. No compensating or phase correcting circuits of any kind were used. With oil-cooled coils, the machine will produce 50-MV X-rays.

621.384.6 **2526**
F.M. Cyclotron.—F. R. (*Electronics*, March 194 , Vol. 20, No. 3, p. 119.) The cyclotron at the University of California has pole faces about 15 ft in diameter, with a 20-inch gap and a peak potential of 50 kV across the gap between the dees. The oscillator used to charge the dees is frequency modulated at 120 c/s between 12.5 and 8.17 Mc/s by a rotary vacuum capacitor.

621.384.6 (43) **2527**
European Electron Induction Accelerators.—H F. Kaiser. (*J. appl. Phys.*, Jan. 1947, Vol. 18, No. 1, pp. 1–18.) The development of betatrons in Germany during and since the war is reviewed. Details are given of the constructional features of 6- to 15-MeV betatrons and of the theory and design of 15- and 200-MeV betatrons. The smaller units, especially the Siemens 6 MeV, are more advanced than comparable American units. No large machines were actually built, but the projected 200 MeV design presents novel features ; it would only weigh about 40 tons.

621.385.1.001.8 : 531.768.087 **2528**
Vacuum-Tube Acceleration Pickup.—W. Ramberg. (*Bur. Stand. J. Res.*, Dec. 1946, Vol. 37, No. 6, pp. 391–398.) A fixed indirectly-heated cathode has an elastically mounted plate on each side which is deflected when accelerations normal to the plates occur. Enough output is obtained at accelerations of the order of 10*g* to drive a recording galvanometer directly.

621.385.833 **2529**
New Electron Microscope.—(*Electrician*, 28th March 1947, Vol. 138, No. 3589, pp. 789–790.)

ummary and discussion of an I.E.E. Measurements ection paper entitled "The Design and Construc-ion of a New Electron Microscope", by M. E. laine.

21.385.833 2530

The Magnetic Electron Microscope Objective: ontour Phenomena and the Attainment of High esolving Power—J. Hillier & E. G. Ramberg. (*. appl. Phys.*, Jan. 1947, Vol. 18, No. 1, pp. 48–71.) he Fresnel diffraction fringes present in extra-ocal images obtained withs mall angular aperture illumination provide a sensitive criterion of the egree of symmetry of the objective. They also rovide a relatively simple method for correcting symmetry. Image quality with corrected lenses much improved.

1.385.833 2531

On the Aberration of Electrostatic Lenses due to llipticity.—F. F. Bertein & E. Regenstreif. (*C. R. cad. Sci., Paris*, 10th March 1947, Vol. 224, No. 10, . 737–739.) Formulae are derived for the limit of solution imposed by the ellipticity and experi-ents are described which confirm the existence of e aberration.

1.386.1 2532

A High-Intensity Source of Long-Wavelength Rays.—T. H. Rogers. (*Proc. Inst. Radio Engrs, & E.*, March 1947, Vol. 35, No. 3, pp. 236–241.) scription of an X-ray tube, giving radiation ensities of several million röntgens per minute er a 180° solid angle. Application to bactericidal d X-ray photo-chemical research is suggested.

1.386.84 2533

Application of Electronic Radiography to the tection of Thin Organic or Mineral Layers.—J. Trillat & C. Legrand. (*C. R. Acad. Sci., Paris*, March 1947, Vol. 224, No. 9, pp. 645–646.) plate of polished steel provides secondary elec-ns and its surface is covered with a very thin er of cellulose paint, grease, oil, etc. Fine-ined photographic paper is applied and, after osure and development, provides a measure of layer thickness. The method is applicable to knesses from 0.001 mm to several hundredths a millimetre. See also 1549 of May.

.395.623 : 578.088.7 2534

A Simplified Encephalophone.—Conrad & Pacella. 2350.)

.396.9 : 621.397.5 2535

elevision takes to the Air.—McQuay. (*See* 7.)

.396.9.083.7 : 551.5 2536

elemetering from V-2 Rockets: Part 1.—V. L. ren, C. H. Hoeppner, J. R. Kauke, S. W. tman & P. R. Shifflett. (*Electronics*, March 7, Vol. 20, No. 3, pp. 100–105.) An account, with uit diagrams, of the time-modulated pulse pment carried in the nose of the rocket. The lings of 23 instruments are sampled successively transmitted to the mobile ground station on a uency of 1 000 Mc/s.

396.96 : 551.41 2537

ew Radar Device.—(*Engineering, Lond.*, 14th 1947, Vol. 183, No. 4753, p. 181.) National arch Council, Canada, attempts to speed up map-making by flying aircraft fitted with a radar altimeter over uncharted territory; a contour map of 200 square miles can be made in three hours.

621.398 : 621.43 2538

A Telecontrolled Motor Car.—S. Coudrier. (*T.S.F. pour Tous*, March 1947, Vol. 23, No. 221, pp. 63–65.) Details of the control equipment of a model car, 50 cm long. With a 15–30 W transmitter working on a wavelength of 4–6 m the control radius is 2–3 km.

621.398 : 629.13 2539

Teleguided Missiles.—J. A. Niland. (*Radio Craft*, Feb. 1947, Vol. 18, No. 5, pp. 24..57.) A review of the use of radio-controlled planes, bombs and rockets with brief descriptions of methods of control.

623.454.25 : 621.396.9 2540

The Optical Proximity Fuze.—F. A. Zupa. (*Bell Lab. Rec.*, Feb. 1947, Vol. 25, No. 2, pp. 70–74.)

623.454.25 : 621.396.96 2541

Guidance of Shells by Radio Brain [proximity fuse].—(*Télévis. franç.*, Feb. 1947, No. 22, Supplement *Électronique*, p.3.) The fuse VT, known as 'Madame X', is a 4-valve receiver-transmitter of small dimensions, operating on radar principles and designed by R.C.A. It was fitted in the nose of shells used very successfully against V-1 projectiles.

623.454.25 : 621.396.96 : 621.385.3 2542

The Vibrotron.—J. V. (*See* 2624.)

621.3.078 2543

Electronic Control Handbook. [Book Review]—R. R. Batcher & W. Moulic. Caldwell-Clements, New York, 1946, 334 pp., $1.00 plus two years' subscription ($8.00) to *Electronic Industries*. (*Electronic Engng*, March 1947, Vol. 19, No. 229, pp. 100–101.) Believed to be the first book to present a general treatment of transducers from the viewpoint of the electronic engineer. Indispensable to those dealing with a wide range of electronic problems. A very favourable review.

621.38 2544

Electronic Engineering Handbook. [Book Review]—R. R. Batcher, W. Moulic and others. Caldwell-Clements, New York, 1944, 456 pp., 22s. 6d. (*Electronic Engng*, March 1947, Vol. 19, No. 229, pp. 100–101.) Deals mainly with fundamental valve types, circuits and applications. Valuable to those concerned with a wide range of electronic problems. A very favourable review.

PROPAGATION OF WAVES

535.13 2545

Quasi-Optical Links: Models of Ellipsoids [of diffraction] **and Spatial Aerials with Experimental Results.**—J. Dreyfus-Graf. (*Helv. phys. Acta*, 12th July 1944, Vol. 17, No. 4, pp. 245–250. In French.) See also 2058 of July.

538.566.2 2546

The Method of 'Phase Integral' as applied to the Solution of the Problem of Propagation of Radio Waves around the Earth.—M. I. Ponomarev. (*Bull. Acad. Sci. U.R.S.S., sér. phys.*, 1946, Vol. 10, No. 2, pp. 189–195. In Russian.) The problem presents great difficulties, to overcome which Eckersley proposed the 'phase integral' method (1932 Abstracts, p. 514). An attempt to justify the method mathematically was made by him with Millington (3835 of 1938), and later by Millington alone (2640 of 1939).

The method is examined in the present paper and the following conclusions are reached: (*a*) it cannot be regarded as a new method for solving the diffraction problem since it is only a modification of Watson's method: (*b*) it has limited possibilities and the field intensity cannot be determined without resorting to the classical solution of the problem: (*c*) the introduction of Fresnel's reflection coefficient is not fully justified: (*d*) the existence of the modified Watson's series requires proof; the simplification of the differential equation is not justified.

621.396.11 : 621.396.93 **2547**

A New Source of Systematic Error in Radio Navigation Systems requiring the Measurement of the Relative Phases of the Propagated Waves.—Norton. (*See* 2429.)

621.396.11.029.45 : 551.510.535 **2548**

The Oblique Reflexion of Very Long Wireless Waves from the Ionosphere.—M. V. Wilkes. (*Proc. roy. Soc. A*, 27th March 1947, Vol. 189, No. 1016, pp. 130–147.) "An attempt is made to provide a satisfactory theoretical basis for a future discussion of the experimental data on the propagation of very long radio waves (18 800 m) given by Best, Ratcliffe & Wilkes, and Budden, Ratcliffe & Wilkes [3441 of 1939 and back references]. The reflexion of very long plane waves incident obliquely on a horizontally stratified ionized medium with a vertical magnetic field is first considered in general terms, and it is shown that the medium can be divided into a transition region and a reflecting region. If the ionization in the reflecting region increases linearly with height it is shown that propagation is governed by the equations:

$$\frac{\partial^2 L}{\partial \zeta^2} + (\alpha + \zeta)\ L + \beta M = 0,$$

$$\frac{\partial^2 M}{\partial \zeta^2} + (\alpha - \zeta)\ M + \beta L = 0,$$

where α and β are constants depending on the angle of incidence. Under the conditions of the experiments β is small, and a solution, in terms of contour integrals, valid in this case is obtained."

621.396.11.029.62/.64 **2549**

On the Propagation of Ultra-Short Electromagnetic Waves in the Zone of Direct Visibility.—S. Ya. Braude & I. E. Ostrovski. (*Bull. Acad. Sci. U.R.S.S., sér. phys.*, 1946, Vol. 10, No. 2, pp. 225–234. In Russian.) The propagation of electromagnetic waves of wavelength 1 cm to 9 m over sea and land is discussed theoretically. The intensity of the field due to a vertical dipole is calculated for the case of a small elevation above the surface of the earth (which is assumed to be flat) of the transmitting and/or receiving dipoles. Certain conclusions are reached with regard to the depth and extension of the field when the dipoles are raised and also with regard to the effect of the operating frequency on the intensity of the field. The variation of the dielectric and conductivity properties of the medium with frequency and the effect of this on the field intensity of the dipole are examined. In studying the propagation of the waves along the surface of the earth, data are obtained on reflection coefficients different from those derived by Fresnel.

621.396.812 + 551.510.535] : 523.752 **2550**

Eruptions of the Solar Chromosphere and Their Influence on the Ionosphere and on Wave Propagation. Their Effects in Different Regions of the Radio Spectrum.—R. Bureau. (*Onde élect.*, Feb. 1947, Vol. 27, No. 239, pp. 45–56.) The main sources of information discussed are continuous records of the level of atmospherics on wavelengths in the neighbourhood of 10 000 m, together with records on various wavelengths between 20 m and 24 000 m. Comparison with results obtained in Great Britain for very long waves reveals a spectral effect which is interpreted as due to altitude. The sudden fade-outs on decametre waves and strengthening of long-wave signals are discussed. Some records on 2 000 m show, during the same eruption, successive fade-outs and strengthenings. This also is attributed to an altitude effect. February 1946 was marked by the passage across the solar disk of groups of spots and of eruptions larger than any previously observed. Examples are given of the radio effects then noted. The majority show simultaneous strengthening of long-wave signals and fade-outs on short waves. Two exceptional cases are discussed and also two cases of fade-out on 24 000 m. An explanation of the latter may be found in a particular structure of the abnormal D region.

2551

621.396.812 : 523.78 "1945.07.09" : 551.510.535

On the Results of the Ionosphere Measurements made during the Solar Eclipse of 9th July 1945.—Bulatoff. (*See* 2412.)

2552

621.396.812 : 523.78 "1945.07.09" : 551.510.535

Results obtained in observing the Propagation of Radio Waves during the Solar Eclipse of 9th July 1945.—Grigor'eva. (*See* 2411.)

621.396.812.029.64 **2553**

Attenuation of 1.25-Centimeter Radiation through Rain.—L. J. Anderson, J. P. Day, C. H. Freres & A. P. D. Stokes. (*Proc. Inst. Radio Engrs, W. & E.*, April 1947, Vol. 35, No. 4, pp. 351–354.) An account of an experimental investigation over a 6 400-ft optical path with nine equally spaced rain gauges. Readings were taken over 30-second intervals. Drop sizes were measured by the blotter method but no definite conclusions were obtained. The average measured attenuation was 0.37 db/mile/mm/hr, which is somewhat higher than Ryde's calculated value (515 of February).

RECEPTION

534.862.4 **2554**

Perfect v. Pleasing Reproduction — Discussion. G. F. Redgrave : F. Slater : B. C. Sewell : F. Duerden : J. Moir. (*Electronic Engng*, April 1947, Vol. 19, No. 230, pp. 115–116.) Comments on 1 85 of April and a reply by the author.

621.396.621 + 621.396.69 **2555**

Automatic Circuit Making. New Automatic Machine for Radio [receiver] Production.—(*Elect. Times*, 6th March 1947, Vol. 111, No. 2887, p. 237.) Summary of 1913 of June (Sargrove).

621.396.621 + 621.396.69 2556
Automatic Receiver Production.—(*Wireless World*, April 1947, Vol. 53, No. 4, pp. 122–123.) For a full account see 1913 of June (Sargrove).

621.396.621 2557
Measurements of Temperature of the Different Parts of a Radio Receiver and of the Oscillator Drift during Warming-Up Period.—I. L. Chakravarty. (*Indian J. Phys.*, Oct. 1946, Vol. 20, No. 5, pp. 193–195.) Tests on a Philips 595HN receiver. Temperature rise was highest (about 84°C) above the ballast tube. Near the i.f. transformer the temperature rose to 42°C. Stable conditions were reached in 2½ hours. The oscillator frequency decreased from 2 515 to 2 492 kc/s, corresponding to a temperature rise from 31°C to 35°C near the oscillator coil.

621.396.621 : 621.396.619.11 2558
The "Synchrodyne": A New Type of Radio Receiver for A.M. Signals.—Tucker. (*See* 2364.)

621.396.621 : 621.396.619.13 2559
Designing an F.M. Receiver: Part 1.—Roddam. (*See* 2365.)

621.396.621 : 621.396.681 2560
Rodina [receiver].—E. N. Genishta. (*Radio, Moscow*, April 1946, No. 1, pp. 32–38. In Russian.) Description of a battery-operated receiver, with details of construction and loudspeaker characteristics.

621.396.621.029.6 : 621.396.645 2561
I.F. Amplifier for High Gain F.M. Receiver.—Martin. (*See* 2368.)

621.396.621.029.64 : 621.396.96 2562
Considerations in the Design of Centimeter-Wave Radar Receivers.—S. E. Miller. (*Proc. Inst. Radio Engrs*, *W. & E.*, April 1947, Vol. 35, No. 4, pp. 340–351.) General principles of design and operation for duplex working. Typical circuit arrangements for various elements of the receiver, including the TR switches and automatic tuning unit, are described with particular reference to the 10 000–30 000 Mc/s frequency band. Average values for noise figures of the elements are given.

621.396.621.54 2563
Superregenerative Frequency Converter.—P. V. Mace & M. Barat, Jr. (*Radio News*, Feb. 1947, Vol. 37, No. 2, pp. 39..134.) Construction and operation details of an inexpensive converter for extending the range of existing types of communications receivers into the v.h.f. and u.h.f. regions. The circuit diagram of a 144-Mc/s unit is given.

621.396.621.54.029.56/.58 2564
5-Tube Ham Super.—C. V. Hays. (*Radio News*, Feb. 1947, Vol. 37, No. 2, pp. 62–63..120.) Constructional and circuit details of a receiver for the 10, 20, 40 and 80 m bands.

621.396.667 2565
Towards High Fidelity. Expansion Circuits.—Tabard. (*Télévis. franç.*, March 1947, No. 23, Supplement *Électronique*, pp. 10–13.) A general discussion of frequency expansion and compression, with circuit diagrams of various practical devices.

621.396.813 : 621.317.72 2566
Distortion Analyzer.—Goode. (*See* 2499.)

621.396.822 : 621.314.631 2567
Noise Spectrum of Crystal Rectifiers.—P. H. Miller, Jr. (*Proc. Inst. Radio Engrs*, *W. & E.*, March 1947, Vol. 35, No. 3, pp. 252–256.) A study in the frequency range from 50 c/s to 1 Mc/s. The measurement circuits are described. Noise temperature was found to vary inversely as the frequency.

621.396.822 : 621.396.621 2568
Specification and Measurement of Receiver Sensitivity at the Higher Frequencies.—J. M. Pettit. (*Proc. Inst. Radio Engrs*, *W. & E.*, March 1947, Vol. 35, No. 3, pp. 302–306.) An outline of the factors involved in measuring sensitivity and an attempt to evaluate their relative importance. The influence of receiver noise at higher frequencies has led to the specification of sensitivity in terms of noise figure and a method of measuring this quantity with a diode noise generator is introduced. To include both overall gain and noise threshold a combined sensitivity figure is proposed.

621.396.822 : 621.396.621.53 2569
Some Considerations governing Noise Measurements on Crystal Mixers.—S. Roberts. (*Proc. Inst. Radio Engrs*, *W. & E.*, March 1947, Vol. 35, No. 3, pp. 257–265.) A discussion of the principles of the analysis and measurement of noise in radio receivers. Noise generated in a crystal rectifier is analysed in terms of 'noise temperature'. The design of a noise-measuring set is discussed. It is found practicable to measure the noise temperature of a crystal rectifier independently of its impedance.

621.396.822.08 : 621.396.62 2570
Visual Measurement of Receiver Noise.—D. Williams. (*Wireless Engr*, April 1947, Vol. 24, No. 283, pp. 100–104.) A pulse-modulated carrier is injected into the receiver and the output observed on a c.r.o., the input being adjusted until an assigned relation between the magnitudes of the output pulse and the noise is observed. Results obtained with three variations of the method are discussed.

621.396.828 : 621.327.43 2571
Preliminary Study of Radio Interference as caused by Fluorescent Lamps in the Home.—L. F. Shorey & S. M. Gray. (*Illum. Engng, N.Y.*, March 1947, Vol. 42, No. 3, pp. 365–376.) Tests carried out on a number of fixed and portable lamps, mainly of the 32-W circular type, showed that by the use of metal wire screens and non-inductive capacitors, interference could be reduced to a tolerable level and in some cases eliminated altogether.

621.396.621.004.67 2572
Wireless Servicing Manual. [Book Review]—W. T. Cocking. Iliffe & Sons, London, 328 pp., 10s. 6d. (*Elect. Rev., Lond.*, 28th March 1947, Vol. 140, No. 3618, p. 480.) Revised edition. A book essentially for the repairer.

STATIONS AND COMMUNICATION SYSTEMS

003.62(100.1) : 621.396 2573
Call Signs of the Countries.—(*Radio, Moscow*, April 1946, No. 1, pp. 54–55. In Russian.) Includes details of the Russian Zones.

621.395.44 : 621.315.052.63 **2574**

Transmissions in Power Distribution Networks.—A. Chevallier. (*Onde élect.*, March 1947, Vol. 27, No. 240, pp. 79–86.) A description of methods used in the French grid system for carrier current telephony, the transmission of power measurements, including power exchanges with neighbouring grid systems, transmission to works of control orders after measurement of power and/or frequency, and transmission of information on synchronism and of signals necessary for the selective protection of the lines.

621.396.029.56/.58 **2575**

Amateur Frequency Bands.—V. S. Saltikoff. (*Radio, Moscow*, May 1946, No. 2, pp. 50–52. In Russian.)

621.396.65.029.64 **2576**

Microwave Communications System.—(*Electronics*, March 1947, Vol. 20, No. 3, pp. 138, 140.) Point-to-point relay equipment operating in the 2 450–2 700 Mc/s or 3 700–4 200 Mc/s bands. See also 265 of January.

621.396.65 Vanguard **2577**

H.M.S. Vanguard. Radio Communication Arrangements for the Royal Cruise.—G. M. Bennett. (*Wireless World*, March 1947, Vol. 53, No. 3, pp. 80–83.)

621.396.931 **2578**

Radio Communication in a French Marshalling Yard.—(*Engineer, Lond.*, 7th Feb. 1947, Vol. 183, No. 4752, p. 157.) For one-way working at Trappes a 25-W 166-Mc/s transmitter is used, with damp- and dust-proof receivers and loudspeakers in the shunting locomotives' cabs. Later equipment, comprising light-weight transmitter-receivers, gives a two-way communication range of 3 to 4 km.

621.396.931.029.62 **2579**

Radio Despatching for Taxicabs.—A. A. McK. (*Electronics*, March 1947, Vol. 20, No. 3, pp. 97–99.) Some details of a two-way radio system now in operation in New Jersey, using f.m. on frequencies of 152.27 Mc/s and 157.53 Mc/s respectively.

621.396.97 (213) **2580**

Tropical Broadcasting.—" Radiator ". (*Wireless World*, April 1947, Vol. 53, No. 4, pp. 139–140.) Summary of and comment on 1942 of June.

SUBSIDIARY APPARATUS

621.314.632/.634 **2581**

Rectifiers : Selenium and Copper-Oxide.—W. H. Falls. (*Gen. elect. Rev.*, Feb. 1947, Vol. 50, No. 2, pp. 34–38.) A general account of their characteristics, including forward and leakage resistance, voltage rating, regulation, operating temperature, intermittent overload operation and aging.

621.314.634 : 621.396.621 **2582**

Selenium Rectifiers for Broadcast Radio Receivers.—E. W. Chadwick. (*Elect. Commun.*, Dec. 1946, Vol. 23, No. 4, pp. 464–467.) The high forward peak current rating of selenium rectifiers permits a larger input capacitance in power supply filters than is possible with diodes. The construction is described and practical circuits given.

621.318.5.077.8 **2583**

Capacity Operated Relays.—R. G. Rowe. (*Radio News*, Feb. 1947, Vol. 37, No. 2, pp. 50–51 . . 137.) Brief notes on four general types, and a detailed account of a method depending on changes of reflected resistance in the tuned circuit of a capacitance-controlled sensing element.

621.398+621.314.12 **2584**

Selsyns and Amplidynes.—F. Penin. (*Tech. mod.*, 1st/15th April 1947, Vol. 39, Nos. 7/8, pp. 126–129.) Describes the basic principles and applications of selsyns for telecontrol of angular position and of amplidynes in power amplification where electronic amplifiers are not practicable.

621.398 **2585**

Remote Control and Indication.—(*Elect. Rev., Lond.*, 14th March 1947, Vol. 140, No. 3616, p. 389.) Fundamental principles and brief constructional details of the ' Magslip ' transmission system. A basic element comprises two rotors with common a.c. feed, the stator windings being interconnected phase-for-phase so that no current flows between them when the rotors are in coincident angular positions. Displacement of one rotor upsets this balance and causes a corresponding displacement of the other rotor. Accuracy greater than 1° is possible.

TELEVISION AND PHOTOTELEGRAPHY

621.397.26.029.64 **2586**

U.H.F. Television Relay System.—W. Boothroyd. (*Electronics*, March 1947, Vol. 20, No. 3, pp. 86–91.) Wide-band f.m. equipment, operating on 1 350 Mc/s, for black-and-white video signals. Suitable either for inter-city multiple links or studio-to-transmitter work.

621.397.5 : 621.396.9 **2587**

Television takes to the Air.—J. McQuay. (*Radio News*, Feb. 1947, Vol. 37, No. 2, pp. 57–59 . . 102.) A review of the ' Block ' and ' Ring ' systems developed during the war and of proposed applications for a video news service.

621.397.5 (44) **2588**

Television throughout France. Coaxial [cable], Hertzian [radio] Relays or Stratovision.—Y. Angel. (*Télévis. franç.*, March 1947, No. 23, pp. 7–11.) A discussion of some of the problems connected with the construction of a national television network. Stratovision could serve 80% of France, containing 85% of the population, by means of three receiver-transmitter aircraft suitably located.

621.397.5 (44) **2589**

Incoherence.—M. Chauvierre. (*Radio franç.*, 1947, No. 4, p. 35.) Criticizes the lack of a decision as to the future line standard for television in France, but gives cogent reasons for the opinion that all the data necessary for making such a decision are not yet available.

621.397.5 (73) **2590**

Television in the U.S.A.—M. Chauvierre. (*Radio franç.*, 1947, No. 4, pp. 36–47.) A review of the television systems and services at present available, including the N.B.C., C.B.S. and Allen B. Dumont systems, with a detailed discussion of the rival colour television systems proposed by C.B.S. and by R.C.A. Receiver production is also considered. The author concludes that Europe need not envy merica regarding receivers, which in the U.S.A. nust provide for 13 frequency bands. As regards uality of service, however, he considers much an be learned from the efficiency of private enterrise in the U.S.A.

21.397.6 : 621.385.832 **2591**
Experimental C.R. Tubes for Television.—F.R. *ee* 2629.)

21.397.61.029.63 **2592**
Color-Television Transmitter for 490 Mc/s.—. H. Young. (*Elect. Commun.*, Dec. 1946, Vol. 23, o. 4, pp. 406–414.) Specifications and descriptions a C.B.S. equipment with output 1 kW installed the Chrysler Building, New York. The final nplifier stages all use 6C22 valves.

1.397.611 : 621.383 **2593**
Theory and Improvement of the Iconoscope.— Barthélemy. (*Télévis. franç.*, March 1947, . 23, p. 17.) Short summary of paper presented a meeting of the Television Section of the ciété des Radioélectriciens, 15th Oct. 1946. r another account of the iconoscope see 917 of rch.

.397.62 **2594**
Postwar Television Receivers.—D. W. Pugsley. *ect. Engng, N.Y.*, March 1947, Vol. 66, No. 3, 249–253.) Summary of A.I.E.E. paper. A eral description of the design features and struction of the latest American receivers, luding both direct-view and projection types.

.397.62 **2595**
Television Receiver Construction : Parts 3 & 4.— *ireless World*, March & May 1947, Vol. 53, s. 3 & 5, pp. 103–107 & 164–169.) Frame s are wound as plain slab coils and then bent to pe. Full details are given of winding formers, unting board, final frame coil assembly, frame e base and synchronizing separator. For parts 2 see 1245 of April and 1953 of June.

.397.62 **2596**
he Coudert Simplified Television Receiver.— Coudert. (*Radio en France*, 1947, No. 3, pp. 22.) An account of the principles, lay-out circuits of an economical and simple receiver h only 22 valves.

397.62 : 621.317.79 **2597**
levision Synchronizing Signal Generating Units : t 2.—Batcher. (*See* 2507.)

397.62 : 621.396.615.029.6 **2598**
he 6C5 and 54 Mc/s.—Pinot. (*See* 2359.)

397.62.018.078.3 **2599**
utomatic Frequency-Phase Control in TV Rers.—A. Wright. (*Tele-Tech*, Feb. 1947, Vol. No. 2, pp. 74–76, 127.) Interference which es line instability is overcome by using a stable wave oscillator for line synchronization. ations in phase between the generated sine and the incoming synchronizing pulses pro- a d.c. voltage which is used for automatic uency correction of the oscillator.

397.621 **2600**
erlacing.—W. T. Cocking. (*Wireless World*, 1947, Vol. 53, No. 4, pp. 124–128.) Diagrams are given showing that regular timing and also similarity of waveform of successive timebase cycles are of great importance for good interlacing. To achieve this, careful design of the synchronizing pulse separator circuits and the saw-tooth generator is necessary.

621.397.645 : 621.396.615.17 **2601**
Electromagnetic Deflexion in Television.—(*Télévis. franç.*, Feb. 1947, No. 22, pp. 2–4.) Summary of 3086 of 1946 (Cocking).

TRANSMISSION

621.396.61 **2602**
Station in Lipstick Tube.—(*Sci. News Lett., Wash.*, 22nd Feb. 1947, Vol. 51, No. 8, p. 117.) A development from methods used in the proximity fuse. The circuits are painted on the envelope of a miniature valve and small batteries and a microphone complete the transmitter. Similar methods may give vest-pocket radio receivers and hearing aids.

621.395.61.029.56/.58 **2603**
10-kW Short-Wave Telegraph Transmitter, Type T.-H. 1343.—J. J. Brieu. (*Rev. tech. Comp. franç. Thomson-Houston*, Dec. 1946, No. 6, pp. 37–43.) A monobloc transmitter for transcontinental links. Six quartz-controlled frequencies are available and a high-stability auto-oscillator can be used on any frequency between 5 and 20 Mc/s.

621.396.61/.62].029.62 (52) **2604**
250–300 Mc/s Radiophone.—R. F. Scott. (*Radio Craft*, Feb. 1947, Vol. 18, No. 5, pp. 20–21.) Description of a Japanese portable transceiver having a horizontally polarized directional aerial and designed for speech or i.c.w. modulation. Photographs and circuit diagrams are given.

621.396.61.029.62 **2605**
A Three-Phase Rotating-Field Transmitter for Ultra-Short Waves.—W. Dieterle. (*Helv. phys. Acta*, 31st March & 8th May 1942, Vol. 15, Nos. 2 & 3, pp. 127–161 & 199–220. In German.) Three horizontal rods (tripole) excited with currents of equal amplitude but 120° phase difference provide a uniform radiation pattern. The theory of the three-wire feeder with star or delta terminations and the method of feeding it from the transmitter are described. The adjustments and monitoring of the transmitter, feeder and aerials are considered in detail with numerous diagrams. A radiated power of 300 W on λ 6.2 m is obtained on the system described.

621.396.65.029.63 **2606**
48-Channel F.M. Phone Transmitter.—A. van Weel. (*FM & Televis.*, March 1947, Vol. 7, No. 3, pp. 28–30 . . 61.) A transmitter for an u.h.f. link between the Philips factories at Eindhoven and Tilburg. Wavelengths used are 90.5 and 99 cm in the two directions. Modulation with frequencies from 12 to 204 kc/s, for 48 simultaneous calls, takes place on a carrier wave with a frequency $\frac{1}{8}$ of the transmitter frequency, the maximum frequency swing being 67 kc/s. A new method of interstage coupling simplifies the wiring. The transmitting valves used are QQE06/40 double tetrodes, which have a common screen grid for the two balanced systems and will give 40 W on λ 3 m or 30 W on λ 1 m.

VALVES AND THERMIONICS

621.317.7.085 2607
"Magic Eye" as Null Indicator.—D. A. Ward. (*Wireless World*, April 1947, Vol. 53, No. 4, p. 150.) Comment on 1255 of April. Circuit modifications are given for the EM34 which result in a sensitivity approximately the same as that of the pre-war EM1. *Note.* In 1255 of April EM2 should read EM1.

621.38+621.317.7+621.396.69 2608
Physical Society Exhibition.—(*See* 2494.)

621.385 : 620.193.91 2609
Tubes Life Tested under Pulsed Operating Conditions.—(*See* 2485.)

621.385 : 621.317.79 2610
A Method of Measuring Grid Primary Emission in Thermionic Valves.—A. H. Hooke. (*Elect. Commun.*, Dec. 1946, Vol. 23, No. 4, pp. 471–478.) Reprint of 1598 of 1946.

621.385 : [621.396.822+537.525.5 2611
Effects of Magnetic Field on Oscillations and Noise in Hot-Cathode Arcs.—Cobine & Gallagher. (*See* 2400.)

621.385 : [621.396.822+537.525.5 2612
Noise in Gas Tubes.—Cobine & Gallagher. (*See* 2401.)

621.385 : 669.718.6 2613
A Substitute for Nickel in Radio Valves.—(*See* 2473.)

621.385.032.3 2614
Carbide Structures in Carburized Thoriated-Tungsten Filaments.—C. W. Horsting. (*J. appl. Phys.*, Jan. 1947, Vol. 18, No. 1, pp. 95–102.) The wide variety of carbide structures in the surface layers of such filaments is traced to carburizing conditions and subsequent processing during valve manufacture. A laminated structure frequently found contains less carbon than W_2C. Thyratron control of carburization is shown to be excellent, provided the filaments have uniform surface conditions and the hydrocarbon content in the hydrogen atmosphere is maintained. Abnormal filament current in valves is due to changes in thermal emissivity caused by surface conditions.

621.385 "1920/1946" 2615
A Quarter Century of Electronics.—I. E. Mouromtseff. (*Elect. Engng, N.Y.*, Feb. 1947, Vol. 66, No. 2, pp. 171–177.) An outline of the main stages in the development of high-vacuum valves from the manufacturing standpoint.

621.385.1 2616
Recent Developments in Transmitting Valve Technique. A Series of Modern Valves.—R. Suart. (*Ann. Radioélect.*, Oct. 1946, Vol. 1, No. 6, pp. 391–408.) A concise review of new materials and methods of construction which have resulted in a great increase of maximum power, reduced inter-electrode capacitance and transit time and increased maximum operating frequency. Details are also given, with operational characteristics, of a series of valves made by the Société Française Radioélectrique, ranging from P2, a 2-W pentode of very small dimensions, to water-cooled 450-kW triodes.

621.385.1 : 621.386.16 : 548.0 2617
Usefulness of X-Ray Crystallography Examination in the Valve Industry.—Nguyen Thien-Chi. (*Ann. Radioélect.*, Oct. 1946, Vol. 1, No. 6, pp. 383–390.) Examples are given of a wide variety of tests, mainly employing X-ray diffraction, carried out on valve parts and materials from many stages of valve production.

621.385.1.012(47) 2618
Radio Valves : Soviet Valves.—K. I. Drozdoff. (*Radio, Moscow*, April & May 1946, Nos. 1 & 2, pp. 39–44 & 37–41. In Russian.) Valve base data and tables of characteristics.

621.385.1.001.8 : 531.768.087 2619
Vacuum-Tube Acceleration Pickup.—Ramberg. (*See* 2528.)

621.385.1 "1939/1945" 2620
Electron Tubes in World War II.—J. E. Gorham. (*Proc. Inst. Radio Engrs, W. & E.*, March 1947, Vol. 35, No. 3, pp. 295–301.) Summary of advance made in design and performance of both transmitting and receiving valves used by the U.S. Army. Discussion of : improvements in cathodes, filaments and the alloys used to reduce grid emission; mode separation leading to anode strapping in magnetrons, for which methods of tuning and maximum power outputs are given ; characteristics of gas-filled TR tubes and the use of crystal rectifiers as mixers, detectors and d.c. restorers ; development of both klystrons and planar triodes for low power output requirements ; improvements in electron guns for c.r.ts ; various types of screen ; the use of low supply voltages for receiving valves ; improved protection against vibration ; and the trend towards miniature types.

621.385.3 2621
Triode Amplification Factors.—J. H. Fremlin, R. N. Hall & P. A. Shatford. (*Elect. Commun.*, Dec. 1946, Vol. 23, No. 4, pp. 426–435.) The validity of certain formulae for the amplification factor as a function of the ratio of wire diameter to grid pitch is discussed. Experiments with a triode of high shadow ratio, in which the anode/grid and grid/cathode spacings could be varied, indicate that Ollendorff's formula is the most accurate. The determination of amplification factor, for small anode/grid spacing, from a mechanical model agrees closely with a formula derived by one of the authors.

621.385.3 : 621.396.694.012.8 2622
Valve Equivalent Circuit.—B. Salzberg. (*Wireless Engr*, April 1947, Vol. 24, No. 283, pp. 124–125.) The constant voltage generator and constant-current generator forms of equivalent circuit for a triode valve are compared. It is shown that they are equivalent as regards the external impedance but not as regards the internal impedance unless the two impedances are equal. The constant voltage representation is considered to be the more fundamental. See also Howe's editorial, 2623 below, and back references.

621.385.3 : 621.396.694.012.8 2623
On the Use of Equivalent Circuits to represent the Valve.—G.W.O.H. (*Wireless Engr*, April 1947, Vol. 24, No. 283, pp. 97–99.) Editorial discussion of the valve equivalent circuit, confirming Salz-

berg's conclusions (2622 above). For earlier discussion see 949 of March and 1966 of June.

521.385.3 : 623.454.25 : 621.396.96 2624
The Vibrotron.—J.V. (*T.S.F. Phono-Ciné Électricité*, 10th March 1947, Vol. 23, No. 516, p. 17.) An R.C.A. miniature triode weighing only 2 gm, of the type used during the war for proximity fuses. The anode passes out through a metal diaphragm forming the end of the envelope and is terminated in a stylus. Mechanical vibrations applied to the stylus produce variations of inter-electrode capacitance. The triode may be used in a very light or sensitive pickup, or as a microphone if the stylus is replaced by a membrane of suitable surface area.

621.385.4 2625
Space-Current Division in the Power Tetrode.—. M. Wallis. (*Proc. Inst. Radio Engrs, W. & E.*, April 1947, Vol. 35, No. 4, pp. 369–377.) The methods already used for the determination of the current division in a triode (435 of 1942) may be applied, in a modified form, to the power tetrode.

621.385.4 2626
Subminiature Electrometer Tube.—C. D. Gould. (*Electronics*, March 1947, Vol. 20, No. 3, pp. 106–109.) A tetrode which requires only 13 mW for filament heating and has a very high input resistance. Applications to radiation meters are described.

621.385.82.032.29.027.3 2627
Ion Beams in High Voltage Tubes using Differential Pumping.—E. S. Lamar & W. W. Buechner. (*J. appl. Phys.*, Jan. 1947, Vol. 18, No. 1, pp. 22–27.) Focused hydrogen ion beam currents of 5 μA were obtained at the target end of a 6-ft tube operated at 300–400 kV. See also 2218 of 1941.

621.385.83 : 621.396.615.029.64 2628
The Multireflection Tube. A New Oscillator for Very Short Waves.—F. Coeterier. (*Philips tech. Rev.*, Sept. 1946, Vol. 8, No. 9, pp. 257–266.) The general principles of reflex oscillators are discussed. The new tube has a glass envelope 55 mm in diameter. An oxide cathode behind the aperture of a control electrode sends an electron beam through holes in the sides of a box-shaped anode. A λ/4 Lecher modulator system is located inside the envelope, the repeller electrodes being outside. The anode is between the repeller electrodes and the cathode. Capacitive coupling to the Lecher system is used, with strip leads sealed through the envelope. With a magnetic field directed along the beam and an anode voltage of 3 000 V, an effective power of 10 to 20 W is obtained on a wavelength of 12 cm.

621.385.832 : 621.397.6 2629
Experimental C.R. Tubes for Television.—F.R. (*Electronics*, March 1947, Vol. 20, No. 3, pp. 112–115.) New tubes include one with a screen brightness of 300 foot-lamberts for monochrome receivers, a projection tube and a direct-viewing tube for trichrome receivers, and a tube with a very fast-response phosphor for use in photovision scanning.

621.385.832 : 666.1 2630
Gas Heat speeds Production of Electron Tubes.—(See 2468.)

621.396.615.141.2 2631
A Magnetron Oscillator with a Series Field Winding.—L. H. Ford. (*J. Instn elect. Engrs*, Part III, Jan. 1947, Vol. 94, No. 27, pp. 60–64.) A continuous-wave magnetron oscillator whose magnetic field is provided by an electromagnet energized by the anode current of the valve. Experiments were conducted over a frequency range of 40–750 Mc/s with two-segment-anode and four-segment-anode magnetrons, and oscillations were obtained over a large range of anode voltages. With the two-segment-anode magnetron, oscillations occurred at the fundamental frequency of the circuit connected to the valve; with the four-segment-anode magnetron, oscillations at 3, 5, 7 . . . times the fundamental appeared as the anode voltage was increased. During oscillation the anode current assumes the optimum field value. Danger from excessive anode current is largely removed and stability is good.

621.396.615.141.2 : 537.291 2632
Electron Trajectories in a Plane Single-Anode Magnetron — A General Result.—L. Brillouin. (*Elect. Commun.*, Dec. 1946, Vol. 23, No. 4, pp. 460–463.) A theorem previously developed for a plane diode (3883 of 1945) is extended as follows: if an arbitrary voltage variation is applied to the anode of a plane magnetron, electron trajectories will never cross each other provided (*a*) the current never becomes negative and (*b*) the current remains space-charge limited and saturation current is never obtained.

A method of computing the electron trajectories is discussed assuming 'single stream motion' where the electrons are unidirectional. The theorem is shown to hold for space charge limited current but when saturation is reached "inter-crossing of trajectories will occur near the end of the first 'double Larmor' period and the motion will become double stream". Electron trajectories are plotted using the method described. See also 75 of January.

621.396.622.63 : 621.317.79 2633
Crystal Diode reduces Probe Size.—Bein. (See 2506.)

621.396.694 : 538.3 2634
On the Helix Circuit used in the Progressive Wave Valve.—Roubine. (See 2339 & 2340.)

621.396.694.032.2 : 621.317.335 2635
Measuring Inter-Electrode Capacitances.—Young. (See 2488.)

MISCELLANEOUS

001.89 : 061.31 2636
British Commonwealth Scientific Co-Operation.—(*Nature, Lond.*, 22nd Feb. 1947, Vol. 159, No. 4034, pp. 257–259.) Comment on 2295 of July. See also 3828 of 1946 and 961 of March.

016 : 621.396"1945/1946" 2637
Radio Progress during 1946.—(*Proc. Inst. Radio Engrs, W. & E.*, April 1947, Vol. 35, No. 4, pp. 399–425.) A review of the literature published during 1945 and 1946 containing some 750 references.

061.6(54) 2638
The National Physical Laboratory of India.—K. N. Mathur. (*Nature, Lond.*, 8th Feb. 1947, Vol. 159, No. 4032, pp. 184–186.) A comprehensive scheme detailing the functions, organization,

staff, etc., for the laboratory to be erected at New Delhi, drawn up after consultation with the National Physical Laboratory, Teddington, and the National Bureau of Standards, Washington. The work to be carried out in the various sections is briefly described. An important division will be that of Electronics and Sound, which will include all aspects of electronic work and of acoustical measurements.

061.6(54) **2639**

National Research Laboratories of India.—S. Bhatnagar. (*Nature, Lond.*, 8th Feb. 1947, Vol. 159, No. 4032, pp. 183–184.) These will include a Physical, a Chemical and a Metallurgical Laboratory, a Glass and Ceramic Research Institute and a Fuel Research Iustitute. Their functions and the scope of the work to be carried out are outlined.

535.65-15 **2640**

On the Stability of Spectral Characteristics of Selenium Filters for Infra-Red Radiation.—A. V. Kurtener (Courtener) & E. K. Malyšev. (*Bull. Acad. Sci. U.R.S.S., sér. phys.*, 1941, Vol. 5, Nos. 4/5, pp. 475–477. In Russian with English summary.) The stability of filtration capacity was investigated for filters prepared by the deposition of selenium evaporated in vacuo upon rock salt. For at least three months after preparation, the characteristics of these filters remained unchanged in the range of wavelengths from 1–15 μ.

621.3+669] (73) "1946" **2641**

Research and Laboratory Investigations.—(*Gen. elect. Rev.*, Jan. 1947, Vol. 50, No. 1, pp. 12–15.) A review of developments in a wide field ranging from atomic energy to chemical and metallurgical research. Reference is made to (*a*) betatrons and synchrotrons giving very high accelerating voltages, (*b*) an X-ray photometer using a split beam from a single source, (*c*) Permafil-treated transformers and coils, (*d*) new alloys, (*e*) stainless wire for recorders, (*f*) a clear casting resin for obtaining surface replicas, and (*g*) new magnet alloys and materials, including Alnico-6 and Vectolite, a hardened, sintered combination of iron oxide and cobalt oxide which is non-conducting and light in weight.

621.3.016.25 **2642**

Sign of Reactive Power.—(*Elect. Engng, N.Y.*, Feb. & March 1947, Vol. 66, Nos. 2 & 3 pp. 206–208 & 321–323.) Comment on the recent recommendation of the A.I.E.E. Standards Committee noted in 971 of March; see also 1972 of June and back references.

621.362 **2643**

Sensitive High-Speed Radiation Thermocouple.—H. Cary & K. P. George. (*Phys. Rev.*, 15th Feb. 1947, Vol. 71, No. 4, pp. 276–277.) Summary of Amer. Phys. Soc. paper. The conditions are analysed for obtaining the maximum signal/noise ratio. A vacuum thermocouple designed for optimum performance at 10 c/s is described.

621.39 "1939/1945" **2644**

Telecommunications in War.—(*Electrician*, 28th March 1947, Vol. 138, No. 3589, pp. 777–778.) Summary of the speeches made by Sir Stafford Cripps and Col. Sir Stanley Angwin at the opening session of the I.E.E. Radiocommunication Convention.

621.395 Bell **2645**

Alexander Graham Bell, born 3rd March, 1847—died 2nd August, 1922.—G.W.O.H. (*Wireless Engr*, March 1947, Vol. 24, No. 282, pp. 65–67.) A short review of his life and work.

621.395 Bell **2646**

Alexander Graham Bell — Scientist.—F. J. Mann. (*Elect. Engng, N.Y.*, March 1947, Vol. 66, No. 3, pp. 215–236.) A detailed account of his life and work.

621.396 **2647**

Radio Convention.—R. L. Smith-Rose. (*Elect. Times*, 3rd April 1947, Vol. 111, No. 2891, pp. 351–353.) A review of about 100 papers presented at the I.E.E. convention, 25th March–2nd April, 1947, dealing with radio communication, broadcasting and certain types of navigational aid excluded from the 1946 Radiolocation Convention. The subjects covered by the principal papers included the wartime developments in radio, radio components and valve manufacture, long-distance transmission, special problems of naval, military and aircraft communications, radar pulse technique, propagation, broadcasting and direction finding for military and naval purposes. In many cases peacetime developments and applications were also indicated. See also 2648 and 2469.

621.396 **2648**

Radiocommunication Convention. I.E.E. Record of Seven Years' Progress.—(*Electrician*, 4th April 1947, Vol. 138, No. 3590, pp. 850–852, 854.) A list of the 16 main papers presented at the convention, with short summaries of four of them.

621.396 **2649**

Review of Radio Progress.—(*Electrican*, 4th April 1947, Vol. 138, No. 3590, pp. 853–854.) Summary of the concluding address by Sir Clifford Paterson at the I.E.E. Radiocommunication Convention. For another account see *Engineer, Lond.*, 4th April 1947, Vol. 183, No. 4758, pp. 293 294.

621.396.029.4/.6 **2650**

Classifying Frequencies and Wavelengths.—(*Wireless World*, April 1947, Vol. 53, No. 4, p. 117.) A plea for a generally acceptable classification, with criticism of existing systems. The classification proposed by the Inter-Services Radio Circuit Symbols Committee is favoured.

621.396 Bethenod **2651**

The Radio Work of Joseph Bethenod.—L. Bouthillon. (*Onde élect.*, Feb. 1947, Vol. 27, No. 239, pp. 65–74.) Reprint of 974 of March.

621.396 (083.72) **2652**

Glossary of Radio and Radar Terms.—(*Elect. Times*, 6th Feb. 1947, Vol. 111, No. 2885, p. 183.) I.R.C.S.C. Paper No. 38, "Interservice Radio Glossary", published by the Central Radio Bureau, should be used by industry as well as the Services as a standard reference book.

621.3 **2653**

Electrical Engineering. [Book Review]—F. H. Pumphrey. Prentice-Hall, New York, 1946, 359 pp., \$5.35. (*Proc. Inst. Radio Engrs, W. & E.*, Feb. 1947, Vol. 35, No. 2, p. 190.) A textbook for students specializing in other fields.