

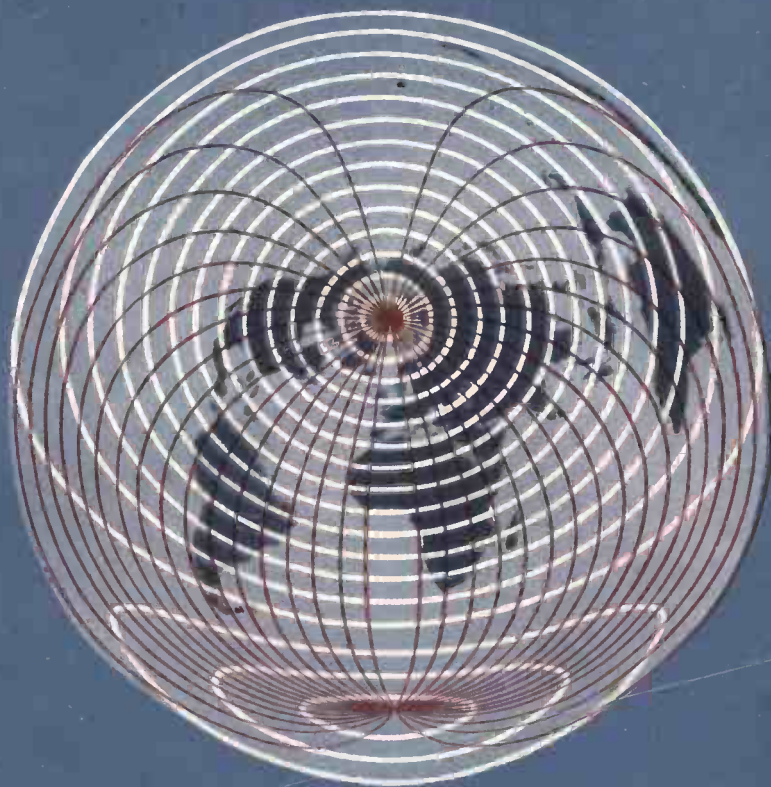
JANUARY 1960

TWO SHILLINGS

# Wireless World

**ELECTRONICS**

**Radio · Television**



**FORTY-NINTH YEAR OF PUBLICATION**

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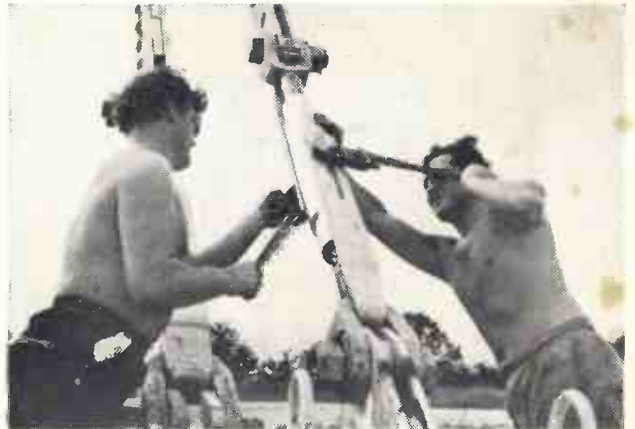
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# BICC GROUP

*Note: Our artist's impression of the Mendlesham mast shows it flying the Union Jack. This in fact was only flown during "Topping Out"—an informal ceremony held by erectors on completion of large-scale construction jobs.*

*Tightening one of the steel wire supporting stays.*



BRITISH INSULATED CALLENDER'S CABLES LIMITED  
21 BLOOMSBURY STREET LONDON WC1

# Wireless World

ELECTRONICS, RADIO, TELEVISION

JANUARY 1960

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OF PUBLICATION

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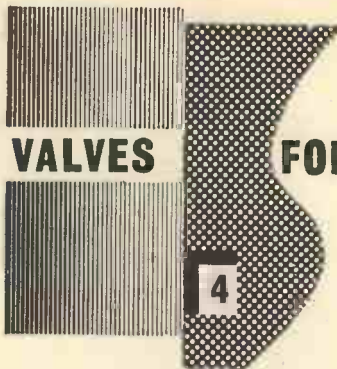
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# FRAME GRID VALVES FOR TELEVISION



The second advertisement in this series described the EF183, which is a variable- $\mu$  r.f. pentode, and discussed its use in the i.f. stages of television receivers.

When little or no control is required, a straight r.f. pentode, the EF184, is available. This valve is particularly suitable for use in uncontrolled final i.f. amplifiers, or in television systems using f.m. sound.

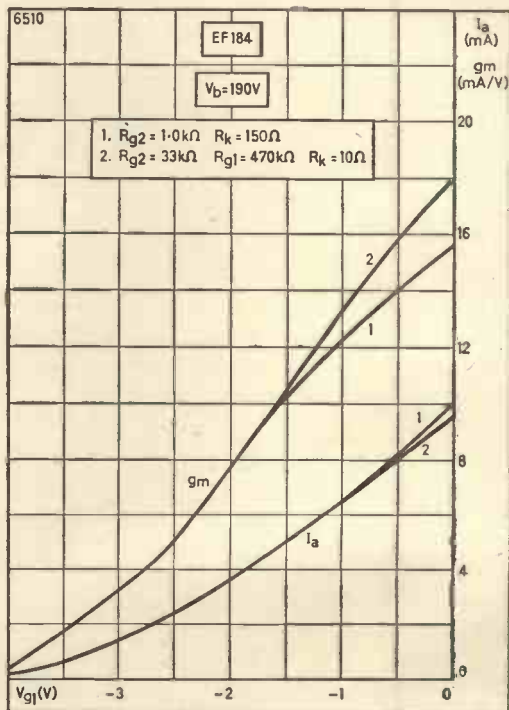
The EF184, in common with the other types in the Mullard frame grid range, has about twice the slope of its conventional counterpart. Under comparable conditions, the conventional EF80 has a slope of 7.4mA/V, as against 15.5mA/V for the EF184. This doubling of the slope provides a substantially improved gain per stage, of the order of 2 or 2½ times.

Under cathode bias conditions the EF184 shows an advantage in gain of 6dB over the EF80. If grid current bias is used, the advantage can be increased to 8dB. It should be noted that it is good practice to include a certain amount of cathode bias for these high slope valves, even when they are working under grid current bias conditions, and when a large value of sliding screen resistor is used. A suitable value for the EF184 under these conditions is about 10 $\Omega$ . This value is also sufficient for input capacitance compensation with small amounts of a.g.c., or with variations in bias that might be caused by changes in signal level with large signals.

It was said above that the EF184 is suitable for use when little or no control is required. This should be interpreted to mean a control of not more than 2 or 3 times. If a

greater control ratio is required, the variable- $\mu$  EF183 should be used instead, since the variations of its tail from valve to valve are kept within narrow limits.

Typical anode current and mutual conductance characteristics under cathode bias and grid current bias conditions are shown in the graph.



EF184



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## Writing it Down

THE stimulating and exemplary article on the use of words by P. P. Eckersley in our November 1959 issue and the corollary advanced by R. A. Waldron on page 22 of this issue must serve as pretexts for referring on this occasion to ourselves and to our chosen medium—the written and printed word.

To us it is axiomatic that printing is the best medium for the communication of technical knowledge. It is cheap and it is permanent. No time factor is involved. The reader can skim or study at leisure. There is no obligation to keep up with the pace of the thought processes of an author, as there may be with the spoken thoughts of a lecturer or broadcaster.

The benefits of good writing to the reader are obvious. What may not be quite so apparent, except to those who have tried it, is the value of writing for its own sake, as an exercise, as a discipline and as means of finding out how much (more often how little) one knows about a subject. The act of writing is a clarifying and very often a scarifying experience. Many people fight shy of writing because they think that a special gift or specific training is necessary, that writing is an esoteric craft to be learned by hard and long apprenticeship, for which they cannot spare the time. It may be true that special training is necessary for the writing-up of technical specifications and instructional manuals (as distinct from the writing *down* of levitating facts and ideas) and we would not deny that there are general precepts of which a conscious knowledge is sometimes advantageous. Certainly the techniques of preparation for press and of printing production are the province of specialists. Many excellent textbooks\* and training courses exist for the guidance of those who wish to take up technical writing as a profession, but for the beginner essaying his first article for submission to a journal the less he knows about these things the better. The recipe for good writing is quite simple and involves only two processes; first, making up one's mind what to say, and then saying it. As in painting and decorating it is the preparation that takes the time. Putting on the paint is the easy part, but it will soon have to be done all over again if the preparation has been less than thorough.

In a technical journal like ours the content of an article is of greater importance than the style in which it is written; matter is more important than manner. But that is not to say that style is unimportant. It may help or hinder the reader in getting to grips with the subject. It is even more significant in revealing the writer's mental make-up and capacity. As Buffon has put it (rather more succinctly), "*Le style est l'homme même.*" And if a turgid and

obscure first draft, full of irrelevant digressions is turned by the author into a simple and direct exposition of a single central theme, the struggle will not have been made without leaving its mark on the man.

In writing there is no substitute for practice, but one should not despair if there seems to be too slow a gain in facility; remember the dictum that "easy writing makes hard reading."

If the matter seems worthy of a wider readership and it is decided to send the article to a journal, it should be typed or legibly written on one side of the paper with space between the lines for printers' instructions (and, who knows, spelling corrections). Time spent by the author on beautifully inked-in diagrams, and lettering on photographs is usually wasted, as most journals like to prepare illustrations themselves. There are many technical reasons why this should be so, and in this journal all we ask is legibility, and, if there is any doubt about size or quality of photographs, the loan of the negatives to make our own enlargements. It is not safe to assume that there will always be time to send proofs to authors for reading. Do not count, therefore, on having an opportunity for second thoughts, but make sure that the manuscript is in a finished state *before* it is submitted. We will then see that the printer has properly interpreted the author's intentions, and it goes without saying that no major alterations will be made without consultation (*pace* Mr. Waldron).

There can be no doubt that a well-written article gains wide recognition for its author, not only from his compeers but also from his employers. The Radio Industry Council and the Electronic Engineering Association have acknowledged this by making a number of premium awards annually for technical writing, and on the occasion of the last prize distribution L. T. Hinton, Chairman of the E.E.A., had this to say:

"I can tell you that we look upon [these awards] as of the utmost importance in so far as they encourage technical authors to give of their best.

"These articles are not only helpful to British industry, but the prestige and standing of British research and engineering in the countries of the world can be greatly enhanced by the standard of technical writing. The product we sell is highly technical. We sell it to technical customers and good, authoritative, well presented and well distributed technical writing does more to help our vital exports than all the glossy brochures put together."

\* For example "The Technical Writer" by J. W. Godfrey and G. Parr (Chapman & Hall).

# THE SMITH CHART

Survey of Transmission Line Phenomena : Derivation and Uses of the Chart

By R. A. HICKSON\*

**T**HE Smith chart<sup>1</sup> is a transmission-line chart which facilitates the solution of almost all problems arising in the use of coaxial or balanced transmission lines, and some related problems, such as the design of lumped-element matching networks. However, its forbidding appearance, and the severely mathematical tone of most references to it in the literature<sup>2, 3, 4</sup> have given it a reputation for difficulty which is not merited. The Smith chart is no more difficult than the slide rule and saves a comparable amount of time and effort in its own field. In addition, its use is of great assistance in understanding transmission-line behaviour at very high frequencies.

**Transmission-line Phenomena.**—If a radio-frequency generator is connected to one end of an infinitely long transmission line the power supplied to the line will travel along it towards the remote end and will gradually be dissipated in the line. There will be no power travelling in the opposite direction. If now the line is cut, a certain load can be connected to the cut end which will simulate the missing portion of the line by absorbing all the power reaching it; the impedance of this load is the same as the characteristic impedance of the line ( $Z_0$ ). This is for practical purposes equal to a pure resistance of value  $\sqrt{L/C}$  where  $L$  is the inductance and  $C$  the capacitance of equal lengths of line. This formula is an approximation which assumes that the loop resistance is negligible in comparison with the inductive loop reactance and that the conductance between the two conductors is negligible in comparison with the capacitive susceptance between them. In other words it assumes good conductors and a good dielectric, and operation at a reasonably high frequency.

Any load other than the characteristic impedance will not absorb all the power travelling from the generator. (The power may be dissipated directly as heat at radio frequency, or rectified and used to operate, e.g., a meter, or radiated, as in the case of an aerial). The power which is not absorbed by the load is reflected by it and travels back along the line towards the generator. It will be assumed for the moment that the generator has the same impedance as the line and so absorbs all the reflected power. A load or generator having the same impedance as the line is said to be matched to the line.

The extent to which a load is matched to a line can be expressed by stating the voltage reflection coefficient or the return loss of the load. The value of the concept of return loss has been discussed recently<sup>5</sup> and we will mention only the definition at this point. Return loss is the attenuation between the incident power and the reflected power. A

related concept is reflection loss, which is the attenuation between the incident power and the power absorbed by the load. Formulae for both these losses, which are customarily expressed in decibels, will be derived later.

The voltage reflection coefficient  $K$  is the ratio of the reflected wave voltage  $E_r$  to the incident wave voltage  $E_i$ . The best possible match, given by a load of impedance equal to  $Z_0$  will produce a voltage reflection coefficient of zero. The worst possible match, given by a loss-free load, i.e. an ideal open circuit, an ideal short-circuit, an ideal capacitor or an ideal inductor, will produce a voltage reflection coefficient of unity. The phase of the reflected wave with respect to the incident wave will depend on the nature of the load, and may have any value from  $0^\circ$  (in-phase) to  $\pm 180^\circ$  (exactly out-of-phase). As the incident and reflected waves are being propagated along the line in opposite directions the phase angle will vary with the distance from the load. In a distance in which each wave alters in phase by  $180^\circ$ , that is, in a half wavelength, the total change in phase between the two waves will be  $360^\circ$ .

The phase angle of the voltage reflection coefficient will therefore have the same value at half-wavelength intervals along the line. For a frequency of  $F$  Mc/s, one wavelength in air is approximately equal to  $300/F$  metres. For other dielectrics the wavelength in air is divided by the square root of the effective permittivity of the dielectric, or multiplied by the velocity factor of the line.

The reflection coefficient may be plotted on a polar chart showing the phase angle as the angle from an arbitrary direction and the magnitude  $E_r/E_i$  as distance from the centre. Movement along a transmission line will then correspond to movement round a circle of constant radius on the chart, assuming that line losses are negligible. In cases where the line losses are not negligible the magnitude of the reflection coefficient will decrease as distance from the load increases. If the attenuation between two points is  $N$  dB each voltage will change by  $\text{antilog } N/20$ , so that their ratio  $E_r/E_i$  will change by  $\text{antilog } N/10$ .

Movement along a line having attenuation will therefore be represented by movement along a spiral on the chart, the radius of the spiral decreasing as distance from the load increases. Fig. 1 shows the change in reflection coefficient entailed in moving along loss-free and lossy lines through a distance of one half-wavelength from a load giving a voltage reflection coefficient of 0.8 ( $180^\circ$ ). The loss of 2.5dB per wavelength is greater than will normally be encountered. For example, a typical cellular polythene feeder in Band III would have a loss of only about 0.25dB per wavelength. The choice

\* Belling and Lee Ltd.

of the clockwise direction to represent movement away from the load is the accepted convention.

**Effect of Type of Load on Reflection Coefficient.**—The nature of the voltage reflection coefficient produced by various types of load will now be considered. Considering the current and voltage relationships in the incident wave, the reflected wave and the load, we may write:—

$$\begin{aligned} E_i &= Z_0 I_i \\ E_r &= -Z_0 I_r \\ E_i &= Z_i I_i \end{aligned}$$

The minus sign in the second equation expresses

the fact that the reflected power is propagated in the reverse direction.

Applying Kirchoff's laws to the junction of line and load:—

$$\begin{aligned} E_i + E_r &= E_l \\ I_i + I_r &= I_l \end{aligned}$$

Simultaneous solution of these five equations gives:—

$$\frac{E_r}{E_i} = \frac{Z_l - Z_0}{Z_l + Z_0}$$

As stated above,  $Z_0$  may be considered as a pure resistance, which we may call  $R_0$ , so that:—

$$\frac{E_r}{E_i} = \frac{Z_l - R_0}{Z_l + R_0}$$

Writing  $K$  for  $E_r/E_i$

$$K = \frac{Z_l - R_0}{Z_l + R_0}$$

(a) **Characteristic impedance  $R_0$ .**—By definition, see above, this will produce a voltage reflection coefficient of 0 ( $0^\circ$ ).

(b) **Short circuit.**—As this cannot absorb any power,  $E_r = E_i$  and, as no voltage can exist across a short circuit,  $E_r$  and  $E_i$  must be exactly out of phase. The voltage reflection coefficient is 1 ( $180^\circ$ ).  
Mathematically

$$K = (0 - R_0)/(0 + R_0) = -1.$$

This is equivalent to +1 ( $180^\circ$ ) as can be seen by considering that the positive direction along the  $0^\circ$  line is from the centre of the chart towards the edge,

(c) **Open circuit.**—As with the short circuit no power is absorbed and  $E_r = E_i$ . Since no current can flow across an open circuit the current due to  $E_i$  must be exactly out of phase with that due to  $E_r$ , that is,  $I_i = -I_r$ . As  $(E_i/I_i) = Z_0 = -(E_r/I_r)$ ,  $E_i = E_r$ , that is, they are in phase and the voltage reflection coefficient is 1 ( $0^\circ$ ).

$$K = (\infty + R_0)/(\infty - R_0) = 1$$

(d) **Capacitor.**—A loss-free capacitor whose reactance at the operating frequency is numerically equal to the line impedance will be considered:—

$$\begin{aligned} Z_l &= 0 - jR_0 \\ K &= \frac{0 - jR_0 - R_0}{0 - jR_0 + R_0} = \frac{-j1 - 1}{-j1 + 1} \\ &= \frac{(-j1 - 1)(+j1 + 1)}{(-j1 + 1)(+j1 + 1)} \\ &= \frac{-j^2 - j2 - 1}{-j^2 + 1} = -j1 \end{aligned}$$

In polar notation,  $K = 1 (-90^\circ)$ .

(e) **Inductor.**—For a loss-free inductor whose reactance at the operating frequency is numerically equal to the line impedance,  $Z_l = 0 + jR_0$ . A calculation on the same lines as that for the capacitor, above, shows that  $K = 1 (90^\circ)$ .

We are now ready to derive the Smith chart.

**Derivation of the Smith Chart.**—The five points corresponding to loads of  $R_0$ , 0,  $\infty$ ,  $0 + jR_0$ , and  $0 - jR_0$ , as determined previously, are indicated in Fig. 2, which shows the voltage reflection coefficient produced at the load itself; as discussed in connection with Fig. 1, the reflection coefficient will change as we move along the line away from the load. Further calculations on the same basis will show that the reflection coefficients produced by the five possible types of load are as shown in Fig. 3. It will be appreciated that infinite reactance is, like infinite resistance, an open circuit; similarly

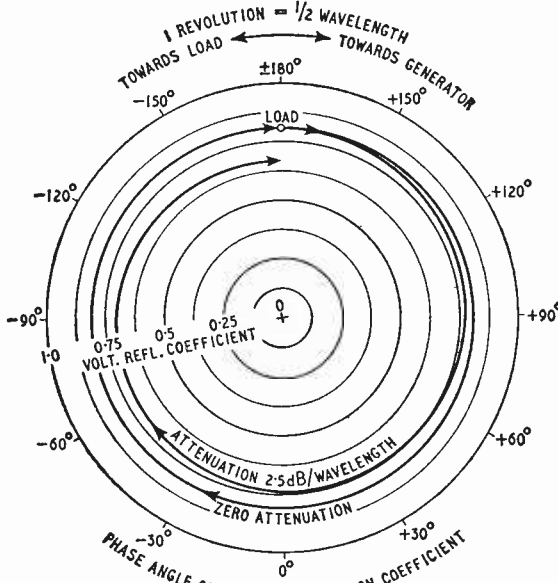
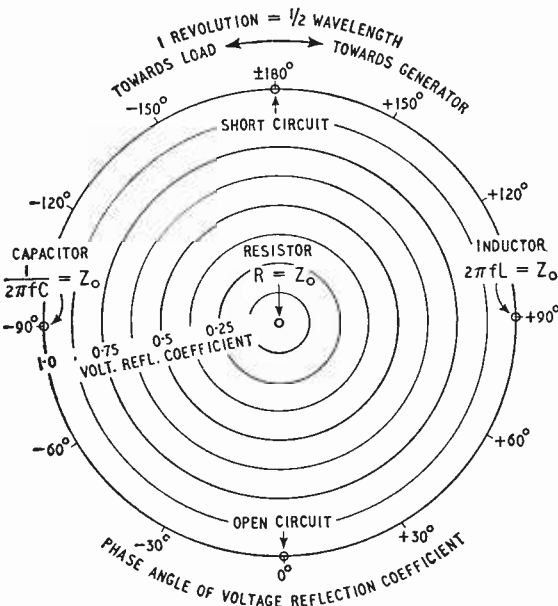


Fig. 1. Polar diagram of voltage reflection coefficient. Effect of movement along loss-free and lossy lines.

Fig. 2. Voltage reflection coefficients produced at the load by five specific loads.





zero reactance is, like zero resistance, a short circuit, so that the points  $\infty$  and 0 are common to the resistance and reactance axes.

Since in any particular problem the characteristic impedance of the transmission line is a constant,

it is customary to normalize the load impedance by expressing it as a multiple of the line impedance. Fig. 4 shows the same loads as Fig. 2, now normalized, together with certain intermediate points obtainable by means of similar calculations.

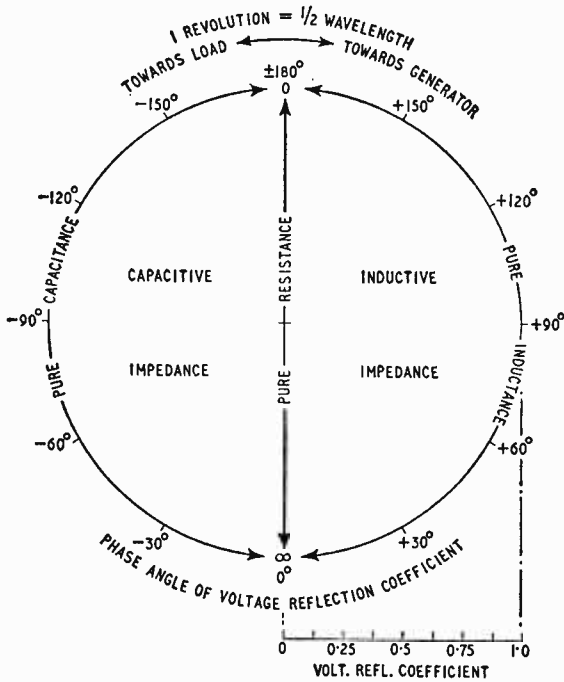


Fig. 3. Voltage reflection coefficients produced at the load by the five possible types of load. Magnitude of the reflection coefficient is shown on an auxiliary scale.

Fig. 4. Voltage reflection coefficients produced at the load by various normalized loads.

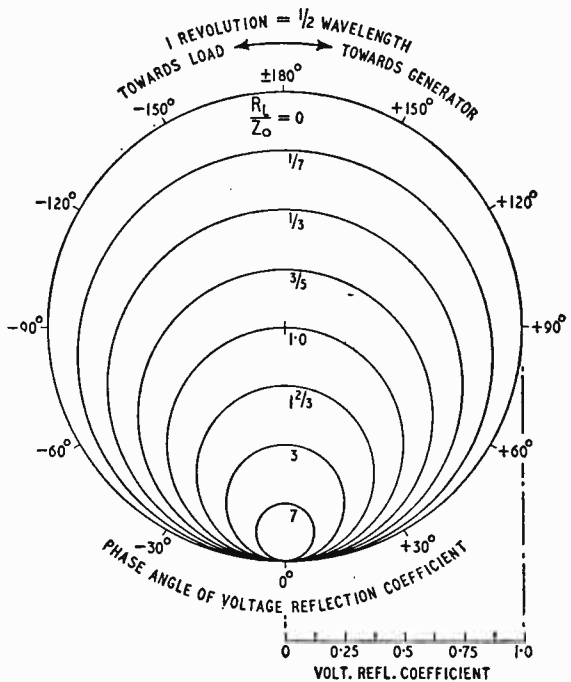
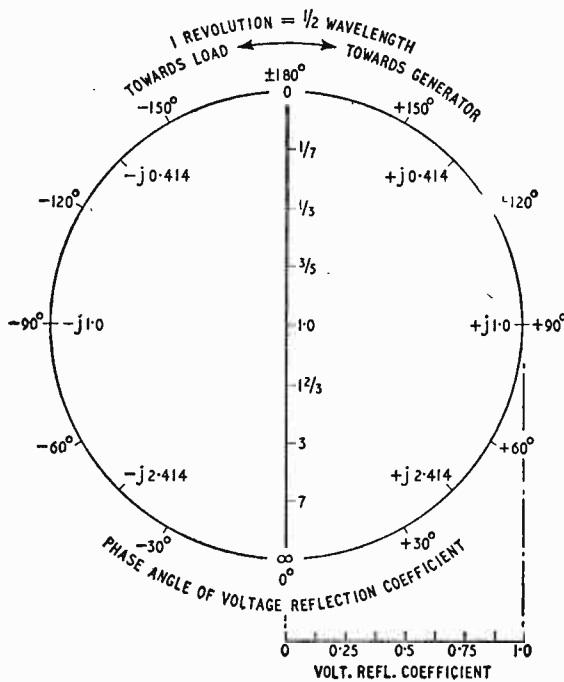
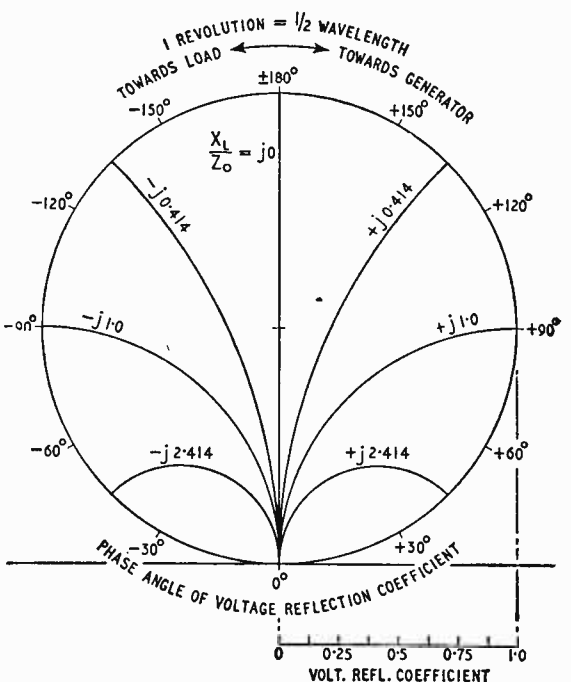


Fig. 5. Voltage reflection coefficients produced by loads having the same normalized resistive component of load impedance lie on a circle.

Fig. 6. Voltage reflection coefficients produced by loads having the same normalized reactive component of load impedance lie on an arc of a circle.



It is found that all loads having the same normalized resistive component of load impedance  $R_l/R_o$  produce reflection coefficients which lie on a circle. A mathematical demonstration of this is given in Appendix I. The centre of the circle lies on the resistance axis and the circle passes through the point of reflection coefficient 1 ( $0^\circ$ ). Some of these circles of constant ratio  $R_l/R_o$  are shown in Fig. 5.

Similarly it is found that all loads having the same normalized reactive component of load impedance  $\pm jX_l/R_o$  produce reflection coefficients which lie on an arc of a circle. Each circle again passes through the point of reflection coefficient 1 ( $0^\circ$ ) and the centre of each circle lies on the line through this point at right angles to the resistance axis. Some of these arcs of circles of constant ratio

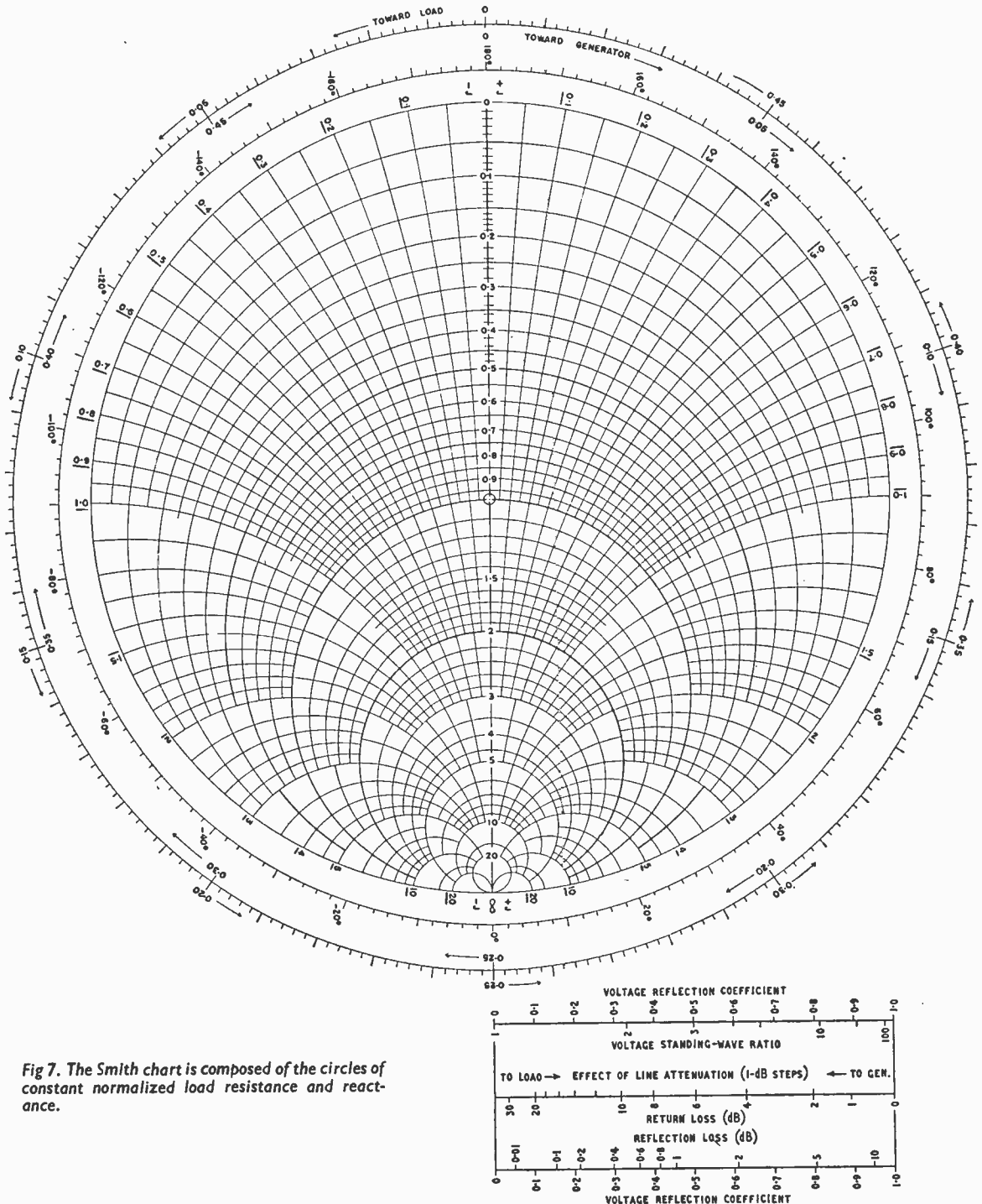


Fig 7. The Smith chart is composed of the circles of constant normalized load resistance and reactance.

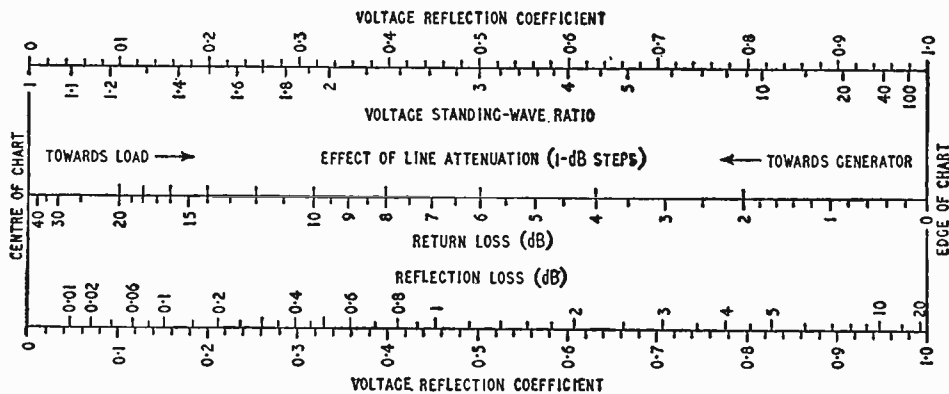


Fig. 8. Auxiliary scales are provided for radially-scaled parameters to avoid additional circles on the chart.

$\pm jX_l/R_o$  are shown in Fig. 6. The portions lying outside the circle defined by a reflection coefficient of unity have no physical significance here, as we are considering only passive loads, which cannot reflect a voltage greater than the incident voltage.

The Smith chart, Fig. 7, is a reflection coefficient chart drawn in terms of these circles of constant normalized load resistance and reactance.

The underlying circles of constant magnitude of voltage reflection coefficient and the radial lines of constant phase angle of voltage reflection coefficient are not shown on the chart, to avoid confusion. Instead, a separate auxiliary scale is provided for the magnitude, and a scale of phase angles is provided round the perimeter of the chart.

In addition to the phase-angle scale, scales for "Wavelengths towards Generator" and "Wavelengths towards Load" are normally provided round the outside of the chart. As shown earlier, a complete circle round the centre of the chart represents a distance of one half-wavelength: movement clockwise represents movement towards the generator and vice versa. These scales are customarily shown with their zeros at the point of minimum impedance (phase angle  $180^\circ$ ). This is, of course, an arbitrary choice, and in practical problems one may wish to start at any phase angle. In one commercially available Smith chart calculator the wavelength scales are movable and the zeros can be set to any phase angle.

Returning now to radially scaled parameters, Fig. 8, these may include, in addition to voltage reflection coefficient:—

- (a) Voltage standing-wave ratio.
  - (b) Return loss.
  - (c) Reflection loss.
  - (d) Effect of line attenuation.
- (a) *Voltage standing-wave ratio.*—The v.s.w.r. scale is the same as the resistive component scale along the pure resistance axis. This is demonstrated in the later section "Voltage Variations along a Mismatched Line," where it is also shown that, writing  $S$  for v.s.w.r.,  $S = (1 + K)/(1 - K)$ .
- (b) *Return loss.*—This is the attenuation between the incident wave and the reflected wave, so that it is equal to the square of the reciprocal of the voltage reflection coefficient. It is usually expressed in decibels so that:—  
Return loss =  $20 \log 1/K \dots$  dB.
- (c) *Reflection loss.*—This is the attenuation between the incident wave and the power absorbed by

the load. As the power absorbed  $P_a$  is that which is not reflected  $P_r$ , the reflection loss is complementary to the return loss:—

$$P_a = P_i - P_r$$

$$\frac{P_a}{P_i} = 1 - \frac{P_r}{P_i} = 1 - \left(\frac{E_r}{E_i}\right)^2 = 1 - K^2$$

$$\frac{P_i}{P_a} = \frac{1}{1 - K^2}$$

$$\text{Reflection loss} = 10 \log \left( \frac{1}{1 - K^2} \right) \dots \text{dB}$$

- (d) *Effect of Line Attenuation.*—This effect on the voltage reflection coefficient was discussed in the first section, where it was shown that if there is an attenuation of  $N$  dB between two points the ratio of the voltage reflection coefficients at the two points is  $\text{antilog } N/10$ . The effect of line attenuation on the v.s.w.r., return loss and reflection loss can be arrived at by use of the radial scales. As with the wavelength scales round the perimeter of the chart, the line attenuation scale may be entered at any point and the graduations, shown here as 1-dB steps, are not normally numbered. This makes interpolation rather difficult at the open end of the scale. However, the difficulty may be eased by use of the "Return Loss" scale. Steps of 2dB on this scale are mathematically equivalent to steps of 1dB on the "Effect of Line Attenuation" scale. The two scales are placed side by side to facilitate this use. It should be pointed out that the equivalence is purely mathematical and it is meaningless to say that, for example, a return loss of 4dB corresponds to a line attenuation of 2dB. The "Return Loss" scale is an absolute one, in the sense that any point on the scale has a definite significance. The "Effect of Line Attenuation" scale is a relative one, and a point on this scale has no significance in itself; only distances along this scale are of interest.

**Impedance Variations Along a Mismatched Line.**—Comparing Fig. 1 with Fig. 7 it will be seen that the impedance looking towards the load will vary at different points along a mismatched transmission line. The Smith chart shows directly the effect of the length of line on its input impedance.

Taking the example of Fig. 1, in which the load is resistive and less than the characteristic line impedance, the input impedance, moving away from the load, is inductive for the first quarter-wavelength, then, at  $\lambda/4$  from the load, a resistance



greater than the characteristic line impedance, then capacitive for a quarter-wavelength, then, at  $\lambda/2$  from the load, again becomes resistive and less than the line impedance. If it is permissible to neglect line losses, then the line input impedance is the same at half-wavelength intervals. Thus a half-wavelength section of line may be said to repeat the load: the impedance of the line itself does not enter into this result. This is not the case for any shorter length. At quarter-wavelength intervals, for example, the impedances are such that, when multiplied together, the result is equal to the square of the characteristic impedance.

This result is easily verified in the case of resistive impedances; for example, the point  $2 + j0$  is on the same voltage reflection coefficient circle as the point  $\frac{1}{2} + j0$ . Similarly, an open-circuit at the end of a line will appear as a short circuit a quarter-wavelength away from the end, and vice versa. A quarter-wavelength section of line is said to invert the load. In the case of loads which are not purely resistive, the impedance is inverted and the phase angle is changed by  $180^\circ$ , so that a capacitive load is transformed into an inductive load, and vice versa, by a quarter-wavelength section of line. For example a load of impedance  $3 + j4$ , i.e.,  $Z_L = 5$ , is transformed into  $(0.12 - j0.16)$ , i.e.,  $Z_L = 0.2$ . This can be seen by starting from the point  $3 + j4$  and moving through  $180^\circ$  round a circle centred on the centre of the chart; as stated in connection with Fig. 1, this angle corresponds to a movement along the line of one quarter wavelength. The apparent impedance is  $0.12 - j0.16$  after this movement, and the phase angle of the reflection coefficient has changed from  $+18^\circ$  to  $-162^\circ$ , i.e., from inductive to capacitive.

**Voltage Variations Along a Mismatched Line.**—The instantaneous voltage along the line is varying sinusoidally at the operating frequency, and it is not this voltage, but the peak value which it attains, that is referred to here. Neglecting line losses, the power flowing along a line under steady conditions does not change. As  $P = E^2/R$ , the maximum total voltage  $E_i + E_r$  will occur at points of high impedance. As  $E_i$  and  $E_r$  are vector quantities, this implies that they are in phase at these points. Fig. 7 indicates that the phase angle of the reflection coefficient (i.e., the vector difference between  $E_i$  and  $E_r$ ) is zero for a load of infinite impedance. Similarly, at points of low impedance the resultant voltage will have a minimum value, and  $E_i$  will be exactly out of phase with  $E_r$ . This is again in agreement with Fig. 7, which indicates a phase angle of  $\pm 180^\circ$  for a load of zero impedance. The maximum and minimum points do not move along the line with time, and the resultant pattern of peak voltage distribution is referred to as a quasi-stationary or standing-wave pattern. The ratio between the maximum and minimum peak voltages is called the voltage standing-wave ratio, S.

$$S = \frac{E_{max}}{E_{min}} = \frac{E_i + E_r}{E_i - E_r} = \frac{1 + (E_r/E_i)}{1 - (E_r/E_i)} = \frac{1 + K}{1 - K}$$

A number of British workers define v.s.w.r. as  $(E_{min}/E_{max})$  but the American practice, followed here, is becoming more common. As the v.s.w.r. is never greater than unity in the one system, and

never less than unity in the other, there is no possibility of confusion.

For loads other than resistive, the v.s.w.r. will bear the same relation to K. The only difference in the v.s.w.r. pattern produced by resistive and reactive loads of the same voltage reflection coefficient will be in the positions of the maxima and minima with respect to the load. The whole standing-wave pattern will be displaced along the line according to the phase angle of the reflection coefficient at the load.

It is interesting to note that the v.s.w.r. is simply related to the load impedance.

$$S = \frac{1 + K}{1 - K} \text{ and } K = \frac{Z_L - R_0}{Z_L + R_0}$$

Writing  $z$  for  $\frac{Z_L}{R_0}$ ,  $K = \frac{z - 1}{z + 1}$

$$S = \frac{1 - \left(\frac{z - 1}{z + 1}\right)}{1 + \left(\frac{z - 1}{z + 1}\right)} = \frac{z + 1 + z - 1}{z + 1 - z + 1} = z$$

In words, the v.s.w.r. is equal to the normalized load impedance, or to its reciprocal if this is greater than unity.

The importance of the v.s.w.r. is that it can be measured with comparatively simple equipment, and from the result useful deductions can be made. It is clear that movement along a line having attenuation will result in a change in v.s.w.r., as it does in voltage reflection coefficient. The change can be evaluated with the aid of the auxiliary line attenuation scale of the Smith chart.

A quantity sometimes encountered in the literature is the so-called power standing-wave ratio. In fact, of course, there are no standing waves of power. The power flowing along a transmission line can only vary gradually, by attenuation, or once-for-all, by reflection, not in the cyclic manner in which the voltage varies when reflection occurs. The term arises when a square-law indicator is used in the measurement of v.s.w.r. The readings obtained are proportional to the square of the voltage and so their ratio represents the power ratio which would correspond to the voltage ratio if both voltages were developed across the same impedance. As they are not, the term is meaningless. Some workers, to avoid the possibility of confusion, convert their standing-wave ratios to decibels. This cure is worse than the disease, as the decibel is a power ratio, and may only be used for voltages when the voltages are developed across identical impedances.

**Representation of Admittance of the Smith Chart.**—In certain applications, such as the addition of a matching stub in parallel with a load impedance, the use of normalized admittance is convenient. This is because admittances add when placed in parallel. The normalized admittance  $y$  is the reciprocal of the normalized impedance  $z$ .

$$y = \frac{1}{z} = \frac{1 - k}{1 + k} = \frac{1 + k}{1 - k} = \frac{1 - (-k)}{1 + (-k)}$$

Thus the relation of  $y$  to  $-k$  is the same as that

of  $z$  to  $k$ . The Smith chart may therefore be used for admittance calculations with the scale for reflection coefficient angle rotated through  $180^\circ$ .

¶ When it is necessary to change from an admittance to an impedance basis during the course of a calculation, all that is necessary is to rotate the point representing the value through  $180^\circ$  round a circle of constant  $K$ . This operation amounts to finding the reciprocal of a complex number.

Some Smith charts are provided with a circle of unity conductance to facilitate operations. This is the circle of unity resistance rotated bodily through  $180^\circ$  about the point  $(1 + j0)$ .

Loads expressed as admittances, conductances or susceptances are normalized by dividing the values by the characteristic admittance of the line, that is, by multiplying the values by the characteristic impedance. For example, a load of  $0.02 - j0.01$  mhos on a 75-ohm line would have a normalized value of  $1.5 - j0.75$ .

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- <sup>2</sup> W. Jackson. "High Frequency Transmission Lines." Methuen (*Monographs on Physical Subjects*) 1945, pp. 119-148.
- <sup>3</sup> W. Jackson and L. G. H. Huxley. "The Solution of Transmission-Line Problems by Use of the Circle Diagram of Impedance." *Journal I.E.E.* Volume 91 Part III No. 15, pp. 105-127, September 1944.
- <sup>4</sup> F. E. Terman. "Radio and Electronic Engineering." McGraw-Hill, 1955, pp. 100-104.
- <sup>5</sup> T. Roddam. "Return Loss." *Wireless World*, Volume 63, Nos. 11 and 12, November and December 1957, pp. 521-524, 583-588.

### APPENDIX I.

*Construction of the Smith Chart.*—The voltage reflection coefficient is shown in Fig. 1 in polar co-ordinates. However, it may also be expressed in rectangular co-ordinates, and this will be done here, as it leads to easier mathematics.

The use of  $u + jv$  does not imply that the reflection coefficient has resistive and reactive components. It is merely a mathematical device for describing the location

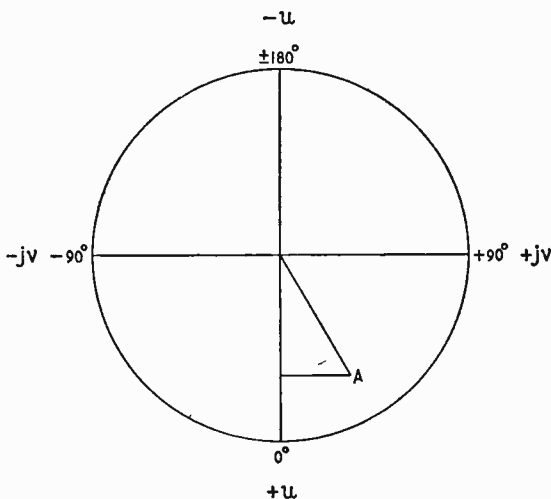


Fig. 9. Use of rectangular co-ordinates for voltage reflection coefficient.

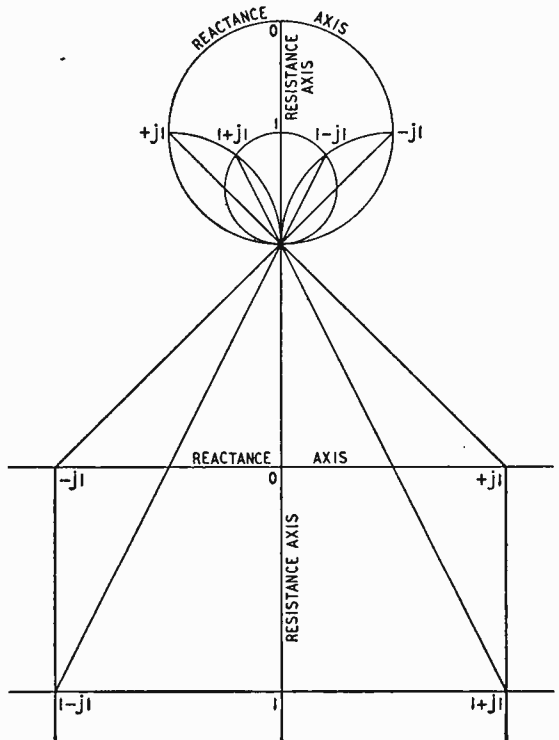


Fig. 10. The Smith chart is geometrically related to the Cartesian impedance diagram.

on the chart of the point representing the reflection coefficient. For example, point A in Fig. 9 represents a reflection coefficient of  $0.75(30^\circ)$ ; using the  $u + jv$  notation it would become  $0.65 + j0.375$ .

Let  $K = u + jv$

$$\frac{R_1}{Z_0} = r$$

$$\frac{X_1}{Z_0} = x$$

$$\text{Then } \frac{Z_1}{Z_0} = r + jx = \frac{1+K}{1-K}$$

$$r + jx = \frac{1 + u + jv}{1 - u - jv}$$

Rationalizing

$$r + jx = \frac{1 - u^2 - v^2 + i2v}{(1 - u)^2 + v^2} \dots \dots \dots (1)$$

Equating the real parts of (1)

$$r = \frac{1 - u^2 - v^2}{(1 - u)^2 + v^2}$$

$$r(1 - u)^2 - rv^2 = 1 - u^2 - v^2$$

$$r + ru^2 - 2ru + u^2 = 1 - v^2 - rv^2$$

$$u^2(1 + r) - 2ru + r = 1 - v^2(1 + r)$$

$$u^2 - \frac{2ru}{1+r} - \frac{r}{1+r} = \frac{1}{1+r} - v^2$$

Subtracting  $\frac{r}{(1+r)^2}$  from both sides

$$u^2 - \frac{2ru}{1+r} - \frac{r^2}{(1+r)^2} = \frac{1}{(1+r)^2} - v^2$$

$$\left(u - \frac{r}{1+r}\right)^2 + v^2 = \frac{1}{(1+r)^2} \dots \dots \dots (2)$$

This is the equation of a circle in the  $u, v$  plane with centre at the point  $\frac{r}{1+r} + j0$  and with radius  $\frac{1}{1+r}$ .

Substitution of the value of  $r$  in these formulae will give the circle of constant normalized resistance equal to  $r$ . Similarly, equating the imaginary parts of (1)

$$jx = j \frac{2v}{(1-u)^2 + v^2}$$

$$x - 2ux + xu^2 + xv^2 = 2v$$

$$u^2 - 2u + 1 + v^2 - \frac{2v}{x} = 0$$

Adding  $\frac{1}{x^2}$  to both sides

$$u^2 - 2u + 1 + v^2 - \frac{2v}{x} + \frac{1}{x^2} = \frac{1}{x^2}$$

$$(u - 1)^2 + \left(v - \frac{1}{x}\right)^2 = \frac{1}{x^2} \dots\dots\dots (3)$$

This is the equation of a circle in the  $u, v$  plane with centre at the point  $(1 \pm j\frac{1}{x})$  and with radius  $\frac{1}{x}$ . Substitution of the value of  $x$  in these formulae will give circles of constant normalized reactance equal to  $x$ . For a given arithmetical value of  $x$ ,  $jx$  may be positive or negative. Equations (2) and (3) give the basis for the construction of the chart itself. The auxiliary radial scales are constructed on the basis of the equations given earlier.

## APPENDIX II.

*Original Derivation of the Smith Chart.*—The Smith chart can be obtained from the Cartesian impedance diagram by means of a conformal transformation. This is the method originally used by Smith (1) and is referred to in the standard texts<sup>2, 3, 4</sup>. However, it is less satisfying from the physical standpoint than the approach presented above. The Cartesian diagram is the normalized form of the Argand diagram of impedance; the negative resistance axis is omitted, as only passive loads are considered. To accommodate an open circuit this diagram would require extension to infinity, and so it is not in common use. Another, related, defect of this diagram is that the voltage reflection coefficient cannot be represented on it in the skeleton form used in the Smith chart, but must be shown in full.

A suitable conformal transformation distorts the straight constant-resistance and constant-reactance axes into circles, but preserves the orthogonality of their intersections. Details are given in references 1, 2 and 3. The geometrical equivalent of the transformation is shown in Fig. 10.

The Cartesian chart is inverted about the point  $(-1 + j0)$ , which becomes the infinity point on the Smith chart. Corresponding points in the two charts lie on the same straight line and the distances of the points from  $(-1 + j0)$  are reciprocally related. Derivation for the Argand diagram is the reason why the Smith chart is often shown with the resistance axis horizontal, although the chart itself is more readily handled with the resistance axis vertical.

# Radio Hobbies Exhibition

## SINGLE-SIDEBAND EQUIPMENT ON SHOW

**T**HIS year, two awards for outstanding design and construction were made. Both took the form of silver plaques; one, as in previous years, being awarded for the most outstanding home-constructed piece of equipment and, an innovation, one for the piece of commercial equipment of the greatest value to the amateur.

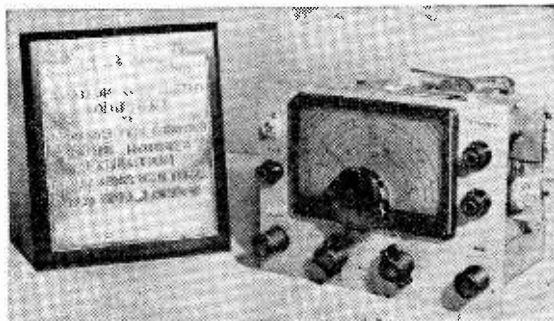
W. J. Colclough, G3XC, gained the amateur award with his transistor communications receiver, which uses 14 transistors, covers 1.9 to 29.5Mc/s in six bands and operates from an internal 6-V dry battery. The receiver is a double superhet with an r.f. amplifier using OC170 transistors for this stage, the first mixer and the oscillator: the first i.f. is 1Mc/s and the second, is 500kc/s. A "Q-multiplier" operates on the 500kc/s i.f. stage and a.g.c. is derived from a two-stage amplifier.

The Minimitter Company won the commercial award with their MR44 communications receiver. This is an 11-valve set—again a double superhet—covering six amateur bands between 1.8 and 30Mc/s, each band being represented by 8-in of tuning scale. The MR44 is designed for reception of a.m. R/T, s.s.b. and c.w. signals; for s.s.b. it uses a half-lattice crystal filter and a product detector. This, though, was not the only commercial equipment offering single-sideband facilities but all the apparatus seen used the filter system for generation or demodulation of s.s.b. signals.

The recent relaxation of dollar-import regulations resulted in the appearance of two well-known American names at the show—Collins and Hallicrafters—both with equipment which, in appearance and performance specification, is of the highest quality. James H. Scott, representing Hallicrafters, were showing an extensive range of receivers and transmitters, notable among which was the SX-101A—a 15-valve double superhet giving

a.m., c.w. or s.s.b. reception on the amateur bands between 160m and 10m: it has a sensitivity of better than 1μV for a signal-to-noise ratio of 10dB. On show was the Collins KWM-2 which, in a cabinet 8×15×13in, combines a five-band s.s.b./c.w. transmitter of 100W p.e.p. output and a receiver of sensitivity 0.5μV (for 10dB s.n. ratio). The power supply is separate and two versions are available; one is a straight-forward a.c.-mains unit and the other is a low-voltage transistor converter so that the KWM-2 may be used as a mobile station. Two interesting features of Collins equipment are their s.s.b. filters, and a noise suppression circuit which, in contrast to more common arrangements, uses the slow response of the narrow-band main receiver as an advantage. The noise-blanking unit receives electrical interference on a separate wide-band receiver

W. J. Colclough's amateur-award-winning receiver.





( $\pm 0.5\text{Mc/s}$ ) operating at about 40Mc/s and produces from the noise a pulse which is used to cut off the main receiver. Due to the difference in speed of travel of the noise through the two receivers (slow in the main set, fast in the wide-band receiver) this blanking action can occur before the noise has completed its transit through the main receiver. For s.s.b. generation and detection Collins use a "mechanical filter" which consists of a set of resonant discs coupled together mechanically and excited by a magnetostrictive transducer.

Another s.s.b. transmitter, using an exciter unit based on a design by G2NH, comes from K. W. Electronics. The basic output of the exciter is in the 80-m band and for operation on other bands crystal beat oscillators are switched in by the band switch. Provision is made for normal a.m. and c.w. transmission and the s.s.b. output is 180W p.e.p. from the class-AB1 push-pull stage.

Printed-circuit panels are used for the exciter and modulator of the Labgear LG50 50-W and "Top-bander" 160-m, 10-W transmitters. These employ screen-grid modulation and they have a "power control" which varies the power-amplifier screen-grid potentials, allowing the maximum power to be reduced to 7W and 3W respectively, whilst preserving a reasonably linear modulation characteristic.

Often the problem of coupling 300- $\Omega$  or 80- $\Omega$  twin feeder to a coaxial 80- $\Omega$  transmitter output, or *vice versa* is encountered. Whilst it is relatively easy to make up a balance-to-unbalance transformer—with, if necessary an impedance adjustment—for one band, a wide-band device is rather more of a problem. Heathkit, however, now offer a "balun" unit consisting of two bifilar transformers in a screening box. These have one pair of windings connected in parallel to a coaxial socket,

and the other windings may be joined in series or parallel to give either a 300- $\Omega$  or 80- $\Omega$  balanced feeder connection. Minimitter were showing an aerial rotator with a beam-direction indicator consisting of a sector of light of included angle equivalent to the beam width shining through a great-circle map centred on London. This is rotated in synchronism with the aerial (not the drive motor) by a selsyn system. Labgear have produced a three-band "quad" design (14, 21 and 28Mc/s) consisting of three separate "quad" aerials, which are supported concentrically on eight bamboo poles radiating from castings at the ends of the boom. These poles are angled so that correct parasitic-element spacing from the driven elements avoids the need for tuning stubs.

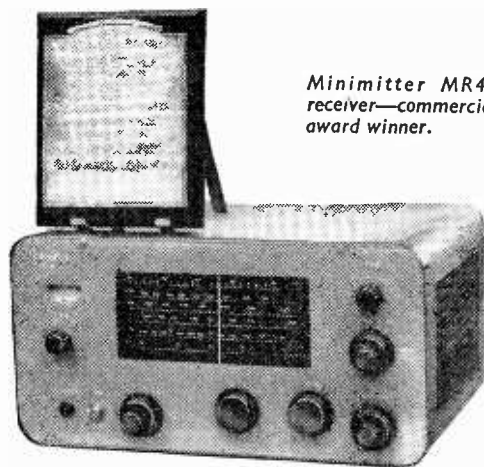
To the R.S.G.B. credit is due for another innovation—a most successful one, too. Entitled "Communications Receivers of the World," this exhibit comprised thirteen "famous name" receivers of British and foreign manufacture. In all except one case, the receivers were working and visitors to the exhibition were invited to put the sets through their paces. This they did, most enthusiastically!

The items in the display of R.S.G.B.-members' work again reached a very high standard, both in ingenuity of approach to electrical design and in the mechanical execution of the design idea. Here mention must be made of J. D. Heyes' (G3BDQ) mains-powered communications receiver, which has one of the most comprehensive specifications any "DX-hound" could want. Using 18 valves, this set provides for s.s.b., a.m. and c.w. reception on the 14, 21 and 28Mc/s bands in four ranges, the 28-Mc/s band being split into two parts. Using a grounded-grid buffer first stage followed by a tuned r.f. amplifier, the double-superhet design utilizes a wide-band first i.f. amplifier which is followed by a fixed-frequency second i.f. section at 460kc/s. The oscillator for the first frequency-changer is crystal controlled: the second is tunable to give band-spread.

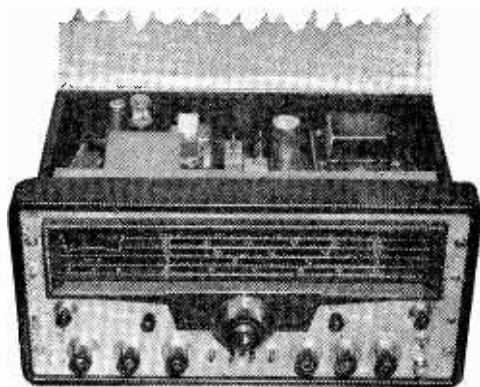
Mullard were demonstrating, for classroom use, a simple method of displaying the properties of magnetic materials using an oscilloscope.\* Two coils with a large number of turns (about 3,000) are used and one coil is fed with 50c/s a.c. which provides the horizontal deflection for the c.r.o. The output from the second coil, when a magnetic core is used to couple the pair, represents the rate of change of flux density. Integration of this by an R-C combination provides the vertical-deflection voltage for the oscilloscope, which then displays the hysteresis loop.

A new item of test equipment from Jason is the W11 "wobulator." This gives a frequency-modulated output from 0 to 85Mc/s on fundamentals, in three ranges (0-2, 0-40 and 35-85Mc/s), using only two double valves and a rectifier. The basic oscillator operates at 150Mc/s

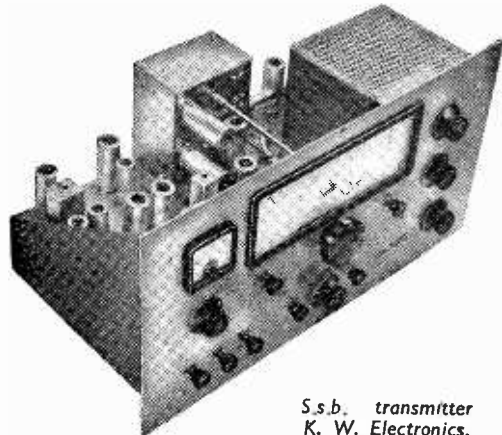
\**Wireless World*, Vol. 64, p. 433 (September, 1958) (oscilloscope), and "Demonstrations and Experiments in Electronics No. 9." Mullard Educational Service (hysteresis demonstration).



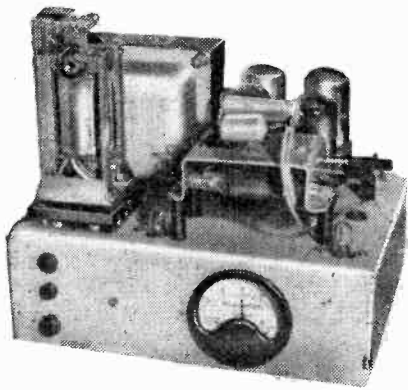
Minimitter MR44 receiver—commercial award winner.



Hallicrafters SX-101A receiver.



S.s.b. transmitter by K. W. Electronics.



G2UK's f.s.k. teleprinter terminal unit.

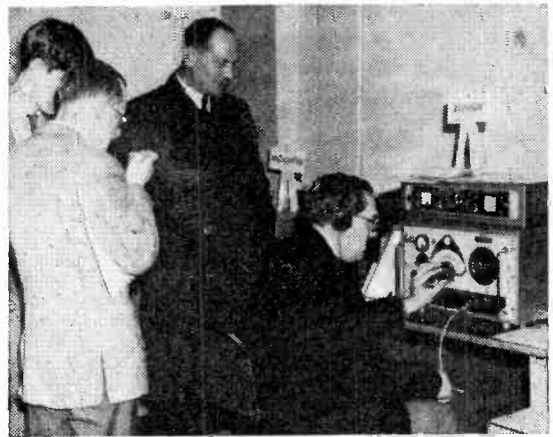
and is frequency modulated by a back-biased junction diode. The output from this oscillator beats with another oscillator whose frequency is varied by the manual controls, the beat being detected and amplified for use as the generator output. In this way a maximum sweep of about 8Mc/s is achieved, but the relation between frequency and back-bias voltage for a semiconductor-diode-controlled oscillator is not linear. Thus, to provide a linear sweep, the 50c/s sweep voltage is fed through a non-linear amplifier, whose non-linearity is the inverse of the bias/frequency characteristic.

Amateur television activity was represented, as usual, by the British Amateur Television Club. Right up to the minute, one of the items on this stand was a working display of slow-scan television equipment, similar in principle to the method used recently by the B.B.C. over the transatlantic cable†. Chemical processing of quantities of film was regarded as ruling out this means of storing the pictures, so they were recorded on magnetic tape running at 7½in/sec. Two systems were represented; one, developed by WA2BCW of the U.S.A., uses an amplitude-modulated 2kc/s sub-carrier, whilst J. A. Plowman (G3AST) uses a composite a.m./f.m. system. A recording made by WA2BCW was played back at the exhibition on Plowman's equipment, which uses a VCR517 long-persistence c.r.t. to build up the picture: the line-scan frequency was 20c/s, resulting in a read-out time of 6 sec for the complete 120-line picture.

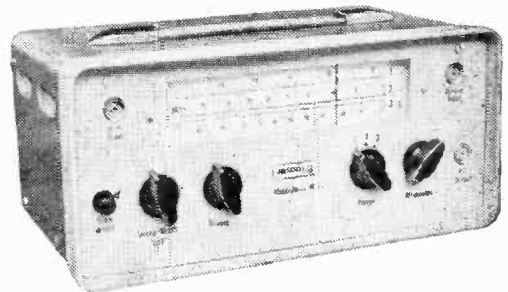
Mobile radio is another facet of the amateur's interests and a recently formed group—the Amateur Radio Mobile Society—caters for enthusiasts. The transistor has done much to ease both the physical and electrical loads on cars—some examples of both British and American transistor power convertors were shown on this stand. One, available as a kit of parts or "ready made" from Transpack, provides an output of 115W high-voltage d.c. at the seemingly incredible efficiency of 95%. This is achieved by the use of a toroidally-wound transformer, silicon-junction bridge rectification of the transformer output and a diode circuit which recovers the energy stored in the transformer core.

Teletype is not often thought of as a means of communication between radio amateurs; but it has for some years been gaining ground in the U.S.A. and it has now gained a foothold in the U.K., with the formation of the British Amateur Radio Teletype Group. Due to a purchase of some G.P.O.-surplus machines, several amateurs now have the basic facilities for generating and receiving teleprinter signals. These are used with frequency-shift keying (the normal form for teletype transmission) transmitter excitors in which the shift is usually achieved by "pulling" the v.f.o. by the required amount. Reception is effected by a unit which, fed

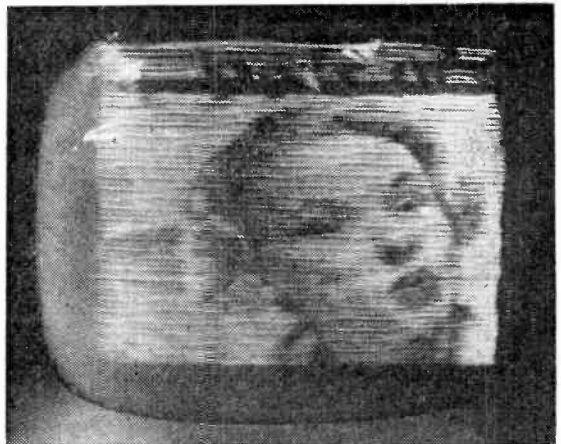
† High-speed Facsimile, *Wireless World*, Vol. 65, pp. 314 and 362 (July/August, 1959).



"Communications Receivers of the World". Visitors put one of the working receivers through its paces.



Jason frequency-modulated test oscillator.



Untouched reproduction of 120-line picture from slow-scan television (British Amateur Television Club).

from the receiver, converts the 860c/s frequency shift back into  $\pm 80V$  signals for the machine. These convertors are usually specialized discriminators, and A. C. Gee's (G2UK) unit, using modified TV width-control coils for the tuned circuits, was on show, together with some "copy" from several contacts with the U.S.A. and Australia, made over radio "circuits." The great advantage of f.s.k. is, of course, the small bandwidth required; but a side issue of the work of this group is that the identity of commercial operators who infringe the amateur band allocations can now be established without the necessity for professional help.

# WORLD OF WIRELESS

## Sound Broadcasting

IN view of the recent discussion both in Parliament and the lay Press on the subject of commercial broadcasting and especially its potentialities as a local broadcasting service, the B.B.C. has stated that "Any major extension of the existing services, particularly for local broadcasting, depends in the first instance on the allocation of additional frequencies in the v.h.f. band."

The B.B.C. has already made known to the Post Office its desire to use further frequencies to fill gaps in its present v.h.f. coverage and for local broadcasting, and the statement adds "These frequencies, which are allocated internationally for broadcasting, are at present used in this country by other services, and their release for broadcasting is problematical. Until this question is resolved it is not possible to proceed with detailed plans."

The frequencies referred to are those between 95 and 100Mc/s. Although the 88-100Mc/s band is allocated throughout the world for broadcasting, the Atlantic City allocation table does include a provision that the top 5Mc/s may be used in the U.K. for fixed and land mobile services. There is also a provision that the meteorological aids service in the U.K., France and India may be operated between 94.5 and 95Mc/s.

It remains to be seen what changes in these allocations will be made at the Geneva Conference.

## Government Radio Research

WITH the announcement of the appointment of J. A. Ratcliffe as successor to Dr. R. L. Smith-Rose (see "Personalities") as director of the D.S.I.R. Radio Research Station, the Council for Scientific and Industrial Research has also announced changes in the terms of reference of the Station.

The Radio Research Station at Slough, which has an international reputation for its detailed studies of ionospheric and tropospheric radio propagation, is to extend its programme to take advantage of the techniques provided by rockets and earth satellites.

Under its new terms of reference the Station, which has a staff of about 160 scientists and assistants, will undertake investigations of the upper atmosphere and outer space by both radio and non-radio methods. At the invitation of the present director, Mr. Ratcliffe will assist in planning the future research programme before taking up his appointment in October.

## Broadcasting in Italy

ITALY'S network of v.h.f. transmitters is by far the largest in Europe and possibly in the world. At the beginning of December she had 235 stations and as each station radiates three programmes, the total number of f.m. transmitters in use was over 700.

Television stations in Italy now total some 340. They are all accommodated in eight 7-Mc/s channels in Bands I and III. Only about 10% of them have an e.r.p. of over 1kW and some are as low as 0.4W.

The majority of both the television and v.h.f. sound broadcasting stations are operated as satellites of main transmitters. Italy also operates 116 transmitters in the medium-wave band, more than half of which are low-power. A total of about 7.5M licences, including well over 1M for television, are now in force.

**International Conferences.**—In our comment on page 421 of the October, 1959, issue we suggested the desirability of a Conference on conferences to anticipate congestion. We now learn that the 1st Congress of International Congress Organizers and Technicians was, in fact, held in Düsseldorf in February, 1959, and that the 2nd Congress is already arranged for March 15th-18th, 1960, in Lausanne. It will be held under the auspices of the Union of International Associations whose U.K. representative is E. S. Tew, 91, Lyndhurst Gardens, London, N.3. Other participating bodies include the International Association of Congress Palaces and the International Association of Conference Interpreters.

**Medical Electronics Conference.**—The third international conference on medical electronics is to be held at Olympia, London, from July 21st to 27th, 1960. It is being organized by the Electronics and Communications Section of the I.E.E. in association with the International Federation for Medical Electronics, which was set up at the Paris conference a few months ago. Those requiring registration forms and further particulars or who are interested in submitting a paper should write to the secretary, I.E.E., for further information. The I.E.E. is also promoting an international scientific exhibition which will be run concurrently with the conference. The exhibition organizers are Industrial Exhibitions Ltd., 9 Argyll Street, London, W.1.

**Vibration.**—The Acoustics Group of the Physical Society will hold a symposium on the subject of "Vibration" in the Physics Department, Imperial College, Imperial Institute Road, London, S.W.7, at 2.30 on January 20th. Papers will be read on the analysis of noise-excited vibrations in aircraft, on vibration-isolation, on ground vibrations and on the influence of vibration, including that from small power tools, on the human body. Speakers will include Prof. E. J. Richards and Dr. B. L. Clarkson, of Southampton University, P. H. Allaway, of Absorbit, Dr. N. Ambraseys, of Imperial College, Dr. J. N. Agate, formerly of the London Hospital, and Flt. Lt. Guignard, of the R.A.F. Institute of Aviation Medicine.

**The College of Technologists,** established by the National Council for Technological Awards last May to administer "an award higher than the Diploma in Technology," to be known as M.C.T. (Membership of the College of Technologists), has issued a memorandum giving guidance to applicants for registration. It outlines the qualifications required, the procedure for the submission of an application and the fees payable. The eight-page leaflet is available from the National Council for Technological Awards, 9 Cavendish Square, London, W.1.

**Correspondence Courses.**—Approval has now been given by the Royal Navy, the Army and the Royal Air Force for the acceptance of the C.R.E.I. (Capitol Radio Engineering Institute) courses in electronic engineering as qualifying for part refund of fees for external correspondence courses used by members of the Armed Services. The value of the concession may amount to up to 50% of the cost of the course.



**V.H.F. radio-telephone** service to ships, which is already provided on the Clyde and from the North Foreland, Niton (Isle of Wight) and Humber coast radio stations, will soon be available from the Land's End station also. All these stations operate on frequencies around 160Mc/s. The charge for a three-minute call to a vessel within the 40 to 50 mile service area of a station is 6s 6d plus a land line charge of from 6d to 2s 6d, depending on the distance the inland telephone subscriber is from the coast station.

**Orkney Television Station.**—The permanent installation at the B.B.C.'s Orkney television station, replacing the temporary low-power equipment which has been in use for the past year, was brought into service on December 17th. The station radiates in channel 5 (vision 66.75Mc/s, sound 63.25Mc/s) and its directional aerial provides an e.r.p. of from 4 to 14kW, depending on direction. Transmissions are vertically polarized. The station serves the whole of the Orkney Islands and a large part of Caithness.

**E.B.U. Station Lists.**—Revised lists of television and v.h.f. sound broadcasting stations in Europe have been prepared by the European Broadcasting Union. These show the situation at July 1st last year. The next edition will give the position on January 1st, 1960, and in future only one edition will be published each year, but supplements will be issued every two months. The price for each of the lists plus the supplements is 50 Belgian francs. They are obtainable from the E.B.U. Technical Centre, 32 avenue Albert Lancaster, Brussels 18, Belgium.

**Televis'ion Society.**—In an endeavour to attract more student members into the Television Society, the Council has decided to waive the entrance fee, which is 30s. Student membership, for which the annual fee is £1, is open to those over 16 but under 21, but students over 21 who are taking a recognized college course in television are also eligible. Details of membership are obtainable from the secretary, Television Society, 166, Shaftesbury Avenue, London, W.C.2.

**Provincial Centres.**—Readers in South Wales may be interested to know that a Centre of the Television Society has been formed in the area. The secretary is D. M. Thomas, 39 Gron Ffordd, Wenallt Road, Rhiwbina, Cardiff. The Society also announces the reformation of the Leicester Centre (secretary E. F. Dawson, 28 Clumber Street, Melton Mowbray) and plans to revive the Manchester and Birmingham centres.

"**Engineering Education in the Region**" is the title of a booklet produced by the London and Home Counties Regional Advisory Council for Technological Education to assist those who wish to follow a recognized course in some branch of engineering in the region. The courses, grouped under some 50 subjects, are also classified under "grades," ranging from degree and diploma courses to those for craftsmen. The 38-page booklet costs 3s 6d from the Council at Tavistock House South, Tavistock Square, London, W.C.1.

**Control Engineering.**—A course of ten evening lectures on the principles of control engineering, covering both linear and non-linear servo systems, will be given at the South East London Technical College, Lewisham Way, S.E.4, on Wednesdays, from January 20th. Fee £1.

The **Technical Publications Association** is donating two £10 awards annually to the City and Guilds of London Institute for the top students in the final grade in the two recently introduced training courses in technical authorship and technical illustration.

**Norwood Technical College, London, S.E.27,** celebrated its centenary by holding in December a two-day exhibition. It included demonstrations showing some aspects of the work of the various departments and also equipment lent by manufacturers.

**Swedish Television.**—In the three years since Sweden opened her television service, the number of stations has grown to 23 and half a million television receiving licences are now in force. Although the present stations cover only about 60% of the 7.4M population, the present number of licences represents a television density of 66 sets per 1,000 inhabitants. It is planned to open a further 19 stations before July 1st this year. Sweden employs the 625-line 7-Mc/s standard with f.m. sound and all the present transmitters operate in Bands I and III.

**Receiving Licences.**—October's total of 9,844,365 combined sound and television licences in the U.K. was 125,893 up on the previous month. Sound-only licences totalled 5,084,380 including 410,372 for car radio.

**West German TV.**—The number of television licences issued in the German Federal Republic and West Berlin increased by 102,000 in September, and the total is now well past the three million mark.

**U.S.S.R.**—Television sets in the U.S.S.R. are stated to be among the consumer goods in short supply. Steps are therefore being taken to increase the output from the 1958 total of 979,300 to 1,926,000 in 1961.

**Soviet Radio Telescope.**—The first Soviet steerable radio telescope was recently completed at the scientific station of the Lebedev Physics Institute near Moscow. It has a 22-metre (over 72-feet) paraboloid with a focal length of 9.5 metres. The parabolic mirror weighs 65 tons and the overall weight of the telescope is 380 tons. The paraboloid of the Jodrell Bank radio telescope has a diameter of 250 feet.

**For Yachtsmen.**—Details of radio beacons and coast radio stations, a map showing the weather forecasting areas and details of the B.B.C.'s transmissions of time signals are included in the 52-page reference section of the *Yachting World Diary, 1960*. It costs 6s 3d (with leather cloth cover) or 9s 9d (Morocco leather).

## CLUB NEWS

**A.R.M.S.**—A meeting of the Amateur Radio Mobile Society will be held on January 30th at 3.0 in the Small Hall of the St. Bride Foundation Institute, Bride Lane, Fleet Street, London, E.C.4. The programme will include a lecture and films. Details are available from the secretary, G. E. Storey, 10 Avon Road, Sunbury-on-Thames, Middx, from whom information on the mobile rally planned for April or May is obtainable.

**Birmingham.**—The January programme of the Midland Amateur Radio Society includes a talk on the 7th by R. Rew on the construction of a 70-cm transmitter and on the 19th a talk by H. Buckley, of Bradmatic, on sound recording and reproduction. Meetings are held at 7.0 at the Birmingham Midland Institute, Paradise Street.

**Calcot.**—A lecture-demonstration will be given by a representative of Dynatron Radio to members of the Calcot Radio Society on January 21st at 7.45 in the St. Birinus Church Hall, Calcot, near Reading.

**Cleckheaton.**—A representative of Philips is giving a talk on tape recorders to members of the Spen Valley and Leeds Amateur Radio Societies at the George Hotel, Cleckheaton, at 7.30 on January 20th.

**Halifax.**—A talk on television interference is to be given by H. Swift (G3ADG) to the Halifax and District Amateur Radio Society on January 5th at the Sportsman Inn, Oden.

**Mitcham.**—Meetings of the Mitcham and District Radio Society are held every Friday at 8.0 at "The Cannons," Madeira Road, Mitcham. Lecture meetings alternate with instruction classes. On January 8th a member of the G.P.O. engineering department will give a talk on cable link systems.

**Wellingborough.**—"Transistors" is the title of the talk to be given by F. Manning at the January 21st meeting of the Wellingborough and District Radio and Television Society. Meetings are held every Thursday at 7.30 at Silver Street Club Room.

# Personalities

**Brigadier Sir Lionel Harris, K.B.E., T.D., M.Sc., F.C.G.I., M.I.E.E.**, who is 62, is retiring at the end of January from the position of Engineer-in-Chief of the Post Office. He joined the Post Office research branch at Dollis Hill in 1922 having previously spent four years with signals in the Australian Imperial Forces. During the 1939-45 war he successively commanded G.H.Q. Signals; was Chief Signal Officer, Lines of Communication; and for two years chief of General Eisenhower's Telecommunications Section. From 1949 until his appointment in 1954 as engineer-in-chief he was controller of research.



Sir LIONEL HARRIS.



A. H. MUMFORD.

**A. H. Mumford, O.B.E., B.Sc.(Eng.), M.I.E.E.**, deputy engineer-in-chief of the Post Office for the past six years, succeeds Sir Lionel Harris as Engineer-in-Chief. He joined the Post Office as a probationary assistant engineer in 1924 and after a short period at headquarters went to Dollis Hill laboratory. He was in charge of the Radio Branch during much of the war. Mr. Mumford was a member of the Post Office team which first recorded aircraft reflections of radio waves in June, 1932. He is 56.

The Postmaster-General has also appointed two deputy engineers-in-chief—**Capt. C. F. Booth, O.B.E., M.I.E.E.**, and **D. A. Barron, M.Sc., M.I.E.E.** Both have been assistant e.-in.-c. since 1954. Capt. Booth, who is 59, joined the Post Office in 1923 and was for twenty-five years at Dollis Hill. He led the U.K. delegation to the recent I.T.U. Conference at Geneva. Mr. Barron entered the Post Office engineering department as a probationary assistant engineer in 1927 at the age of 20. In 1947 he was placed in charge of a working party which examined problems of subscriber trunk dialling.

**A. H. M. Arnold, Ph.D., D.Eng.**, has had the title of Professor of Electrical Engineering conferred upon him by the University of London in respect of his post at King's College, where he has been reader in electrical engineering since 1955. Professor Arnold, who is 59, graduated at Liverpool University in 1923. He spent a year with Metropolitan-Vickers before going to the National Physical Laboratory in 1926 where he was head of the electronics section of the Electricity Division when he left in 1955 to join the staff at King's College.

**R. G. Kenwright** has rejoined the Plessey Co. as chief engineer, Television Components Division, Ilford. He was a radio design engineer with the company prior to 1940 when he joined Pilot Radio of which he became chief engineer in 1946. For ten years Mr. Kenwright was a member of the B.R.E.M.A. technical committee.

**R. Hanbury Brown, B.Sc.(Eng.)**, who has been I.C.I. Research Fellow at the Jodrell Bank Research Station, Manchester University, since 1949 has been granted the status of professor with the title of Professor of Radio Astronomy from January 1st. This chair is a personal appointment and is additional to that held by Professor A. C. B. Lovell, F.R.S. Professor Brown, who received a monetary award from the Royal Commission on Awards to Inventors for his contribution to the development of radar—especially metre-wave AI and ASV—joined the staff of the Bawdsey Research Station in 1936. He participated in the early experimental flying with night-fighter equipment (AI) and ship and submarine detection gear (ASV). With Dr. E. G. Bowen he detected the first submarine by radar in 1939. From 1942 to 1945 Professor Brown was in the Naval Research Laboratory, Washington, D.C., as assistant head of the combined research group working on the development of radar equipment. He is 43.

**V. J. Cooper, B.Sc., A.C.G.I., M.I.E.E., M.Brit.I.R.E.**, since 1956 Marconi's chief television engineer (an office which, under a reorganization, no longer exists), has been appointed manager and chief engineer of the company's new Closed Circuit Television Division. He joined Marconi's in 1936 and was chief engineer, advance development, from 1954 to 1956. Mr. Cooper is a member of the technical sub-committee of the P.M.G.'s Television Advisory Committee.

**J. E. H. Brace, B.Sc.**, who joined Marconi's Broadcasting Division in 1954 when a specialist industrial TV unit was established, has been appointed deputy manager and chief of sales and contracts of the Closed Circuit Television Division. Since 1956 he has been chief of the industrial television group with headquarters at the company's Basildon works.

**N. N. Parker-Smith, B.Sc., A.M.I.E.E.**, is appointed chief development engineer of Marconi's Closed Circuit Television Division. He has been with the company since 1947 and for most of the time has been engaged in television development work. From 1953 to 1956 he headed the section of the advance development group handling colour television.

Consequent upon the formation of the new division by Marconi's, the following appointments have been made in the Broadcasting Division: **G. E. Partington, B.Sc., A.M.I.E.E.**, becomes chief engineer and **J. F. James, B.Sc., M.I.E.E.**, chief development engineer. Mr. Partington joined Marconi's in 1938 when he attended a course of advanced training for post-graduate engineers at the Marconi College. In 1949 he was appointed chief of the television studio development group and in 1956 became deputy chief television engineer. Mr. James went to Marconi's from the Ministry of Supply (where he was a senior scientific officer) in 1949. He became deputy to the chief of the radar development group in 1952 and for the past four years has been in charge of this group.

**R. E. Burnett, M.A.(Oxon.), A.M.I.E.E., A.Inst.P.**, general manager of Marconi Instruments since 1956, has been elected to the board and appointed managing director of the company. Mr. Burnett, who is 44, joined the Marconi organization in 1950 when he was appointed principal of Marconi College and manager of the Technical Personnel and Education Department. In 1954 he became assistant to the general manager of Marconi's W/T Co., and a year later transferred to Marconi Instruments as deputy general manager.

**A. J. Young, B.Sc.(Eng.), M.I.E.E.**, general manager of the English Electric Valve Co. since 1956, has been elected to the board and appointed managing director of the company. He joined Marconi's W/T Co., as a valve engineer in 1934 and in 1947 transferred to the English Electric Valve Co. as assistant general manager. He is 51. **F. N. Sutherland, C.B.E., M.A., M.I.E.E.**, managing director of Marconi's W/T Co., has also been elected to the board of the English Electric Valve Co.

## OUR AUTHORS

**Dr. R. L. Smith-Rose**, C.B.E., is to retire from the directorship of the Radio Research Station of the D.S.I.R. at the end of September and is to be succeeded by **J. A. Ratcliffe**, C.B.E., F.R.S., who is head of the radio section of the Cavendish Laboratory, Cambridge. Dr. Smith-Rose, who is 65, has been in the Scientific Civil Service since 1919 and was from 1939 until 1947 superintendent of the Radio Division of the National Physical Laboratory. In 1948 he was appointed as the first Director of Radio Research when the post was created by the D.S.I.R. Dr. Smith-Rose, who has served on many national and international scientific committees, is a member of the technical sub-committee of the Television Advisory Committee and also of the P.M.G.'s Frequency Advisory Committee. Mr. Ratcliffe joined the Cavendish Laboratory in 1924 and worked with E. V. Appleton (now Sir Edward) on his researches on the ionosphere. He founded the Army radar school at Petersham and he later built up the "Post-Design Service" for the R.A.F. which was concerned with the study of radar equipment under Service conditions. During the latter part of the war he was superintendent of T.R.E. He is 57.



J. A. RATCLIFFE.



Prof. E. B. MOULLIN.

**Professor E. B. Moullin**, M.A., Sc.D., M.I.E.E., is to retire next October from the chair of electrical engineering at Cambridge University, which he has occupied since it was established in 1945. He is 66. Dr. Moullin, who is a Fellow of both King's College, Cambridge, and Magdalen College, Oxford, was a lecturer at Cambridge from 1920 until 1929 when he was appointed Donald Pollock reader in engineering science at Oxford where he stayed until 1945. He is author of a number of books including "Principles of Electromagnetism" and "Radio Aerials", and his research studies have covered a very wide range of radio subjects. Professor Moullin is a member of the Editorial Advisory Board of our sister journal, *Electronic Technology* (previously *Electronic & Radio Engineer*).

**C. Collaro**, O.B.E., has resigned from the board and chairmanship of Hartley Baird, Ltd. **A. W. M. Hartley** has succeeded him as chairman and simultaneously has resigned as managing director. **H. J. D. L. Walmsley** and **J. Symonds** have been appointed joint managing directors. Mr. Collaro has also resigned from the board of Camp Bird, Ltd., and from Camp Bird Industries, of which he was managing director. He joined the Camp Bird Group in 1957 following his resignation from the chairmanship and managing directorship of Collaro, Ltd.

**E. R. Lewis**, chairman of the Decca Group of Companies, and **Group Captain E. Fennessy**, C.B.E., managing director of Decca Radar, Ltd., have joined the board of General Precision Systems, Ltd. (formerly Air Trainers Link, Ltd.), following the acquisition by Decca Radar of a 25% interest in that company. The two companies are to co-operate in the development of air traffic control systems.

**Dr. Manfred von Ardenne**, a pioneer in the development of the cathode-ray tube for television, writes in this issue on the evolution of the c.r.t. Dr. von Ardenne, who is now head of a research institute in Dresden, East Germany, first wrote for *Wireless World* over thirty years ago and has made many notable contributions to the development of television. Sydney Moseley and H. J. Barton Chapple in their book "Television Today and Tomorrow" wrote of von Ardenne "he commenced his researches on television in 1930 . . . within a year he earned the distinction of being the first to demonstrate publicly cathode ray reception comparable with that produced by mechanical means."

**A. R. Bailey**, M.Sc.(Eng.), author of the article on page 25, took his London B.Sc. degree in 1953 at Bradford Technical College (now Bradford Institute of Technology) where he stayed to undertake research into precision three-phase a.c. voltage stabilizers under a D.S.I.R. grant. He went into industry for a short while but returned to the college where he is now a lecturer.

**A. E. Falkus**, B.Sc.(Eng.), M.I.E.E., who writes in this issue on loudspeaker magnet design, was chief loudspeaker designer of the Plessey Company for eight years until 1958 when with D. A. Newbold he formed Fane Acoustics Ltd. He obtained his degree at London University in 1925 and was at one time chief engineer of Reproducers and Amplifiers Ltd.

**Robert Hickson**, whose article on the Smith Chart is on page 2, is technical librarian of Belling and Lee, Ltd. During his national service in the Royal Navy (1945-47) he was a radio mechanic and before joining Belling and Lee he had been a technical writer on the staffs of Marconi Instruments and S.T.C.

**J. M. Waddell**, M.A., A.M.I.E.E., who with D. R. Coleman discusses Zener diodes in an article on page 17, spent a little over two years in R.E.M.E., after leaving Cambridge where he read physics. From 1949 to 1958 he worked in the Rectifier Division of Standard Telephones and Cables and from 1956 was responsible for the development and applications of silicon rectifiers. For the past year he has been with Texas Instruments, Ltd., Bedford.

**D. R. Coleman**, B.Sc.(Eng.), A.M.I.E.E., co-author of the article on Zener diodes, joined S.T.C.'s rectifier division in 1956 and is now in charge of the group concerned with the evaluation and applications of semiconductor devices. After three years in the Royal Engineers he studied at the Regent Street Polytechnic and then spent five years (1951-56) on the development of aircraft electrical equipment.

## OBITUARY

**Hilary F. C. Williams**, B.Sc., chief electronics engineer of Andec, Ltd., for the past 12 months, died suddenly on November 11th at the age of 45. After graduating at London University in 1935 he became a schoolmaster and during the war was at the Royal Aircraft Establishment where he held an honorary commission in the Royal Air Force. He was with Cossor's for nine years after the war as a development engineer and later assistant chief engineer of Racial Engineering.

**Joseph Poliakov**, founder of the Multitone Electric Co. in 1931, died on November 24th at the age of 86. Mr. Poliakov, who established the Telephone Construction Co. in Russia (it was nationalized in 1921), came to this country in 1924. He was managing director of Multitone until 1938 when owing to ill-health he resigned in favour of his son, but continued on the board and took an active part in the day-to-day affairs of the company. Although his life-work was devoted to the alleviation of deafness, he was an engineer of wide interests—he had a patent for recording sound on film in 1894.

# News from the Industry

**A.E.I. Reorganization.**—On January 1st the British Thomson-Houston Co., Metropolitan-Vickers Electrical Co. and Siemens Edison Swan changed their names to Associated Electrical Industries (Rugby) Ltd., Associated Electrical Industries (Manchester) Ltd., and Associated Electrical Industries (Woolwich) Ltd., respectively. At the same time five new Product Divisions of A.E.I. (making 12 in all) come into operation. They are: Cable Division and Construction Division combining the interests of the S.E.S. Cables Division with those of W. T. Henley's Telegraph Works Co. and Liverpool Electric Cables; Telecommunications Division, hitherto a Product Division of Siemens Edison Swan; and a Radio and Electronic Components Division. These four Divisions will be managed by Associated Electrical Industries (Woolwich) Ltd. The fifth is the Instrumentation Division combining the interests of Sunvic Controls with the instrument and meter, X-ray, and scientific apparatus departments of Metropolitan-Vickers and will be managed by Associated Electrical Industries (Manchester).

**G.E.C.-Plessey Co-operation.**—An arrangement has been entered into by the Semiconductor Division of the G.E.C. and Semiconductors Ltd., of the Plessey Group, whereby each will handle information on the products of both organizations.

**Plessey's trading profit** for the year ended in June was £2.206M compared with £1.350M the previous year. The net profit after tax deduction was £1,194,499 as against £561,991 last year.

**Gresham Automation Ltd.** has been formed to handle the Gresham Unit Sequencing System. The directors are John P. Coleman (chairman of Gresham Transformers Ltd. and of the Gresham Lion Group) and R. M. Campbell, a director of Gresham Transformers. Dr. D. B. Foster is appointed as consultant to the board. The offices of the new company are at Gresham House, Twickenham Road, Hanworth, Middx. (Tel.: Feltham 2271.)

**Marconi's W/T Co.** have received a contract from the B.B.C. for the supply of a considerable quantity of equipment, valued at approximately £115,000, to extend the coverage of the television and v.h.f. sound broadcasting services to "difficult" areas. The order includes 10 television translators (for picking up sound and vision signals from one station, and re-transmitting them on other frequencies); 4 television transmitters and 30 f.m. translators—all of 10 watts output. The associated amplifiers for the equipments vary in power from 100 watts to 1kW.

**E.M.I. apprentices** with Clifford Metcalfe, C.B.E., managing director of E.M.I. Electronics, who presented them with prizes for obtaining their Higher National Diploma in electrical engineering with three or more distinctions. The recipients (from left to right) are David Jackson, George East and James Jordan, who were among thirteen E.M.I. apprentices who enrolled for the first four-year sandwich course at Southall Technical College in 1956. All thirteen have obtained their H.N.D. and are taking the fourth year of the course to qualify as Grad. I.E.E.

**Electronic Associates Ltd.**, with offices and works at Victoria Road, Burgess Hill, Sussex, have been formed by Electronic Associates Inc., of Long Branch, N.J., U.S.A., manufacturers of Precision Analog Computing Equipment (PACE). The Burgess Hill works will be managed by H. Turner, a director of the new company and a graduate of Manchester University, who has been with the parent company for several years. The managing director is Dr. B. Murphy, who is also general manager of the European branch of Electronic Associates Inc, set up in Brussels in 1957.

**Pye Telecommunications Ltd.**, have moved their London sales and service headquarters to 1 Carrol Place, Highgate Road, N.W.5 (Tel.: Gulliver 8771), where Brigadier E. J. H. Moppett, the London-based director, has an office.

**Datum Metal Products Ltd.** (formerly Davis and Thompson), members of the J. Langham Thompson Group, have moved into a new factory on the Colne Way Trading Estate, Watford By-Pass, Herts (Tel.: Watford 22351). These new premises have trebled the production area of the company.

**Aircraft-Marine Products (G.B.) Ltd.**, who market the range of A-MP solderless terminations, have moved from Regent Street to Amplo House, 87-89 Saffron Hill, London, E.C.1 (Tel.: Chancery 2902). The building houses the head office, the research laboratory (formerly at Bournemouth), the sales and engineering departments, and the international trade division (previously at Bedford Row).

**Lasky's Radio** have opened new premises at 207 Edgware Road, London, W.2 (Tel.: Paddington 3271), in addition to their branch at 42 Tottenham Court Road, London, W.1.

**Pye** have supplied the equipment for the inter-branch television network recently introduced by the Westminster Bank in Manchester. The cable system linking two branches with the central book-keeping department in the main city office, is provided by the G.P.O. The 625-line system is employed.

**Smiths.**—Examples of many of the products manufactured at the twenty factories in the Smiths Group, which includes Kelvin-Hughes and Radiomobile, are displayed at the Smiths Centre, Cricklewood, which was officially opened by H.R.H. the Duke of Edinburgh on November 19th.



# ZENER DIODES — THEIR PROPERTIES AND APPLICATIONS

By J. M. WADDELL,\* M.A., A.M.I.E.E., AND D. R. COLEMAN,† B.Sc. (Eng.), A.M.I.E.E.

**A**MONG the many new components now appearing in electronic equipment as a result of the intensive work which has been done on semiconductors in the last few years is a useful group usually known as "Zener" diodes. What are these "Zener" diodes, and what do they do?

If we examine the reverse characteristic of a typical silicon junction rectifier, shown in Fig. 1, we can see that the reverse current remains extremely small at all voltages below a certain value, the "Zener voltage." Then, as the voltage is raised slightly above this value, the current increases very rapidly indeed into the so-called "breakdown" region. For power rectifiers, the manufacturer arranges that this breakdown region occurs well above the normal reverse operating voltage, in order to avoid excessive power dissipation in the reverse direction and consequent failure due to overheating.

It should be noted that this phenomenon is not a breakdown in the ordinary sense of the word (in the sense in which a dielectric breaks down), but is a completely reversible process which of itself causes no damage to the rectifier. However, if the rectifier were run continuously in this region it is probable that the maximum allowable dissipation of the device would be exceeded and the rectifier damaged; but if excessive dissipation is avoided the diode can be run in the "broken down" condition indefinitely. A diode used deliberately in this way for any purpose is called a "Zener diode."

The term "Zener diode" was coined when this

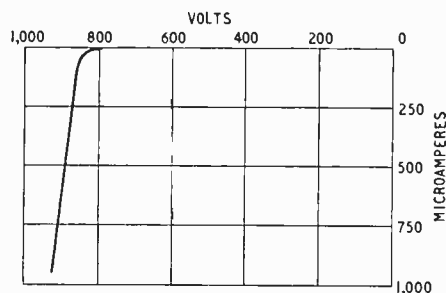
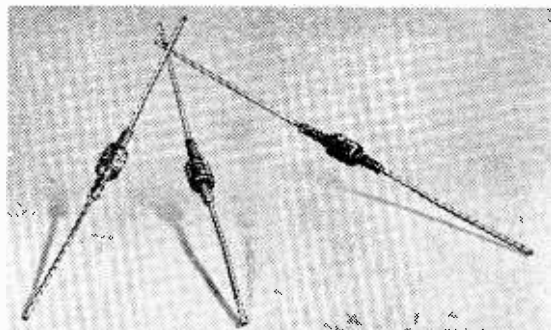


Fig. 1 Reverse characteristic of a typical silicon junction rectifier.

breakdown was first observed<sup>1</sup> because it was thought that the mechanism responsible was that proposed by C. Zener in 1934 to account for the breakdown of solid dielectrics<sup>2</sup>. It turns out that this "Zener breakdown" is responsible where the breakdown occurs at low voltages (below 5 volts in silicon), but that at higher voltages breakdown is



A group of typical Zener diodes.

due to another mechanism, "avalanche multiplication," similar to the breakdown process in gaseous dielectrics described by Townsend.<sup>3</sup> Thus the higher voltage Zener diodes should really be called avalanche diodes. While one of the purposes of this article is to draw attention to the different behaviour of Zener and avalanche diodes—for example, the "knee" of the breakdown characteristic is more rounded in a Zener diode and so the slope resistance of such diodes is higher than that of the corresponding avalanche diodes—it is convenient to have a generic term to cover all such devices, and the term "Zener diode" has received widespread acceptance.

It is possible to use a term denoting the application, e.g., "reference diode," "regulator diode," but the range of use of these devices is so vast that no one application can be singled out for such special mention. We recommend the continued use of "Zener diode" as the most useful general term.

One of the great advantages of these devices over previously available voltage stabilizing devices, such as gas discharge tubes, is that the breakdown voltage can be controlled during manufacture to any value from about two volts to several hundred volts. In addition the transition from "off" to "on" takes place smoothly, without the discontinuity associated with gas discharge tubes. No special arrangements are needed for starting, and the absence of negative resistance means that shunt capacitance can be added without causing oscillation. Under appropriate conditions, substantially zero temperature coefficients of voltage may be obtained. Furthermore, Zener diodes are smaller and more robust than gas tubes or batteries, and by comparison they have an almost indefinite life.

Fig. 2 shows typical characteristics of some diodes specially made for use in this way. It will be noted that here the breakdown voltages are quite low, from about 4 to 9 volts. From this graph the important parameters which define the properties

<sup>1</sup>J. S. Townsend. "The passage of ions in gases." *Nature*, 62, p. 340, 9th August, 1900.

\* Texas Instruments, Ltd., formerly with Standard Telephones & Cables, Ltd.

† Standard Telephones & Cables, Ltd.  
<sup>2</sup>K. B. McAfee, E. J. Ryder, W. Shockley and M. Sparks. "Observations of Zener current in germanium p-n junctions," *Phys. Rev.*, 83, p. 650, 1951.

<sup>3</sup>C. Zener. "Theory of the electrical breakdown of solid dielectrics," *Proc. Roy. Soc.*, 145, p. 523, 1934.



current as that at which the nominal voltage is measured. The lower the slope resistance the more constant is the operating voltage with changes in current. As will be seen from the curves, the operating voltage at a given current changes with working temperature, and so for many applications the temperature coefficient of voltage is also important. Finally, since these devices, like most components, are given a maximum operating temperature, the maximum dissipation limits the maximum continuous working current.

**Operating Mechanism.**—In order to understand the way in which these various parameters change for different values of working voltage, it is helpful to have some understanding of the alternative mechanisms involved in the breakdown region. In a silicon rectifier biased in

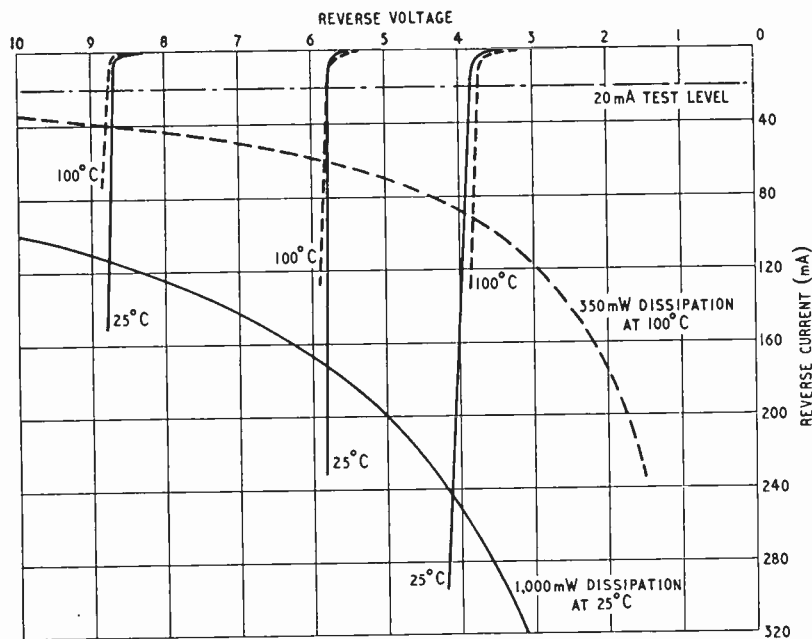


Fig. 2 Typical characteristics of diodes specially made for Zener operation.

of a particular Zener diode can be clearly seen. The first and most important is the voltage in the breakdown region. This is not a unique and fixed value, but increases with the operating current; thus the current at which the voltage is measured must be specified. Usually the manufacturer chooses a particular value of current and quotes the voltages of a complete range of diodes at this particular current.

The next most important parameter is the "slope resistance," or the dynamic resistance of the diode in the "breakdown" region. This again is measured at a particular current, usually the same

the reverse direction almost all the applied voltage appears across the narrow depletion layer located immediately on either side of the junction, and the remaining volume of the silicon is essentially field free. For a given applied voltage the field in the depletion layer depends on the width of this layer, being a function of the centre region resistivity of the diode. This resistivity is controlled during manufacture so that the field in the finished diode can be made to have any desired value for a given voltage across the diode: the higher the resistivity, the wider the depletion layer and the smaller the field per unit of applied voltage. The depletion layer is normally quite narrow, so that fields of the order of several hundred thousand volts per cm. are readily reached.

With fields of this order in the depletion layer the current carriers which constitute the reverse current are accelerated to considerable energies between each collision with the stationary silicon atoms of the

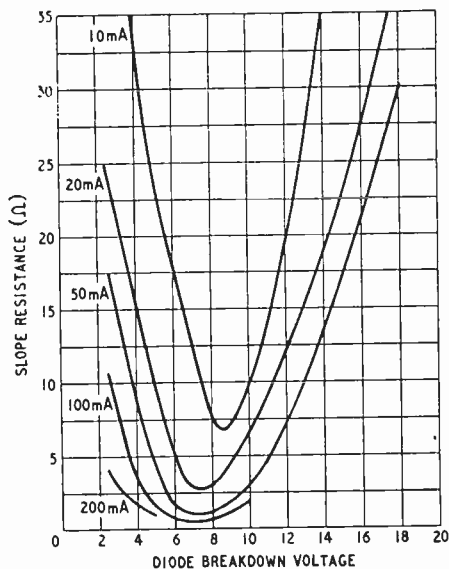


Fig. 3 Variation of slope resistance with reverse current for a typical range of Zener diodes.

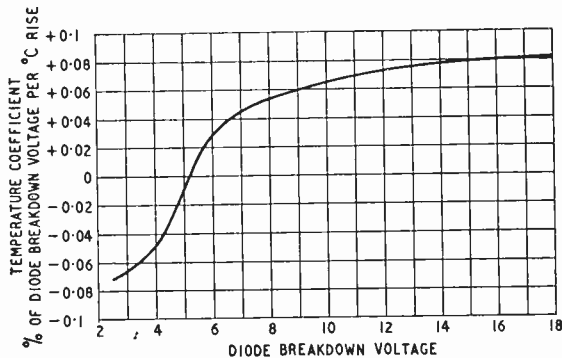


Fig. 4 Temperature coefficient of voltage for a typical range of Zener diodes.

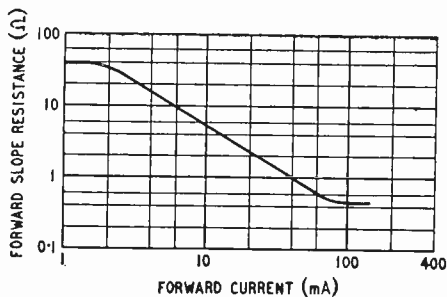


Fig. 5 Variation of forward slope resistance for a typical Zener diode.

lattice. As the voltage across the diode is raised, the field increases, and when it reaches a critical value the energy obtained by each electron or hole between collisions is sufficient to eject an additional electron from the atom with which it collides, thus creating a hole-electron pair. These additional free carriers are also accelerated in their turn, and produce yet more free carriers which all add to the total reverse current. Thus the reverse current, initially no larger than the saturation reverse current present at low voltages, is multiplied to a much larger value by this "avalanche" process, in a manner analogous to the Townsend mechanism in gas discharge tubes.

**Zener Effect.**—In order to produce low breakdown voltage diodes, the depletion layer must be made very narrow. Under these conditions the current carriers are accelerated through the barrier without ever striking an atom of the lattice, and so the avalanche effect does not occur. In these circumstances, as the voltage across the diode is increased the field can rise until it reaches a higher critical value at which true Zener effect occurs. This is a quantum mechanical effect in which hole-electron pairs are generated directly from the energy of the electrical field. The resultant current increases rapidly with voltage, but not quite as rapidly as with the avalanche effect, so that the "knee" of the curve is more rounded.

For silicon junction diodes the changeover occurs in the region of 5-8 volts, those diodes below 5 volts exhibiting Zener breakdown, while those above 8 volts exhibit avalanche breakdown. The breakdown of diodes between 5 and 8 volts is due to a combination of the two mechanisms. An important difference between these two mechanisms is that the temperature coefficient of voltage or the Zener process is negative, whereas that for the avalanche process is positive.

**Characteristics.**—As a result of the above, it is customary to present the characteristics of a particular series of Zener diodes (that is, a range manufactured to the same physical dimensions and differing only in breakdown voltage) in the form of curves showing the various parameters plotted against the breakdown voltage at which the diode under consideration actually operates. Since the characteristics of Zener diodes are related to their operating temperature, it is important to distinguish between a "convection-cooled" (such as a wire-ended) diode for which the immediate ambient temperature is considered, and a "conduction-cooled" (such as a stud-ended) diode for which the characteristics are

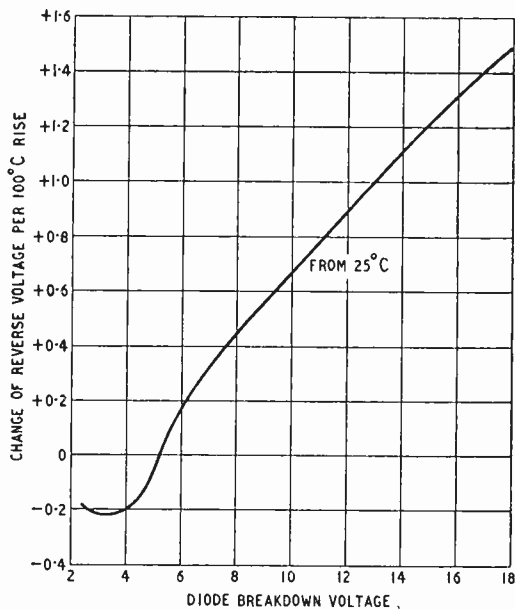


Fig. 6 Change of reverse voltage (at constant current) for a typical range of Zener diodes.

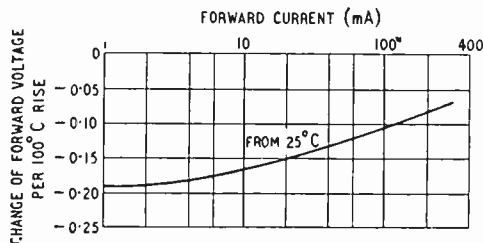


Fig. 7 Change of forward voltage for a typical Zener diode.

quoted in terms of the stud temperature. The following data may, for simplicity, be considered applicable to wire-ended diodes at the stated ambient temperatures.

Fig. 3 shows, for example, the variation of slope resistance with voltage for typical Zener diodes from a particular range. Since the slope resistance is also a function of the operating current, curves for several currents are given. The higher current curves are limited in voltage excursion by the allowable dissipation in the diodes. The slope resistance shows a minimum in the changeover region around 7 volts and rises steeply on the low voltage side of this point, but less steeply on the high voltage side. On the high voltage side, however, the slope resistance increases more rapidly than the voltage, so that if slope resistance is important better results can be obtained by using, say, five 7-volt diodes in series, instead of one 35-volt diode.

The variation of temperature coefficient of voltage against working voltage is shown in Fig. 4. It will be seen that diodes with breakdown voltages in the region of 5 volts are the most attractive from this point of view. However, approximately zero temperature coefficients can also be obtained by connecting a diode having a positive coefficient in series with one having a negative coefficient, although this

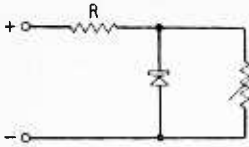


Fig. 8 Application as a voltage regulator or reference source.

Fig. 9 Surge limiting circuit using a Zener diode.

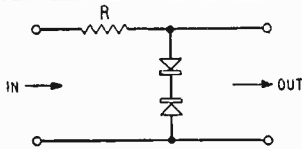
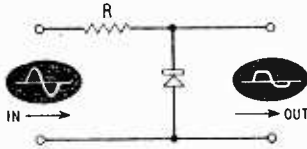


Fig. 10 Balanced clipping circuit using back-to-back diodes.

arrangement will probably give a higher slope resistance. In a similar way the negative temperature coefficient of the forward characteristic of a diode may be used to cancel a positive temperature coefficient of reverse breakdown voltage. The slope resistance in the forward direction is low (Fig. 5).

In making up series chains of Zener diodes to achieve approximately zero temperature coefficient, it should be noted that the calculations require curves showing actual change in voltage per °C (as in Figs. 6 and 7), and not the conventional values of temperature coefficient of voltage expressed as percentage change of voltage per °C.

The exact value of the temperature coefficient of a given diode is a function of the operating current, and of the precise temperature range over which the change in voltage is measured. Consequently, zero temperature coefficient of voltage will only be possible at one value of current for any one diode, and only over a limited temperature range. Where the very best performance as a voltage reference is required, care should be taken to keep the current constant, and if possible at that value which gives zero temperature coefficient.

As explained above, the manufacturer can design diodes to operate at any given voltage by adjustment

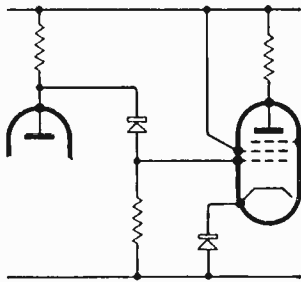
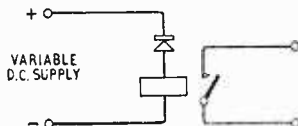


Fig. 11 Zener diodes used for coupling elements and cathode bias in a d.c. amplifier.

Fig. 12 Application as a voltage-sensitive relay.



of the resistivity of the base region of the diode; but this can only be done with limited accuracy. A given batch of diodes as manufactured has a certain spread of voltage values. Of the many varied uses of Zener diodes, some applications may call for the diode to have an accurately specified working voltage with a tolerance of, say,  $\pm 1\%$ , while others may merely require a breakdown voltage between, say, 15 and 20 volts. In an application as a source of reference voltage, the working voltage of the diode may be quite unimportant; but extreme stability, coupled with low slope resistance and low temperature coefficient, will be desirable. As a result, if care is not exercised, there will grow up a vast proliferation of types, each differing only slightly from the next, and the manufacturer and the user will be faced with the problem of stocking reasonable numbers of each type, while the small demands for any one type will result in uneconomic manufacturing runs.

To deal with this problem, manufacturers in this country are at present marketing "general purpose" Zener diodes, which are available in  $\pm 5\%$ ,  $\pm 10\%$ , and  $\pm 20\%$  tolerances, using the same preferred numbers for nominal breakdown voltage which are familiar to users of resistors and capacitors, e.g. 3.3, 3.6, 3.9, 4.3, 4.7V, etc.

**Applications.**—The number of possible applications for these diodes appears to be extremely large. The most obvious applications are as voltage regulators and voltage reference sources (Fig. 8). For regulator application a low slope resistance and high power handling capacity are desirable features, while for reference purposes, stability of reference voltage with time and a low temperature coefficient are the most important factors. Suitably chosen voltage reference Zener diodes appear at this moment to be comparable with industrial standard cells in their voltage stability.

Another large field of application lies in the use of Zener diodes for surge limiting and waveform clipping, etc. Fig. 9 shows a circuit which gives both top and bottom clipping using only one diode. This circuit makes use of the fact that Zener diodes, being in other respects normal silicon rectifiers, have a forward characteristic which may be used on many occasions. The same circuit may also be used for protecting transistor circuits from line surges. If a balanced clipping action is required, two Zener diodes should be used, connected back to back (Fig.

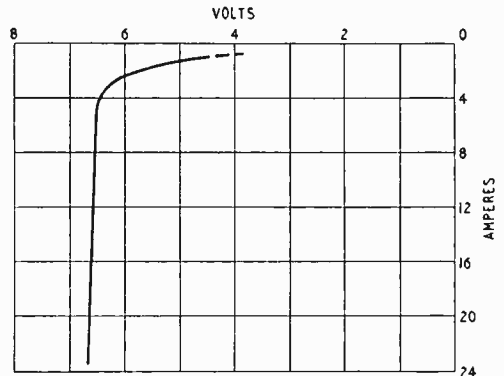


Fig. 13 Characteristic of an experimental high-power shunt regulator Zener diode for the region 2-20 amperes.

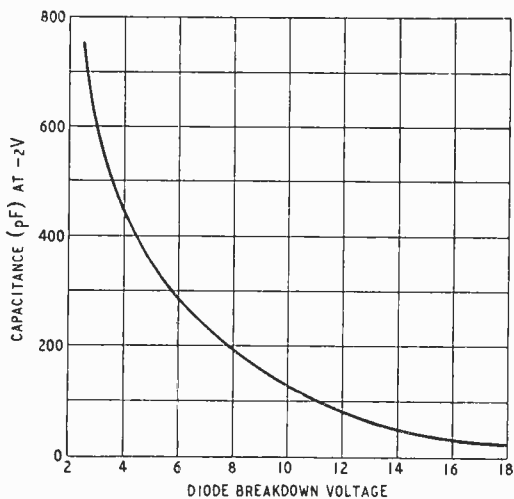


Fig. 14 Capacitance effect over a range of Zener diodes.

10). Some manufacturers now make special clipper diodes for this purpose.

Zener diodes have a much lower a.c. resistance than d.c. resistance (i.e.  $\frac{dV}{dI} \ll \frac{V}{I}$  which means that they behave rather like a capacitor or battery. They are particularly useful for coupling and decoupling elements in d.c. amplifiers, where capacitors cannot be used because of the rise in impedance at low frequencies. Even in a.c. circuits at low frequencies the Zener diode may be more economical than a large capacitor, especially in space. Fig. 11 shows the use of a Zener diode as a coupling element and for fixed cathode bias in a d.c. amplifier.

Fig. 12 shows a method of obtaining a robust and inexpensive voltage sensitive relay; the relay should operate with a low voltage across it and thus the Zener diode used must be capable of passing a reasonably large current. Zener diodes can be made capable of handling quite large powers. Fig. 13 shows the characteristic of an experimental 150-watt unit intended for shunt regulation of power supplies, to operate between 2 and 20 amps.

A further useful property of silicon junction diodes (such as Zener diodes) is their "self capacitance." In addition to the electrostatic capacitance between the diode leads, or between the leads and metal case, there is a "self capacitance" associated with the junction itself; because the depletion layer is extremely narrow in a Zener diode, the junction capacitance is usually much greater than the case capacitance. This "self capacitance" is seen when the diode is biased in the reverse direction below the breakdown voltage. Fig. 14 shows the variation over a range of Zener diodes, the capacitances being measured at the same low voltage for all diodes in the range.

In addition, for any one diode, the capacitance depends upon the bias voltage applied. Increase of bias voltage up to the breakdown value causes a reduction of capacitance, as illustrated in Fig. 15. The voltage-dependent capacitance has applications in automatic frequency control. With an f.m. tuner, for example, the diode may be used as part of the tuning capacitance, whose value is controlled by the output from the discriminator.

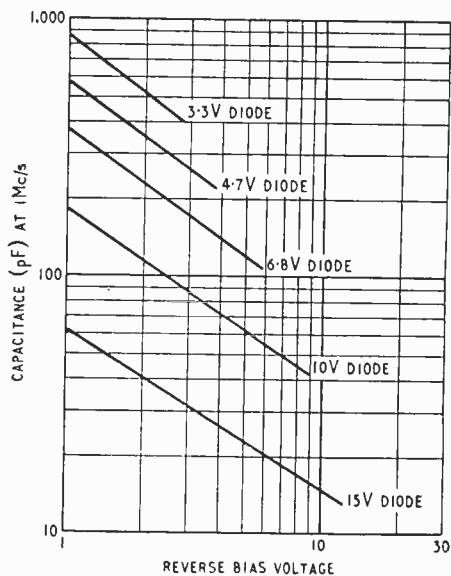


Fig. 15 Typical values of capacitance for reverse bias voltages before the breakdown region (at 25°C).

It is hoped that sufficient has been said about these new components to stimulate interest in their application and to give some guidance in their use. Much remains to be learnt of their characteristics and possible applications. Perhaps this article will help to speed the process.



**Semiconductor Production at the G.E.C. Semiconductor Division factory at Hazel Grove, Stockport, Cheshire, is now about 70,000 transistors and diodes per week. This automatic wafer measuring machine sorts germanium and silicon wafers according to thickness at the rate of 1,200 per hour. Another interesting technique uses a centrifuge to ensure good glass-to-metal seals in the housings. The glass and metal components are placed in jigs in an annular-shaped boat which is rotated and heated in an inert atmosphere, so that centrifugal force throws the molten glass into intimate contact with the metal parts. The method of operation, including control of temperature and cooling, is completely automatic. Using such methods the firm claims to have achieved an average yield of between 70% and 80%.**

# LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents

## Single-channel Stereo

HASN'T "Free Grid" (in the October issue) gone a bit wild over his one amplifier, two channels. If you sample (with rectangular wave) at 50c/s you get every frequency in the spectrum modulated by 50, 100, 150, etc., and that's a nasty noise. You should sample at something over twice the highest frequency in the wanted spectrum and put in a low-pass filter to get rid of higher-frequency unwanted modulator products. But the low-pass filters you would need have a reaction component in their impedances; they store energy and so forbid the clean cut that is essential for sampling as "Free Grid" wants it.

London, S.W.3.

P. P. ECKERSLEY.

## Editors and Editing

IN his article "Words, Words, Words" in the November "Wireless World," Mr. Eckersley very rightly calls for an improvement in the standard of writing of technical articles and papers. Victorian scientists, he says, wrote well, even excellently; many of them could be described as cultured. Nowadays, it is of no help to a scientist to be cultured and to write well, because the editors won't let him publish a paper as he writes it. Editors quite rightly tidy up a badly-written piece of work, but when a paper is well written, they should leave it alone.<sup>2</sup>

The interference frequently consists in making alterations to the style to bring it into line with editorial policy<sup>3</sup>. People who believe that it is possible to make small alterations in the style of a well-written piece of prose without ruining its effect—an effect that the author has probably worked hard to achieve—ought not to sit in editorial chairs. One famous Learned Society<sup>4</sup> will never allow an author of a paper to refer to that paper as "this paper," always substituting "the paper," to which a reader of any sensibility<sup>5</sup> reacts by asking "what paper?" The same Learned Society<sup>4</sup> recently allowed

one of its vice-presidents to use the phrase "a whole diversity of new materials"<sup>6</sup>. If it is willing to allow such a phrase to appear in its Proceedings, by what right does it sit in judgment on the work of other authors? The Chairman of the Editorial Board of another Learned Society<sup>4</sup> is the author of several books from which it is clear that he does not know how to punctuate. Yet this Learned Society<sup>4</sup>, like many others, dares to have an editorial policy on style—as if style can ever be a matter of policy.

May I therefore make a plea that writers be allowed to publish their papers and articles in the language in which they were originally conceived? While the various Learned Societies<sup>4</sup> should do all they can to improve standards of writing, they should refrain from interference with a piece of work, once it is written, except on technical grounds—and even then, any alterations called for should be made by the author<sup>7</sup>. Let the editors confine their activities to editing—that is, to deciding the arrangement of the material on the printed page, to interpreting the author's intentions to the typographers, to correcting obvious errors, and to adding footnotes, e.g. "continued on page. . ."<sup>8</sup> And, critics, please be a little more charitable to the author<sup>9</sup>. Why should he take all the blame, when things are done to his work over which he has no control, and of which he may even have no knowledge until his alleged work appears in print?<sup>10</sup>

Chelmsford.

R. A. WALDRON.

<sup>1</sup> Or decline to publish.

<sup>2</sup> Being busy men they are usually happy to do so.

<sup>3</sup> This journal welcomes diversity of style.

<sup>4</sup> Capitals for a common noun and its adjective?

<sup>5</sup> Sense is shorter than sensibility and does not involve the emotions.

<sup>6</sup> What is wrong with this? Collectively the materials are finite and although diverse can be comprehended as a whole.

<sup>7</sup> Who will then permit the editor's name to appear as co-author?

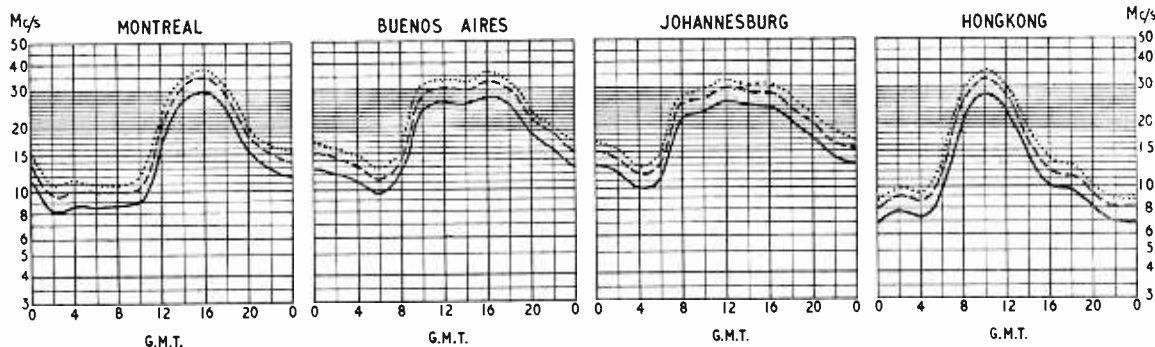
<sup>8</sup> This is the dull mechanic trade of sub-editing.

<sup>9</sup> Touche!

<sup>10</sup> Mr. Waldron's letter is printed as received with the exception of the interpolation of reference numbers to the rejoinders which the Editor feels compelled to make in defence of his vocation. He is nevertheless glad to publish this letter if only to show that he is mindful of the feelings of his contributors—present and future.]

## SHORT-WAVE CONDITIONS

Prediction for January



THE full-line curves indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during January.

Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.

..... FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME

--- PREDICTED MEDIAN STANDARD MAXIMUM USABLE FREQUENCY

— FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS



**Speed-Change Drive** for magnetic tape data recording equipment has been devised by E.M.I. Electronics for applications where it is necessary to play back the data for analysis at a different speed from that at which it was recorded. It is a simple device giving a wide-ratio change of speed without mechanical complexity. Power is applied to one shaft carrying a stepped plain pulley A, and the output drive is taken from another shaft carrying flywheel B which also has two working surfaces of different radii, one external and the other internal. An idler carriage E is mounted on a plain bearing on the input shaft, so that it is dragged round by friction as far as it is free to move in whichever direction the input shaft is turned. If, in the diagrams, the drive shaft is turned anti-clockwise (State 1), the resulting anti-clockwise motion of the idler carriage will draw the idler wheel F, supported on E by the swinging arm H, into engagement with the larger diameter (C) of pulley A and the smaller diameter 'd' of the flywheel B. B will move anti-clockwise, and

# Technical Notebook

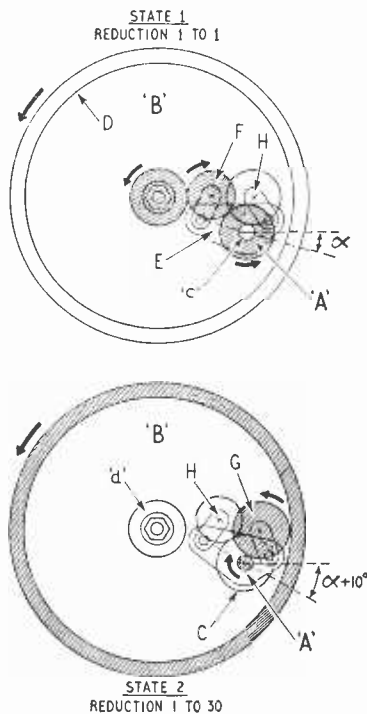
of D to 'c.' In the case drawn this ratio is about 1 to 30. Thus it will be seen that by reversing the direction of the input shaft a large speed reduction may be obtained—the output shaft always revolving in the same direction. A large number of speed ratios may be obtained by suitable selection of diameters and positioning of components.

**Magnetless Masers** are possible according to an article by G. S. Bogle and H. F. Symmons in the *Australian Journal of Physics* for March 1959 (p. 1). Normally in the three level type of maser, three suitable spin quantum levels between which transitions are possible can only be obtained in certain paramagnetic salts in a magnetic field. The authors point out, however, that certain paramagnetic salts possess three suitable energy levels between which transitions are possible even in the absence of a magnetic field. Unfortunately, unlike ordinary masers, magnetless masers will not be tuneable over a wide frequency range. On the other hand, magnetless masers possess a number of compensating advantages over ordinary masers. For example, exacting requirements of magnetic field uniformity and stability are avoided and, since crystal orientation is no longer necessary, a single crystal is not required for a magnetless maser.

**Directly Printed Circuits**, as distinct from the usual etched variety, are made possible by a new copper-bearing paste developed by Bell Telephone Laboratories in the U.S.A. The paste is applied in the required circuit pattern to a ceramic base and the process is completed by heat treatment. The main advantage of the new system is the strong adhesion of the copper coating to the base material, compared with conventional etched circuits. Failure of bonding does not occur, it is claimed, until the pulling strength exceeds 2,000 lbs./sq. in. In preparation a paste is made from a finely ground mixture of copper oxide and a special glass "frit" (a term from glass-making), blended with a standard silk-screen printing material. After the pattern of paste is printed on the ceramic, the circuit card is dried to remove solvents. The card is then fired in

air at 750°C for twenty minutes to burn off the screen-printing material. This operation leaves a non-conducting copper oxide pattern, ready to be reduced to metallic copper. The second firing operation is conducted at 850°C for thirty minutes, in an atmosphere containing hydrogen, nitrogen and oxygen. The hydrogen reduces the copper oxide to metallic copper, while the oxygen prevents reduction of other oxides in the system and promotes good wetting of the glass frit and the ceramic. Without the oxygen present, a poor bond results. Printed wiring cards prepared this way can be dip-soldered without bond failure, and without the use of corrosive fluxes. Resistivity of the copper film is said to be well within requirements for typical printed wiring applications. The process is suitable for automatic production techniques, and is expected to be competitive with other printed wiring methods in cost. Another possible application is in making metal-to-ceramic bonds.

**Distortion Reduction** in class-B amplifiers using biased diodes to switch in different signal potential dividing resistors at different signal levels to compensate for non-linearities in the class-B input/output characteristic is described in an article by B. Sklar in *Electronics* for May 22, 1959 (p. 54). One arm of the signal potential divider consists of a fixed resistor, and the other a number of branches in parallel, each branch containing a fixed resistor in series with a diode and biasing battery. Thus, at a signal voltage determined by the biasing battery voltage, the diode switches the fixed resistor into one arm of the potential divider. The resultant resistance in this arm thus varies with the signal level, and the consequent changes in the signal potential dividing ratio with the signal level can be used to compensate for non-linearities in the class-B input/output characteristic. A graphical method of determining from the input/output characteristic the resistance required in series with each diode for a given biasing voltage is described in the article. In a practical case the total harmonic distortion in a push-pull amplifier (mainly third harmonic) was reduced from 13 to 2.6%.



as in the figure C and 'd' are approximately equal, there is no change of angular velocity in the mechanism. If the direction of the drive shaft is reversed (State 2), the carriage E will move clockwise until the alternative idler G engages between the smaller diameter (c) of A and the larger diameter (D) of B. When this occurs the flywheel B will move anti-clockwise as before, but with a speed reduction determined by the ratio

# Physical Society Exhibition

Manufacturers and Research Establishments Exhibiting

ON the majority of the 140 stands at the 44th exhibition of scientific instruments and apparatus arranged by the Physical Society there will be equipment of interest to radio and electronic engineers. The exhibition will be held from January 18th to 22nd in both the Old and New Halls of the Royal Horticultural Society, at Westminster, London, S.W.1.

The opening ceremony will be performed by J. A. Ratcliffe, C.B.E., F.R.S., president of the Physical

Society, at 11.0 on January 18th. On the opening day admission will be limited to members of the Society and the Press until 2.0. The times of opening are: 18th, 10.30 to 7.0; 19th, 10.0 to 9.0; 20th and 21st, 10.0 to 7.0; and 22nd, 10.0 to 1.0.

Tickets of admission are obtainable free from exhibitors or from the Society, 1, Lowther Gardens, Prince Consort Road, London, S.W.7.

A feature of the Society's exhibition each year has been the series of

demonstration lectures. This year the lectures will be given on each of the first three days at 5.45. On the 18th the subject will be "Some reactions of the human body to the stresses of high performance flight" and the lecturer, Flt. Lt. J. Billingham (R.A.F. Institute of Aviation Medicine); on the 19th "Atomic Time" by Dr. L. Essen (N.P.L.); and on the 20th "Recent developments in solid state physics" by Dr. D. A. Wright (G.E.C. Research).

Name	Stand	Name	Stand	Name	Stand
Accles & Pollock	75	Fleming Radio (Developments)	19	Perkin-Elmer	8
Admiralty Research Estab.	40	Furzehill Laboratories	5	Physical Society	27
Advance Components	9	G.E.C. Research Laboratories	115	Physical Society Acoustics Group	140
Armament Research and Development Estab.	1	Gallenkamp, A., & Co.	46	Physical Society Colour Group	42
Associated Electrical Industries	123	General Electric Co.	23	Planer, G. V.	53
Atomic Energy Research Estab.	86	General Radiological	71	Plessey Co.	28
Atomic Weapons Research Estab.	86	Grubb, Sir Howard, Parson & Co.	98	Prior, W. R., & Co.	83
Avo	90	Guy's Hospital Medical Electronics Lab.	132	Pullin, R. B., & Co.	72
B.T.H. Group Research Lab.	123	Harrison, W.	3	Pye, W. G., & Co.	93
Baird & Tatlock	127	Hatfield Instruments	39	Racal Instruments	17
Baker, C., Instruments	79	Hilger & Watts	95	Radio Research Station	44
Baldwin Industrial Controls	112	Imperial College	133	Rank Cintel	113
Barr & Stroud	51	Infra Red Development Co.	4	Reading University Dept. of Physics	134
Beck, R. & J.	80	Institute of Physics	32	Royal Aircraft Establishment	1
Bellingham & Stanley	107	Isotope Developments	34	Royal Meteorological Society	33
Birlec	123	Johnson, Matthey & Co.	48	Royal Radar Establishment	1
Birmingham University Physics Dept.	137	Joyce, Loebel & Co.	69	Royston Instruments	10
British Physical Laboratories	20	Kelvin & Hughes	108	St. Thomas' Hospital Electronics Dept.	131
British Scientific Instrument Research Association	77	Labgear	35	Salford Electrical Instruments	22
Burndept	29	Lintronic	41	Sangamo Weston	96
Cambridge Instrument Co.	97	Locarte Co.	74	Science Museum	50
Cambridge University	136	Lyons, Claude	37	Services Electronics Research Laboratory	40
Cawkell Research & Electronics	36	Marshall of Cambridge Electronics	76	Servomex Controls	11
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By  
**ARTHUR R. BAILEY\***,  
*M.Sc.(Eng.), B.Sc.(Eng.)*

# Economical High-Gain A.F. Amplification

MICROPHONE AND TAPE-REPLAY AMPLIFIERS USING UNUSUAL CIRCUIT

FOR many years engineers have been trying to obtain the maximum amplification from the minimum number of components. During research into precision three-phase a.v. stabilizers, the author came across a somewhat unorthodox phase-splitter<sup>1</sup> which gave an unusually large gain for the valves and components used. This circuit, which is shown in Fig. 1, utilizes the high input impedance of a concertina phase-splitter to provide a very high load impedance to the anode of a pentode amplifier. As the amplification factor for an r.f. pentode can be over 10,000 at low values of anode current (0.1mA) and the anode slope resistance may then be as high as 20M $\Omega$ , then it can be seen from the formula

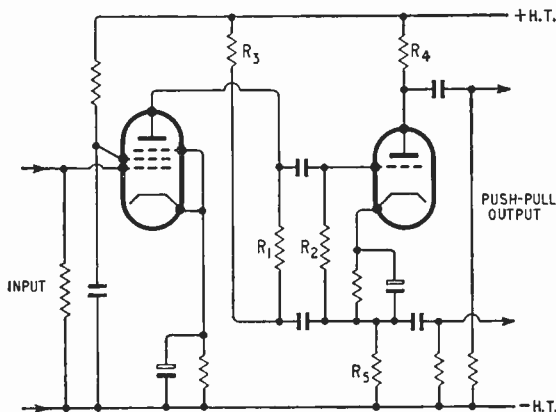


Fig. 1. Theoretical circuit of high-gain phase-splitter.

$A = \mu R_L / (r_a + R_L)$  that if the load resistance can be made greater than  $r_a$  then the amplification will be greater than  $\mu/2$ .

In the high-gain phase-splitter circuit the maximum amplification obtained is about 1,000 times. This compares favourably with the normal overall gain for a pentode amplifier (and "concertina" phase-splitter) of 100 to 300 times. Providing that a push-pull output is required, it is difficult to see how this circuit can be improved. If, however, a single-ended output is desired, then the circuit can be modified with advantage.

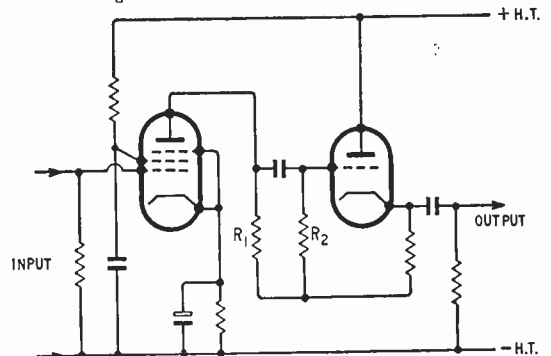
The first obvious step is to remove the anode load resistor  $R_1$  of the triode valve: this is unnecessary as it merely provides the phase-inverted output. It will now be noted that the cathode load of the cathode-follower so formed consists of the pentode valve and its load resistor  $R_1$  (in series) in parallel with the h.t.-feed resistor  $R_3$  and the cathode resistor  $R_5$  (in parallel). If the circuit is now re-

arranged, as shown in Fig. 2, it will be seen that the pentode valve now obtains its anode supply through the triode valve and the loading effects of resistors  $R_3$  and  $R_5$  (Fig. 1) are removed. The cathode-follower has now a very high effective load in its cathode circuit; thus it will generate a cathode-to-earth voltage of very nearly  $\mu$  times the grid-to-cathode input voltage<sup>2</sup>. This grid-to-cathode input is developed across the anode-load resistor  $R_1$  of the pentode valve. Hence for 1V of signal developed across this resistor there will be approximately  $\mu V$  (where  $\mu$  is the amplification factor of the triode) developed at the cathode of the triode. This means that the signal voltage on the pentode anode will be approximately  $(1 + \mu)V$ . As 1V is developed across the pentode anode-load resistor  $R_1$ , the triode must therefore be acting as an additional a.c. load of approximately  $\mu R_1$ . To be accurate, both  $R_1$  and  $R_2$  should be considered; but as  $R_2$  is over 10 times larger in value than  $R_1$  its effect is very small.

The voltage drop in the triode valve need not exceed about 75V and so the triode will only slightly reduce the dynamic mutual conductance of the pentode valve. The triode therefore acts as a low resistance to d.c., but as a very high anode-load resistance. The pentode will give a very large gain due to this high anode load and the gain may approach the pentode amplification factor. For some pentodes this may be 10,000 times, and under these conditions the effective anode load may rise as high a value as 100M $\Omega$ . The effect of stray capacitances is then extremely serious and care has to be taken if a useful a.f. bandwidth is to be obtained.

Providing that the pentode anode-circuit components are physically small and sensibly arranged, the main capacitances in shunt with the pentode-anode circuit are the anode-to-grid capacitance of the

Fig. 2. High-gain amplifier derived from phase-splitter shown in Fig. 1.



\* Bradford Institute of Technology.

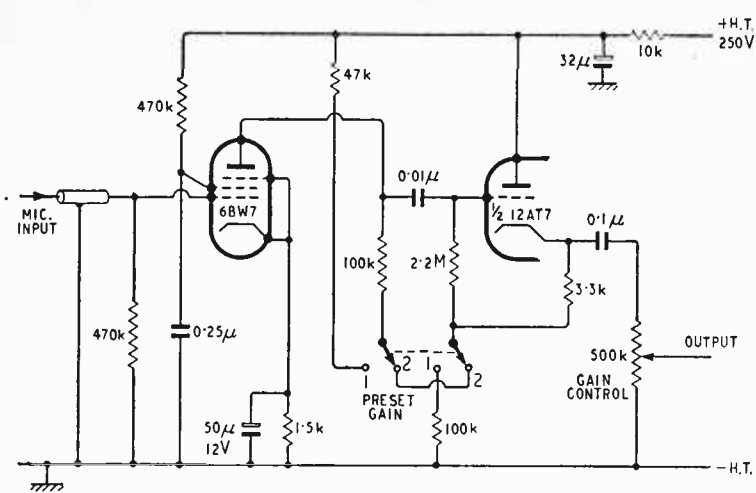


Fig. 3. High-gain amplifier used as microphone pre-amplifier. Preset gain switch positions: 1, low gain; 2, high gain.

triode and the output capacitance of the pentode. The anode-to-grid capacitance of a 12AT7 is only 1.5pF and is therefore hardly worth neutralising. The output capacitance of a 6BW7 is 3.5pF which is also quite small. The effect of these capacitances could be reduced somewhat by the "Cathoguard" circuit<sup>3</sup>. If the response is to be maintained up to 10kc/s with a maximum of 3dB fall in response, then the total capacitance of 5pF (ignoring stray and valve-base capacitances) will limit the effective anode output impedance to  $10/\pi M\Omega$ . This value is composed of the anode load of the pentode in parallel with the anode slope resistance of the pentode valve. Assuming a dynamic anode-slope resistance for the pentode of  $5M\Omega$ , this gives a maximum pentode anode load in the order of  $8M\Omega$ . This was halved to allow for the stray capacitances that were ignored; thus a value of  $4M\Omega$  was obtained. With a 12AT7 valve a voltage amplification of 40 would be expected, hence a value of  $4 \times 10^6/(40+1)$ , or approximately  $100k\Omega$ , for the pentode load resistor  $R_1$  was obtained.

The circuit has been used in a tape-recorder built by the author and has given very satisfactory results. The microphone amplifier of the recorder is shown in Fig. 3. This can be used at either high or low gain to allow for a wide range of input signals. In the high-gain position the circuit operates as previously described; in the low-gain position the pentode is re-connected as a "straight" amplifier driving a cathode-follower. The gain of the circuit is approximately 200 in the low-gain position and 3,500 in the high-gain position. The output is at low impedance, and providing that the output-voltage swing is restricted to several volts, loads of as little

as  $50k\Omega$  can be placed across the output without giving rise to any measurable distortion.

The circuit used in the replay amplifier is shown in Fig. 4. A much higher value of anode load can be used in this case as the effect of stray capacitance is swamped by the tape compensating circuit, which is based on the C.C.I.R. recommendations for the  $7\frac{1}{2}$  in/sec speed and on accepted practice (in the absence of a standard) for the  $3\frac{1}{2}$  in/sec speed. The output of the replay amplifier is in the order of 0.5V and is sufficient to drive most power amplifiers.

**Hum and Microphony.**—The use of high-slope r.f. pentodes in the early stages of a.f. amplifiers can give rise to bad microphony and hum troubles. The author has experienced little difficulty with microphony; anti-microphonic

value bases and selection of the valve to be used enable a very low microphony level to be achieved.

Hum, however, is apt to cause more trouble, due to the a.c. heater supply. There is no convenient means of obtaining enough d.c. to feed the heater of a 6BW7 unless a separate supply is used. An a.c. supply was therefore used and the hum level was not above the tape-noise level providing the following precautions were taken:—

(a) the valve heaters were fed from a centre-tapped supply, (b) the heater-transformer centre-tap was raised to a potential of about 20V positive with respect to earth by means of a decoupled potentiometer between h.t.+ and earth, and (c) a  $1.5-\Omega$  resistor was included in each heater lead to the valve.

If a loss of gain of some five times can be tolerated, then one of the low-noise pentodes such as the 6BR7 can be used. This valve has very low hum and noise figures but it suffers from the disadvan-

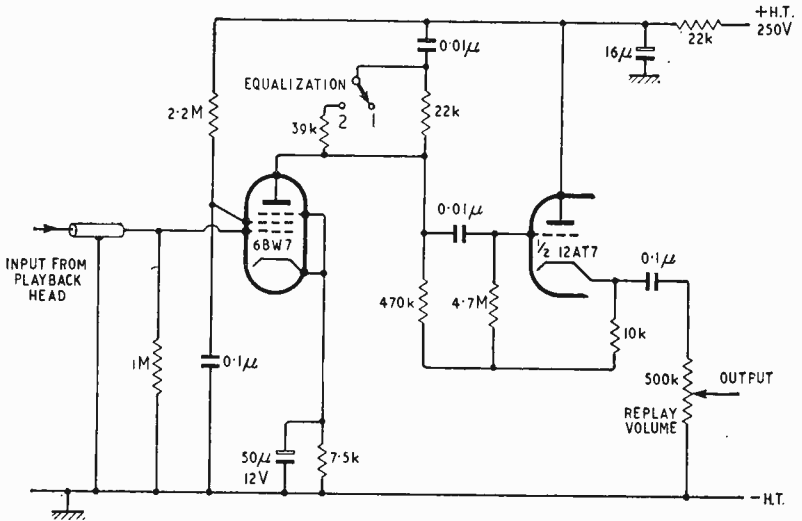


Fig. 4. Tape-playback pre-amplifier providing equalization facilities. Switch positions: 1,  $3\frac{1}{2}$  in/sec; 2,  $7\frac{1}{2}$  in/sec.

tage of a relatively low amplification factor. When using a 6BR7 in place of the 6BW7 the value of the cathode-bias resistor must be decreased to 4.7k $\Omega$  for the tape-replay amplifier and to 1k $\Omega$  for the microphone amplifier.

Summing up, the advantages of the circuit are that few components are required and that all the amplification is obtained from the pentode valve. Due to this and the low output impedance of the circuit, the hum and noise introduced by the second valve is negligible, whatever valve type is used. The one disadvantage is that it is difficult to maintain a high amplification at supersonic frequencies; but this is not normally important.

**Acknowledgement.**—The author wishes to acknowledge the facilities provided by the Bradford Institute of Technology where most of the work on this circuit has been carried out.

#### REFERENCES

- <sup>1</sup> Push-Pull Phase-splitter, by E. Jeffery, *Wireless World*, Vol. 53, p. 274 (August 1947), also "Amplifiers" (1st Edition) p. 101, by G. A. Briggs and H. H. Garner, Wharfedale Wireless Works.
- <sup>2</sup> Radio Engineering (3rd Edition) by F. E. Terman, p. 308, McGraw-Hill Publishing Co., Ltd.
- <sup>3</sup> The "Cathoguard" by L. G. White, *Wireless World*, Vol. 64, p. 312 (July 1958).

## JANUARY MEETINGS

*Tickets are required for some meetings; readers are advised therefore to communicate with the secretary of the Society concerned.*

### LONDON

6th. Brit.I.R.E.—"Some new possibilities in civil underwater echo-ranging—current research at the University of Birmingham" by Professor D. G. Tucker at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

8th. I.E.E.—Discussion on electrical and electronic techniques in respiratory research at 6.0 at Savoy Place, W.C.2.

8th. Television Society.—"Problems of u.h.f. television: transmission, propagation and reception" by T. M. J. Jaskolsky (E.M.I.), R. A. Rowden (B.B.C.) and K. Moulding (Mullard) at 7.0 at the Cinematograph Exhibitors' Association, 164, Shaftesbury Avenue, W.C.2.

11th. I.E.E.—"A quadrature network for generating vestigial-sideband signals" by G. G. Gouriet and G. F. Newell; "The input impedance of rectifier modulators" by Professor D. G. Tucker; and "Rectifier modulators with frequency-selective terminations, with particular reference to the effect of even-order modulation products" by D. P. Howson and Professor D. G. Tucker at 5.30 at Savoy Place, W.C.2.

13th. Brit.I.R.E.—"A proposal for a space-charge-limited dielectric triode" by Dr. G. T. Wright at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

15th. B.S.R.A.—"Stereophonic hearing" by Professor Colin Cherry at 7.15 at the Royal Society of Arts, John Adam Street, W.C.2.

20th. Physical Society Acoustics Group.—Symposium on "vibration" at 2.30 in the Physics Dept., Imperial College, Imperial Institute Road, S.W.7.

21st. Television Society.—Fleming Memorial Lecture on "Crystal Imperfections" by Professor R. King at 7.0 at the Royal Institution, Albemarle Street, W.1.

22nd. R.S.G.B.—Presidential address by W. R. Metcalfe (G3DQ) at 6.30 at the I.E.E., Savoy Place, W.C.2.

25th. I.E.E. Graduate and Student Section.—"Transistors in switching circuits" by M. Paskins at 6.30 at Savoy Place, W.C.2.

25th.—Radar and Electronics Asso-

ciation.—"The problems of technical reviewing" by J. C. G. Gilbert and R. S. Roberts at 7.30 at the Royal Society of Arts, John Adam Street, W.C.2.

27th. British Computer Society.—"Storage elements for very-high-speed computers" by Dr. G. G. Macfarlane (R.R.E.) at 2.30 at Northampton College of Advanced Technology, St. John Street, E.C.1.

27th. I.E.E.—"The oral presentation of scientific material" by Dr. A. Clow at 5.30 at Savoy Place, W.C.2.

27th. Brit.I.R.E.—"Training for operating and maintaining television broadcasting equipment" by Dr. K. R. Sturley and A. E. Robertson at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

28th. I.E.E.—"Radio communications by means of satellites" by Dr. A. W. Lines at 5.30 at Savoy Place, W.C.2.

29th. I.E.E.—"Beam-type parametric amplifiers: some aspects of design and use" by R. B. Dyott and C. R. Russell at 5.30 at Savoy Place, W.C.2.

### BIRMINGHAM

19th. I.E.E.—Faraday Lecture on "Electrical machines" by Professor M. G. Say at 6.30 at the Town Hall.

25th. I.E.E.—"Long-distance waveguide communication" by F. J. D. Taylor at 6.0 at the James Watt Institute.

### BRISTOL

27th. Brit.I.R.E.—"An equipment for automatically processing time multiplexed telemetry data (Tintape)" by J. H. Russell, N. Purnell and T. Walters at 7.0 at the School of Management Studies, Unity Street.

### BROADSTAIRS

26th. Association of Supervising Electrical Engineers.—"The Decca navigational system" by B. A. A. Smye-Rumsby at 8.0 at the Clarendon Hotel.

### CARDIFF

21st. I.E.E.—Faraday Lecture on "Electrical machines" by Professor M. G. Say at 6.0 at Sophia Gardens Pavilion.

28th. British Computer Society.—"Basic principles of programming" by Dr. R. J. Ord-Smith (S.T.C.) at 6.30 at University College.

### CHESTER

25th. I.E.E.—"The characteristics and protection of semiconductor rectifiers" by D. E. Corbyn and N. L. Potter at 6.30 at the Town Hall.

### LEICESTER

19th. Television Society.—"The electrical synthesis of music" by A. Douglas at 7.30 at the College of Technology and Commerce.

### LEEDS

4th. Association of Supervising Electrical Engineers.—"Radio control" by E. B. Hill at 7.30 at the Great Northern Hotel.

### LIVERPOOL

11th. Brit.I.R.E.—"High frequency propagation—its present and future use for communication purposes" by A. F. Wilkins at 7.0 at the University Club.

14th. Institute of Physics.—"Electronic applications of superconductivity" by Dr. E. Mendoza at 7.0 at the University.

18th. I.E.E.—"Radio aspects of the International Geophysical Year" by Dr. R. L. Smith-Rose at 6.30 at the Donnan Laboratories, Vine Street.

### MANCHESTER

18th. Institute of Physics.—"Recent developments in scintillation counting" by Dr. J. B. Birks at 7.0 at the University.

### NEWCASTLE-UPON-TYNE

13th. Brit.I.R.E.—"Data processing machines" by J. Allen and J. Keating at 6.0 at the Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road.

### TREFOREST

13th. Brit.I.R.E.—"Television broadcasting methods" by H. J. M. Hockley at 6.30 at the Glamorgan College of Technology.

### WOLVERHAMPTON

13th. Brit.I.R.E.—"Electronics in medicine" by P. Styles at 7.15 at the Wolverhampton and Staffordshire College of Technology, Wulfruna Street.

# Evolution of the Cathode-Ray Tube

A Survey of Developments over Three Decades

By MANFRED VON ARDENNE\*

UNTIL the year 1928 the cathode-ray tube devised in 1897 by Ferdinand Braun only found application on rare occasions, despite the fact that Wehnelt (in 1905) and Westphal (in 1908) had already improved it considerably by the introduction of the incandescent cathode. In 1928 the cathode-ray tube emerged from its latent existence and rapidly gained in importance in two directions of development:

1. About this time the high-tension cathode-ray oscillograph with cold cathode and continuous

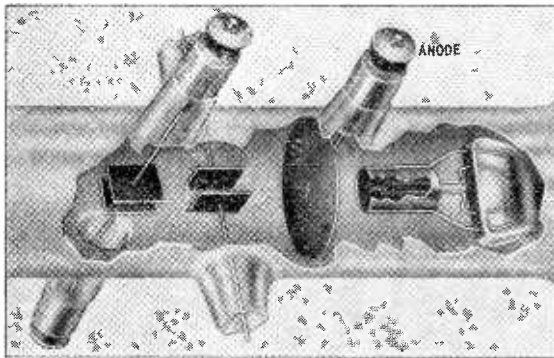


Fig. 1. The electron gun developed in 1928 with negatively-biased control electrode and beam cross-over. This gun, which is used in most present-day electron beam appliances, is shown here in an oscillograph tube for anode voltages above 1 kV, introduced by Leybold of Cologne in 1929.

evacuation made its appearance for the investigation of transient waves. The development of this instrument is linked with the names of Rogowski, Gabor, Dufour, MacGregor-Morris, von Borries and Binder.

2. The cathode-ray tube of modern design, which today plays important roles in the fields of oscillography, radar, and television, made its appearance.

A kindly fate has made it possible for me to collaborate actively in this second direction of development over a period of more than three decades. Today, perhaps, I may be permitted to look back over the field of my personal experience in this work.

## Looking Back

The development of the modern cathode-ray tube received a decisive impetus in 1928 when it became possible, in my laboratory at Lichterfelde, to produce a fine electron beam with a current density of about  $100\mu\text{A}$  and an acceleration of up to 3,000 volts as a result of a three-electrode system with

a hot cathode and a control electrode with a negative bias. This electron gun was not only characterised by its construction from a thermal small-area cathode, a control electrode with negative bias and an anode, as well as by the geometry employed. Its most significant feature was the formation of an electron beam cross-over of small cross-sectional area and high current density. This emitting system differed from all earlier methods of operation of similar electrode arrangements in that the negative bias of the control electrode had a definite value somewhat below the initial voltage of the cathode-ray current. So far as can be seen from the literature available, these features were combined for the first time in the oscillograph tube<sup>1</sup> developed by me in 1928 and put on the market in 1929 by E. Leybold's Nachfolger of Cologne. Fig. 1 shows the structure of this tube with the type of electron gun characterised by the cross-over formation, as is used today in a great many electron devices.

Another branch of oscillograph technology which was making strides at that time, and which was later to achieve great significance in television engineering, radar engineering and high-frequency carrier telecommunications, was the wide-band amplifier or, as we called it in those days, the "aperiodic high-frequency amplifier." Together with Siegmund Loewe, we had begun in 1925 to combine several valve systems with their low-capacitance coupling units in a single evacuated glass envelope. In this way the Loewe dual valve, shown in Fig. 2, which had a space-charge grid system with a steep slope, was able to achieve a bandwidth of  $1\text{ Mc/s}^2$ .

In order to change over from timebase deflection by mechanical/optical means (rotating mirror) to deflection by low-inertia electrical methods, relaxation oscillator devices were devised in that particular year in the

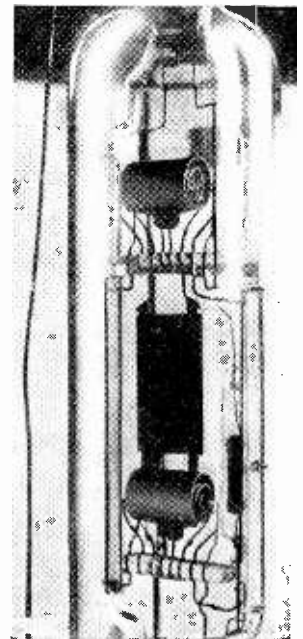


Fig. 2. The Loewe dual tube, developed in 1925, was in fact the first wide-band amplifier, in the modern sense of the term, and had a bandwidth of  $1\text{ Mc/s}$ . This was obtained by the combination of a particularly low-capacitance circuit with high-slope valve systems.

\* Forschungs Institut Manfred von Ardenne, Dresden, E. Germany.



Lichterfelde laboratory, on the basis of publications by B. van der Pol and H. Frühauf<sup>3</sup> with the collaboration of I. Kammerloher. These gave triangular waveforms which could be synchronised by means of a cold-cathode thyatron with external control from the signal.

In the year 1930 there were available, in my laboratory in Lichterfelde, electron beam tubes with intensity modulation electrodes and high focal point brightness<sup>4</sup>, relaxation oscillator devices to suit these and wide-band amplifiers in large numbers ready for operation. At that moment it was only a short step to the realisation of television on a purely electronic basis. The technical prerequisites for this purpose were so favourable as a result of the fact that the three basic elements were standing ready in one building, that this realisation, from the time of making the decision to the time of succeeding in an experiment, required hardly more than one day's wiring operations and experimental effort.

The stimulus for starting this work came in the main from outside. Since 1924 I had been following with great interest the reports of the pioneer experiments by J. L. Baird in England using mechanical scanning of the picture by means of a Nipkow disc<sup>5</sup>. This interest was considerably increased when D. von Mihaly demonstrated practical experiments at the Berlin Radio Exhibition of 1928, using an arrangement which was somewhat similar to a Baird televisor, and the demonstrations of mechanical television continued at the Radio Exhibitions of 1929 and 1930 with increasing quality. Finally, I received a particularly powerful stimulus to carry out this work from the experience of a personal meeting with Baird himself, and from the detailed discussions with him regarding the limits of the mechanical methods employed at that time.

Despite repeated indications of the advantages of the electronic method by Fritz Schröter and myself, in lectures and articles, television experiments continued to be conducted with mechanical scanning only. The time had become ripe for some experiments of our own. These experiments led to the achievement, on the 14th of December, 1930, of the first television pictures obtained on a purely electronic basis. One of the pictures, obtained in the year 1930, is shown in Fig. 3(a). A few months later the quality of the pictures had already been increased to the stage shown in Fig. 3(b).

An important factor in carrying out the television transmission experiment so quickly with electron ray tubes both at the transmitter and at the receiver, was the conception of the flying spot scanner<sup>6</sup>. Since then the flying spot scanner has been further developed for the scanning of colour films, for facsimile transmission of over 1 million words per minute (Ultrafax), for counting and sorting of particles on microscope slides, for optical auto-correlation measurements and many other purposes. As is known, this scanner works by deflecting a light spot over the screen of a cathode-ray tube with short after-glow so as to produce a bright raster which is focused by an object lens on the slide or film to be transmitted. The beam of light passing through the slide or film is then fed to a photoelectric cell. According to the optical density of the picture points encountered by the scanning spot a greater or lesser quantity of light is absorbed, so that the electron current emitted by the photoelectric cell is proportional to the brightness values of the picture points.



(a)



(b)

Fig. 3. Electron beam television pictures produced (a) in the year 1930 and (b) in 1931.

Soon after the first experiments with slides, the device used at that time was converted for the scanning of cinematographic films. The first public demonstration of the equipment as a whole was made in the autumn of 1931 at the Berlin Radio Exhibition. It had already been demonstrated to most of the leading technicians of the various European development centres. Because of the simplicity of the arrangement and the brightness of the pictures obtained, these demonstrations turned out to be such effective propaganda for the electronic method that, one year later at the Radio Exhibition of 1932, television receivers with cathode-ray tubes were exhibited by several radio firms. Today I still regard one of the great events of those days to be a visit to the Lichterfelde laboratory, of J. L. Baird, who unfortunately is no longer with us (see Fig. 4). During these demonstrations there had already been a display of the projection of television pictures from a cathode-ray tube on to a large screen of about 1 square metre, using a special optical system<sup>7</sup>.

In the efforts to increase still further the brightness of the picture, and to increase the number of picture elements which could be transmitted for a given frequency band of the transmission channel, experiments were carried out in the Lichterfelde laboratory in 1932, partly with the collaboration of Kurt

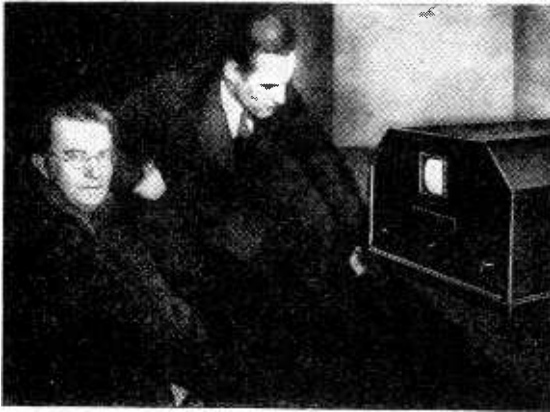


Fig. 4. The British television pioneer J. L. Baird (left) on a visit to our television laboratory in Berlin-Lichterfelde.

Schlesinger, using the so-called "variable speed scanning method" proposed shortly before by Richard Thun<sup>7</sup>. As is known, in this method the control of the brightness of the picture elements is effected by changing the speed of deflection of the light spot, so that at the receiving end the picture is reproduced always with the maximum possible spot brightness. Against this, in the modern television method only a mean spot brightness is effective.

In view of the advantages offered by the variable speed scanning process it is surprising that, up to the present time, nobody has tried out this process in industrial television, where there are no television standards which have to be observed. At that time, in 1932, our efforts with a system of television picture reproduction using variable speed scanning very soon found powerful support in the London laboratories of Cossor in the work of Bedford and Puckle<sup>8</sup>. These workers improved the quality of the picture by controlling the brightness not only by varying the line deflection speed, but also by using a certain amount of intensity control of the light spot.

In the year 1933 the demand for electron ray tubes began to increase at a tremendous rate. One of the largest customers in those days was the development centre at Slough in charge of R. A. (now Sir Robert) Watson-Watt, which often required deliveries of from 50 to 100 cathode-ray tubes. At the same time there arose an ever-increasing demand for the construction of complete cathode-ray oscillographs with built-in power packs and timebase units. It could be foreseen that the production possibilities of our small Lichterfelde laboratory would rapidly be exhausted. For this reason, working in collaboration with Leybold, the "Leybold-von Ardenne-Oszillographen-Gesellschaft" was founded which grew extremely rapidly in the years which followed. Even this company was no longer able to cope with the tremendous increase in the requirement for oscillographs, and shortly before the outbreak of the second world war it was taken over by the firm of Siemens and Halske of Berlin.

As a result of the development in Lichterfelde, the Leybold - von Ardenne company brought out the polar co-ordinate electron beam oscillograph in the year 1936<sup>9</sup>. In this apparatus, which made use of some of the radar techniques being introduced at that time, the timebase was described by an exactly circular movement of the light spot and the measur-

ing deflection was carried out in a radial direction.

Already the transition from the gas-filled to the high-vacuum cathode-ray tube with beam concentration by electron-optical methods had been completed. Already, in the television tubes of 1930 and 1931, electrode arrangements had been used in the Lichterfelde laboratory<sup>4</sup> which are known today as electrostatic focusing lenses, and the control knob on the receiver for adjusting the voltage to these lenses was marked "Focusing." Based on the work of Busch<sup>10</sup>, the electron-optical mode of operation had been developed by Calbrick-Davisson, Brüche, Knoll, Recknagel, Scherzer and others<sup>11</sup>. It was therefore soon possible in Lichterfelde, with comparatively few stages of experimentation, to develop high-vacuum cathode-ray tubes with a long cathode life and with anode voltages of up to more than 8 kV for mass production<sup>12</sup>.

A parallel idea to my electron raster microscope came into being in 1938 in the form of the closely related electron-optical ray path of the electron micro-oscillograph<sup>13</sup>. In this type of oscillograph,

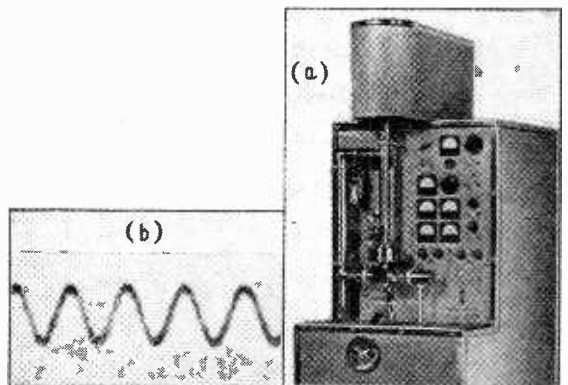


Fig. 5. (a) The electron micro-oscillograph devised in 1939 became well known, particularly through the equipment developed by Lee shown here. At (b) is a "one-shot" oscillogram of a wave with a frequency of 3,000 Mc/s, traced with a 10-micron scanning spot.

which was developed for Siemens with three or four scanning systems, the scanning spot was focused by means of a magnetic lens with a short focal length and a comparatively large beam aperture. In this way a scanning spot having a diameter of only about 10 microns was obtained, which gave an extraordinarily high current density at the anode voltage of 50 kV. This feature made it possible for the oscillograph to have an unusually high scanning speed. Since the deflection plates were also produced in "micro" construction and consequently the transit time effects were reduced, the instrument opened up possibilities of oscillographical investigation of transient phenomena at very high frequencies. This oscillograph principle has become known particularly through the Lee<sup>14</sup> equipment in Fig 5.

Very often certain inventive ideas occur quite independently of one another, and almost simultaneously, when the time for their conception is ripe. As an example of this I would like to recount here an incident from the early part of the second world war. H. E. Hollmann, a radio physicist also working in Lichterfelde, and I had decided in 1940 to work jointly on the development of a panoramic  
(Continued on page 31)

radar apparatus with decimetric waves<sup>15</sup>. The basic concept was already pretty obvious to us as a result of the polar co-ordinate oscillograph I have already mentioned. We foresaw the tremendous importance of the panoramic radar principle for the future, and so the development proposal was taken direct to the German government minister, Goering, who was at that time responsible for aviation research. Goering's answer, that the war was already won and consequently there was no longer any need for a development which would not bear fruit for one or two years, characterizes the mental capacity of the system of government ruling in Germany at that time. Approximately at the same time as ourselves, Watson-Watt had begun the development of his panoramic radar system which found its way into the history of the second world war and, encouraged by the farsightedness of his Government, was brought to such a successful conclusion during the years which followed.

At the end of the war, the Lichterfelde laboratory, which had remained completely intact, was transferred, together with its staff, to the south of the Soviet Union. Here, in 1952, was the first opportunity for re-commencing our work in the field of electron beam devices. The result was the precision electron beam oscillograph with a scanning spot of about 3 microns diameter and a scanning area of almost  $9 \times 12$  centimetres. Fig. 6 shows the apparatus<sup>16</sup> which was further perfected after the return to Dresden from the Soviet Union. The fine focusing of the scanning spot was carried out with the help of a grainless luminous screen, which was observed through an optical microscope. The photograph in the vacuum camera is taken on a  $9\text{cm} \times 12\text{cm}$  photographic plate with a fine-grain thin emulsion layer.

This oscillograph differs from the micro-oscillograph mentioned earlier in respect of the increased length of the deflected beam and the extreme sharpness of the spot. By virtue of the large deflected beam length and the extremely small convergence angle of the writing beam, the deflection errors with this system are reduced to the extent that nearly  $10^9$  image points can be accommodated on an oscillograph screen of the size mentioned. This figure is about four orders of magnitude higher than in the case of the usual cathode-ray oscillograph. Consequently, as a result of the smallness of the beam convergence angle

( $2\alpha_L \approx 3 \times 10^{-4}$ ), the photographic scanning speed of this type of oscillograph (as also the scanning speed in relation to the diameter of the scanning spot) is necessarily small. Furthermore, as a result of the smallness of the scanning spot the oscillograms are not visible to the naked eye, so that in order to observe them it is necessary to use an optical microscope.

By means of this type of oscillograph, which is only at the beginning of its applications in research work, the fine structure of oscillograms is opened up to direct observation. Two sections of an oscillogram obtained with this apparatus, one highly magnified and the other very highly magnified, are shown in Fig. 7. These will perhaps serve to give an idea of the properties of this latest child of the electron beam oscillograph family. By recording the fine structure of characteristics in plasma investigations (characterizing the stability of the plasma), by making visible details of curves produced by the Barkhausen effect, by plotting fine details of transistor characteristics, the precision electron beam oscillograph has already introduced a new era in the graphical recording of electrical phenomena. The first results of this type of oscillographic recording have already shown great promise, particularly in studying the fine structure of electro-encephalograms, electro-cardiograms and nerve action potentials.

### Looking Forward

It is perhaps a comforting thought for the younger generation that there are still many important problems in the science and technology of electron beam devices which remain to be solved in the future. Some of these problems can be clearly seen already, or are delaying the introduction of apparatus into practical use. Perhaps I may be permitted to conclude this article with a few remarks regarding such fields which so far have hardly been broached.

As far back as 1955 H. E. Kallmann<sup>17</sup> had mentioned a new deflection system by means of which the deflection sensitivity in the Y direction can be increased by about one order of magnitude. It is worthy of note that this system has found no application up to the present. A start was made at testing it out in conjunction with the precision electron beam oscillograph, because the new deflection principle could be a great step forward in this technique, where there is a very small beam cross-section in the deflection space. The relative deflection sensitivity of the precision oscillograph in terms of the diameter of the scanning spot is already more than one order of magnitude higher than that of the cathode-ray oscillograph tubes available on the market. One should therefore expect that this combination, at present in the development stage, should provide a total increase of more than two orders of magnitude of Y deflection sensitivity.

With very many measuring problems this advance would make it possible to manage completely without a deflection amplifier. This prospect is particularly valu-

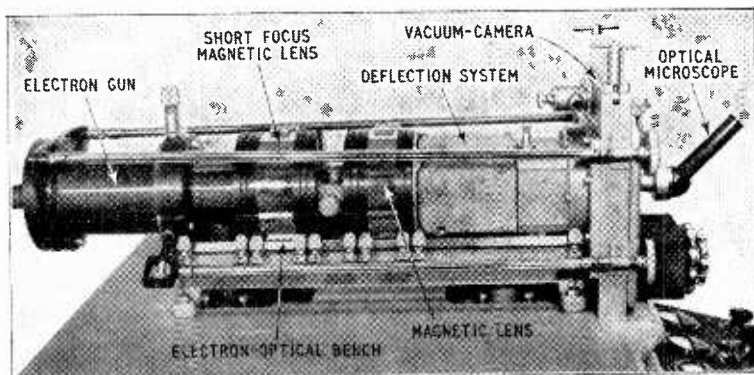


Fig. 6. Layout of the precision electron beam oscillograph developed during the period 1952-55. In this apparatus, built by VEB Vakutronik of Dresden, the scanning spot is only 3 to 5 microns and the scanning area is about  $9 \text{ cm} \times 12 \text{ cm}$ .

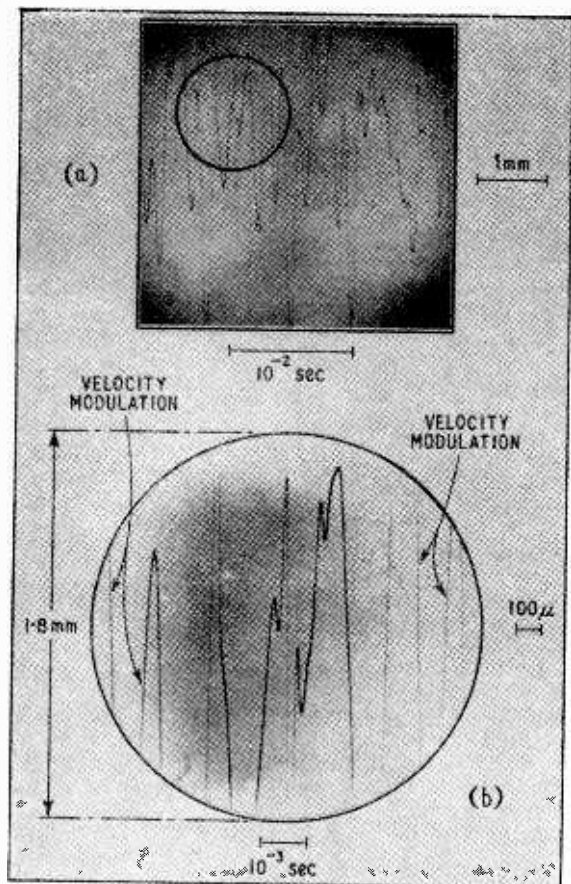


Fig. 7. Highly-magnified sections from a precision oscillogram of a music waveform at the output of a radio receiver: (a), section magnified 15 times (approx.  $1/900$  of the area of the 9 cm x 12 cm photographic plate); (b), section magnified 56 times, showing velocity modulation of the scanning line by residual i.f. signal from the receiver. (Approx.  $1/4000$  of the surface area of the 9 cm x 12 cm photographic plate!)

able in the case of the precision oscillograph, because the fine structure of the oscillogram would no longer be restricted by fluctuations in the deflection amplifier, and only the fine structure of the waveform under investigation would be made visible.

Closely related to the questions I have just touched upon is another line of development, in which low-noise amplifiers are used as deflection voltage amplifiers for oscillographs, especially for precision instruments. The future use of low-noise amplifiers in conjunction with precision oscillographs, for example, in the field of action-potential oscillography in medicine and physiology (observing the details of electro-cardiograms, electro-encephalograms and so on) should lead to interesting results.

Some of the tasks which face the precision oscillograph today will perhaps also be carried out by means of a special oscillograph tube with a very high spot sharpness (e.g. 5 to 10 microns), equipped with a suitable electron lens, with a grainless cemented luminous screen and with an anode voltage of 10 to 30 kV.

A wide field of application, especially in the field

of medical electronics, should be claimed by the single-gun multiple oscillograph with television tube bulb, of which individual examples have already been constructed. With this 4 to 6 waveforms can be traced simultaneously on an after-glow screen with the help of an electronic switch.

Far greater efforts will be made than in the past to achieve the direct recording of oscillograms in single processes. Going beyond the recording tubes which have already been developed so far there should be wide use in practice for tubes with the facility of storing traces and also for instruments with xerographic recording of oscillograms developed from the old idea of Selényi<sup>18</sup>.

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# Subjective Colour Tests

MEASUREMENTS ON A REDISCOVERED "TWO-COLOUR" SYSTEM

**T**ELEVISION engineers have recently been showing a good deal of interest in a system for reproducing pictures in colour which has the unusual feature of using white as one "colour" component and, say, red as the other. This phenomenon has been known for some time, but about a year ago was rediscovered and studied in detail by E. H. Land in the U.S.A.—as a result of which it has become popularly known as "Land colour." The feature of Land colour which would seem attractive for possible use in colour television is that it would only be necessary to transmit two simple signals carrying colour information. In the established N.T.S.C. colour television system it is necessary to transmit a luminance signal plus two colour-difference signals which, in a very complex way, contain information on the three primary-colour components of the picture. Even if Land colour did not offer an advantage in bandwidth economy it would apparently make things much simpler for the engineer.

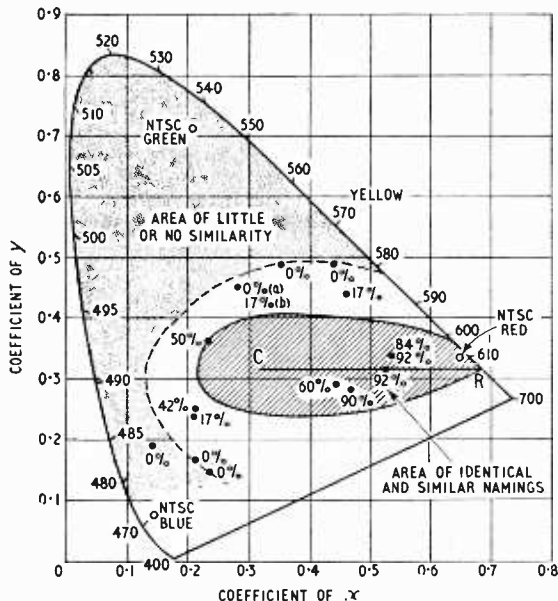
Unfortunately, Land colour has a big drawback in that it depends on subjective effects to convey some of the colour information to the mind of the observer. And the extent to which the observer "sees" these colours, which are not presented physically to his eyes, depends very much on their positions and areas in the colour picture. At a recent meeting of the Physical Society's Colour Group some very fine examples of Land colour

pictures were presented by M. H. Wilson and R. W. Brocklebank of the Goethean Science Foundation, Stourbridge. These, to most people, would have certainly passed muster as genuine three-colour reproductions, but it was pointed out that their success was very much a result of the careful composition of the coloured objects in the pictures. The effectiveness of the subjective colours cannot easily be determined, of course, but one speaker at the meeting, W. N. Sproson, described some subjective measurements for this purpose which had been conducted at the B.B.C. Research Department, using colour-matching procedures. Before giving details of the B.B.C. tests, however, it may be as well to recapitulate the basic method of producing Land colour pictures, for the benefit of those readers who may not be able to consult the relevant literature.\*

Two photographs are taken of the scene to be reproduced; one through an optical filter passing only light of wavelengths longer than about  $590 \times 10^{-9}$  m (appears red when viewed by transmitted light) and the other is taken through a filter passing wavelengths shorter than this figure: this filter appears green or bluish-green. Processing to produce positive black-and-white images is then carried out—images in which the amount of light passed at any point represents the brightness of the scene at that point, within the pass-band of the filters used. These two records are thrown together on to a screen by two projectors, or otherwise superimposed additively (i.e., taking the electrical analogue, the images are in parallel, not series), the long-wavelength record being illuminated by light of a "longer" wavelength and the short record by light of the "shorter" wavelengths. The point on the wavelength scale about which the terms "longer" and "shorter" apply does not seem to be critical as the result is a picture in colour, even if two similar filters, such as orange and yellow, are used in projection. Also one positive may be illuminated by white light and the other by coloured light: Land concentrated on this latter method, using red light for the long record and white for the short.

"Simultaneous contrast" effects, in which the apparent colour of an area is influenced by its surroundings, have been known (and exploited) for a long time, especially in fields such as stage lighting.† However, the only result one would expect from the use of red and white lights would be the appearance of "minus red" (blue-green, the complementary colour to red). As Land's claims went far beyond this, *Wireless World* decided, as did many others, to repeat Land's experiments. Photographs of a test piece containing coloured cloths, china,

Results of the B.B.C. tests plotted on the C.I.E. chromaticity diagram, which also shows the N.T.S.C. red, green and blue primaries for colour television. The figures around the spectrum locus are wavelengths in millimicrons ( $10^{-9}$  m). (a) and (b) are two different results for one colour.



\*E. H. Land. *Proc. Nat. Acad. Sci. (U.S.A.)*, 45, 1, p. 115, Jan. 1959; 4, p. 636, April 1959 (Parts I and II of three). Also *Scientific American*, 200, 5, p. 84, May 1959, and 201, 3, p. 16, Sept. 1959. A. Karp. *Nature*, 184, 4687, p. 710, 29th August 1959. "Two Co-ordinate Colour" by "Quantum." *Electronic & Radio Engineer*, 36, 8, August 1959.

†See, for instance, "The Technique of Stage-Lighting" (2nd Edn.), p. 151, by R. G. Williams. Pitman, 1958.



fruit and flowers were taken through Ilford filters Nos. 204 and 404 and these were processed to form positive transparencies for projection with red and white light. The colour rendering varied over the scene, being fair on small areas, such as the fruit, good on one or two points of fine detail such as the yellow centre of a white daisy, and poor in large areas. Another interesting point was that a suggestion of blues appeared in the right places in the reproduction, but, in fact, little blue light could have been registered on the film, for the pair of filters used were the red and green from a set of three designed to split the spectrum into three parts centred on the three primary colours in light; red, green and blue. Also, *Wireless World* was invited to view some work being done by J. P. Wilson, of the Information Systems Group, King's College, London, where similar effects were noted. An interesting side-issue of this visit was a demonstration which seemed to indicate that the simultaneous-contrast effects occur not in the retina, but in the brain. The experiment consisted of displaying one positive transparency to each eye, the long record having also the appropriate filter included in the light-path. In this way, each retina was presented with only one picture, but the result was still a Land-colour rendering of the scene.

In the B.B.C. tests the object was to form an estimate of the range of chromaticities given by Land colour reproduction, and the results were plotted on the standard C.I.E. chromaticity diagram† as shown in Fig. 1. A triple projector was used. Two-colour and three-colour versions of the same slide were shown to the observers individually. The three-colour version used red, green and blue positive separations projected through the same coloured filters. The two-colour version used the red and green separations projected in red and white lights.

A colour-naming technique was used to assess the accuracy of the two-colour version in terms of the three-colour version. Specific areas of a given picture were named by the observer; no restriction was placed on the actual colour names to be used by the observers but consistency of naming was requested. The same areas were named in both a two-colour and a three-colour reproduction. The colour namings were then analysed into the three classes: "identical," "similar" and "different." Chromaticities of the colours were estimated by comparison with the Munsell Colour Atlas.

On the C.I.E. chromaticity diagram in Fig. 1 are shown the results of the colour namings. The numbers at specific chromaticities are the percentages of observers giving "identical and similar" namings to the two-colour and three-colour versions. On the basis of these few results a central area has been shaded in, over which 50% or more of the observers gave "identical" and "similar" namings. The diagram shows a straight line CR (joining Illuminant C standard white to red) which represents the "objective" range of colours produced. A further, outer area is also shaded in, and over this there is little or no similarity in the colours produced by a two-colour and a three-colour reproduction.

The effect of the size of colour patch is important, and the C.I.E. diagram gives the results for fairly

large colour patches. The tests have shown that the range produced by this two-colour process is definitely greater when the colour patch is somewhat smaller. Yellows, greens and blues have been reported in small areas, although the C.I.E. diagram indicates, correctly, that in larger areas these colours are not accurately reproduced. This fact has been confirmed by the *Wireless World* experiments.

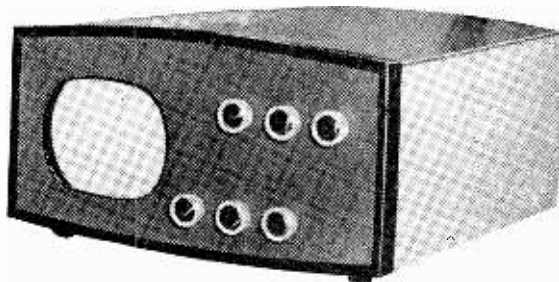
Thus, in view of the subjective nature of the colours and the fact that they depend a great deal on the composition of the pictures, it does not seem that Land colour has much to offer for a practical system of colour television. One has only to compare the limited range of chromaticities indicated by the central area in Fig. 1 with the wide range enclosed by the N.T.S.C. primaries to see the disadvantage of Land colour for large-area reproduction. It has been suggested that the phenomenon might be valuable in prompting us to revise our orthodox ideas on colour vision, but at the above-mentioned meeting Professor W. D. Wright, the eminent authority on optics, expressed the view that the established theories are not likely to be affected by it.

## Doctors' Hobbies Exhibition

DIVIDED into 22 classes covering activities ranging from the collection of antiques to photography, this exhibition included an Electrical Class in which the winning entry was a small television receiver described on the accompanying card by its maker, Dr. M. J. Ball, as "... suitable for the invalid's bedside or the bureaucrat's desk". The set is housed in a cabinet made by resin-bonding Formica to a wooden frame and it uses a 5-in magnetically deflected and focused c.r.t. (Type 5FP7). The long-persistence afterglow of the screen phosphors had been partly destroyed by exposure to ultraviolet light. Providing for the reception of both B.B.C. and I.T.A. programmes on its attached 16-in rod aerial, the receiver consists, in the main, of sections of commercial receivers modified and adapted to suit the 5-in tube. In all, 17 valves of various heater-current ratings are used and these are interconnected in a series-parallel configuration to provide a 0.3-A heater chain.

As the receiver is made up from units and components of normal size, their close packing inside the case caused difficulties due to deflection of the c.r.t. beam by stray magnetic fields and the heat produced by the 120W or so of mains power consumed. The use of Mumetal screening and careful orientation of iron-cored components overcame the first problem, whilst ventilation through the loudspeaker grille in the top of the cabinet, coupled with the use of an aluminium deflector assisted in the removal of heat.

The exhibition was organized by Benger Laboratories, Ltd., and held at the London headquarters of the British Medical Association.



Small television receiver seen at recent exhibition.

† For an explanation of the C.I.E. (Commission Internationale de l'Eclairage) chromaticity diagram and its  $x$  and  $y$  co-ordinates, see "Colour Fundamentals," by H. Henderson, *Wireless World*, August 1956.



# Electromechanical Analogies

By  
"CATHODE RAY"

Some Further Details of How to Represent  
Mechanical "Works" as Electrical Circuits

**L**AST month we agreed that developing the analogy between electrical circuits and mechanical (and acoustical) devices was a very nice idea, and most instructive and useful if correctly handled. But it was easier to go wrong with it than might seem at first sight.

On the electrical side, we all understand how to represent a piece of equipment as a circuit diagram, made up of standardized graphic symbols joined up by lines representing wires. Our difficulties begin when we try to represent a piece of mechanical equipment by an analogous type of diagram. Even when that part of the job is done for us in a book, we may not be quite clear how the various components are "connected." Not clear enough, anyway, to apply a foolproof rule for translating the diagram into its equivalent electrical circuit.

That was the part of the problem we dealt with last time. Before going on let us recapitulate.

The analogy we considered was the familiar "direct" one in which force is represented by e.m.f., velocity by current, mass by inductance, compliance by capacitance and resistance, reactance, impedance, etc., are terms common to both. Mechanical links such as rods (assumed massless, or their masses represented separately in lumps) correspond roughly with wiring, but if we treat them in the same way as electrical connections we can hardly fail to go wrong. In particular, the order in which they are connected—unimportant in electrical circuits—makes all the difference. If an applied "a.c." force gives two mechanical elements the same linear vibratory velocities, reckoned between their "terminals," they are by definition analogous to corresponding electrical elements in series, though visually they are "in parallel." Whereas the two "terminals" of a mechanical resistance (represented conventionally by two flat surfaces sliding across one another frictionally, or by the piston and cylinder of a dashpot) and of a compliance (represented by a coil spring) can easily be located, a mass has only one connection to the force. But it can be regularized by "completing the circuit"—drawing a dotted line back to the other "terminal" of the source of force. To avoid uncertainty as to whether the description of a mechanical "circuit" as "parallel" refers to arrangement or to behaviour, Dr. A.

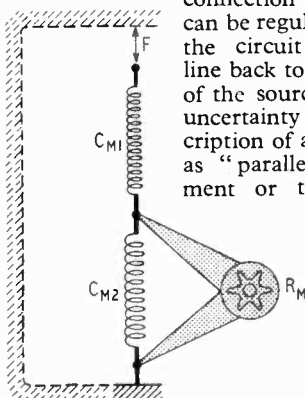


Fig. 1. Mechanical "circuit", in which an alternating force  $F$  is applied to two springs, to one of which is connected a frictional damper.

Bloch\* suggested the term "co-resistive" for both it and an electrical series circuit. And because the analogue of an electrical parallel circuit is one in which the same force comes across each mechanical element equally, which happens when they are apparently in series, he uses the description "co-

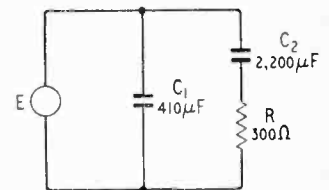


Fig. 2. Direct electrical analogue of Fig. 1.

yielding" for both. So to transform a mechanical system into its equivalent electrical circuit in accordance with the direct analogy, first draw it as a mechanical "circuit" by the foregoing conventions, to bring out the points of application of forces and to show whether elements are connected in what we electrical people would call series or parallel; then convert it to the "dual" arrangement (in which series and parallel are all interchanged), and at the same time—or as a separate step if we aren't sufficiently adept—exchange the mechanical symbols for the corresponding electrical ones.

If you are new to all this, not having read the last instalment, you may have found its condensation into a single paragraph rather bewildering. If so, a simple example should make it clearer. We might at the same time make some progress towards the practical side by working in numerical values.

Fig. 1, then, shows a mechanical system consisting of two springs with a frictional damper across one of them. When the springs are tested separately, a 1-kg. weight (about 2½ lbs.) compresses  $C_{M1}$  0.4 cm. and  $C_{M2}$  2.15 cm. The same force applied between the ends of the damper arms makes the distance between them change steadily at 3.3 cm/sec. We shall assume that this velocity varies exactly in proportion to the applied force. (In practice it probably wouldn't, but we don't want to involve ourselves in non-linear resistances right at the start.) The masses of these parts are supposed to be negligible. We can now calculate the compliances and mechanical resistance, and if we do so in m.k.s. units they will be in mechanical farads and ohms, which will at least make us feel partly at home straight away. Capacitance is equal to charge/voltage, so compliance is displacement/force; and mechanical resistance is force/velocity. The m.k.s. unit of force is the newton, which is enough to give a mass of 1 kg. an acceleration of 1 metre/sec.<sup>2</sup>. The force of gravity at sea-level gives a mass of 1 kg. an accelera-

\* "Electromechanical Analogies and their Use for the Analysis of Mechanical and Electromechanical Systems", *Journal I.E.E.*, Part 1, April 1945, pp. 157-169.

tion of 9.81 m/s<sup>2</sup> ("g"), so 1 kg. weight is equal to 9.81 newtons. Therefore

$$C_{M1} = \frac{0.004}{9.81} = 0.00041 \text{ mech. farad} = 410 \text{ mech. } \mu\text{F}$$

$$C_{M2} = \frac{0.0215}{9.81} = 0.0022 \text{ mech. farad} = 2,200 \text{ mech. } \mu\text{F}$$

$$R_M = \frac{9.81}{0.033} = 300 \text{ mech. ohms.}$$

With such a simple arrangement there is really no need to draw a separate diagram to show the "circuit"; the only thing to remember is that in order to impart the force *F* to the springs the source of the force must be rigidly attached to the framework or "earth" to which the bottom spring is anchored. So we have to imagine, if we don't dot in, this completion of the circuit.

There should be no difficulty in arriving in one stride at the equivalent electrical circuit. Capacitances take the place of compliances, and resistance the place of mechanical resistance. *C<sub>M1</sub>* being (visually) in series with *F* and the combination of *C<sub>M2</sub>* and *R<sub>M</sub>*, its analogue *C<sub>1</sub>* in Fig. 2 must be in parallel with them. And the analogues of the parallel pair *C<sub>M2</sub>* and *R<sub>M</sub>* appear in series with one another. The translation into electrical units consists simply in deleting the prefix "mechanical."

Note that frequency hasn't come into this at all. So Fig. 2 should be valid for any waveform. But we must not forget that such conclusions are true only so far as our assumptions are true. For instance, we neglected the mechanical masses entirely. While that might be justifiable at very low frequencies, it could hardly be so at high. A rough way of deciding whether it was significant or not would be to suppose that something of the order of half the total mass was concentrated at the junction of the three mechanical elements. This, being subjected to the same velocity as *C<sub>M2</sub>* and *R<sub>M</sub>*, would appear in Fig. 2 as an inductance of 1 henry per kg. in the *C<sub>2</sub>R* branch. The resonant frequency of this branch could then easily be calculated.

Confining ourselves to the simple Fig. 2, we can find the frequency at which the impedance of *C<sub>2</sub>* equals that of *R*:

$$\frac{1}{2\pi f C_2} = R$$

$$\therefore f = \frac{1}{2\pi C_2 R} = \frac{1}{2\pi \times 0.0022 \times 300} = 0.24 \text{ c/s.}$$

At this frequency, the impedance of *C<sub>1</sub>* would be several times greater than that of *C<sub>2</sub>* and *R* combined, so would take that much less current. We conclude that at the same frequency the upper spring would be relatively stiff, flexing only a fraction as much as the other. At much higher frequencies (short of mass

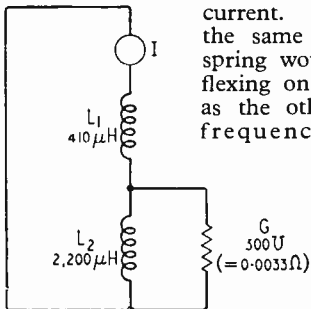


Fig. 3. Inverse electrical analogue of Fig. 1 and dual of Fig. 2.

being important) the impedance of *C<sub>M1</sub>* is relatively low, so it flexes most.

If the exercise is confined to paper, the question of rate of exchange between mechanical and electrical quantities need hardly arise. So far we have made it one-to-one in every case, and because we have worked in a single system of units throughout (m.k.s.) we can be sure the analogy can be relied upon throughout. For instance, the amount of power needed to make a point on the machine vibrate with an r.m.s. velocity of 0.01 m/s would be the same as that needed to make 0.01 amp r.m.s. flow through the corresponding part of the circuit at the same frequency.

With mechanical systems complicated enough to make this sort of study worth while, however—and especially when distributed masses, etc., are involved—it may be more convenient to measure the performance of the electrical circuit than to calculate it. If so, you may ask, why not measure the performance of the mechanical system direct and save all the trouble of translation? The answer is that it is usually easier and more accurate to measure electrically, and *much* easier to vary circuit quantities continuously during test than machine quantities.

When it comes to building actual electrical models, the 1 : 1 scale may be awkward. We may not have a 2,200 μF fixed capacitor, for example; much less a variable one for trying other values. The solution is to use some other scale, but we must take care to keep it consistent.

We can decide to represent a velocity of 1 metre/sec by *a* amps, and a force of 1 newton by *b* volts. That is to say

$$\frac{I}{V} = a \text{ and } \frac{E}{F} = b \quad \dots \quad (1)$$

$$\text{Therefore } \frac{R}{R_M} = \frac{E}{I} \cdot \frac{V}{F} = \frac{b}{a} \quad \dots \quad (2)$$

and similarly for impedance and reactance. So, as inductive reactance is proportional to inductance and mass reactance to mass,

$$\frac{L}{M} = \frac{b}{a} \quad \dots \quad (3)$$

and inversely

$$\frac{C}{C_M} = \frac{a}{b} \quad \dots \quad (4)$$

Frequency of resonance is proportional to  $1/\sqrt{LC}$  and therefore to  $1/\sqrt{MC_M}$ , so the analogue works in "real time."

Power is proportional to *EI* and *FV*, and

$$\frac{EI}{FV} = ab \quad \dots \quad (5)$$

so 1 mechanical watt is represented by *ab* electrical watts, and the same for energy. If you want watts to be the same size in both domains, you must choose *b* = 1/*a*.

If it would suit us to make *C<sub>2</sub>* in Fig. 2 2.2 μF, then from eqn. (4) *b/a* = 1,000, and if we make *b* = 1/*a* we have *b*<sup>2</sup> = 1/*a*<sup>2</sup> = 1,000. Substituting these in eqns (1)–(5) we find our scale factors to be:

- 1 newton is represented by  $\sqrt{1000}$  volts
- 1 metre/sec is represented by  $1/\sqrt{1000}$  amp.
- 1 mech. watt     "     "     1 electrical watt
- 1 mech. c/s     "     "     1 electrical c/s
- 1 mech. ohm     "     "     1000 electrical ohms
- 1 kg. mass     "     "     1000 henries
- 1 mech. farad   "     "     by 0.001 farad

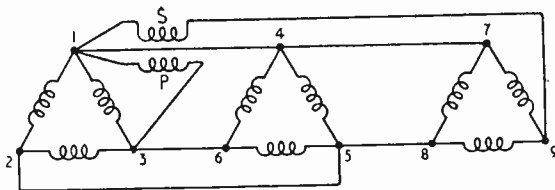


Fig. 4. Use of an ideal 1:1 transformer (PS) to enable a circuit to be drawn without crossing wires. This brings such exceptional circuits within the scope of the rules for drawing dual circuits.

It would be advisable to make a table like this whenever the model is not life-size throughout.

Having (let me optimistically assume) made the effort of mastering this electromechanical analogy chiefly for the sake of avoiding the sweat of learning mechanics, making double use instead of our knowledge of electrical circuits, you may feel very strongly that it is superfluous, not to say positively confusing, to add to it another type of analogy in which everything is upside down and clean contrary to all our technical upbringing. If you add "and common sense" I can hardly blame you, as that was how I used to feel. Now, as Bloch's latest disciple, I am going to try to put across what I was at first extremely reluctant to buy from him, namely the "inverse" analogy (which is the same as the "mobility" analogy invented by F. A. Firestone in 1933). I fear I lack the masterly salesmanship with which he converted my hostility into enthusiasm, but here goes.

In the inverse analogy, force is represented by current and velocity by voltage. I need hardly explain that this necessitates everything else being upside down; mass is represented by capacitance, compliance by inductance, mechanical resistance by conductance, mechanical impedance by electrical admittance, etc. It follows that co-resistive mechanical arrangement is represented by co-yielding electrical arrangement. In fact, the inverse electrical analogue is the "dual" of the direct electrical analogue. And if you don't know what "dual" means in this context and haven't got last month's *Wireless World* or "Second Thoughts on Radio Theory" (Chap. 35) handy for looking up, it means the whole upside-down relationship between the two electrical analogues of any mechanical system.

Before you say rash things about not listening a moment longer to such nonsense as making voltage analogous to velocity and inductance to compliance, may I point out that in the first case they both begin with a "v" and in the second both are shown in diagrams as a curl. Small points, but quite useful for a taxed brain to hang on to.

More important is the fact that in translating from mechanical to electrical circuit diagram the arrangement is the same—there is no interchanging of series and parallel, which can be quite tricky with complicated systems. The translation of symbols is relatively easy, especially as they are much more like one another than in the inverse analogy. Thus instead of Fig. 2 to represent Fig. 1 we would have Fig. 3. ("G" is the symbol for conductance.)

So far, then, all is well. The disadvantage is that when one comes to study the mechanical behaviour on a basis of familiarity with circuit behaviour, one's familiarity is found to be of the wrong kind. It may

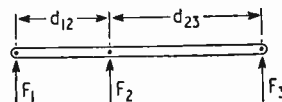
be hard at first to interpret the increase in voltage across  $L_1$  with rise in frequency as an increase in vibrational velocity of the upper spring in Fig. 1. But a little practice soon gets one into the way of it. If it doesn't, there is always the alternative of converting Fig. 3 into its complete electrical dual, as explained last month. The result is Fig. 2.

When Bloch advocated the inverse analogy he did so with the argument that just as in some situations a current can be regarded as the cause of a voltage (e.g., in the anode circuit of a line-scan pentode) so a velocity can be regarded as the cause of a force. While this is quite true, it seems to me that the question of cause and effect confuses the issue of direct versus inverse analogies. As we have just seen, it is possible to use either, according to one's whim, without any interchange of cause and effect.

But I am particularly grateful to him for unconsciously putting the finishing touch to the system of vector diagrams I praised so conceitedly only a month or two ago. Hitherto I had to admit one little flaw—that as regards current vectors it broke down if the circuit diagram couldn't be drawn without crossing wires. Actually there are very few practical circuits, for which one might want to draw vector diagrams, where this difficulty arises. I have never come across any, but the possibility irked me. The same difficulty occurs when drawing the dual of such a circuit, as one may want to do when changing over between inverse and direct analogies. Bloch showed that this difficulty can be overcome by bringing in an ideal 1:1 transformer.

One of the "impossible" circuits, though not

Fig. 5. Diagram of a simple lever. One of the forces  $F_1$ — $F_3$  represents the support given by the fulcrum.



of much interest to most of us, is a 3-phase source connected to two loads, Fig. 4. There is always one lead that can't be run without crossing; in this case, the one from 3 to 9. But there is no rule against an invisible magnetic field crossing, so the transformer PS solves the problem. This enables a vector diagram to be drawn according to my rules (*Wireless World*, August 1954, p.383), and enables the dual circuit diagram to be drawn according to the rules given last month.

Some things still remain to be said in favour of the inverse analogy, and as space is running out I won't go into detail again about units and scale factors for it; the principles are the same as for the direct analogy.

One much-used mechanical component which I have held back until now is the lever, because (notwithstanding what Dr. Bloch seems to say to the contrary) it needs the inverse analogy to link it with its electrical counterpart—the transformer. Ideally, a lever is perfectly rigid and without mass, so is incapable of storing mechanical energy in itself, and it has a frictionless fulcrum, so dissipates no energy. What it does do is vary the ratio of force to velocity (mechanical impedance), gaining say force at the expense of velocity. In the same way, an ideal transformer stores and dissipates no energy, but changes the voltage/current ratio.

A lever must have at least three forces acting on it, as for example in Fig. 5. The sum of the three

$(F_1 + F_2 + F_3)$  must be zero, otherwise it would go flying off. Also to conform to the ideal conditions mentioned, the total power going into it  $(F_1 V_1 + F_2 V_2 + F_3 V_3)$  must be zero. Finally, and obviously the angular velocity  $\frac{d\phi}{dt}$  of both parts of it ( $d_{12}$  and  $d_{23}$ ) must be the same:

$$\frac{d\phi}{dt} = \frac{V_1 - V_2}{d_{12}} = \frac{V_2 - V_3}{d_{23}}$$

Compare this with an auto-transformer, Fig. 6. The clearest analogue of lever length is number of turns,  $N$ . To this, voltage is proportional. Voltage per turn is proportional to the rate at which the magnetic flux in the core (also denoted by  $\phi$ ) is changing:

$$\frac{d\phi}{dt} = \frac{E_1 - E_2}{N_{12}} = \frac{E_2 - E_3}{N_{23}}$$

So voltage is analogous to velocity. This fits the other conditions too. Suppose  $F_3$  in Fig. 5 is an upward (positive) force of 10 kg., and the lever is hinged at the  $F_1$  end. Then, if  $d_{23} = 2d_{12}$ ,  $F_3$  can lift 30 kg. at  $F_2$  (which is therefore negative). To balance these two, the upward pressure  $F_1$  must be 20 kg. If forces were represented by voltages, as in the direct analogy, the transformer figures would be wrong. But if force is analogous to current we

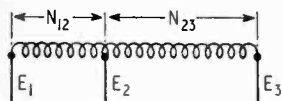


Fig. 6. Electrical analogue of Fig. 6—an autotransformer.

have as the first condition  $I_1 + I_2 + I_3 = 0$ , which is true. The second condition would be true either way.

Our interest in all this is likely to be in connection with "transducers" which are partly electrical and partly mechanical, such as loudspeakers, microphones, pickups, motors, and relays. In early treatises, separate circuit diagrams were shown for the electrical and mechanical portions of these. The reaction of the mechanical portion on the electrical circuit was represented in the electrical circuit diagram as a single element called "motional impedance". One can go further than this, however, and make a single circuit diagram in which all the mechanical elements are separately represented along with the purely electrical. The thing can then be studied as a whole.

You will probably foresee that in order to do this we must accept some restrictions on choice of scale factors. Otherwise the mechanical and electrical portions won't join up properly. For one thing, the law of conservation of energy must be observed. It may be less obvious that there is no longer freedom to choose between the direct and inverse analogies. Bloch deals with this, but unfortunately I couldn't follow his proof and had to satisfy myself on the following lines.

Suppose first we have a device, such as a moving-coil loudspeaker, in which the cause of the mechanical force on a wire is the reaction of a magnetic field on current flowing through the wire. (This is sometimes known as the electric motor effect.) Assuming the wire carrying current  $I$  is at right angles to the field of flux density  $B$ , and the length of the wire is  $l$ , the fundamental equation is:

$$F = B l I \dots \dots \dots (6)$$

If the wire is free to move, this force will move it

and cause an e.m.f. to be generated in it (dynamo effect):

$$E = B l V \dots \dots \dots (7)$$

where  $V$  is the velocity of the wire, assumed to be at right angles to the field and current.

If the electrical impedance of the wire is either negligible or separately represented, its only impedance is due to the back e.m.f. generated by its motion, so is called the motional impedance,  $Z_{EM}$ . It can be derived from equations (6) and (7):

$$Z_{EM} = \frac{E}{I} = (B l)^2 \frac{V}{F}$$

$(B l)^2$  is a constant, and force/velocity ( $F/V$ ) is a mechanical impedance—in this case the mechanical impedance of the wire and all that moves with it. So the electrical impedance is *inversely* proportional to the mechanical impedance, and consequently we are bound to use the inverse analogy. And the scale factor is also fixed for us— $(B l)^2$ .

The same result, except for the details of the constant, emerges from corresponding calculations of other magnetic types of electromechanical transducer.

But now compare the electrostatic type. (I don't like the term "electrostatic" for something that moves, but it will probably be better understood than just "electric".) Suppose we have a pair of parallel plates, each of area  $A$ , separated by a dielectric of thickness  $d$  and permittivity  $\epsilon$ , and supplied with a fixed polarizing voltage  $E_0$ . Then if  $E$  is a relatively very small "signal" voltage, the force caused by it can be shown to be

$$F = \frac{E_0 \epsilon A E}{d^2} \dots \dots \dots (8)$$

If free to move as a result of this incremental force, with velocity  $V$ , the capacitance will vary. If at the same time  $E_0$  is kept constant, the charge must vary, giving rise to a current

$$I = \frac{E_0 \epsilon A V}{d} \dots \dots \dots (9)$$

Deriving the motional impedance from (8) and (9) we get

$$Z_{EM} = \frac{E}{I} = \left( \frac{d^2}{E_0 \epsilon A} \right)^2 \frac{F}{V}$$

so it is *directly* proportional to the mechanical impedance, and we must use the direct analogy, and of course the scale factor specified.

This, of course, is only the beginning of the subject. So far it has been idealized to make the basic principles clear. Extending the thing to distributed masses, etc., is more or less routine stuff, like extending r.f. theory to microwaves.

Since writing these two articles I have had my attention drawn to "Notes on Electro-Mechanical Equivalents" by H. Jefferson in *Wireless Engineer*, December 1944. He deals throughout with both "direct" and "inverse" analogies, which he calls "b-equivalent" and "a-equivalent" respectively; and shows that the "wrong" equivalent can be made to fit a lever or an electro-mechanical transducer by use of an "inverting transformer" with a ratio of  $1 : \sqrt{-n^2}$ . While this is mathematically feasible, it does rather spoil one main purpose of these analogies—to assist easy visualization—and he naturally recommends the other equivalents.

# MIDGETS AND FIDGETS

## -Or Bifocals Anyone?

By JACK DARR\*

AMONG the many unpleasantnesses the American radio-TV repairmen have to put up with is the increasing tendency of the setmakers toward miniaturization of their products. These gentry are evidently firmly convinced of the truth of the old saw about "Good Things Coming In Small Packages!" While this might conceivably be quite useful in the small transistor portable radio field, where we have already seen a 4-transistor set reduced to the size of a packet of cigarettes, to fit into the shirt pocket, it can lead to uncounted confusion in others! Not *too* much trouble is encountered, always providing you have a good supply of very high-powered jeweller's loupes, a soldering-iron with a *very* small bit, and immeasurably good eyesight. (If you do, cherish it: it won't last long!)

The poets sigh for the halcyon days of yore. So, too, do some of us "old gaffers" who remember the radio business "away back when." In this instance the phrase refers to the early 1930s, when the radio business was only beginning to grow into the giant of today. This was the period which saw the biggest home radios ever built. Housed in cabinets faintly reminiscent of grand pianos, in both size and construction, they were filled with masses of chasses (Sorry! Shan't do it again) which were separate power supplies, audio amplifiers, tuners, and so on.

This decade also witnessed the birth of the first "midget" radio. This happy event took place about 1931, with the advent of the Model 6 "Echo-phone." It was about 12 x 14 inches, and about 15 inches high. It had a round-topped cabinet of veneer plywood, a 6-valve circuit, and was famed far and wide as being the only radio set made that one could pick up with only one hand! These sold like hot cakes, and soon every major manufacturer had his finger in the pie, making "midgets."

The classic example was the original Majestic Company (Grigsby-Grunow) who built the immortal Model 50. This was classified as a midget, although there were many who expressed doubt as to the validity of the classification. It was about the same size as the "Echo-phone," although a bit taller, rather square-topped, with a sort of Corrupt Gothic pilaster effect on the front of the cabinet. Its principal feature, though, was its weight. This hefty little giant was so heavy that servicemen with ordinary sized feet often found themselves sinking hock-deep into lawns, and asphalt paving in midsummer, while attempting to carry it to their trucks! The cabinet, while not too large, was reputed to be filled with solid iron. This was a base canard; there *were* a few air-spaces left here and there, albeit not too many! The heft was accounted for by some of the design practices common to that period; massive mains transformers, input and output transformers, and a 10-inch electrodynamic loudspeaker with a tremendous field coil furnished a goodly share of it. A large cast-iron-framed tuning condenser and

large components did the rest. Even the i.f. transformers were about 2 inches square, 3 high, and filled solidly with tar! True! Each i.f. can weighed about two pounds! Incidentally, these were *not* tunable!

For a final touch, these sets were sold with a "matching table," to which they were somewhat insecurely fastened. This consisted of a heavy framework (1 x 2-in lumber!) at the top, and slender, tapered legs; from a scant inch at the top, they wound up less than a half-inch diameter at the bottom! Much to our surprise these tables, despite their decidedly unsafe appearance, never collapsed under their tremendous load. Of course, we did find, now and then, the tiny ends of the legs sunk completely through the lino, or into a soft pine floor, but somehow or other they never did quite completely let go, like the proverbial One-Hoss Shay.

Modern science has once again leaped into the breach, though. From "midgets" that were so heavy we couldn't lift 'em, they have given us radios that are so tiny we can't see 'em! The customer now comes into the shop, saying, "Can you fix my radio?" Upon receiving an affirmative reply (although with certain unspoken reservations), he begins frantically searching his person. Claiming that he certainly had it when he left home, he finally digs it out of his shirt pocket, where it has gone to earth behind a packet of Pall Malls. The difficulty, of course, is occasioned by the fact that the radio is smaller than the fags!

### The Tool Kit

Our brave technician gingerly accepts it, turns on a very bright light over his bench, and rounds up a group of tools filched from local jewellers, surgeons, and the like: tiny tweezers, hæmostats, picks, screwdrivers, and that essential appendage, a jeweller's loupe of at least four power. Screwing this firmly into his eye, he at last attacks the plastic case. Opening this, he discloses a mess of miniaturized components which would be far more at home in the nose of a proximity-fused anti-aircraft shell. (This is where most of them came from, and at the moment he fervently wishes they were back!) At one end is a wee battery. Hopefully, he measures its voltage, in the faint thought that it might be low. No luck; he must work on the thing!

Printed circuits? Oh, definitely, old boy. There isn't room inside the thing for a normal wire! One couldn't close the case! By cleverly mounting all the transistors and parts on one side of the board, and printing the wiring on the other, the designer has managed to render the gadget almost immune from normal maintenance procedures. However, our braw laddie removes a few minute screws, about the size of those securing the balance-staff in a

\* Ouachita Radio-TV Service, Mena, Arkansas, U.S.A.

medium-sized pocket-watch, and gets the thing out into the light. Now, by holding it up between his eyes and the powerful light, he can see through the translucent board. (In the process, he also manages to acquire a mild sunburn on the tip of his nose from the actinic rays, but this is quite incidental.)

A standard test-prod looks rather like a telegraph pole beside the space available for insertion of same. By contrast, the older radios and TV sets had enough space to park a good-sized lorry between components! Nevertheless, Our Hero finally manages to pick up a voltage here, a resistance reading there, and, after a while, he locates the trouble: it is, as usual, a minuscule break in the printed wiring. (Due, no doubt, to the mistress dropping it off the dresser the night before, or bunging it at the master's head!) Flowing solder over this with his special needle-nose bit, it works! He reassembles it and hands it back to the customer, who, as is customary in such cases, has left his wallet in his other coat. Now, in America, would be the ideal time for a coffee break (a "cuppa" in England?).

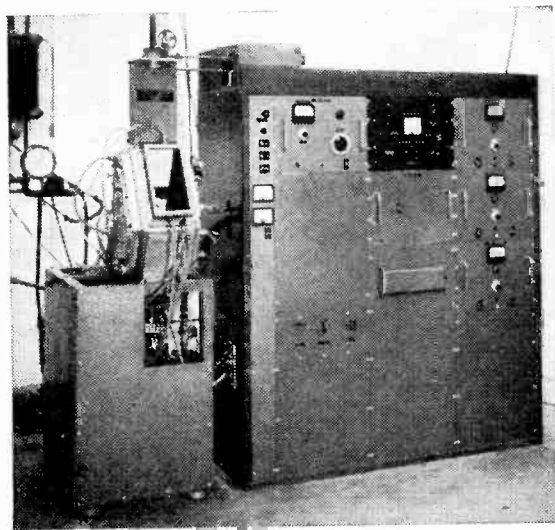
We were getting by with these Minute Marvels until the setmakers decided that too much of a good thing was not enough, and began their shrinking techniques upon TV receivers! Now, the average TV set, even some of our mail-order marvels, need quite a few more parts than a 4-transistor radio. Still, these electronic Jivaros seem to be making an earnest effort to cram all of them into a space of about the same size! This has some quite ridiculous results, at times. Upon opening the back of a modern portable TV, which by this time measures some eight inches in depth, one finds a wee blobby object sticking out in the centre: this is the neck of the picture tube. Upon a perfectly flat wall of glass is apparently pasted some peculiar-looking coils, etc.: these comprise the deflection yoke! Upon looking up the spec's for the picture tube, he finds that it has a deflection angle of 110 degrees! Wondering how long it will be until someone succeeds in making tubes with deflection angles *greater* than 180 degrees, so that the tubes could be built in the shape of inverted ice-cream cones, he begins to look for the chassis. Here the words "look for" are used advisedly. Of the chassis as we knew it, there ain't no such no more. Scattered here and there about the case are odd bits of metal, with valves sticking out at odd angles. A few resistors and capacitors may be seen, and from this evidence, he deduces that this weird assembly is intended to be "the works".

The printed circuits, which were the subject of an earlier diatribe\*\*, abound in these little monsters. Because of their space-saving characteristics, they have been seized upon with glee by the sadists who are in charge of Design. In some cases, they have been cleverly arranged in the form of a box, enclosing the picture tube. This enables the designer to enclose almost totally all parts and valves (Oh, didn't I tell you? The valves are on the *inside* of the box, with their sockets indecently exposed on the outside!) rendering the whole thing something like 89% inaccessible for normal maintenance work! The edges of the PC boards comprising the major part of the assembly are firmly tied together by the wiring and interconnecting leads. To get it out of

the "box" so that it can be checked, it is necessary to spend at least half an hour totally disabling the set, by disconnecting the major part of these. Of course, if the technician has unlimited time on his hands, he may make the set operative in this odd condition by reconnecting the edges with scraps of flex, test leads, etc. This, of course, induces some strange and wonderful feedback lops, aiding no end in the diagnosis of the original defect!

Be that as it may, we *are* learning to live with them, in a resigned sort of way. Patience and fortitude can do wonders when applied to such instances. Really, some of the PC boards are not too difficult to work on, provided the maker has not rendered things too hard, by concealing one side of the board completely with a heavy steel plate, as has been the case in some recent models. Practice will do wonders!

As to radios, one never knows what will come up next. With hearing-aids fitted into the bows of a pair of eyeglasses, one can scarcely blame the unfortunate technician involved in this incident. A customer came into the shop, and said, "Could you fix my radio?" Upon receiving the usual affirmative answer, he began trying to remove a large ornate ring from his finger. The technician turned, saw this, and swooned! When revived, the customer explained that he only wanted one of the prongs of the ring resoldered: the radio was still out in his car! The technician, remembering the article he had just read about future trends in micro-miniaturization, had been under a completely wrong impression!



*This crystal-pulling furnace is made by Nash and Thompson, Ltd., Chessington, Surrey, to the design of the Services Electronics Research Laboratory, Baldock. The temperature of the molten semiconductor material in the crucible, which is heated by a graphite element, is judged by looking into the vacuum chamber (left) at the liquid surface. The meniscus formed is an extremely sensitive indicator, as it depends on surface tension which changes widely with temperature near the melting point of the material. The equipment rack contains the pumps, instrumentation and control apparatus for the heater and pulling motors.*

\*\* *Wireless World*, November 1957.



# Loudspeaker Magnet Design

With Special Reference to Capped Cylindrical Slugs of

Alcomax III

By A. E. FALKUS\*, B.Sc. (Eng), M.I.E.E.

**T**HE development of a process for making production quantities of Alcomax magnets with a semi-columnar structure has placed in the hands of loudspeaker designers a material which, while having a better performance than any used hitherto, yet has certain limitations of shape.

The figure of merit of a permanent magnet material is the maximum value of the product  $BH$ , where  $B$  is the flux density in the magnet and  $H$  the magnetomotive force per unit of length that the magnet can exert when carrying  $B$  in a magnetic circuit. The  $BH$  (Max.) value for semi-columnar Alcomax III is 5.8 mega-gauss-oersteds whereas for normal cast Alcomax III the value is 5. Thus the process whereby longitudinal crystal growth, i.e., semi-columnar structure, is induced increases the performance of a given weight of alloy by 16% for a small extra process cost.

There is, however, a limitation on the shape of the magnet in that the semi-columnar structure can only be obtained when the magnet consists of a solid cylinder.

However, this feature of semi-columnar material, the limitation of the shape to a plain cylinder,

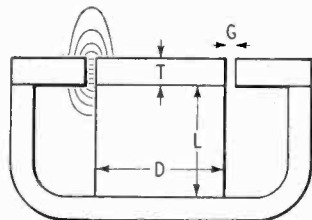


Fig. 1 Dimensions and stray fields in the capped cylindrical-slug magnet design.

leads to a simplified method of design. It will be shown later that for a given load (i.e., mass of cone to be driven) a given input impedance, and given weight of magnetic alloy, there is one optimum value for the pole diameter and depth of gap.

Although semi-columnar Alcomax III is the magnet material considered, the design methods suggested can be applied to any magnet material by using the appropriate values of the magnetic constants.

**Basic Design.**—The best basic design for a loudspeaker magnet of semi-columnar material is that of a capped slug. The magnet consists of a cylindrical slug of a diameter equal to the inside diameter of the voice coil less the working clearances. This slug is capped by a disc of mild steel which forms the pole piece. This disc is of the same diameter as the magnet and of a thickness equal to the desired depth of air gap.

The design is shown diagrammatically in Fig. 1, where the magnet slug has a diameter  $D$  and length  $L$ . It is capped by a disc of mild steel also of dia-

meter  $D$  and thickness  $T$ . The radial width of the air gap is  $G$ .

Since the magnet slug may not have a central hole, it is best fixed to the yoke and pole piece by some form of adhesive, such as Araldite, which will provide a satisfactory bond.

The capped slug design is well known as an efficient design for small sizes of magnet. It will be shown that it may be used for any weight of magnet and, when the proportions are correct, will give high magnetic efficiencies.

**Gap Flux.**—To design a loudspeaker magnet satisfactorily it is necessary to be able to calculate what proportion of the total flux carried by the magnet passes usefully through the air gap and what proportion leaks across above and below the gap.

Referring to Fig. 1 and assuming that the magnet is working at its  $BH$  (Max.) point, the magnetomotive force across the gap, neglecting losses in the yoke, will be  $LH$ . The flux density in the air gap will therefore be  $LH/G$ . Now the gap cross-sectional area is  $\pi DT$ .

The total useful gap flux is therefore  $LH \pi DT/G$  (1)

**Leakage Flux.**—The leakage flux is also driven by the magnetomotive force  $LH$ . The total admittance of the leakage paths will be proportional to a factor which depends on the configuration of the magnet, multiplied by the circumference of the pole piece. That is, the total leakage flux may be expressed as  $LHC \pi D$ .

The factor  $C$  will be constant for all capped slug designs. Measurements of a number of different capped slug magnet designs all give a value for  $C$  of 3.5 when  $L$  and  $D$  are measured in cm and  $H$  in gauss.

The total leakage flux is therefore  $3.5 LH \pi D$ . (2)

It should be noted that the value for  $C$  of 3.5 takes into account only the leakage flux in the vicinity of the gap.

The top leakage between the flat end face of the pole piece and the front plate near the gap will be a constant for a given pole diameter and a given magnetomotive force across the gap. It will be the same for all types of magnet construction, i.e., capped slug, skirted pole piece, ring magnet, etc. It will be a little greater where the front plate is chamfered down in thickness at the gap so that the leakage surfaces are at less than  $180^\circ$  to each other. In general, however, the effect of a chamfer may be neglected.

The internal leakage between the cylindrical surface of the pole piece or magnet below the gap and the under side of the front plate will always be greater than the top leakage because the average leakage path is approximately halved as the surfaces are only at  $90^\circ$  to each other. In the case of the capped slug design, however, the leakage falls off rapidly with increasing distance from the gap. This is

\* Fane Acoustics, Ltd.

because not only is the leakage path increasing, but the magnetomotive force operating is decreasing because the flux is coming from a point below the top of the magnet.

In the case of the skirted pole piece construction of Fig. 2, the magnetomotive force driving the internal leakage increases with increasing distance below the gap due to the drop of magnetomotive potential

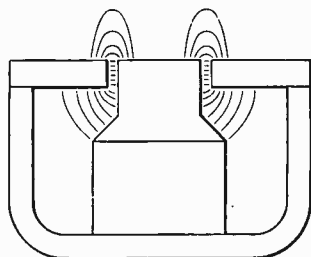


Fig. 2 Skirted pole piece magnet construction showing stray fields.

in the cylindrical portion of the pole piece which is usually working near saturation point. Further, the conical surface of the skirt, which is running nearly parallel to the under side of the front plate, adds considerably to the total leakage. The leakage factor C will thus be considerably greater than 3.5 for this design and will also depend on the ratio of the skirt diameter to the pole diameter and on the length of the nearly parallel portion of the pole piece.

**Magnetic Efficiency.**—The ratio of useful gap flux to leakage flux may be found from equations (1) and (2) as:

$$\frac{LH \pi DT/G}{3.5 LH \pi D}$$

This simplifies to  $T/3.5G$  .. .. . (3)

It is interesting to note that the ratio of gap flux to leakage flux is directly proportional to the depth of the air gap and inversely proportional to its width.

The magnetic efficiency of a loudspeaker magnet system may be defined as the percentage of the total flux supplied by the magnet which passes usefully through the air gap. This may be written as:

$$\frac{\text{Gap flux}}{\text{Gap flux} + \text{Leakage flux}} \times 100\%$$

From equations (1) and (2) this becomes:

$$\frac{LH \pi DT/G}{LH \pi DT/G + 3.5 LH \pi D} \times 100\%$$

This simplifies to

$$\frac{T}{T + 3.5G} \times 100\% \quad \dots \quad (4)$$

**Magnet Diameter.**—The total flux in the magnet

is B times the cross sectional area, i.e.,  $B\pi D^2/4$ . This must equal the sum of the gap flux and leakage flux. Thus, from equations (1) and (2):—

$$B\pi D^2/4 = LH\pi DT/G + 3.5LH\pi D$$

Dividing out by  $\pi D$ , this becomes:—

$$BD/4 = LHT/G + 3.5 LH$$

$$\text{Hence, } D = \frac{4 LHT}{BG} + \frac{14 LH}{B}$$

$$= L \left( \frac{4 HT}{BG} + \frac{14 H}{B} \right) \dots \dots (5)$$

If the volume of the magnet slug is V, then:—

$$V = \pi D^2 L/4$$

Hence  $L = 4V/\pi D^2$

Substituting for L in equation (5) we have:—

$$D = \frac{4V}{\pi D^2} \left( \frac{4 HT}{BG} + \frac{14 H}{B} \right)$$

Multiplying out by  $D^2$  this becomes:—

$$D^3 = \frac{4V}{\pi} \left( \frac{4 HT}{BG} + \frac{14 H}{B} \right) \dots \dots (6)$$

**Air Gap Required to Accommodate the Voice Coil.**—For optimum acoustic response, the voice coil weight must bear a certain relation to the weight of the cone that it drives.

The required impedance of the voice coil is determined by the matching load of the output circuit to which the speaker will be connected. Assuming the impedance to be 10% higher than the d.c. resistance, which it normally is over the middle-frequency range, the required d.c. resistance of the coil may be found.

Knowing the weight and resistance of the voice coil winding, the wire diameter and its total length can be found with the aid of standard wire tables. Let this diameter be  $d$  and the total length of wire be  $w$ .

Then the number of turns in the coil will be  $w/\pi D$  and the total length of the winding, assuming two layers, will be  $w d/2\pi D$ .

This neglects the slight increase of the coil diameter over the magnet diameter.

For maximum sensitivity, particularly where large excursions of the coil are not expected, the voice coil winding may be made equal in length to the depth of the air gap, i.e.,  $T = w d/2\pi D$ .

$$\text{Hence } D = \frac{w d}{2\pi T} \dots \dots \dots (7)$$

In the case of a speaker required to handle considerable power, particularly at low frequencies, the coil should be longer than the gap to reduce harmonic distortion at large amplitudes. In this case T will be less than the coil length by twice the over-hang and equation (7) must be modified accordingly.

**Magnet Dimensions.**—It will be seen from equations (6) and (7) that we have two expressions for

TABLE 1: Magnet Designs For Small Commercial Loudspeakers

Weight of magnet	Diameter of pole and magnet		Depth of gap		Length of magnet		Flux density in gap	Magnetic efficiency
	oz	cm	in	cm	in	cm		
1/2	1.742	0.686	0.445	0.175	0.810	0.319	6,080	62.2
1	2.112	0.832	0.367	0.144	1.102	0.434	8,270	57.6
2	2.565	1.011	0.302	0.119	1.494	0.588	11,220	52.8
4	3.127	1.232	0.248	0.098	2.008	0.791	15,070	47.9

D in terms of T for a given volume of magnet material of known characteristics and a given cone and input impedance.

The gap width G which occurs in equation (6) may be calculated as 2d plus the thickness of the voice coil former plus twice the working clearance between voice coil and pole piece.

B and H for semi-cylindrical Alcomax III may be taken as 10,000 and 580 respectively when the magnet is working at its BH (max.) point. The specific gravity of Alcomax III may be taken as 7.35. The value of V will therefore be its weight in gm divided by 7.35.

By substituting numerical values for V, H, B, G, w, and d in equations (6) and (7), we are left with two simultaneous equations involving D and T which may then be evaluated.

To illustrate the design methods outlined above, a range of designs have been worked out:—

(A) For a small commercial speaker which is to have maximum sensitivity for small power handling and magnet weights of ½ oz to 4 oz.

(B) For a 12-in speaker to handle 20 W at low frequencies and with magnet weights of ½ lb to 1½ lb.

These two series of speakers have been chosen as being near the extremes likely to be met in practice.

**Design of Small Commercial Speakers: Voice Coil.**—It has become standard for this type of loudspeaker to have an input impedance of 3Ω. The d.c. resistance of the voice coil may therefore be taken as 2.7Ω.

Experience has shown that the average 5 in, 6 in × 4 in, or 7 in × 4 in cone requires a voice coil weight of about ½ gm to provide a good tonal balance.

From the standard wire tables we find that the wire gauge which most nearly meets this is 38 s.w.g. which has 2570Ω per lb; since 2.7Ω will weigh  $2.7 \times 454/2570 = 0.48$  gm.

Now, 38 s.w.g. copper wire has 864Ω per 1000 yd. The length for 2.7Ω is therefore  $2.7 \times 1000 \times 91.4/864 = 286$  cm = w.

The overall diameter of 38 s.w.g. wire, enamelled, is 0.0067 in = 0.01703 cm = d.

Substituting for w and d in equation (7), we have:—

$$D = \frac{286 \times 0.01703}{2\pi T} = \frac{0.775}{T} \quad \dots \quad (8)$$

**Magnet.**—The values for B and H for semi-cylindrical Alcomax III are 10,000 and 580 respectively.

The voice coil wire diameter, d, is 0.0067 in. If we assume a thickness for the former of 0.003 in and gap clearances of 0.007 in, we arrive at a gap width G of  $2 \times 0.0067 + 0.003 + 2 \times 0.007$  in = 0.0304 in = 0.0772 cm.

Substituting these values of B, H, and G in equation (6), we have:—

$$D^3 = 1.273 V \left( \frac{4 \times 580 T}{10,000 \times 0.0772} + \frac{14 \times 580}{10,000} \right) \\ = V (3.83 T + 1.034) \quad \dots \quad (9)$$

Now, the specific gravity of Alcomax III is 7.35 and 1oz is equal to 28.4gm. Then, if W is the weight of the magnet slug in oz:—

$$V = W \times 28.4/7.35 = 3.86 W$$

Substituting this value of V in equation (9), we have:—

$$D^3 = 3.86W (3.83 T + 1.034) \quad \dots \quad (10)$$

From equation (8) we have  $T = 0.775/D$ . Substitut-

ing this value of T in equation (10), we have:—

$$D^3 = 3.86W (2.97/D + 1.034)$$

Multiplying both sides by D and simplifying, this becomes:—

$$D^4 - 3.99 WD = 11.44 W \quad \dots \quad (11)$$

We may now insert any required value for W in equation (11) and solve for D by trial and error.

When D is known, the values of T, L, the gap flux density and the magnetic efficiency may be found from the various equations given previously.

These operations have been carried out for magnet weights of ½, 1, 2, and 4 oz and the results are given in Table 1. The dimensions are given in the table in inches as well as in centimetres.

It should be noted that in these calculations no allowance has been made for the magnetomotive force required to drive the flux through the iron circuit between the bottom of the magnet and the air gap. This may be allowed for by adopting a value for H some 5 or 10% less than that given by the magnet manufacturers.

In this country, there are no standard sizes for loudspeaker magnets and one weight of slug may be purchased as easily as another. It will therefore probably be preferred to make the pole diameter a standard size of steel rod for ease of production, rather than to have the magnet an exact number of ounces. For this reason curves are given in Fig. 3 showing pole diameter, gap depth, magnet length and gap flux density in terms of magnet weight. From these curves, for instance, it will be seen that a 1-in pole may be used with a 1.95 oz magnet to give a flux density of 11,100 gauss in a gap of 0.120-in depth.

The suggestion of using a 1-in. pole or larger for a small commercial speaker may seem strange at first. Provided a non-perforated dome is used for an internal dust cover, however, there will be no acoustic disadvantage. In fact, there is an improvement in response to be obtained by partially filling the apex of the cone. The gain in sensitivity and

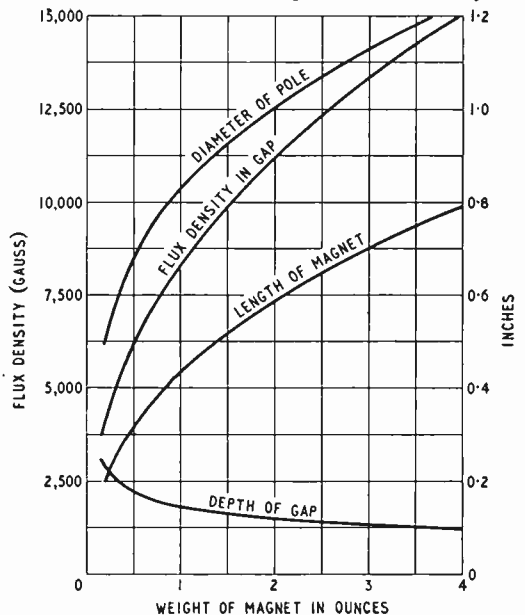


Fig. 3 Magnet designs for small commercial loudspeakers showing diameter of pole, flux density in gap, length of magnet, and depth of gap in terms of weight of magnet.

TABLE 2: Magnet Designs for 12-in Low-frequency Loudspeakers

Weight of magnet	Diameter of pole and magnet		Depth of gap		Length of magnet		Flux density in gap	Magnetic efficiency
	oz	cm	in	cm	in	cm	in	gauss
8	4.663	1.837	0.872	0.343	1.786	0.703	9,050	68.5
16	5.500	2.165	0.644	0.253	2.598	1.023	13,180	61.7
32	6.478	2.505	0.452	0.178	3.748	1.477	19,000	53.0

reduction in overall depth of the speaker as compared with a skirted pole or ring magnet design for magnet weights of 2 or 3 oz is considerable.

**Design of 12-in Low-frequency Speakers:**

**Voice Coil.**—For speakers for public address or high-fidelity reproduction it has become standard to use an input impedance of 15Ω. For a speaker to be used as the bass unit of a multi-speaker combination the most important region is that part of the range below 100c/s because, since the cone diameter is much smaller than the sound wavelength in air at the lowest frequencies, everything possible must be done to off-set the drop in radiation efficiency.

Below 100c/s the impedance will depend on the method of loading and will be considerably more than the d.c. resistance, so that the best compromise is to make the voice coil 8 to 10Ω rather than 15Ω less 10%. For this design we shall take 9Ω.

Again, in order to obtain the best performance below 100c/s, it is best to use a voice-coil weight heavier in proportion to the cone than for a small general purpose speaker. For a 12-in. bass speaker the best coil weight is 6 to 7 gm.

From the wire tables we find the nearest gauge is 35 s.w.g. of which 9Ω has a weight of 6.1gm. This gauge has also 441Ω per 1,000 yd. The length for 9Ω is thus  $1000 \times 91.4 \times 9/441 = 1840 \text{ cm} = w$ . The overall diameter of 35 s.w.g. enamelled wire is  $0.0094 \text{ in} = 0.0239 \text{ cm} = d$ .

A speaker to have a good low-frequency perfor-

mance must be capable of considerable voice-coil excursion without undue distortion due to the coil moving out of the gap. This is achieved by making the coil longer than the gap depth. For a 12-in. speaker to be used primarily as a bass unit it is desirable for the coil to extend some 1/4 in. above and below the gap. Thus the coil will not commence to leave the gap until the amplitude of movement exceeds 1/4 in.

The gap depth may therefore be taken as 1/4 in or 0.625 cm less than the coil length. Thus

$$T = wd/2\pi D - 0.625.$$

Whence  $D = \frac{wd}{2\pi(T+0.625)}$  ..... (12)

Substituting for  $w$  and  $d$  in equation (12), we have:—

$$D = \frac{1840 \times 0.0239}{2\pi(T+0.625)} = \frac{6.98}{T+0.625}$$
 ..... (13)

**Magnet.**—The voice coil wire diameter,  $d$ , = 0.0094in. If we assume a thickness for the former of 0.0045in and gap clearances of 0.011in, we arrive at a gap width,  $G$ , of  $2 \times 0.0094 + 0.0045 + 2 \times 0.011 \text{ in} = 0.045 \text{ in} = 0.1143 \text{ cm}$ .

Substituting for  $B$ ,  $H$ , and  $G$  in equation (6) we have:—

$$D^3 = 1.273 V \left( \frac{4 \times 580 T}{10,000 \times 0.1143} + \frac{14 \times 580}{10,000} \right) = V (2.58 T + 1.034)$$

Substituting 3.86 W for V we have:—

$$D^3 = 3.86 W (2.58 T + 1.034)$$
 ..... (14)

From equation (13),  $T = 6.98/D - 0.625$

Substituting this value of  $T$  in equation (14) we have:—

$$D^3 = 3.86 W (2.58 [6.98/D - 0.625] + 1.034) = 69.6 W/D - 2.24 W$$

Thus  $D^4 = 69.6 W - 2.24 WD$

$$\text{Or, } D^4 + 2.24 WD = 69.6 W$$

We may now insert various values for  $W$  and solve for  $D$ . This has been done for magnet weights of 1/2 lb, 1 lb, and 2 lb and the various details of the design worked out. The figures are given in Table 2.

As for the previous examples, the results are presented graphically in Fig. 4.

In considering these designs, it must be remembered that one requirement was that the voice coil must extend for 1/4 in above and below the gap. A result of this is that, as the pole diameter increases with increasing magnet weight, a smaller proportion of the coil is within the gap. For magnet weights above 1 1/2 lb therefore, it is considered that it would be better to increase the wire gauge and thus the length of wire for 9Ω.

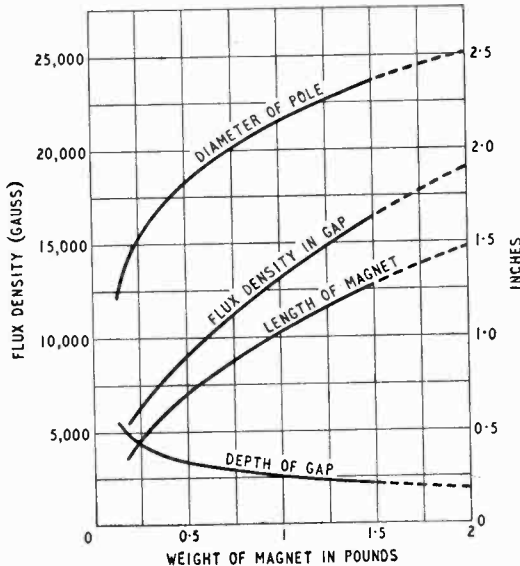


Fig.4 Magnet designs for 12-in low-frequency loudspeakers showing diameter of pole, flux density in gap, length of magnet, and depth of gap in terms of weight of magnet.

# Elements of Electronic Circuits

## 9.—TRIGGERED TWO-STATE CIRCUITS

By J. M. PETERS, B.Sc. (Eng.), A.M.I.E.E., A.M.Brit.I.R.E.

**T**HE freely running multivibrator, as described last month, can be locked on to an applied wave of fixed repetition frequency as shown in Fig. 1. Conditions for an asymmetrical multivibrator are illustrated here. The frequency of oscillation will

This will mean that the multivibrator frequency is then  $\frac{1}{n}$ -th of the input frequency. For example, an

input with a repetition frequency of 500 pulses per second can cause the multivibrator to oscillate at 125 pulses per second by arranging for it to be triggered by every 4th pulse; this is shown in Fig. 2. Frequency division therefore takes place, and it is possible to make  $n=10$  or more by careful choice of component values. It will be noted that the amplitude of the sync pulse will to a large extent govern the frequency of oscillation of the multivibrator.

In the example shown, only the duration of the positive portion of the anode voltage waveform is affected by the triggering action. If the duration of both positive and negative portions of the waveform are to be controlled, it will be necessary for both valves to be triggered. A convenient method is by applying negative trigger pulses between the common cathode and earth.

On account of the possibility of the multivibrator grid voltage changes reacting back on the source of sync voltage, it is often necessary to isolate the oscillator from the source by means of a buffer amplifier stage, as shown in Fig. 3. Sync amplitude can be controlled at the amplifier grid as indicated.

Fig. 4 shows a development of the basic multivibrator in which two pentodes,  $V_1$  and  $V_2$ , are used instead of triodes, and a further refinement is the incorporation of a diode clamp  $V_3$ .

From Fig. 5 we will assume that  $V_1$  is conducting and  $V_2$  is cut off. A negative sync pulse applied to the control grid of  $V_1$  becomes an amplified positive pulse on the control grid of  $V_2$ , and  $V_2$  conducts. This results in a fall in voltage on  $V_2$  screen grid, which is transferred to the suppressor of  $V_1$  by  $C_2$ . As  $C_2$  discharges through  $R_3$  and  $V_2$ , the  $g_3$  of  $V_1$  rises through the suppressor cut-off

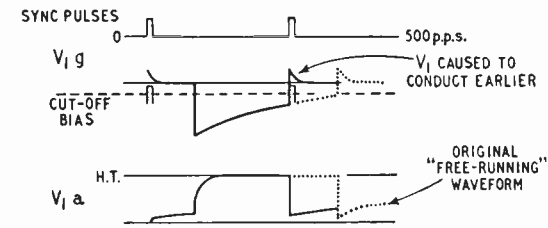


Fig. 1.

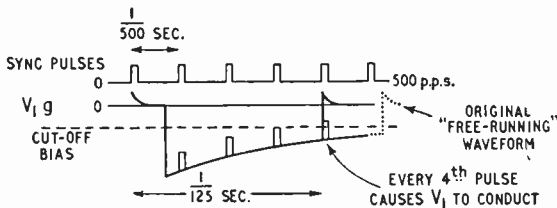


Fig. 2.

increase until it becomes a multiple or a sub-multiple of the frequency of the injected signal.

Positive-going synchronizing pulses are applied to the grid of one valve of the circuit—say  $V_1$  in Fig. 1 of last month. Let us assume that the repetition frequency of these pulses is greater than that of the freely running multivibrator and let us consider a single pulse. It will be seen that when the pulse arrives at the grid of  $V_1$  the potential of the grid, discharging to zero with time constant  $C_2R_3$ , has not quite reached the valve cut-off voltage. The application of the positive pulse carries it over this level, so accelerating the transition of  $V_1$  to its conducting state. In effect it causes  $V_1$  to conduct before it would have done under normal  $C_2R_3$  discharging conditions (shown by the dotted line in Fig. 1). As each positive input pulse causes this to happen, the multivibrator becomes synchronized to the input wave.

Instead of making every synchronizing pulse trigger the multivibrator, it is possible to arrange for the circuit to be triggered by each  $n^{\text{th}}$  pulse.

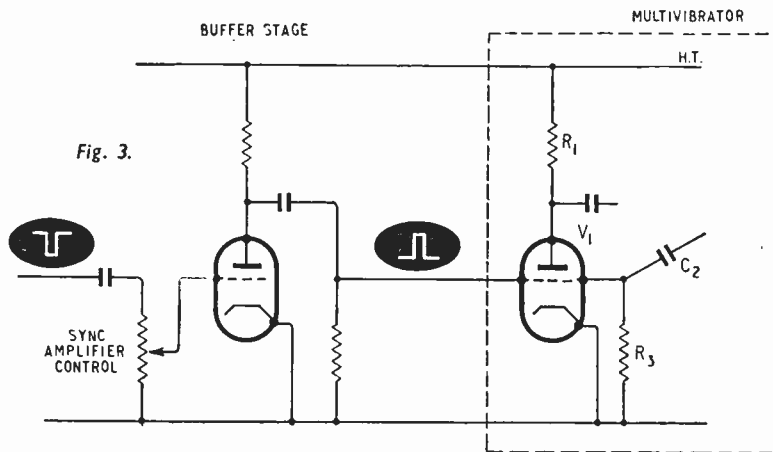


Fig. 3.

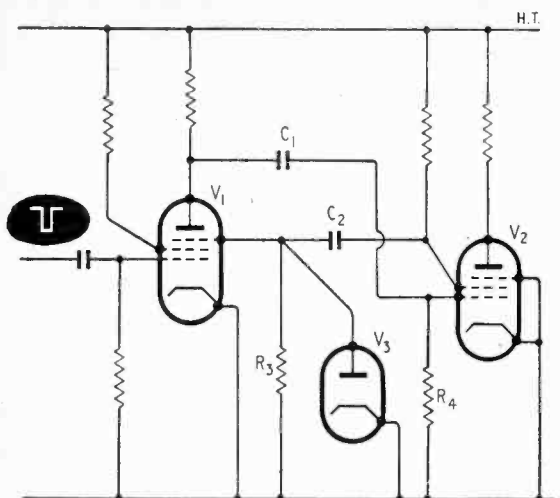


Fig. 4.

voltage, causing anode current in  $V_1$  to flow again and the anode volts of  $V_1$  to fall. This fall in voltage is transferred to  $V_2$  control grid by  $C_1$ , causing  $V_2$  to be cut off. As  $C_1$  discharges through  $R_4$  the voltage on  $V_2$  control grid rises through cut-off,  $V_2$  conducts again and the cycle continues on similar lines, as has been described previously.

It is important to note the advantages gained by making the circuit connection in this manner:—

First, since  $V_1$  control grid is isolated from the

operation of the circuit there is no need for a buffer amplifier, i.e. the sync input is decoupled from the oscillator. Secondly,  $V_2$  anode is unaffected by the charging of  $C_2$  as is the case in the simple multi-vibrator. A squarer output waveform therefore

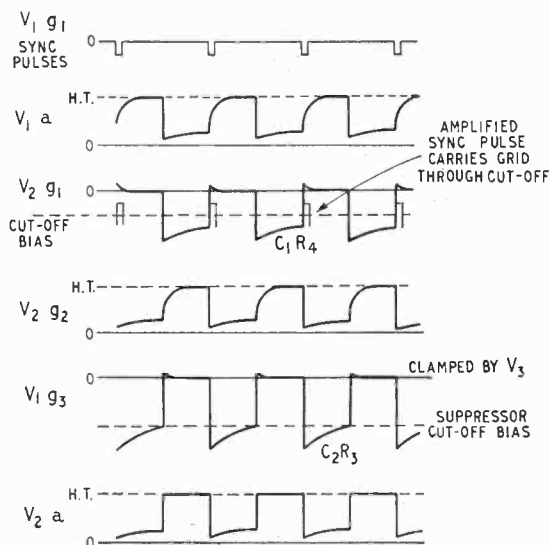


Fig. 5.

results. A further improvement is the incorporation of diode  $V_3$ , the function of which is to clamp the voltage on  $V_1$  suppressor to zero.

## Speedier Component Assembly

SHOWN in the illustration is one of the new rotary dispensing machines for small components, known as the Rotassembler. It consists of 19 vertical hoppers, each divided longitudinally to provide two compartments each 3in wide and 1½in deep. The front one is 20in and the rear one 24in high, the difference being accounted for by the adjacent positions of the two feed lips, as shown



One of several Rotassembler component dispensing machines in use in the Regentone factory at Romford, Essex.

in the illustration. Up to 38 different parts can be accommodated in one machine, and about 2,000 small components in each of the 38 hoppers.

The Rotassembler is rotated by compressed air being operated by a foot-controlled valve. As the hopper next in sequence always stops in exactly the same place as the previous one operator time and fatigue in identifying and selecting the next part for assembly is reduced, and it is claimed that the assembly work is considerably speeded up with assembly errors reduced to a minimum.

The machine, which costs £87 10s, is made by Work Study Equipments, 4, Montalt Road, Woodford Green, Essex, from whom further details can be obtained.

## Printed Wiring Practice

IN order to make known as widely as possible the current practice in designing and producing printed circuits the Electronic Engineering Association has issued a report covering design considerations, general standards (materials, conductor sizes, etc.), production practices and special components. The object of this document is —“(a) To promote the adoption of such design and production practices as have proved to date to be justified as a result of common experience. (b) To make a contribution to any national standards that may be prepared on the subjects covered. Such national standards are considered urgently desirable in order to co-ordinate the numerous documents already in preparation by various sectional interests.” Copies may be obtained from the Secretary, E.E.A., 11 Green Street, London, W.1.



## CONFERENCES AND EXHIBITIONS

Latest information on forthcoming events both in the U.K. and abroad is given below. Further details are obtainable from the addresses in parenthesis.

### UNITED KINGDOM

- Physical Society Exhibition**, Royal Horticultural Society's Halls, Victoria London, S.W.1 ..... Jan. 18-22  
(Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.)
- Managerial and Engineering Aspects of Reliability and Maintenance of Digital Computer Systems (Conference)**, I.E.E., Savoy Place, London, W.C.2. .... Jan. 20-21  
(British Conference on Automation and Computation, c/o I.E.E.)
- Engineering Materials and Design Exhibition and Conference**, Earls Court, London, S.W.5. .... Feb. 22-26  
(Industrial & Trade Fairs Ltd., Drury House, Russell Street, London, W.C.2.)
- Electrical Engineers Exhibition**, Earls Court, London, S.W.5 ..... April 5-9  
(A.S.E.E. Exhibition, Museum House, Museum Street, London, W.C.1.)
- Solid State Microwave Amplifiers (Conference)**, University of Nottingham (Institute of Physics, 47 Belgrave Square, London, S.W.1.) ..... April 6-8
- Audio Fair**, Hotel Russell, Russell Square, London, W.C.1. .... April 21-24  
(Audio Fairs Ltd., 22, Orchard Street, London, W.1.)
- Production Exhibition and Conference**, Olympia, London, W.14 .. April 25-30  
(The Production Exhibition, 11 Manchester Square, London, W.1.)
- Mechanical Handling Exhibition**, Earls Court, London, S.W.5 ..... May 3-13  
(Mechanical Handling, Dorset House, Stamford Street, London, S.E.1.)
- Instruments, Electronics and Automation Exhibition**, Olympia, London, W.14. .... May 23-28  
(Industrial Exhibitions Ltd., 9 Argyll Street, London, W.1.)
- Medical Electronics Conference and Exhibition**, Olympia, London, W.14. .... July 21-27  
(I.E.E., Savoy Place, London, W.C.2.)
- National Radio and Television Show**, Earls Court, London, S.W.5. .... Aug. 24-Sept. 3  
(Radio Industry Exhibitions Ltd., 49 Russell Square, London, W.C.1.)
- Farnborough Air Show** ..... Sept. 5-12  
(Society of British Aircraft Constructors, 29 King Street, London, S.W.1.)
- Industrial Photographic and Television Exhibition**, Earls Court, London, S.W.5. .... Nov. 21-25  
(Industrial and Trade Fairs Ltd., Drury House, Russell Street, London, W.C.2.)
- Radio Hobbies Exhibition**, R.H.S. Old Hall Victoria, London, S.W.1. .... Nov. 23-26  
(P. A. Thorogood, 35 Gibbs Green, Edgware, Middx.)

### OVERSEAS

- Reliability and Quality Control in Electronics (Symposium)**, Washington, D.C. .... Jan. 11-13  
(R. Brewer, G.E.C. Research Laboratories, Wembley, Middx.)
- Instrument-Automation Conference and Exhibition**, Houston, Feb. 2-4  
(Instrument Society of America, 313, Sixth Avenue, Pittsburgh 22, Pa., U.S.A.)
- Solid-State Circuits Conference**, Philadelphia ..... Feb. 10-12  
(Tudor R. Finch, Bell Telephone Laboratories, Murray Hill, N.J., U.S.A.)
- French Components Show (Salon International de la Pièce Détachée Electronique)**, Paris ..... Feb. 19-23  
(Fédération Nationale des Industries Electroniques, 23 rue de Lubeck, Paris 16<sup>e</sup>.)
- Non-Destructive Testing (Conference)**, Tokyo ..... Mar. 15-21  
(Secretary, British National Committee for Non-Destructive Testing, c/o the Institution of Mechanical Engineers, 1 Birdcage Walk, London, S.W.1.)
- I.R.E. National Convention**, New York ..... Mar. 21-24  
(E. K. Gannett, I.R.E., 1 East 79th Street, N.Y.21.)
- German Industries Fair**, Hanover ..... April 24-May 3  
(Schenkers Ltd., 13, Finsbury Square, London, E.C.3.)
- Instrument-Automation Conference and Exhibition**, San Francisco May 10-12  
(Instrument Society of America, 313, Sixth Avenue, Pittsburgh 22, Pa., U.S.A.)
- International Congress on Microwave Tubes**, Munich ..... June 7-11  
(Prof. Dr. W. Kleen, Balanstrasse 73, Munich 8.)
- British Exhibition**, New York ..... June 10-26  
(British Overseas Fairs Ltd., 21 Tothill Street, London, S.W.1.)
- Nuclear and Electronic Congress and Exhibition**, Rome ..... June 15-29  
(Fairs and Exhibitions Ltd., 2, Dunraven Street, London W.1.)
- Automatic Control Congress**, Moscow ..... June 27-July 6  
(British Conference on Automation and Computation, c/o I.E.E., Savoy Place, London, W.C.2.)
- Physics of Semiconductors (Conference)**, Prague ..... Aug. 29-Sept. 2  
(International Union of Pure and Applied Physics, 3 Boulevard Pasteur, Paris 15)
- Instrument-Automation Conference and Exhibition**, New York Sept. 26-30  
(Instrument Society of America, 313, Sixth Avenue, Pittsburgh 22, Pa., U.S.A.)
- Firato-International Radio Show**, Amsterdam ..... September  
(Firato Secretariat, Emmalaan 20, Amsterdam, Z.)
- General and Applied Phonetics Congress**, Hamburg ..... September  
(Dr. H.-H. Wängler, Alsterlaci 3, Hamburg 36, Germany.)
- Interkama-International Congress and Exhibition for Measuring Techniques and Automation**, Dusseldorf ..... Oct. 19-26  
(Nordwestdeutsche Ausstellungen-Gesellschaft m.b.H., Ehrenhof 4, Dusseldorf)

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# RANDOM RADIATIONS

By "DIALLIST"

## The Tenth Million

BY this time the total of British television receiving licences must have reached the ten million mark. The latest figures available at the time of writing were those for the end of October. There were then 9,844,365 licensed TV receivers and there's always a big increase at the end of the year. And to help things on new transmitters and small local boosters have been coming into action. An astonishing business—isn't it?—that progress should have been so rapid since the restart of television in 1946. Ten years ago there were only half a million sets. It's bound to continue and one wonders what the saturation point will be. I'd put it at well over fifteen million, for that's the present number of homes with either sound or television sets in them. As TV coverage increases and improves many—maybe most—of the homes that are now equipped for sound only are bound to go in for television. New homes, too, are being built apace in TV service areas and it looks as if television manufacturers will be kept busy for a long time to come both in supplying the needs of new viewers and in providing sets to replace old ones.

## International Standardization

SOMETHING very badly needed, particularly now that the import restrictions on various kinds of electrical gear have been relaxed, is the adoption of an international colour code for three-wire flex mains leads. A dealer to whom I was talking not long ago told me that he'd seen appliances of foreign origin with mains leads with green covered phase wires! As green is now the colour for the earth lead here, this could have unfortunate consequences should a serviceman not look before he leaps and test carefully before wiring up a 3-pin plug. Another bit of international, or at any rate N.A.T.O., standardization I'd like to see is in the screws, bolts and nuts used in things electrical. During the war the fact that American sizes and threads weren't the same as ours cost this country a pretty penny. You couldn't get American replace-

ments for any which were lost or suffered from stripped threads. The quickest method of replacement we found in radar was to re-drill and re-tap screw holes so that they'd take our own sizes. The loss of a nut usually meant replacing a bolt. Now that the world is growing more and more metric in outlook, the answer might be for everyone gradually to adopt metric sizes and threads.

## Do You Crane?

SHOULD people whose sight is normal or who wear correct glasses find it tiring to the eyes to watch television? That's a question often asked and to me the answer seems to be something like this: No, provided your set is properly adjusted, that the signal is good, that you sit at the proper viewing distance, that you don't switch off the room lighting and that you don't keep your eyes glued to the screen for hours on end. This summarizes the seven simple rules laid down by the Association of Optical Practitioners to avoid eyestrain when viewing. Neglect all or any of these provisions and you needn't be surprised if in time you find watching TV a trying business. Our 405-line system probably gives the best balance between horizontal and vertical

definition that can be obtained on the 5-Mc/s channels now used in this country; but it has one drawback which, to my mind, is a serious one. That is that to avoid liness you must sit quite a way from the screen. As I've mentioned before, a useful rule of thumb is: minimum viewing distance (feet) = half the screen diameter or diagonal (inches). Now, at 8½-feet from a 17-in screen, or 10½-feet from one of 21in it's difficult to feel that you aren't missing something. That's why people watching TV have a tendency to crane forward, thus reducing the effective viewing distance and so increasing the effects of liness.

## Let's Have The Best

That's the reason why I've always been so keen that when u.h.f. channels are assigned to TV we should use them for transmissions of much higher definition. Eugène Aisberg, editor of *Toute la Radio*, after seeing television here, in the U.S.A. and in other Continental countries than his own, wrote that he was indeed thankful that he lived in France with its 819-line system. Any readers who have had the chance of comparing French television pictures with ours will, I am sure, bear me out when I say that they are enormously better than our



## "WIRELESS WORLD" PUBLICATIONS

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own. You can view them, for instance, at a much smaller distance, without being conscious of the lines. I don't just want our new system to be as good as the French; I want it to be better still. We'll soon have the chance to make our u.h.f. television the best in the world and it's a chance that may not come again.

### Bewitched?

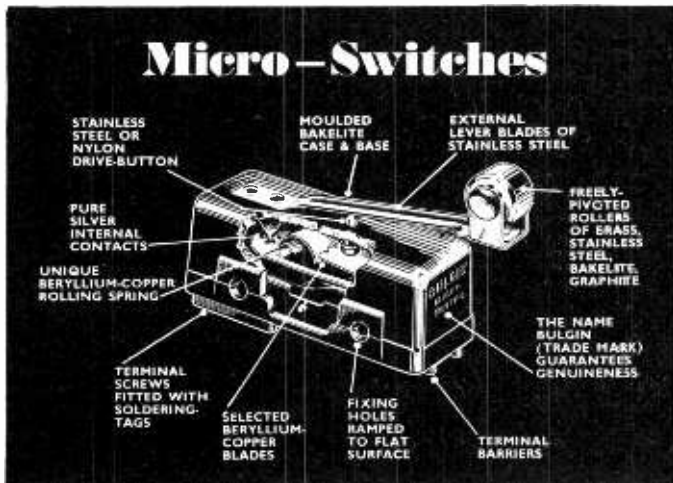
HAVE you ever come across a receiver of first-rate make which seemed to have a hoodoo on it? They're rare, as you'd expect them to be; but just once in a blue moon one of these turns up which seems to be bewitched. A friend was so delighted with the appearance and the performance of a particular set which he'd seen and heard in another house and so impressed by the enthusiastic reports that other owners gave of its utter freedom from trouble of any kind that he promptly ordered one for himself. It came; it was installed; all went well on the first evening; but on the second it just faded into silence. His dealer, who employs first-class servicemen, had it attended to at once. But hardly was the man out of the house when a valve went phut and all was silence again. And so it went on week after week—a day or perhaps two days of perfect listening, and then something always went wrong. At length, he wrote to the makers, adding that he knew from experience how good their sets of that type were—with the unhappy exception of his own. At once, they sent down one of their engineers who having seen this particular set's record in the dealer's files, fitted a new chassis free of charge. The set has been in regular use for nearly a year now and there's been not the slightest sign of any trouble. Queer, isn't it?

### Good Work

IT'S good news that C.R.T., Ltd., of Baldock, who specialize in rebuilding c.r. tubes, are now giving an eighteen month's guarantee on all their products. To my way of thinking every bit and piece in sound and television sets should be covered in the same way. I'm glad to see that Siemens Edison Swan have made a move in the right direction, by giving a twelve month's guarantee on their transistors used in any proprietary set of which it is a standardized part. By the time this note appears other makers may have followed suit. There should, after all, be nothing to go wrong in a properly sealed transistor provided that it isn't badly overloaded.



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## Pedagogic Pedantries

IN his interesting article entitled "Words, Words, Words" in the November issue, P. P. Eckersley, as one of the old guard of the B.B.C., naturally tries to continue the almost hopeless task of educating us, which the B.B.C. started nearly forty years ago when it tried to get us to use the pedantically pedagogic plural violincelli.

I do, however, heartily endorse most of what P. P. Eckersley says but I was a bit surprised that a writer, who rightly chides those who speak of "spectrums" when they mean "spectra," should have used the barbaric adjective "ionic" when he ought to have tried to lead us to better things. The pedantically correct word is, of course, "iontic" as we were all reminded by D. J. Bataimis, of Athens, in a letter published in *Wireless World* of Septem-



"I was a bit surprised"

ber, 1954. We must, at least, credit Mr. Bataimis with knowing his own language.

It is true that the word "ionic" has an ancient history dating back as it does to the issue of *Nature* for October 9th, 1890, but so also has the word "ain't." But antiquity doesn't make ain't correct unless used with its proper meaning of "am not" as Queen Victoria used it. Similarly the word "ionic" has its proper usage in a phrase like "ionic capitals" such as are to be found on the supporting columns of certain public buildings of classical architecture.

As for the Ionians being wanderers, this may well have been so but they took their name from the Greek god Ion from whom they are said to be descended; incidentally, many scholars have tried to identify Ion with Noah's grandson Javan whose sons certainly did a bit of colonizing after the flood (Gen. X 4, 5).

Of course, the real culprit in this "ionic" business is Faraday, who in 1839 coined the word "ion" in connection with electrolysis and made its plural "ions" instead of "ionta." I have a sneaking sympathy with him but regret that he spoke of "cations" and not "cathions." In any case, it would be a pedagogic pedantry to try to do anything about it now, and so we shall have to put up with it; it ain't possible to do otherwise.

## Hypnagogic Hum

IN pre-war years I frequently used to chide the B.B.C. for the dull and feeble programmes it put out, especially on Sunday afternoons. They usually resulted in sending me into a profound sleep. Some of the B.B.C. programmes were particularly feeble, and I recollect one occasion when I happened to be chatting with a water diviner. We were standing rather near to my loudspeaker when suddenly his dowsing rod flew into the air owing to the programme being even more wet than usual.

But I was very puzzled when sometimes I found my head nodding even in the middle of a bright and breezy programme. The mystery is explained now. I recollect that the receiver I was using then had a low-pitched hum which seemed incurable no matter how many times I juggled with the smoothing circuits of the power pack and, I learn now, it was this hum which was causing me to fall asleep, and not the B.B.C. programmes. It appears that this mains hum is so strongly hypnagogic that it is now being used therapeutically in the U.S.A. to produce sleep in restless patients.

## Walkie-Tapie

IT seems astonishing that none of the participants in the new long-distance marching craze has, at the moment of writing, carried a portable radio set to relieve the boredom. It is true there are no B.B.C. programmes on the air during the night when walkers would be in most need of musical good cheer. There are, of course, plenty of programmes to be picked up on short waves in the night, but I suppose what is really needed is a lightweight battery-driven walkie-tapie loaded with some of Sousa's famous marches. I have a good mind to try out the idea myself with the walkie-tapie strapped to my chest rather than on my back in order to facilitate reel changing.

## Peak for Pain

WAY back in 1890 when the electric chair was first installed in Sing Sing there were two rival companies supplying electric power to New York according to a book written by a retired warder of the famous prison. Naturally a.c. was chosen for the chair as it was an easy matter to step up the e.m.f. to provide the necessary 2,000 volts.

This fact was immediately seized upon by the d.c. supply company who pointed out to potential users of electricity that the very fact that a.c. was chosen for the chair proved the product of the rival company to be highly dangerous and unsuitable for domestic use. This ingenious bit of propaganda had a very profound effect on electricity users of that time, and I sometimes wonder if it doesn't do so to a small extent even today.

The reason I say this is because recently when I was going over a house with a friend who was its potential purchaser I said I hoped for his sake that the electricity supply was a.c., otherwise a lot of appliances like synchronous clocks and fan heaters would be denied him. To my surprise he immediately switched on a light, removed the bulb and stuck his thumb in the socket. With scarcely a moment's pause he announced triumphantly that it was a.c. When I asked how he knew, he at once replied cryptically "Peak for Pain", and went on to explain that with a.c. the shock was considerably greater, as one received the benefit of the peak voltage.

## Dr. Crippen

THIS issue of *Wireless World* ushers in the year 1960 and this reminds me of the unique event of 50 years ago which first put wireless on the map in the eyes of the general public. I refer, of course, to the arrest in July, 1910, of Dr. Crippen as a result of a radio message sent by Captain Kendall of s.s. *Montrose* saying he believed the doctor was on board in the guise of a Mr. Robinson. As a result of the message Inspector Dew sailed in late July on the *Laurentic* which overtook the *Montrose* in mid-Atlantic.

I have always thought we radio people have been rather remiss in not putting up a monument to Dr. Crippen to acknowledge his undoubted great service in publicizing radio.

Those who would acclaim Jack Binns, wireless operator of s.s. *Republic*, as the one who first demonstrated the value of wireless when his vessel was in collision with s.s. *Florida* in January, 1909, must remember that his name is unknown today whereas everybody has heard of Dr. Crippen.

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$V_{cb}$ max. (av or d.c.) (V)	-25	-25	-60
$i_c$ (pk) max. (mA)	50	50	50
$I_c$ max. (mA)	50	50	50
$\alpha'$ (or $\beta$ ) spread	15 to 60	20 to 80	10 to 60
$V_{ce}$ ( $I_c = 7$ mA, $I_b = 1$ mA) (mV)	-130	-100	-130
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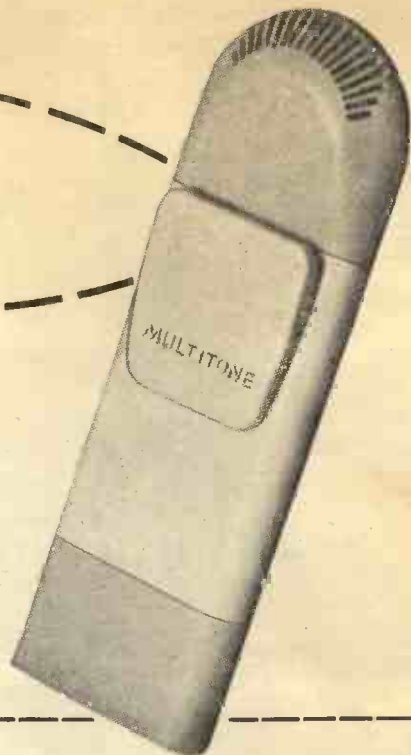
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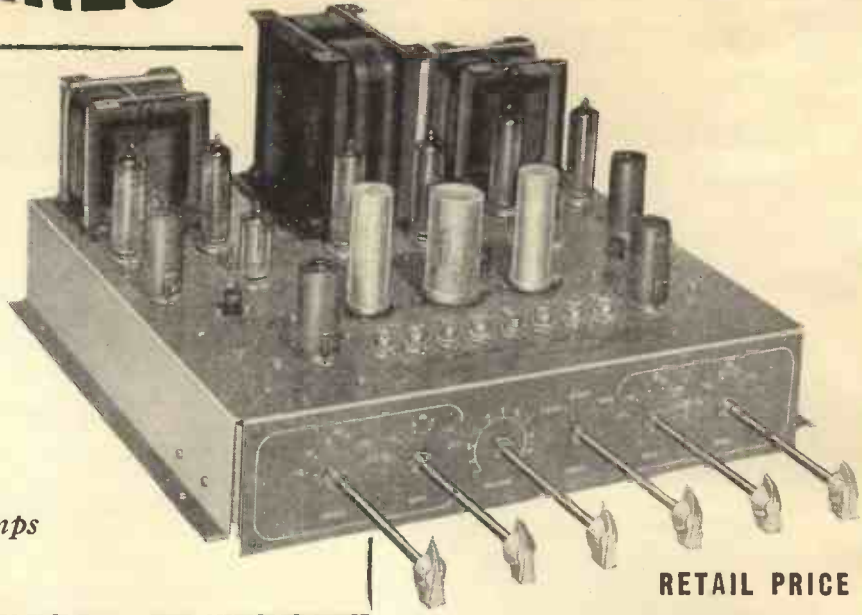
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Please send me the book or books I have selected, without obligation to purchase. I will either return the book or books in 8 days or send the deposit 8 days after delivery, then the monthly subscriptions as set out above, until the total subscription price of the book or books I have selected has been paid.

Mr., Mrs., Miss.....

Address.....

Occupation.....

Your Signature.....

(Or Parent signs if you are under 21)

Tick (✓) where applicable

HouseOWNER	<input type="checkbox"/>
Householder	<input type="checkbox"/>
Living with Parents	<input type="checkbox"/>
Lodging Address	<input type="checkbox"/>

R64/RV90

(A) FOLD ALONG HERE

### HOW TO FOLD

1. Complete the form above.
2. Detach complete page and fold across at (A), turning top half downwards out of sight.
3. Next, fold at (B) and (C) and tuck (C) into (B) so that Reply-paid portion with NEWNES' address is shown.

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BUSINESS REPLY FOLDER  
Licence No. W.C. 1129

GEORGE NEWNES LIMITED,  
15-17 LONG ACRE,  
LONDON, W.C.99

(B) FOLD ALONG HERE

(C) FOLD ALONG HERE

Postage will be paid by George Newnes Ltd.

**PAYS FOR ITSELF OVER AND OVER AGAIN!**

"More than repaid the cost in a short period." Says E. J. S. (Wolvercote).

"One glance only was enough to convince me of its worth," writes J. F. B. (Leicester).

"Of immense help and in constant use."—T. A. (Uxbridge).

"A boon and a must"—J. S. (Manchester)

"Never at a loss now no matter which set I have to deal with."—S B. D. (Croydon).

**IT WILL PAY YOU TO EXAMINE THIS SET NOW**

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# CELESTION

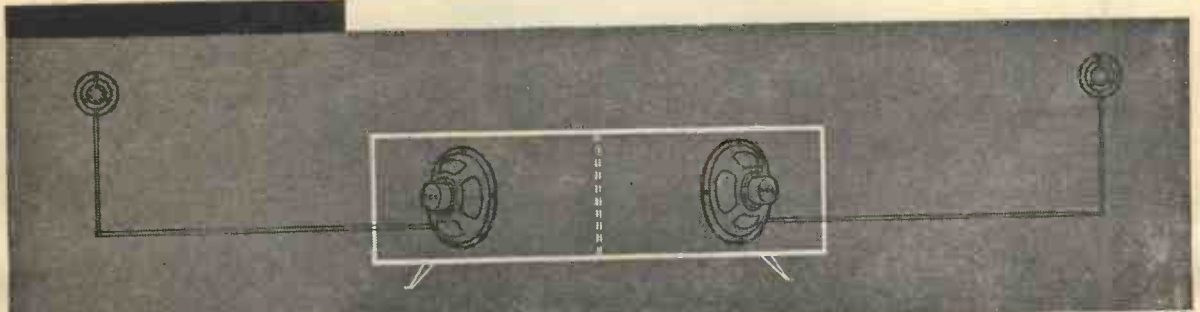
MODEL G44/1300

# FULL WIDTH STEREOPHONIC

## LOUDSPEAKER SYSTEM

The complete answer to the demand for a reasonably priced high quality speaker system for the reproduction of stereophonic recordings in the home.

Utilising two very small pressure type direct radiator units for the higher frequencies and two 12in. reproducers for the lower, the equipment covers a response which is substantially level from 35-15,000 c/s. with true stereophonic effect.



The price for two HF.1300 and two G.44 units, complete with enclosure details is:—

**£18:10:0**

### HIGH-NOTE PRESSURE TYPE UNITS

Designed and developed in CELESTION Laboratories this class of unit has been manufactured for special purposes over the past five years. A new unit, Model HF.1300, has been introduced for the new stereophonic system and its smooth response and wide dispersion ensure an exceptionally high standard of reproduction of the higher frequencies.

### LOW-NOTE REPRODUCER G—44

This new 12in. Loudspeaker has been designed specially to work in conjunction with the HF.1300. A skilfully balanced voice coil and cone assembly with correct cone edge termination result in a level and clean low frequency response.

### COMPLETE SYSTEM

The system uses only one enclosure, 15in. high x 42in. wide x 18in. deep, having a central dividing partition with one G.44 unit mounted at each end. The enclosure should then be positioned near the centre and against one wall so that the speakers are facing outwards and are about 2ft. 6in. from the floor.

The two HF.1300 units should then be placed near the corners of the room, one on each side of the enclosure and approximately 4 feet above the floor. The width of sound will very nearly correspond to the distance between these two units. No elaborate cross-over networks are required and the system is completed by a 12 Mfd. capacitor in series with each high note unit.

Designed and developed by **CELESTION**

**Celestion Ltd., THAMES DITTON · SURREY**

Telephone : EMBerbrook 3402/6

# For details of a NEW range of

**d.c.**

**LOW-INERTIA**  
MOTORS & TACHO-GENERATORS  
and associated gear-boxes



*contact*

**ELECTRO  
METHODS**  
LTD  
OF STEVENAGE

# Five years ago THE WINSTON SEMI-DECADE OSCILLATOR

was designed for use in the development laboratories and test department at our works. It was found to be such a useful instrument that it was decided to produce it in quantity. By advanced production techniques we are able to offer this instrument at a most competitive price.

### DESCRIPTION

The oscillator uses an R.C. Wien bridge circuit with a thermistor controlling amplitude stability. It produces independent sine and square wave outputs. It is attractively styled in smoke grey cabinet with dove grey front panel.

### SPECIFICATION

**Frequency Range:** 10 c.s. to 100 Kcs. in four main ranges with slow-motion vernier dial for setting a continuously variable frequency within the main ranges. The dial is engraved with both direct reading and vernier, for more accurate resetting. Calibration accuracy 1%.

**Output:** Sine wave variable from 0-10v peak, adjustable with a high impedance variable attenuator and divider switch giving

ratios of x1, x0.1, x0.01, x0.001 attenuation. Total content of harmonics and hum is less than 1%. Square wave of fixed amplitude of 10v  $\pm$  5% maximum drop at 10 cps. is 2%. The rise and fall time at 100 Kcs. is 1 microsec.

**Amplitude Stability:** Output stability,  $\pm$ 1% at any frequency.

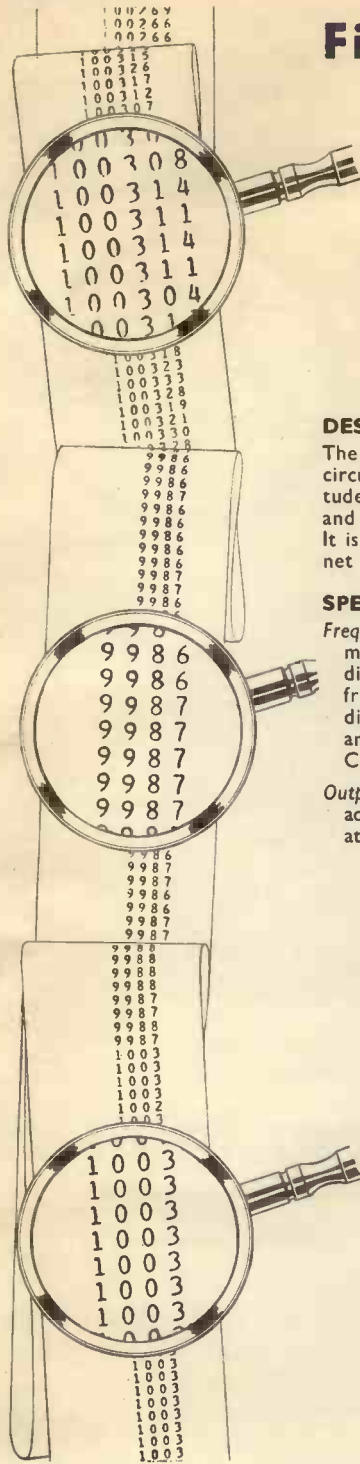
**Frequency Stability:** Better than 1%.

**Power Supply:** 100-120v 200-250v 50-60 cycles.

**Terminals:** Concentric sockets for sine and square wave outputs.

**Accessories supplied:** Mains lead. Coaxial Output Plug.

**Dimensions (overall):** Width 15in. (37.5 cm.). Height 10 $\frac{1}{2}$ in. (25 cm.). Depth 8 $\frac{1}{2}$ in. (22 cm.). Weight 18 lb. (8 Kg.).



Price £48 - 10 - 0

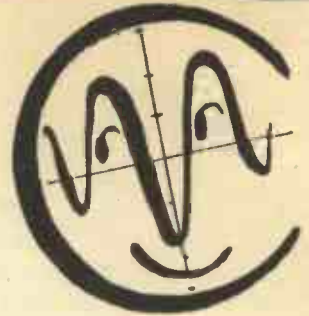
Facsimile of stability checks on the oscillators using a Berkeley Universal Counter/Timer Type 7360 and a Berkeley Digital Recorder Type 1452. Checked at 100 Kcs., 10 Kcs., and 1 Kc. over a period of 24 hours.

**WINSTON**  
ELECTRONICS LIMITED

GOVETT AVENUE  
SHEPPERTON  
MIDDLESEX  
Walton-on-Thames  
26321



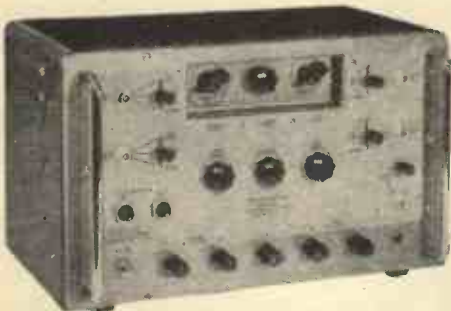
# Voltage Amplifiers



## MODEL I439 WIDE-BAND AMPLIFIER

for TV and VHF distribution systems. The Amplifier is designed to provide simultaneous distribution of signals anywhere in Bands I, II and III, enabling a common aerial to be used for a number of television or VHF radio receivers or other applications requiring a wide band voltage amplifier.

Voltage gain: 20dB at 60 Mc/s.  
Bandwidth: better than 40 Mc/s—220 Mc/s.  
Output voltage: 3V pk-pk max.  
Input and output impedance: 72Ω (matched coaxial).



## MODEL I440 PRE-AMPLIFIER

This instrument is a directly coupled pre-amplifier of high stability which has been designed for use in cascade with a further amplifier or with a recording device.

Frequency response: d.c. : 0—50kc/s, a.c. : 5c/s—50kc/s.  
Gain: continuously variable 10-55 (d.c.), 165 (a.c.)  
Input: balanced or unbalanced, impedance 11.2MΩ (grid-grid.)  
Output: balanced or unbalanced, impedance 2000Ω (output 1—output 2).  
Output voltage: 5V pk-pk max. (output 1—output 2).  
Calibration signal: 1mV or 10mV.



## MODEL I442 LABORATORY HIGH-GAIN AMPLIFIER

Model I442 has been designed for use in the Laboratory and is suitable for voltage amplification in the low frequency ranges. It can be used for special applications in Industry, Nuclear Physics Laboratories, neuro- and myo-graphic investigations and similar purposes.

Frequency response: 5c/s—5kc/s (gain  $10^4$  and  $10^5$ )  
25c/s—3kc/s (gain  $10^6$ ).  
Gain:  $10^6$  Max. Switched and variable controls provide continuous variation.  
Input: balanced or unbalanced, impedance 20MΩ (grid-grid).  
Output: balanced or unbalanced.  
Output voltage: 400V pk-pk max.  
Calibration signal: 0.1 mV, 1mV or 10mV.

Write for the latest Cossor catalogue or ask for a representative to call and discuss your special requirements.

# COSSOR INSTRUMENTS LTD

*The Instrument Company of the Cossor Group*

COSSOR HOUSE, P.O. BOX 64, Highbury Grove, London, N.5.  
Telephone: CANonbury 1234 (33 lines)

Telegrams: Cossor, Norphone, London

Cables: Cossor, London

Codes: Bentley's Second  
TAS/CI 17

# New oscillograph 1059

## ADVANCED \* TRUE DOUBLE-BEAM OSCILLOGRAPH



\* True double-beam—i.e. both beams use a common x-axis and there is no beam switching.

### CATHODE-RAY TUBE

Cosson 4 in. (10 cm.) double-beam, p.d.a., type 93D with green fluorescence, operating with overall accelerating potential of 3 kV or 6 kV.

### Y1 AMPLIFIER

1 c/s to 10 Mc/s (30% down).  
Rise-time: 0.04  $\mu$ sec.  
Output deflection: 6 cm (4 cm at 10 Mc/s).  
Sensitivity: calibrated 100 mV/cm to 10 V/cm.  
Sensitivity control: in steps 3:1 and 10:1 with continuously variable intermediate control.  
Input Attenuator impedance: 1.2 M $\Omega$  and 65 pF.

### Y2 AMPLIFIER

Identical with Y1 amplifier.

### SIGNAL DELAY

200  $\mu$ sec approximately. Not more than 10  $\mu$ sec differential between channels.

### PRE-AMPLIFIER (2)

Gain 10. 5 c/s to 200 kc/s (30% down).  
Input Resistance: 3 M $\Omega$ .  
One for A1 amplifier, the other for A2 or X amplifier.

### PROBES (OPTIONAL EXTRA)

Frequency-compensated "L" attenuator.  
Input impedance: 6 M $\Omega$  and 15 pF.  
Insertion loss: 10:1.

### TIME-BASE

Triggered.  
Range: 0.03  $\mu$ sec/cm to 15 msec/cm in eleven steps. Triggered from positive or negative signals derived externally or from Y1 amplifier.  
Sensitivity: pulse—1 cm. deflection or 2 V external. Sine wave—2 cm deflection or 2 V r.m.s. external at frequencies up to 5 Mc/s.  
Expansion amplifier, continuously variable gain up to 5 times. Time-base output available at front panel on slow speed ranges.  
Delayed time-base: continuously variable delay 2  $\mu$ sec to 150  $\mu$ sec. Delay jitter not greater than 1 part in 1,000. Sensitivity pulse—1 cm deflection or 2 V external.

### X AMPLIFIER

10 c/s to 750 kc/s (30% down).  
As time-base amplifier: continuously variable expansion up to 5 times.  
As independent X amplifier: sensitivity variable from 1 V/cm to 100 V/cm in 5 ranges.

### CALIBRATION

Voltage measurement: internal calibrating voltage (square wave) referred through sensitivity control of the amplifiers. Accuracy  $\pm 3\%$ .  
Time measurement: by directly calibrated X shift control ( $\pm 5\%$ ) and/or by 20  $\mu$ sec ( $\pm 3\%$ ) black-out pips (for accurate measurement of rise-time).

### POWER SUPPLY

Mains: 100 V to 130 V and 200 V to 250 V.  
Frequency: 50 c/s to 100 c/s.  
Consumption: 550 W.  
Internal supplies are stabilized where necessary.

### SIZE AND WEIGHT

Height	17½ in.	(43.2 cm).
Width	12 in.	(30.5 cm).
Depth	24½ in.	(62.9 cm).
Weight	80 lb.	(36.3 kg).

### ACCESSORY

Camera Model 1428.

# COSSOR INSTRUMENTS LTD

The Instrument Company of the Cosson Group

COSSOR HOUSE, P.O. BOX 64, Highbury Grove, London, N.5.

Telephone: CANonbury 1234 (33 lines).

Telegrams: Cosson, Norphone, London.

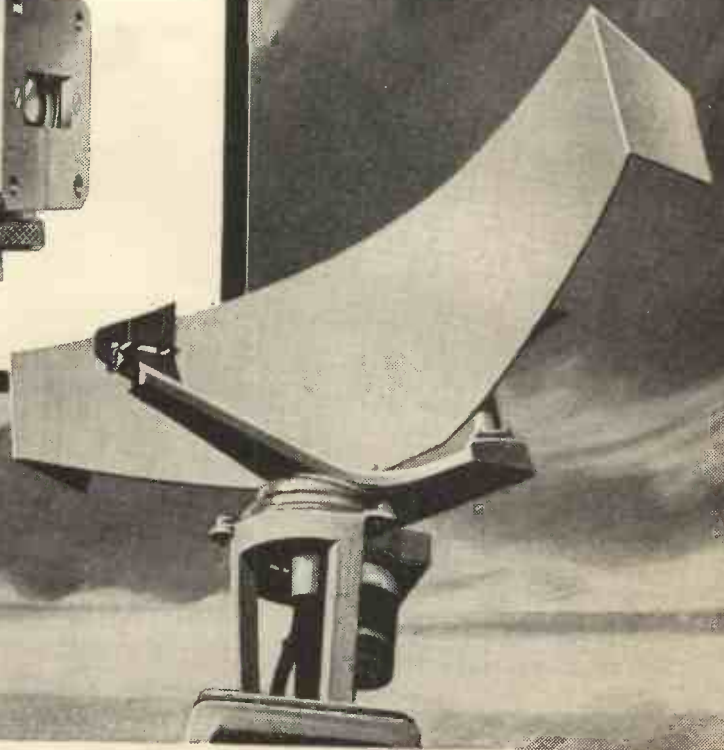
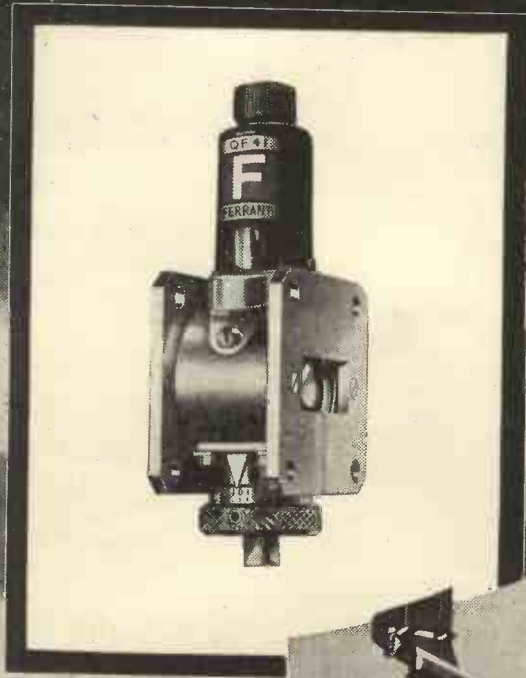
Cables: Cosson, London.

Code: Bentley's Second.

TAS/CL.11

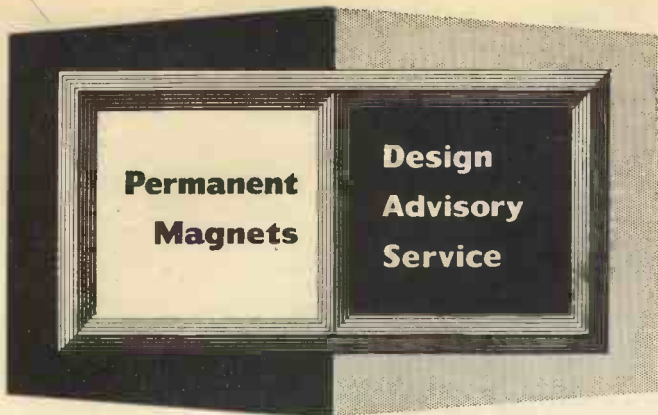
# FERRANTI T.R. CELLS for Marine Radar

The QF 41 Cell already used  
throughout the world has  
been chosen for the D7 Series  
of Decca Marine Radar



FERRANTI LTD • KINGS CROSS ROAD • DUNDEE Tel: DUNDEE 87141



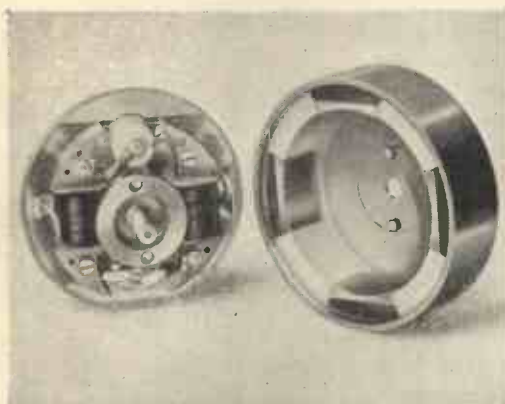


## Fly-Wheel Magnetos

*Advertisements in this series deal with general design considerations. If you require more specific information on the use of permanent magnets, please send your enquiry to the address below, mentioning the Design Advisory Service.*

The improved performance required from modern small petrol engines has resulted in higher specifications for the performance of magnetos to meet both ignition and lighting requirements.

The problems involved in magnetos have been solved in the fly-wheel design by the use of improved materials and in particular, the use of ceramic permanent magnets. An example of the type of design which is being adopted by a number of users is described and illustrated below.

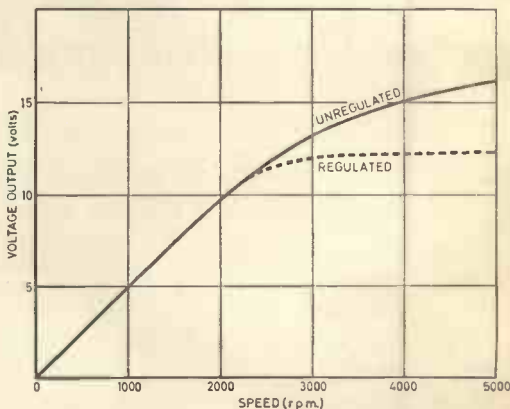


In this magneto the magnetic circuit is designed to have the highest practical efficiency. The rotor consists essentially of four 'Magnadur' 2 segments with mild steel pole pieces equally spaced inside a cup-shaped steel shell. The rotor/stator clearance is nominally 0.02" and the 'Magnadur' magnets maintain a field of 2500 oersteds across this gap. The four pole stator consists of two laminated mild steel yokes in parallel, each having a coil to produce the power output required for both ignition and lighting circuits.

The fly-wheel generator illustrated has an outside diameter of 5" with an overall depth of 2 1/4". The rotor is designed to be magnetised on a special magnetising fixture after assembly and will withstand removal and replacement for maintenance purposes without impairing the magnetic or electrical performance. Previously, one of the major disadvantages of magnetos was the loss of performance resulting from stripping down for maintenance or overhaul.

The power generated at 3000 r.p.m. is in excess of 24 watts, but when regulated to 12 volts, the maximum output decreases to approximately 20 watts.

A typical voltage output/speed curve for this design of fly-wheel magneto is shown for both regulated and unregulated conditions.



This example referred to, represents a typical design of a fly-wheel generator now going into general use, where the designer has taken full advantage of the unique properties of 'Magnadur' magnets with their exceptionally high coercive force and favourable length-to-section ratio.

*If you wish to receive reprints of this advertisement and others in this series write to the address below.*



'TICONAL' PERMANENT MAGNETS  
'MAGNADUR' CERAMIC MAGNETS  
FERROXUBE MAGNETIC CORES

# RCA



*SSB-L1 Fixed Station. 60 watt (500 watt double sideband equivalent) eight channels 3-15 mc/s.*

## SINGLE SIDEBAND

### *Communications system*

Over 4000 RCA single sideband equipments are in use the world over as fixed and mobile stations.

- Eight Channels.
- Instant Selection of Upper or Lower sideband.
- Compatibility with double sideband systems.
- Remote aerial tuning facility for SSB-L1.
- Mechanical Filter giving outstandingly High Selectivity.
- Exceptionally Stable and Reliable Operation.
- Rugged construction for naval and military use.



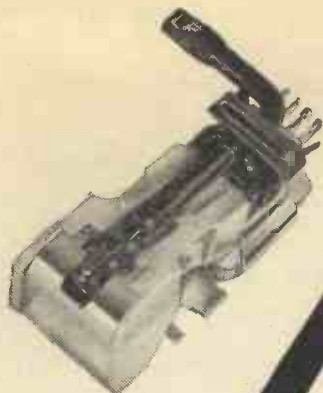
*SSB-L30M Mobile Station. 30 watt (250 watt double sideband equivalent) eight channels 3-15 mc/s.*



*Noise limiter-clipper-filter for heavy interference conditions.*

◀ *Automatic remote antenna tuner AAT-L100*





## SONOTONE 8T

**Ceramics** bring  
reliability and  
high performance  
stereophonic  
reproduction

The new 8T ceramic pick-up cartridge is already accepted in all five continents as the most efficient means of obtaining stereophonic reproduction: it is impervious to all climatic conditions and has proved equally popular both at home and abroad. Intense development and accurate manufacture ensure that this exceptional cartridge provides among other advantages: —

- Response, 40–12,000 c/s  $\pm 1.5$  dB
- Sensitivity, 200 mV at 1 kc/s on stereo
- Compliance  $2.4 \times 10^{-6}$  cm/dyn
- Separation, 20 dB between channels
- Tracking Weight 6 grams on record changers, 4 grams on transcripator arms
- Inbuilt vertical rumble filter
- Completely compatible for 33 $\frac{1}{3}$ , 45 and 78 r.p.m., fits most popular arms
- Stylus weight less than 11mg., diamond or sapphire stylus (easily replaceable)

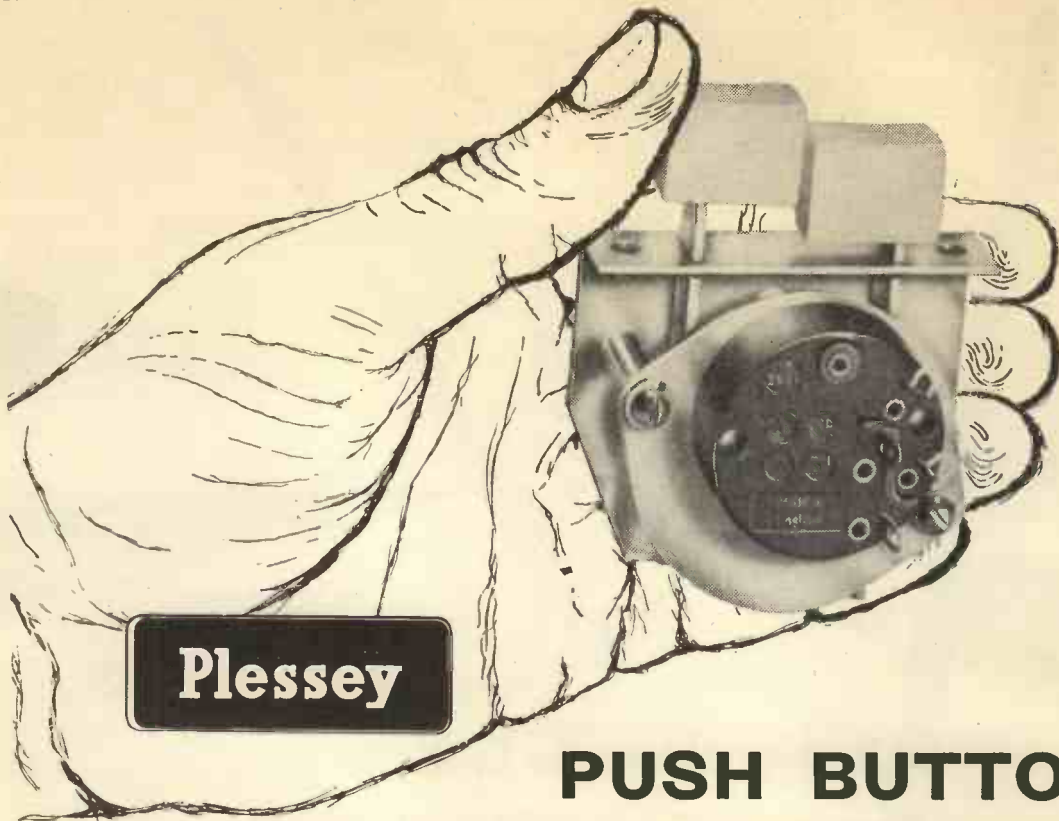
*Performance data is freely available to those interested in fitting this outstanding TCL product.*

**TCL**

**Technical Ceramics Limited**  
Wood Burcote Way · Towcester  
Northants

Tel: Towcester 337

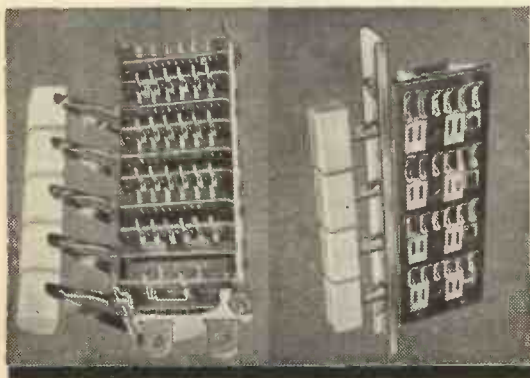




## PUSH BUTTON & PIANO KEY SWITCHES

A whole range of PB and PK switches is provided by Plessey to meet the contemporary requirement in TV, radio and audio equipment design. And whether you plan to employ the one or the other, you will find a suitable Plessey switch with the shape of key or button you prefer—in the colour of your choice.

By the use of Plessey switches you can give your equipment the advantage of self-cleaning, positive contact switching with low contact resistance. All Plessey switches are free from electrical noise, due to their unique 'Wedgelock' riveted construction—which represents a great advance over conventional eyeleted methods. Standard or printed circuit contacts.



### MINIATURE PIANO KEY SWITCHES

Among the many universally employed ranges of Plessey switches is featured a miniature piano key series, available with either standard or printed circuit contacts.

*\* May we suggest that you talk to a Plessey Technical Representative about your switch requirements.*

THE PLESSEY COMPANY LIMITED  
New Lane • Havant • Hants  
Telephone: Havant 1701

**Plessey**

Overseas Sales Organisation: Plessey International Limited • Ilford • Essex • Telephone: Ilford 3040





**A NEW CONCEPT**



**IN POT CORE DESIGN**

**Mullard**

**VINKOR**

**range of**

**adjustable pot cores gives you**

***outstanding* advantages**

- Wide range of sizes
- Easily assembled
- Close tolerance permeability
- Precise and easy inductance adjustment
- Stability
- Single hole chassis mounting

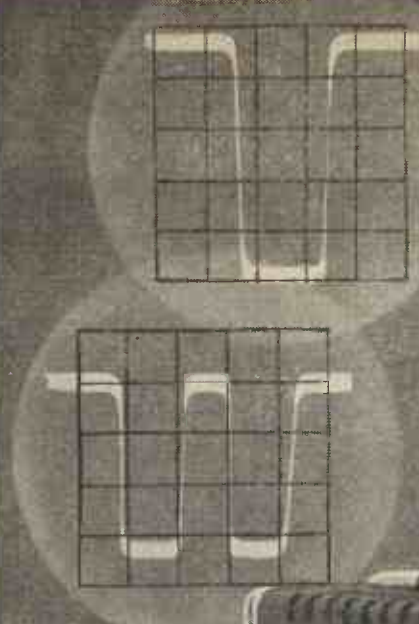
Mullard Vinkors are the most efficient adjustable pot core assemblies commercially available. In addition to high performance, they have the distinct advantage of close tolerance permeability, thus enabling designers to precalculate to within  $\pm 3\%$  the inductance of the core when wound. Final adjustment, taking into account normal capacitor tolerance, can be easily effected to an accuracy of better than 0.02%, by means of a simple self-locking device built into the core.

Write today for full details of the wide range of Vinkors currently available.

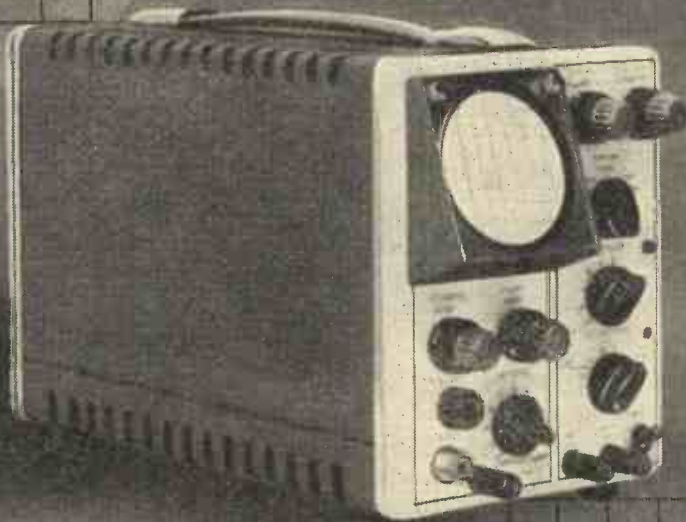
**Mullard**

**VINKOR POT CORES**





**FOR  
MEASUREMENT  
OF TIME  
AND VOLTAGE**



## THE S31

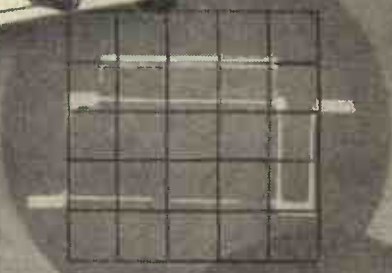
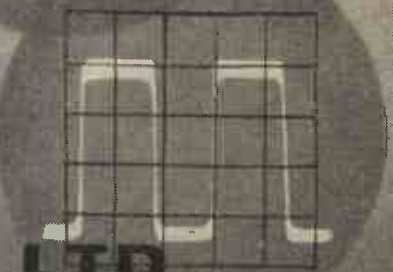

The type S31 Oscilloscope is an improved version of the now famous Serviscope.

It is extremely compact (8½ in. x 6½ in. x 13 in.) and has a performance and specification unequalled by many much larger instruments.

The D.C. coupled amplifier (-3db at 6 Mc/s), voltage calibration, wide-range calibrated time base (.5 sec. to 1µ sec. per cm.) and a precision flat-faced C.R. Tube are only a few of the features that put the S31 far ahead of any other portable scope.

# TELEQUIPMENT LTD

313 Chisle Road Southgate London N14 Tel: 444 Lane 1160



# NEW

## ELAC speakers

### RETAIL PRICE LIST

TYPE	FLUX	POWER RATING PEAK	PRICE	P'TAX
8 x 3G	6500g	2.5 WATTS	19/6	6/3
8 x 3C	8500g	2.5 WATTS	22/6	7/3
7 x 4G	6500g	3 WATTS	18/6	5/11
7 x 4C	8500g	3 WATTS	21/6	6/11
5G	6500g	3 WATTS	18/6	5/11
5C	8500g	3 WATTS	21/-	6/9



8" x 3"

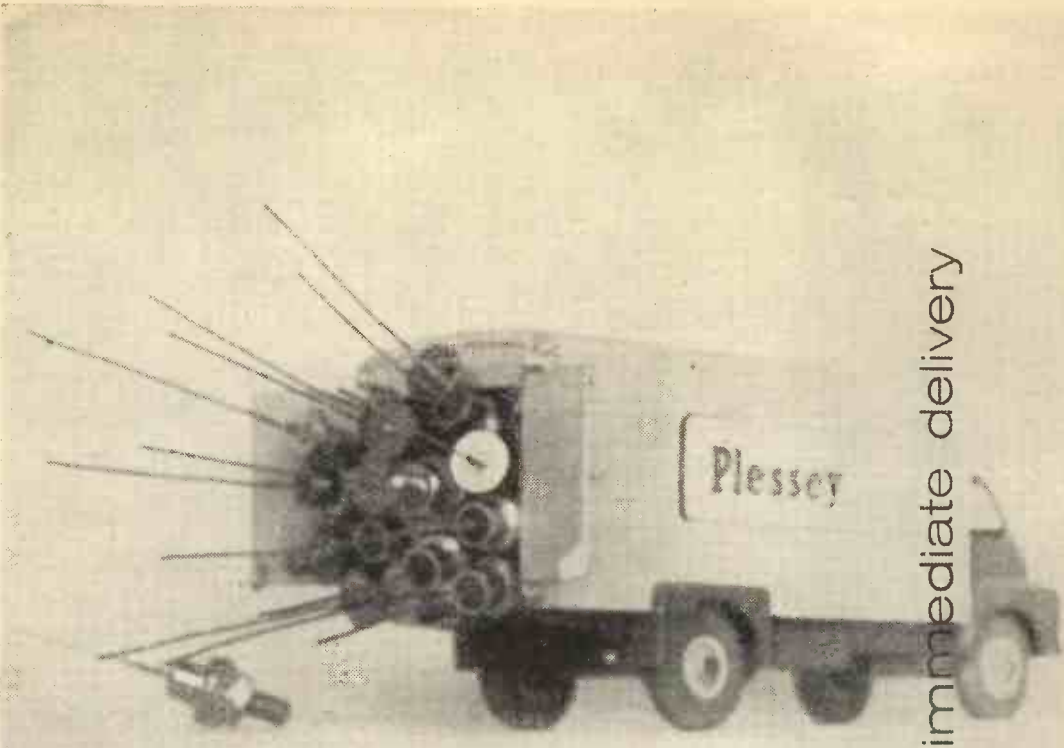


7" x 4"



5"

**ELECTRO ACOUSTIC INDUSTRIES LTD., Stamford Works, Broad Lane, Tottenham, N.15**  
 Tel: Tottenham 0505/9 (5 lines)



## \* Simet "AS" type Silicon Rectifiers

\* and this isn't all.

Simet "AS" type Silicon Rectifiers cost less than Selenium and valve types for a great many applications, operate at higher temperatures than both Selenium or Germanium (up to 150°C), do not age, and show savings in weight, bulk and total cost.

The range is extended to 800 P.I.V. Engineers and Designers who would like to know more are invited to write for complete data . . . and . . . deliveries, remember, are immediate.

# SIMET

THE PLESSEY COMPANY LIMITED

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# "PLUG-IN"

## 3000 TYPE RELAY

**WITH  
TRANSPARENT  
DUST  
COVER  
AND  
PLUG-IN  
BASE**



Pat. No. 38370/57

SIZE OF BASE  
2 1/2" x 1 1/4" x 1"

**CAN NOW BE SUPPLIED AS FOLLOWS :-**

**A.I.D.            A.R.B.**  
**ADMIRALTY**  
**APPROVED**  
**3000 & 600 TYPE RELAYS**

6 CHANGE-OVERS LIGHT DUTY. 6 MAKES OR 6 BREAKS HEAVY DUTY.  
2 CHANGE-OVERS HEAVY DUTY AND 2 CHANGE-OVERS LIGHT DUTY.

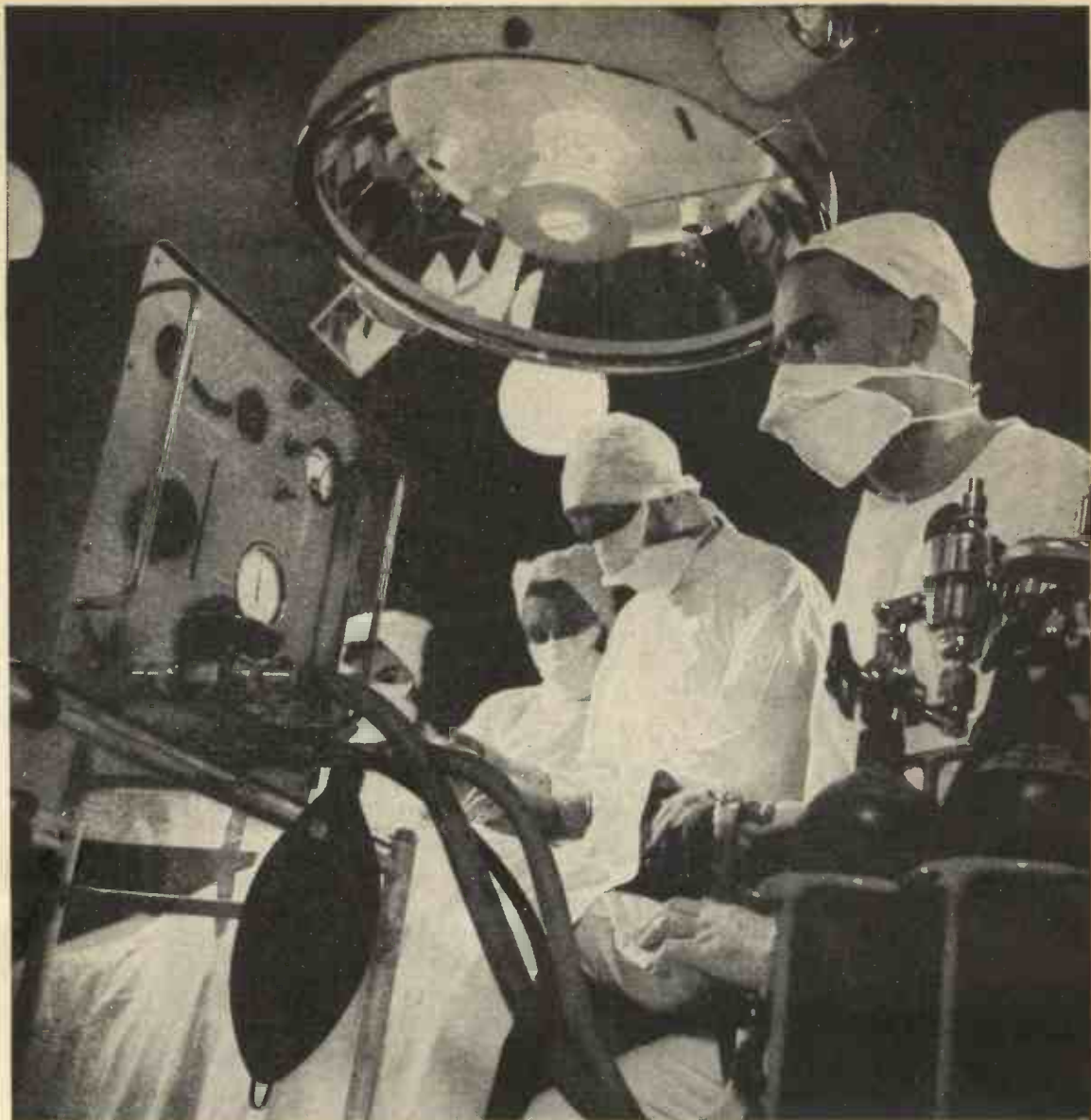
●  
TRANSISTORISED TO OPERATE AS LOW AS 3 MICRO-AMPS.

●  
A.C. OPERATION FOR 6V, 12V, 24V, 50V, 110V AND 250V A.C.

DOUBLE WOUND COILS. P.T.F.E. INSULATION.  
OPERATE AND DELAY UP TO 5 SECONDS.

**A.D.S. RELAYS LTD**  
**89 - 97, ST. JOHN STREET, CLERKENWELL, E.C.1**  
**Telephone: CLERkenwell 3393/4/5**





# The Electronic Lung

A member of the Pye Instrument Group W. Watson & Sons Ltd. has produced an electronic lung which is capable of replacing an iron lung. The Barnet Ventilator, as the instrument is called, is transistorised and is easily portable in cases of emergency. It is shown here in its application in an operating theatre for the administration of anaesthetics.

### The Pye Instruments Group Consists of:

*Pye Atomics Division.  
Pye Industrial Television Division.  
Faraday Electronic Instruments Ltd.  
Labgear Ltd.  
W. G. Pye & Co. Ltd.*

*Pye Telecommunications Ltd.  
Unicam Instruments Ltd.  
W. Bryan Savagè Ltd.  
W. Watson & Sons Ltd.*



**So easy to build**



**So easy to use**

**Thank you!**

We greatly appreciate the complimentary remarks made to us at recent exhibitions in London and Harrogate. It was most gratifying to hear from so many people who had purchased our kits how pleased they were with the performance and professional appearance of the completed instruments. Thank you!

**5in. OSCILLOSCOPE KIT**

**Model O-12U**

Laboratory quality at utility oscilloscope price and ease of assembly make this kit of outstanding value. Vertical frequency response 3 c/s to 5 Mc/s., + 1.5 dB.—5 dB., sensitivity 10 mV. per cm. at 1 kc. Horizontal frequency 1 c/s. to over 400 kc. ( $\pm 1$  dB. up to 200 kc.). The Heath patented sweep circuit functions from 10 c/s. to over 500 kc. in five steps giving five times the usual sweep of other scopes. In addition it has exceedingly short re-trace and rise times and electronically stabilised power supply. Included is a 40-page Instruction Manual ..... **£34.15.0**

**ELECTRONIC SWITCH KIT  
(Oscilloscope Trace Doubler)**

**Model S-3U**

This extremely useful, low priced device will extend the use of your single-beam oscilloscope for duties otherwise only in the province of the double-beam tube. In short, at a nominal cost, the Heathkit model S-3U will give you the advantages of a double (or other multiple) beam 'scope, while retaining all the advantages of your present single-beam instrument. Hitherto an electronic switch of this nature, permitting the simultaneous observation of two signals on the screen of a single-beam C.R.T. oscilloscope, has cost nearly as much as the scope itself. **£9.18.6**

**RESISTANCE-CAPACITANCE BRIDGE**

**KIT Model C-3U**

Measures capacity 10pF. to 1,000  $\mu$ F, resistance 100 $\Omega$  to 5 megohms and power factor. 5-450 v. test **£7.19.6**  
Measures safety switch provided.

**TRANSISTOR PORTABLE KIT  
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Presented in elegant real hide case with tasteful gold relief. Can be assembled in 4 to 6 hours and you have a set in the top flight of the 20-23 guinea class. Preadigned I.F. transformers, printed circuit and a 7in. x 4in. high-flux speaker. **£15.18.6**

**HI-FI STEREO AMPLIFIER KIT  
Model S-88**



Gives 16 w. output (8 per channel with 0.1 per cent. distortion at 6 w. per channel). It has ganged controls, STEREO/MONAUROGRAM, radio and tape recorder inputs and push-button selection as well as many other first class features well above its price range. In two-tone grey metal cabinet with a golden surround and fittings. Also ultra-linear push-pull output. **£25.5.6**  
Basic sensitivity 10mV. (2mV. available, 30/- extra).

**VARIABLE FREQUENCY  
OSCILLATOR KIT  
Model VF-1U**



For all Amateur Bands, 160-10 metres. Ideal for Heathkit DX-40U and similar transmitters ..... **£10.12.0**  
Price less valves **£8/19/6**

**DUAL-WAVE TRANSISTOR  
RADIO KIT Model UJR-1**

This sensitive headphone set is a fine introduction to electronics for any youngster. (Not illustrated) **£2.16.6**

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**Technically**



**excellent**



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A versatile high-quality self-contained STEREO/MONAUROAL Amplifier with adequate output for a living room—or with which to convert a favourite (monaural) radiogram into a stereo-radiogram. 3 watts per channel; 0.3% distortion at 2.5 w/chnl.; 20 dB N.F.B., inputs for Radio (or Tape) and Gram., Stereo—or Monaural; Ganged controls. Sensitivity 100 mV. **£11.8.0**



**VALVE VOLTMETER KIT Model V-7A**

The world's most popular valve voltmeter, with printed circuit and 1 per cent. precision resistors to ensure consistent laboratory performance. It has 7 voltage ranges measuring respectively d.c. volts to 1,500 and a.c. to 1,500 r.m.s. and 4,000 peak to peak. Resistance measurements from 0.1 ohm to 1,000 M ohms with internal battery. D.C. input impedance is 11 Megohms and dB measurement has a centre-zero scale. Complete with test prods, leads and standardising battery ... **£13.0.0**

**R.F. PROBE KIT Model 309-CU**

This complete probe kit will extend the frequency range of the V-7A Valve Voltmeter to 100 Mc/s. and will enable useful voltage indication to be obtained up to 300 Mc/s. **£1.5.6**



**AMATEUR TRANSMITTER KIT Model DX-100U**

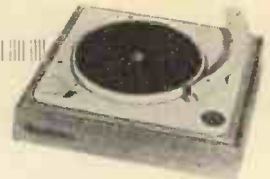
The world's most popular "Ham" TX Kit

- Completely self-contained, compact "Ham" Transmitter.
- Built-in, highly stable VFO and all Power Supplies.
- TVI: Careful design has reduced TVI to a minimum by use of effectively screened frequency-generating stages and pi tuned circuits at the input and output of the PA stage, and by 11 chokes and pi network filters to all outlets from the cabinet. No fewer than 35 disc ceramic by-pass capacitors help to achieve the exceptional stability and high-performance for which this Transmitter is noted.
- The KT88 high-level anode and screen modulator stage gives over 100 watts of audio from less than 1.5 mV. input.
- Adjustable drive and clamp control ensure that valves are only driven sufficiently to maintain the required output.
- Keying on CW is via the VFO and buffer amplifier cathodes; the other RF valves are biased beyond cut-off. When zero-beating the TX with incoming signals, the exciter stages only may be run without the final amplifier being switched on.
- Provision has been made for remote control operation.
- VFO slow-motion drive is very smooth and back-lash free.
- Covers all Amateur bands up to 30 Mc/s. phone or CW.
- VFO or Crystal control.

**£78.10.0**

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- 4-speed Transcription Record Player Model RP-1U ..... **£12 10 0**
- 6 w. HI-Fi Amplifier, Model S-33 ..... **£11 8 0**
- Twin Stereo Speakers System Model SSU-1 ... **£20 11 0**
- Total cost if purchased separately..... **£44 9 0**
- YOURS for **£42/10/-** if all ordered together or **£8/8/-** deposit and 9 monthly payments of **£4/3/-**. Pedestal speaker legs **£2/14/-** optional extra.



**TRANSCRIPTION RECORD PLAYER Model RP-1U**

With 4-speed A.C. motor unit and Stereophonic Pick-up completely assembled on plinth.

High performance at low cost.

This attractive Transcription Record Player incorporates many new features which make it suitable for all types of recordings on discs. It has the new Collaro RP.594 unit with the Ronette Stereo Pick-up and gives excellent results on stereo or mono (33, 45 L.P. or 78 r.p.m.) gramophone records. **£12.10.0**



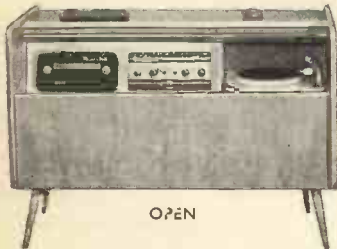
**"HAM" TRANSMITTER KIT Model DX-40U**

Covers all amateur bands from 80 to 10 metres. Power input 75 watts C.W. 60 watts peak controlled carrier phone. Output 40 watts to aerial. Provision for V.F.O. Filters minimise T.V. interference. **£29.10.0**

Our Technical Consultation and Service Departments are always ready to help in the unlikely event of your experiencing any difficulty.

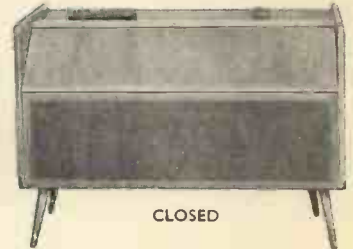
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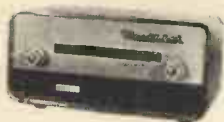


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**COTSWOLD SPEAKER SYSTEM KIT**

This acoustically designed enclosure measures 26 x 23 x 15½ in. and houses a special 12 in. bass speaker with 2 in. speech coil, elliptical middle speaker together with a pressure unit to cover the full frequency range of 30-20,000 c/s. Its polar distribution makes it ideal for really Hi-Fi Stereo. Delivered complete with speakers, cross-over unit, level control. Tygan grille cloth, etc. Left "in the white" for finish to personal taste, all parts are pre-cut and drilled for ease of assembly. **£19.18.6**



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Tuning range 88-108 Mc/s. Flywheel tuning. Attractive Plastic Front Panel in two-tone grey with golden trim, surround and motif. Thermometer type visual tuning indicator. Pre-aligned I.F. transformers (eliminates adjustment). Three I.F. Stages. Wide-band low distortion. Ratio Detector. Complete R.F. Unit, wired, tested and pre-aligned (ready for mounting to chassis). Printed Circuit for I.F. Amplifiers and Ratio Detector, for ease of assembly. No alignment necessary after assembling. Built-in power supply. Output sockets for stereophonic adaptor (for stereo transmission when available).

TUNER UNIT Model FMT-4U (incl. 16/11 P.T.) **£3 2 0**  
with 10.7 Mc/s I.F. output.

I.F. AMPLIFIER Model FMA-4U complete  
with case and valves **£10 10 6**

\*Sold separately ..... Total **£13 12 6**



**CAPACITANCE METER KIT Model CM-1U**

This Direct-Reading Capacitance Meter is a very low priced, time-saving instrument which is so useful that it should be part of the general equipment of every electronic laboratory and production line. Easily built in a few hours. 0-100 µF, 0-1,000 µF, 0-0.01 µF, 0-0.1 µF. The meter has 4½ in. scale and can be used by an unskilled operator after a few minutes instruction **£14.10.0**



**STEREO-HEAD BOOSTER KIT Model USP-1**

Hi-Fi Stereo Pre-Amplifier for low-output Hi-Fi P.U.s. Input 2 mV. to 20 mV. Output adjustable from 20 mV. to 2 V. 40-20,000 c/s. Also suitable as low-noise R.C.-Coupled high-gain monaural amplifier **£5.19.6**



**AUDIO SIGNAL GENERATOR KIT Model AG-9U**

10 c/s. to 100 Kc/s., switch selected. Distortion less than 0.1%. 10 v. sine wave output metered in volts and dB's **£19.3.0**



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Ducted-port bass reflex cabinet, "in the white." Frequency response to 40-16,000 c/s. Power rating 25 watts. Matched speaker units 8 in. high flux (12,000 lines) with hyperbolic cone and 4 in. wide angle dispersion type for higher frequencies. **£10.5.6**  
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Please tick the items in which you are interested and we will send you full details.

S-88	Hi-Fi Stereo Amplifier Kit	UJR-1	Dua-Wave Transistor Radio
S-33	6-Watts Stereo Amplifier Kit	S-3U	Electronic Switch Kit
UXR-1	Transistor Portable Kit	309-CU	R.F. Probe Kit
DX-40U	"Ham" Transmitter Kit	DX-100U	Amateur Transmitter Kit
O-12U	Sin. Oscilloscope Kit	—	Matched Hi-Fi Stereo Kit
V-7A	Valve Voltmeter Kit	RP-UI	Transcription Record Player
SSU-1	Hi-Fi Speaker System Kit	—	Gloucester Stereo Cabinet Kit
AG-9U	Audio Signal Generator Kit	—	Cotswold Speaker System Kit
C-3U	Resistance-Capacitance Bridge Kit	—	Hi-Fi F.M. Tuner
VF-1U	Variable Frequency Oscillator Kit	CM-1U	Capacitance Meter Kit
USP-1	Stereo-Head Booster Kit		

NAME ..... ADDRESS .....

(in CAPITAL letters please) .....

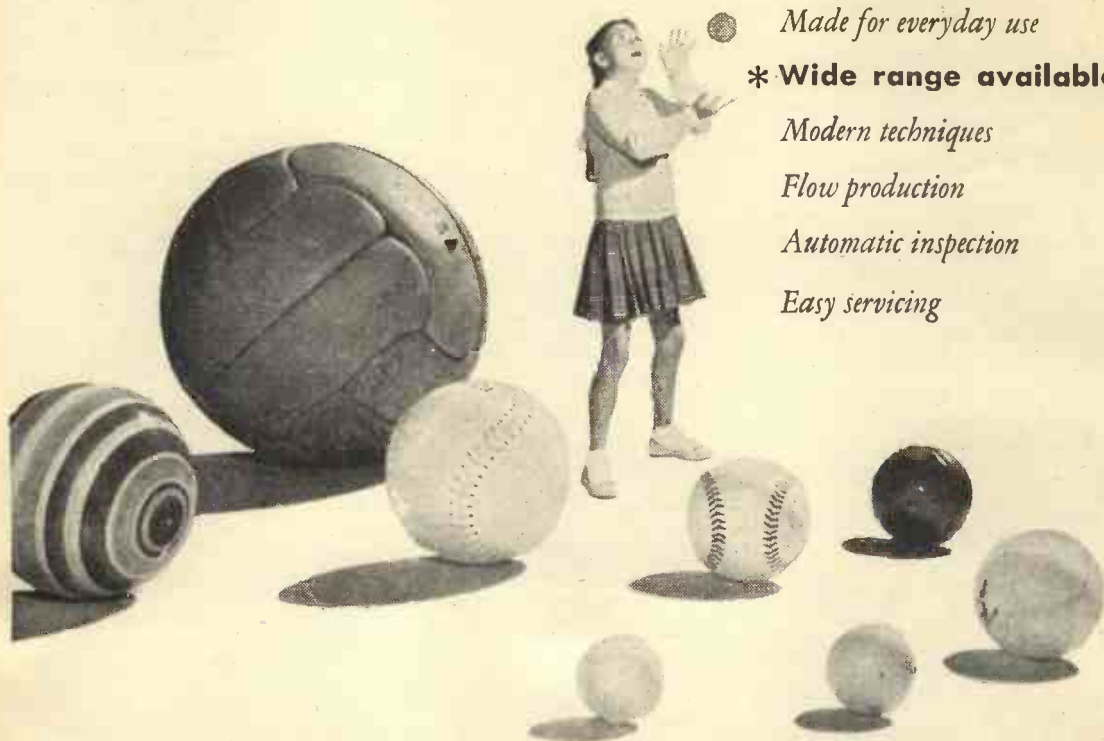
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### GM 6014

#### Broadband HF-Millivoltmeter

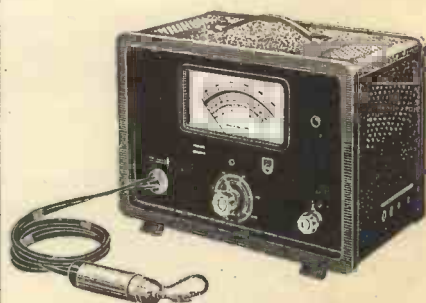
Measuring range: in 10 steps from 1 mV up to 30 V full scale deflection, dB scale from -80 dB ... +32 dB (0 dB = 1 mW into 600Ω)  
Frequency range: 1 kc/s ... 30 Mc/s

Input impedance:

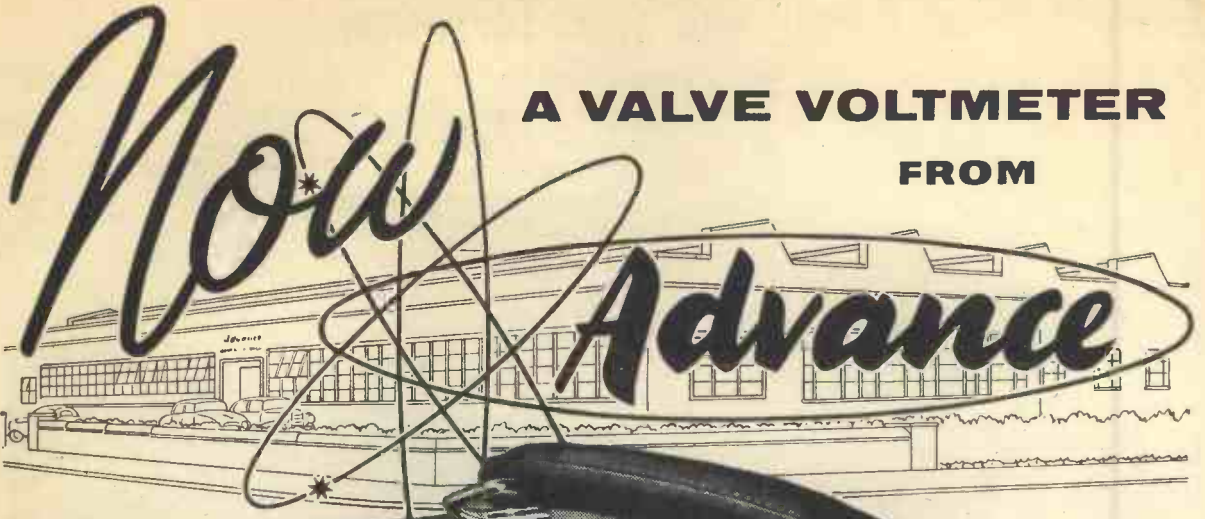
400 kΩ ... 50 MΩ // 7pF ... 2 pF

Overall accuracy: 3% with no respect to variations in the frequency response curve, which variations are limited within 5% of the gain at the calibration frequency.

Mains supply: 110 ... 245 V; 40 ... 100 c/s



The price - a pleasant surprise



**A VALVE VOLTMETER  
FROM**

**Advance**



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**OUTSTANDING FEATURES**

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accurate measurements are possible down to 100µV.

**WIDE VOLTAGE RANGES**

1mV. to 300 volts F.S.D.

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15c/s to 4.5Mc/s

**METER SCALE CALIBRATED IN VOLTS AND dB**

**CAN BE USED AS A NULL DETECTOR AND INDICATOR**  
from 10c/s to 10Mc/s

**CAN BE USED AS AN AMPLIFIER FROM 10 c/s to 10Mc/s**

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**SMALL COMPACT SIZE & ROBUST CONSTRUCTION**

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**£50** nett in U.K.

*(including very low capacity screened lead and probe)*

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# Every Second Family will have Television

About 56 million television sets were available in the world in 1957. By 1958 for every hundred inhabitants in England 17.4 sets were counted. In Belgium this figure amounted to 3.8 and in France to 2.5. The further growth shows a rapid rate of increase. It is predicted that in 10 years' time about 50% of all families in Europe will be in possession of a television set.

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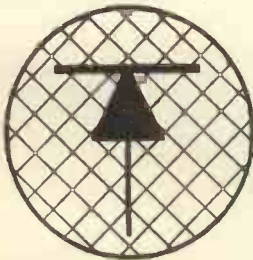
Remarks .....

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A. B. Metal Products Ltd. proudly announce that they have been granted by the Trolex Corporation of Illinois, U.S.A., the sole manufacturing rights of the new "TROLEX" range of switches.

The Trolex method of switch manufacture incorporates a technique which is completely revolutionary and will enable A. B. Metal Products Ltd. to make available shortly in this country a range of multi-pole, multi-way switches which will be unique in design, size and performance. Samples will be available very shortly.



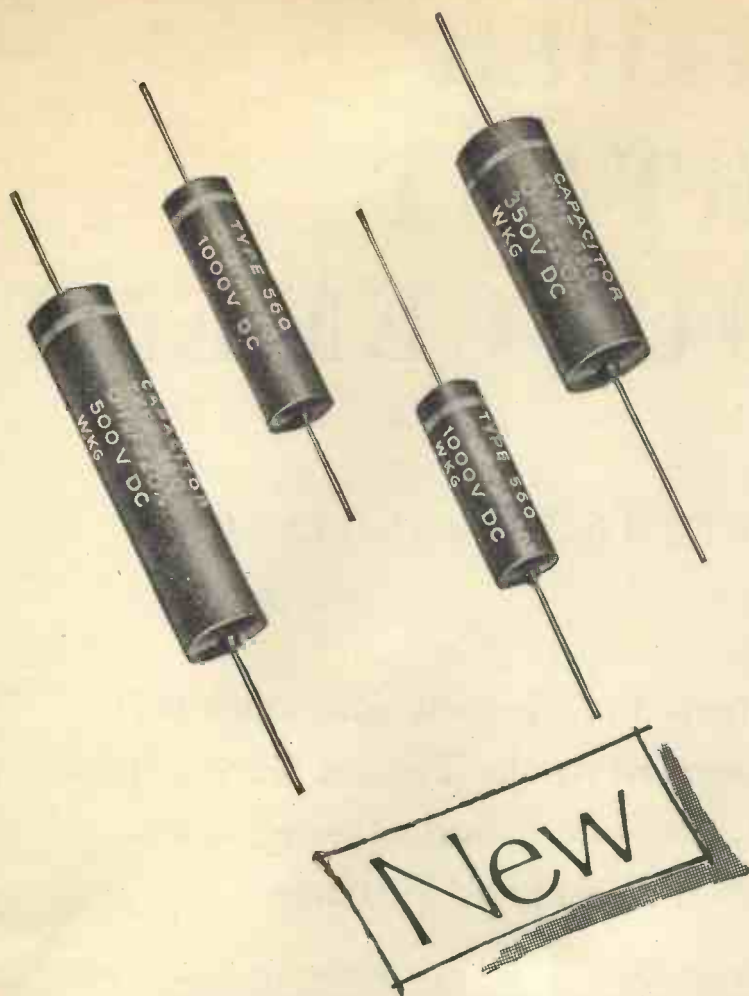
## TROLEX

*The new conception  
in switches*



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● No exposed metal parts other than terminations, which are clean solder coated, thereby ensuring easy soldering.

● Body and terminations free of wax coating or any other low melting point material.

● Long life without voltage derating.

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Capacitance Tolerance;  $\pm 20\%$  normal  $\pm 10\%$  by selection. Power Factor; Less than 1% at 1,500 c/s. Insulation Resistance; Better than 20,000M $\Omega$  at normal temperature. Voltage Application; From  $-40^\circ$  to  $+125^\circ\text{C}$  for d.c. and from  $-40^\circ$  to  $+70^\circ\text{C}$  for a.c.

CAPACITANCE $\mu\text{F}$	VOLTAGE RATINGS			DIMENSIONS	
	d.c. Wkg. at $-40^\circ\text{C}$ to $+125^\circ\text{C}$	d.c. Test at $20^\circ\text{C}$	a.c. Wkg. r.m.s. at $-40^\circ\text{C}$ to $+70^\circ\text{C}$ and up to 60 c/s	Diameter $+0.020^\circ$ $-0$	Length $\pm 0.040^\circ$
0.001	1,000	2,500	250	$\frac{1}{8}$	1
0.002	1,000	2,500	250	$\frac{3}{16}$	1
0.005	1,000	2,500	250	$\frac{3}{16}$	1
0.01	1,000	2,500	250	$\frac{3}{16}$	$1\frac{1}{8}$
0.02	750	2,250	250	$\frac{3}{16}$	$1\frac{1}{8}$
0.05	500	1,500	250	$\frac{3}{16}$	$1\frac{1}{8}$
0.1	350	1,000	180	$\frac{3}{16}$	$1\frac{1}{8}$
0.1	500	1,500	250	$\frac{3}{16}$	$1\frac{1}{8}$

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If you have a problem that can be solved by using digital techniques—then Venner packaged circuits can help.

Their versatility can solve your development or test set problems, because either you or we can build the equipment from fully developed circuit elements.

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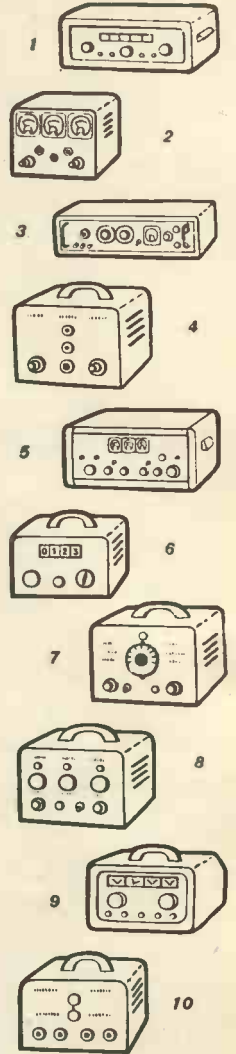
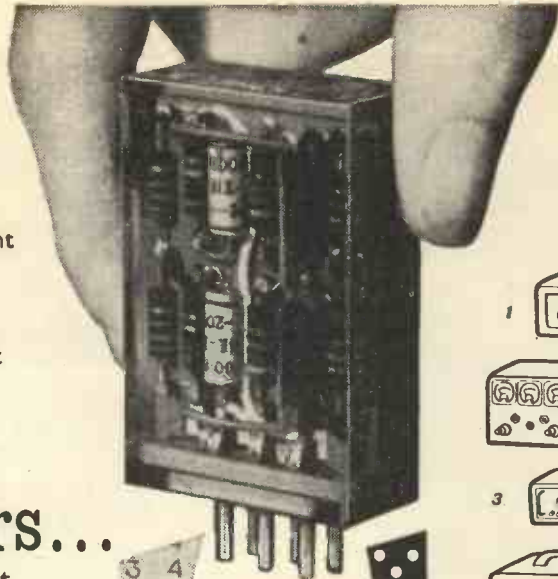
on punched tape, in 1" figures or in print.

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- 2 3 digit counter.
- 3 Frequency source for octave filter testing (12 output frequencies).
- 4 Dual channel tuned amplifier.
- 5 Speedmeter with tape readout.
- 6 In-line readout thermometer.
- 7 Solenoid valve timer.
- 8 3 digit batching counter.
- 9 Special purpose time measuring set.
- 10 Frequency source providing .0 kc/s, 1 kc/s, 100 c/s, and 10 c/s.
- 11 Reaction time indicator.

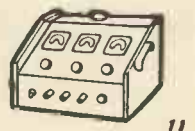
As a general rule we can give you delivery in 6 to 8 weeks of special items built in this way. Alternatively, if you "do-it-yourself", we will give advice and provide the majority of plug-in stages within 7/10 days of receiving your order.

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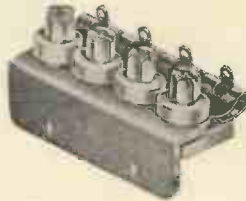




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# COMPONENTS



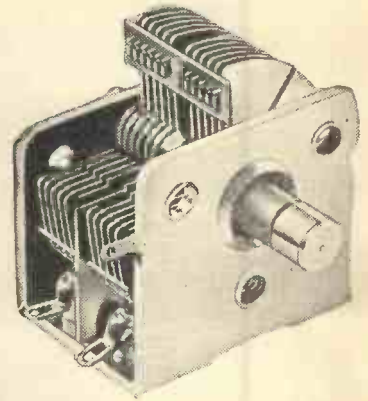
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A popular and well proved Compression Trimmer available in 1, 2, 3, 4, 5 and 6 Bank Units with fixed screwed adjusting stem ensuring high stability. Cap. 3-33pf. and 25-50 pf.



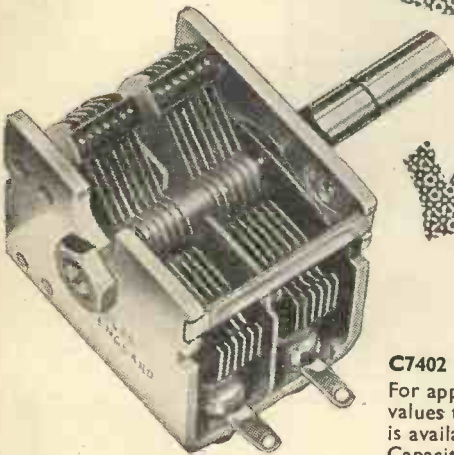
#### S5511 Trimmer

Screw type trimmer for chassis mounting. Capacity 1pf to 10 pfs.



#### C7802 Condenser

A miniature 2-gang less than 1" in length. Can be provided with trimmers and either direct or slow motion drive. Capacity swing 118 pfs and 82 pfs.



#### C7402 Condenser

For applications requiring larger capacity values than C7802. A cut oscillator vane is available for an I.F. of 470 Kc/s. Capacity swing 196 pfs aerial and 110 pfs oscillator or 196 pfs in each section. Either slow motion or direct drive types are offered with trimmers if required.



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Centres are 5/32", available in single, 2, 4, 6, 8, 10 and 12 units with insulators of aluminium oxide possessing high strength in relation to size. Larger versions can be supplied both in single stand-off and strip form with voltage ratings up to 4 K.V. working.

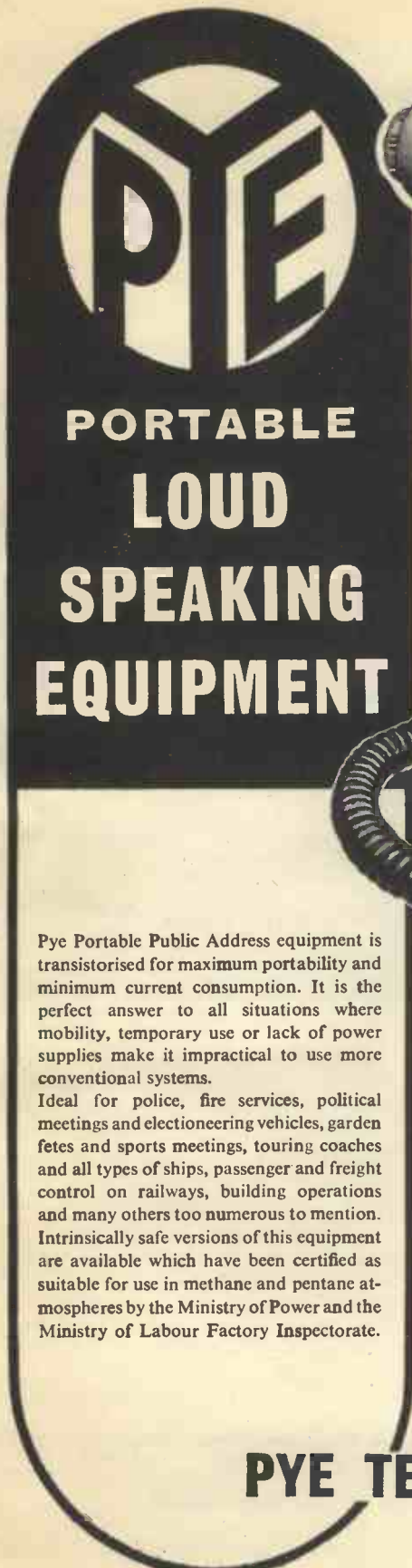
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Pye Portable Public Address equipment is transistorised for maximum portability and minimum current consumption. It is the perfect answer to all situations where mobility, temporary use or lack of power supplies make it impractical to use more conventional systems.

Ideal for police, fire services, political meetings and electioneering vehicles, garden fetes and sports meetings, touring coaches and all types of ships, passenger and freight control on railways, building operations and many others too numerous to mention. Intrinsicly safe versions of this equipment are available which have been certified as suitable for use in methane and pentane atmospheres by the Ministry of Power and the Ministry of Labour Factory Inspectorate.



**3 WATTS** The Hand Portable Electronic Megaphone weighs only 5 lb. The transistor amplifier gives more than 3 watts output. It uses standard torch batteries which last about six months.

The Portable Electronic Megaphone with adjustable stand and separate microphone is suitable for all temporary occasions. It can be stood, mounted at an angle or easily carried. It is similar to the Hand Portable and is completely self-contained.



**10 WATTS** The Portable Transistor Amplifier weighs only 5½ lb. and measures 8" x 3½" x 6". It will deliver 10 watts output for a consumption of 1.8 amps from a 12 volt battery. It is ideal for use in moving vehicles or on sites where a mains supply is not available. A comprehensive selection of microphones and loudspeakers is available.

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## "Ranger" v.h.f. boot-mounting Radiotelephone

**Brief Specification:**

PTC 8201/2: 20 watt F.M.

PTC 2201/2: 15 watt A.M.

PTC 8101/2: 10 watt F.M.

PTC 2101/2: 5 watt A.M.

Available from 25—174 Mc/s.

Simplex or Duplex operation

"Split-channel" selectivity

Up to 6 switch-selected channels

Power supply: Models for 6, 12 or 24 volts operation.

The Pye "Ranger" radiotelephone has been designed to meet the specifications of the American F.C.C. and the British G.P.O. It is suitable for use under all climatic conditions and is vibration proofed. Its features include light weight, low battery drain and low cost of installation and maintenance. Optional features are alternative channel spacing; public address and rebroadcast facility on A.M. types; and a choice of fist microphone or telephone handset. The models listed here form part of a complete series which include dash mounting types and fixed stations.

## PYE TELECOMMUNICATIONS LIMITED

NEWMARKET ROAD • CAMBRIDGE

Telephone: Teversham 3131.

Telegrams: Pyetelecom Cambridge.



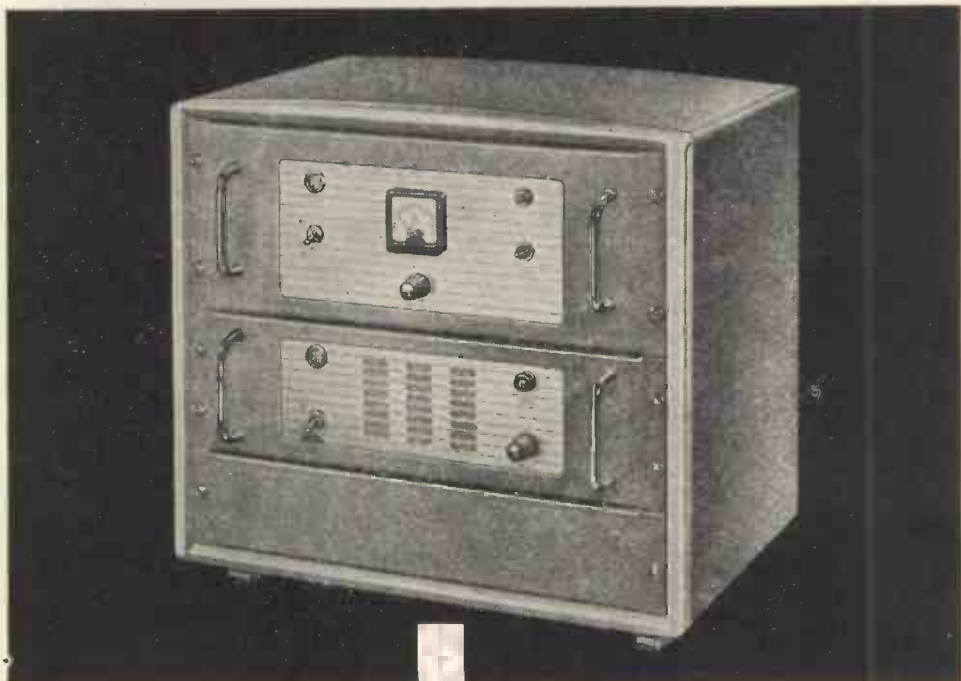


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FEATURING PYE TELECOMMUNICATIONS EQUIPMENT



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TO H.R.M. DUKE OF EDINBURGH  
SUPPLIERS OF  
RADIO TELEPHONE EQUIPMENT  
PYE TELECOMMUNICATIONS LTD.



## Ranger '450' Radiotelephone Fixed Station

### Brief specification:

**Frequency Range:** 450—470 Mc/s.  
**R.F. Output:** 5 watts  
**Channel Spacing:** 50 or 60 Kc/s.  
**Modulation:** F.M.  
**Service:** F 3 telephony  
**Operation:** Single or double  
 frequency simplex  
 or duplex.  
**Power Supply:** 100—150 and  
 200—250 volts  
 A.C. 40—60 c/s.

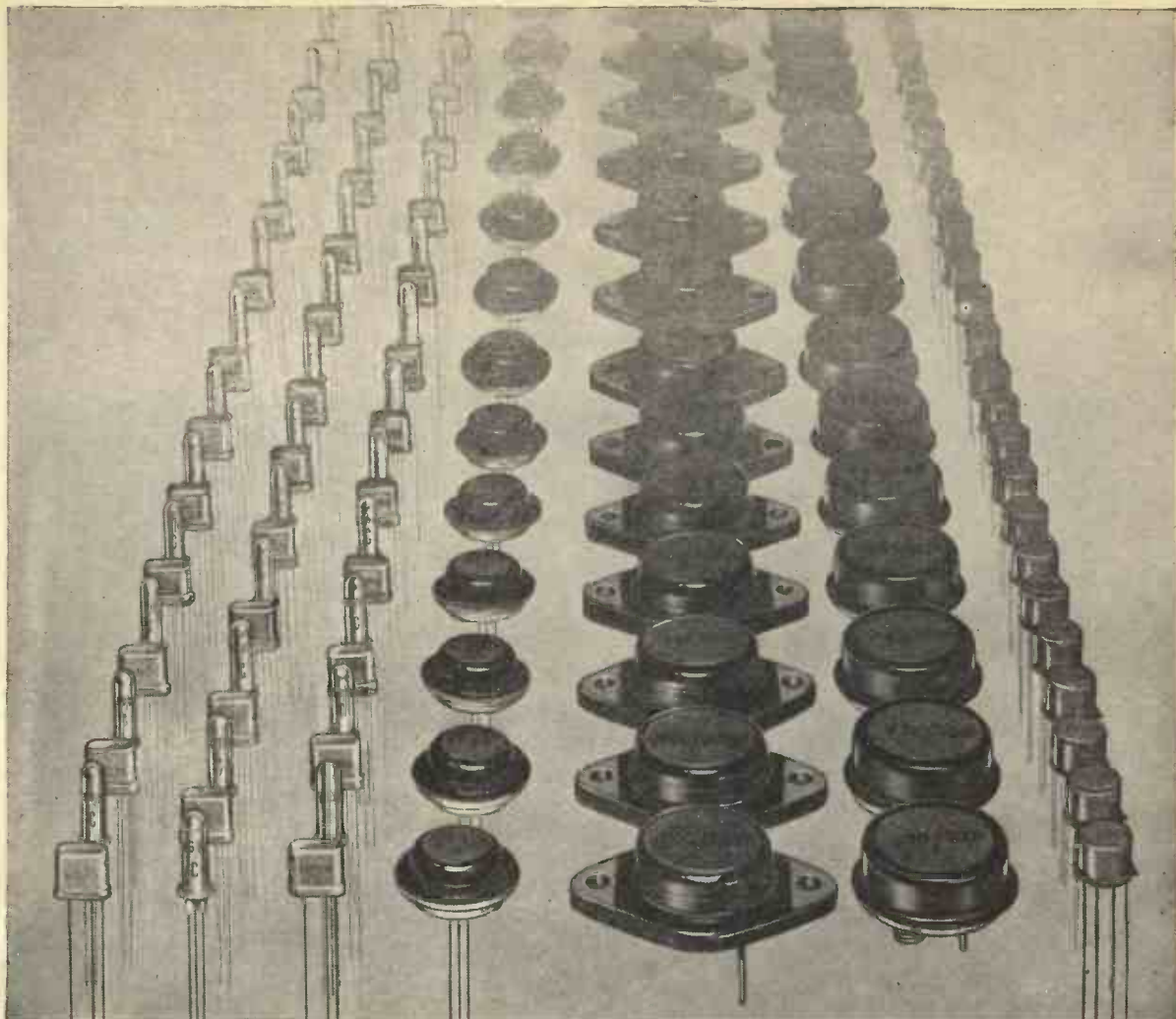
The Pye PTC 8710 Fixed Station has been designed to provide reliable communications in the 450—470 Mc/s band. Both the transmitter and receiver are fitted with temperature-controlled crystal units to ensure an exceedingly high frequency stability over a wide temperature range. All the materials used have been chosen to ensure reliable operation under a wide range of climatic conditions. Additional control equipment is available for operating the Station at distances of up to 200 feet or, via telephone lines, over greater distances. A switchboard Termination Unit is also available for working the Station into a manual or automatic telephone switchboard.

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**NEWMARKET  
TRANSISTORS**

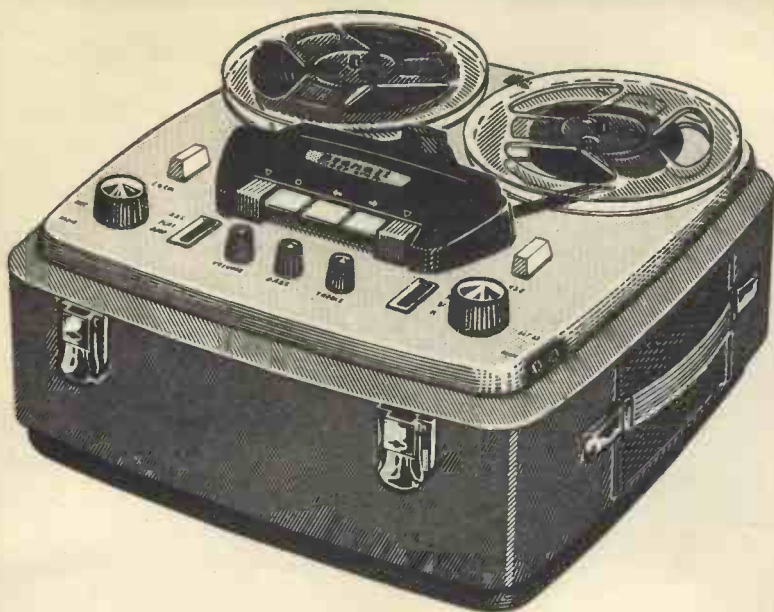
Switching	V10/1S, V10/1SC V10/2S, V10/2SC	Voltage ratings 10, 15, 20V. Switching Rise times down to $\cdot 1 \mu\text{s}$ (V10/1S), $\cdot 2 \mu\text{s}$ (V10/2S). Max. dissipation 125 mW; Peak current 500mA. Rectangular or K1007/A1/D2 standard cylindrical style can.
R. F.	V6/2R, V6/2RC V6/4R, V6/4RC V6/8R, V6/8RC	Voltage ratings 6, 10, 15, 20, 25V. Typ. frequency cut-offs 3, 5.5, 10 Mc/s. Max. dissipation 125mW; Rectangular or K1007/A1/D2 standard cylindrical style can.
A. F.	V10/15A, V10/15AC V10/30A, V10/30AC V10/50A, V10/50AC	Voltage ratings 10, 15, 30V. Typ. betas 20, 40, 75. Max. dissipation 200mW; Rectangular or K1007/A1/D2 standard cylindrical style can.
I. P. (Intermediate Power)	V15/20IP V30/20IP V60/20IP	Voltage ratings 15, 30, 60V. Typ. beta 40. Max. dissipation 2W; Max. current 2 Amp.
N. P. (Noodle Power)	V15/15NP V15/30NP V30/15NP V30/30NP	Voltage ratings 15, 30V. Typ. betas 25, 40. Max. dissipation 15W; Max. current 6 Amp. Standard Diamond (JEDEC E2-42) Base. Cold welded case.
P. (Power)	V15/10P   V30/10P   V60/10P V15/20P   V30/20P   V60/20P V15/30P   V30/30P   V60/30P	Voltage ratings 15, 30, 60V. Typ. betas 18, 24, 40. Max. dissipation 10W; Max current 3 Amp.
VHF Drift	V15/20R	Voltage rating 15V. Typ. frequency cut-off 30 Mc/s. Max. dissipation 75mW, Max. current 12mA. JEDEC TO-5 welded case.

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Exning Road, Newmarket, Suffolk. Tel: Newmarket 3381/4. Cables: Semicon Newmarket

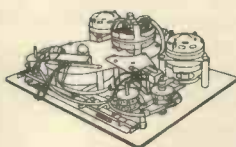
TA 2722



**BRENELL 3 STAR 58 GNS.**



**BRENELL MK. 5 RECORDER 64 GNS.**



**BRENELL MK. 5 DECK 28 GNS.**

**Inside and out . . .** the expertly designed Brenell tape recording equipment establishes a lasting impression of quality at its best. How true this is of its performance too!

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Alphasil .013" thick is produced in coil 30 inches wide, and can be supplied slit to narrower widths by arrangement.

TABLE OF WATTS LOSSES  
Frequency cycles/second      Guaranteed max. total losses at B, Max. 15 Kilogauss

ALPHASIL 44	50	.62 watts/lb.
ALPHASIL 40	50	.56 watts/lb.
ALPHASIL 37	50	.51 watts/lb.
ALPHASIL 33	50	.46 watts/lb.

ABOVE—A 4,000-lb. coil of 30" wide x .013" thick, ready for despatch.

RIGHT—Core-loss testing of Alphasil by the 'double-lap' Epstein method.

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ALPHASIL .004HF	400	8.00 watts/lb. at B. Max 15 Kilogauss
ALPHASIL .002HF	8,000	9.50 watts/lb. at B. Max 2 Kilogauss

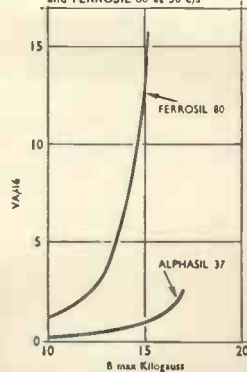
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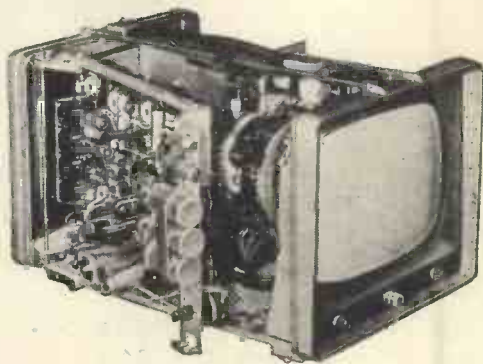
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- ★ Available for operation on either 405, 525, or 625-line standards.
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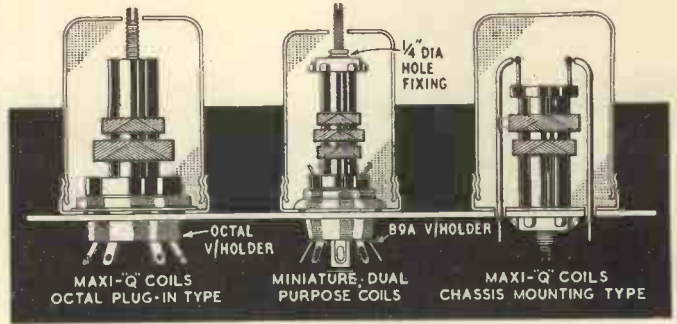
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**Phoenix**

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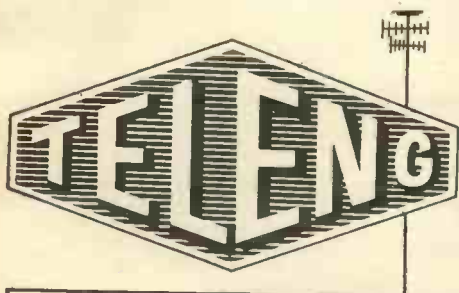
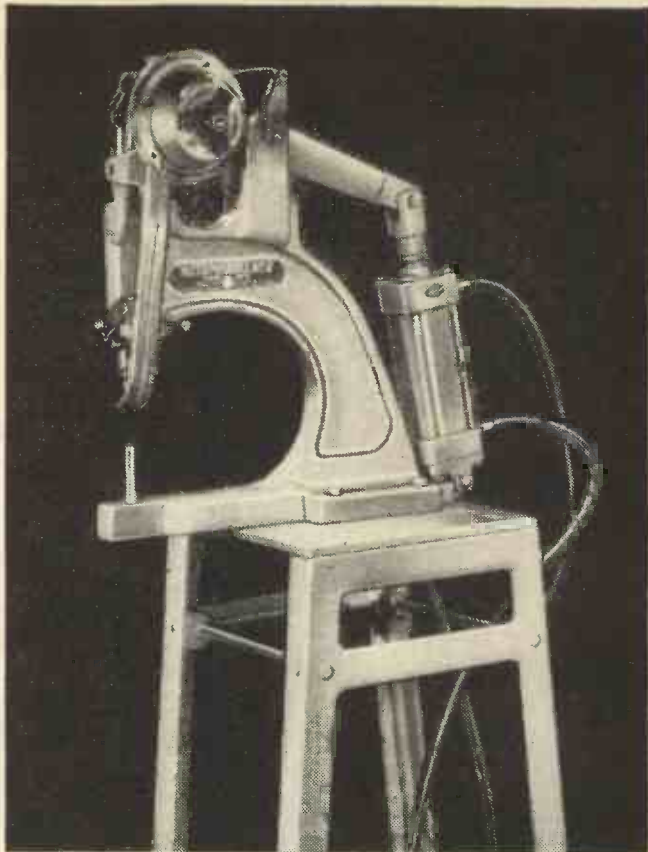
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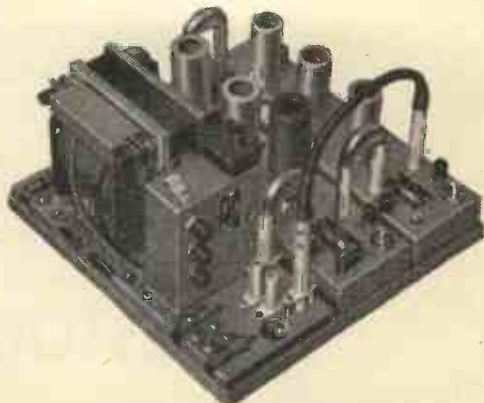
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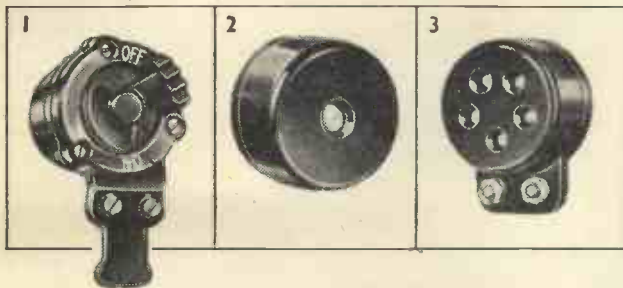
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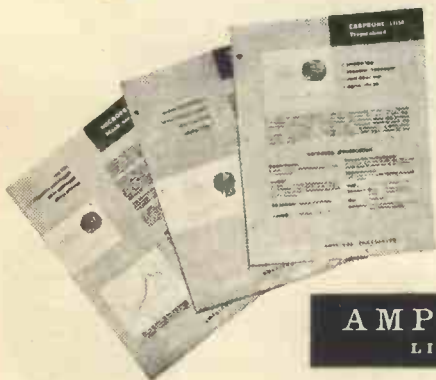
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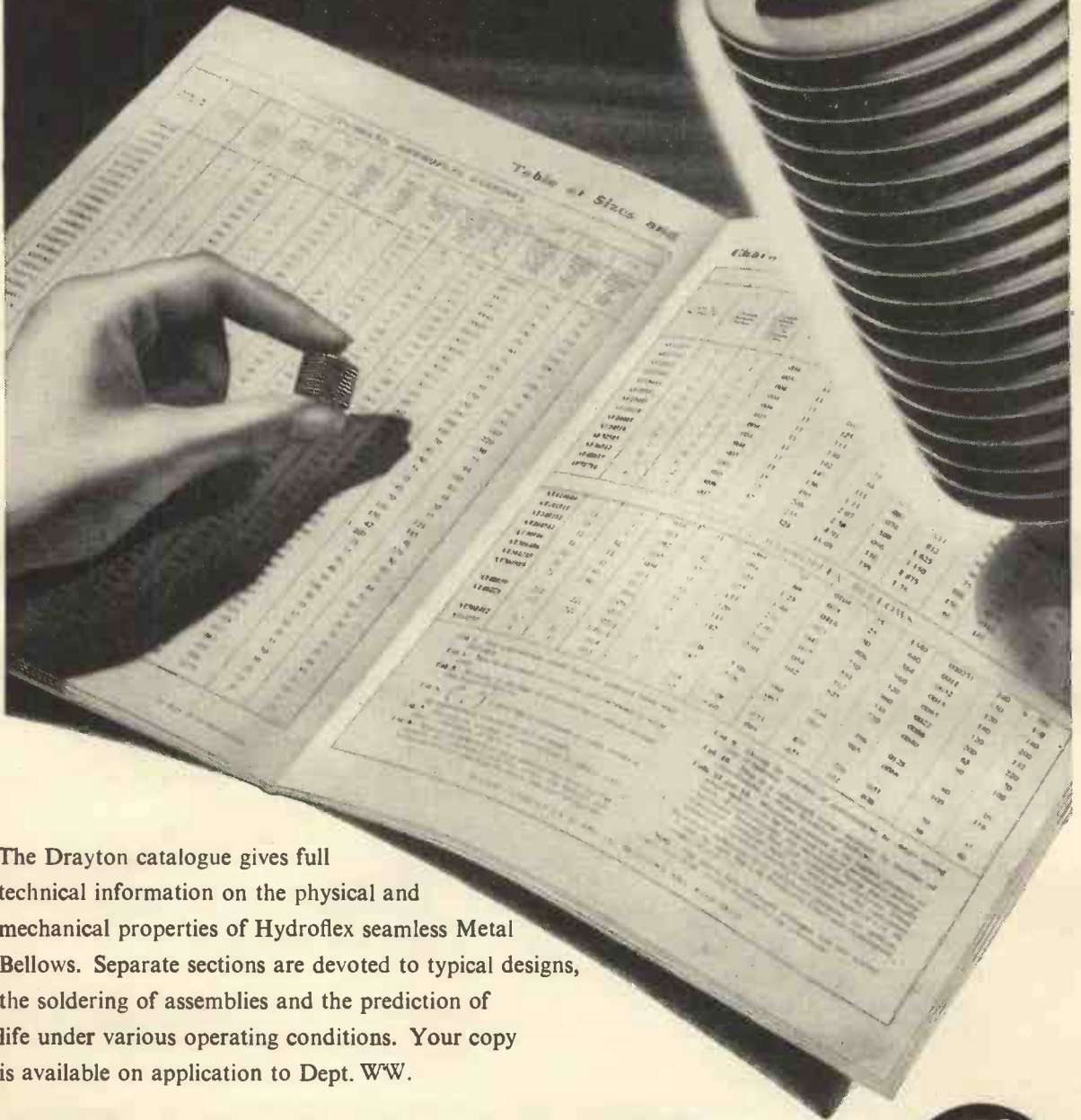
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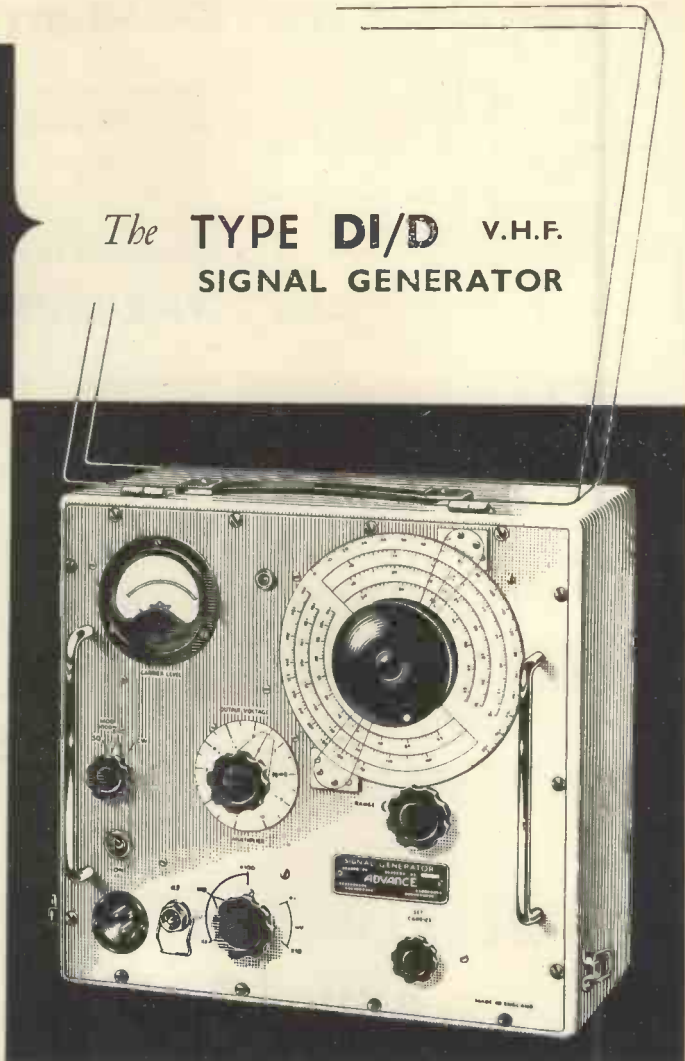
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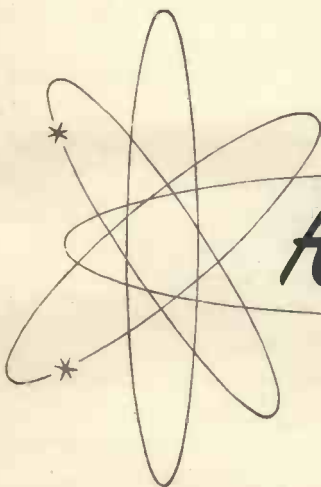
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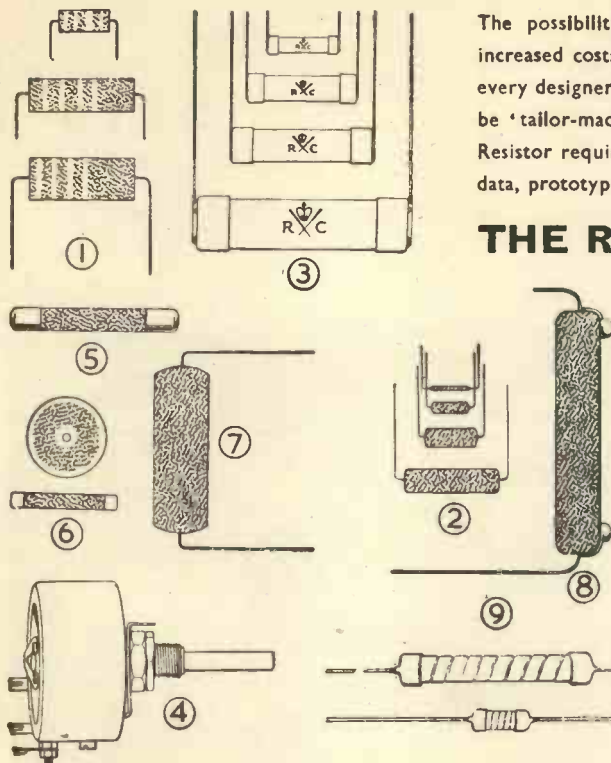
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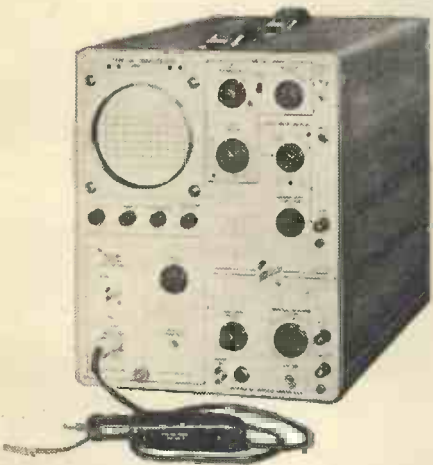
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**3.5 - millimicrosecond risetime.**

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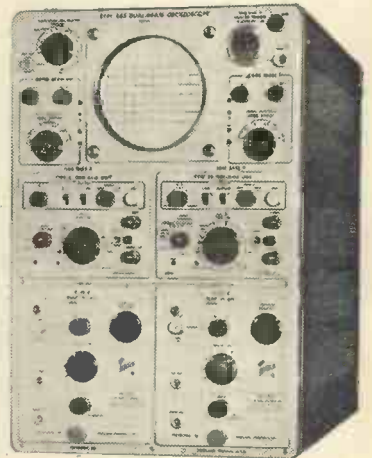
Having the identical general specifications as Type 581, the 585 has second time base generator. This acts as a sweep delay generator, providing a wide range of calibrated sweep delay, continuously variable over the range of 1 $\mu$ sec to 10 sec. Colour-correlated controls eliminate confusion, making this new high performance oscilloscope easy to operate.

### NEW DC to 30 MC

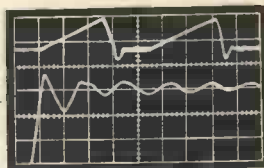
### Dual - Beam Oscilloscope

### Type 555.

Two electron beams, each with its own X and Y deflection systems, help make possible a highly versatile dual-beam oscilloscope. Either of the two time-base generators in the Type 555 can deflect either beam for dual and single displays, and either can deflect both beams for a dual display on the same time base. Time-base units are the plug-in



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Same signal displayed simultaneously on slow sweep (upper beam) and fast sweep (lower beam) shows both coarse and fine structure of waveform. Delay range—0.5  $\mu$ sec. to 50 secs.



Full details from

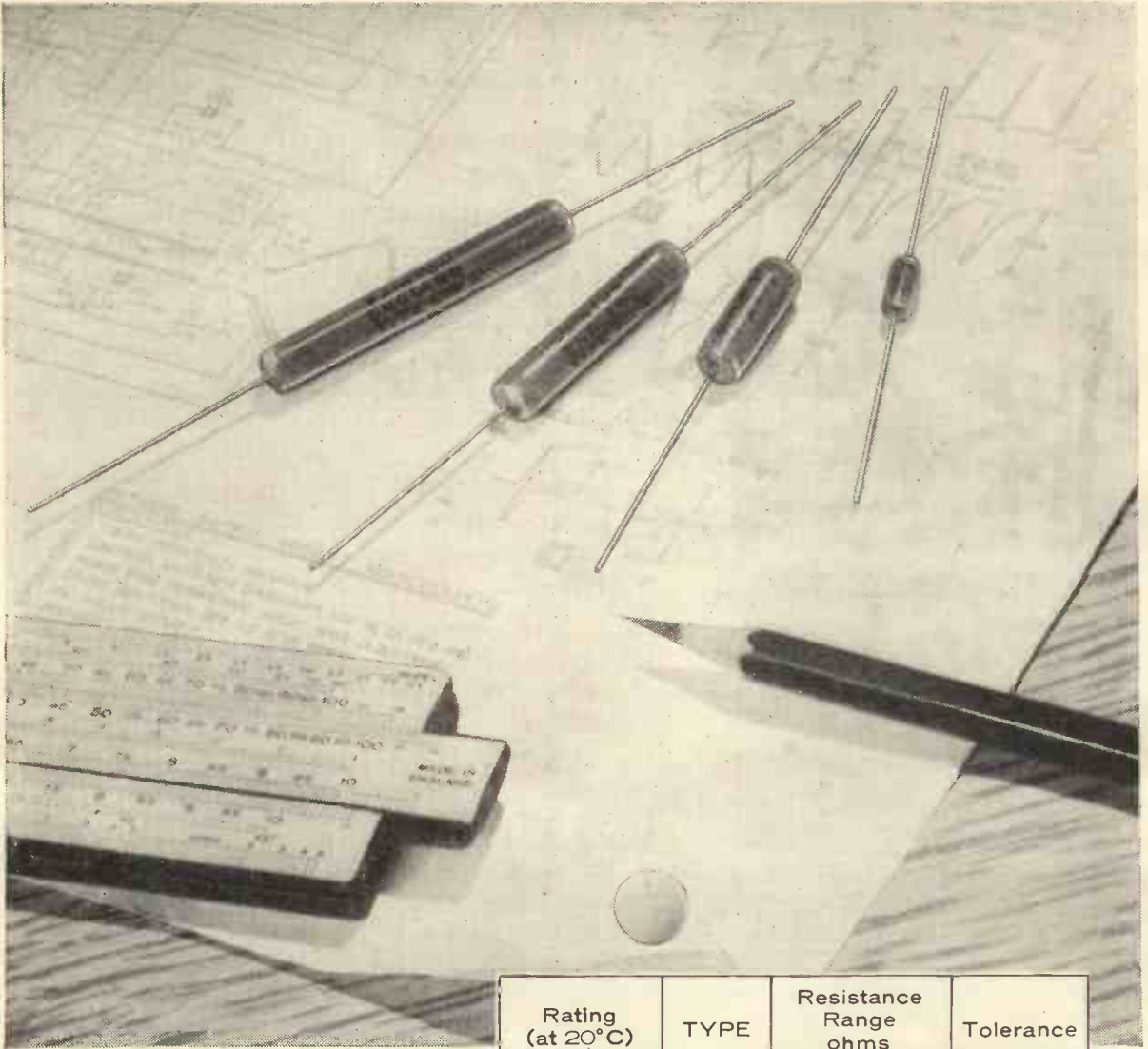
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# PAINTON Miniature Vitreous Wirewound Resistors



Rating (at 20°C) Watts	TYPE	Resistance Range ohms		Tolerance
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4	MV1A	1	9.9	10%
		10	6,800	5%
7	301A	2	68,000	5%
10	302A	4	140,000	5%
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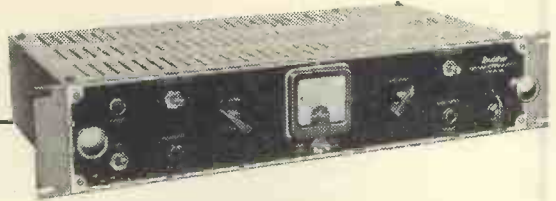
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# Greater versatility for the Redifon G.R. 400 TRANSISTORISED SSB Radiotelephone



The Redifon **GK. 189**

Two-Tone Keyer/converter, when used in conjunction with the GR. 400 gives the added facilities of TELEPRINTER working.



The Redifon **GR. 400**

TRANSISTORISED SSB Radiotelephone gives all the advantages of single side-band, yet is as simple to operate as an ordinary telephone. For R/T or CW operation. Compact. Reliable. Full tropical specification.

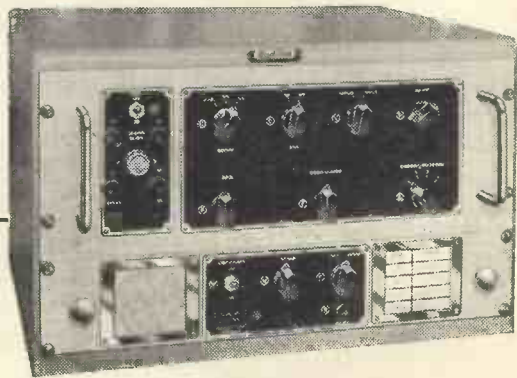
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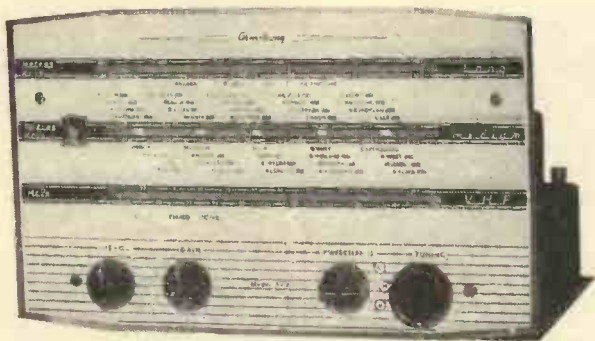
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The name ARMSTRONG is our registered trade mark.

## ST3 AM/FM TUNER price 26 gns.



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### ▶ THREE WAVEBANDS

Full coverage of the VHF band (87 to 108 m/cs.) and of the Medium and Long Wavebands.

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Incorporates its own power pack and the mains input is adjustable for different AC supply voltages.

### ▶ MATCH ANY AMPLIFIER

Variable feedback control adjusts output from 0 to 1 volt; with cathode follower, ensures perfect matching to any amplifier.

### ▶ EASE OF TUNING

On VHF, automatic frequency control gives  $\frac{1}{2}$  in. broad tuning for each transmission. Magic eye on medium and long.

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Unique 2nd I.F. stage on AM and very efficient AVC action, provide Continental reception of excellent programme value.

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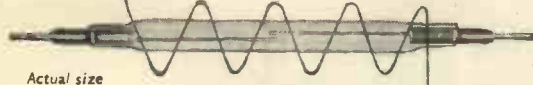
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A gold plated relay contact hermetically sealed in inert gas for absolute reliability, high speed and low contact bounce.



maximum current...	...	250 mA
maximum resistive load ...	...	15 W
maximum closed resistance...	...	50 mΩ
minimum open resistance...	...	5 x 10 <sup>11</sup> Ω

nominal operate ampere turns	120 AT
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operate time less than ...	2 mS
bounce time less than ...	0.5 mS
release time less than ...	0.5 mS

our Technical Service Department is ready to provide further details of characteristics or application.

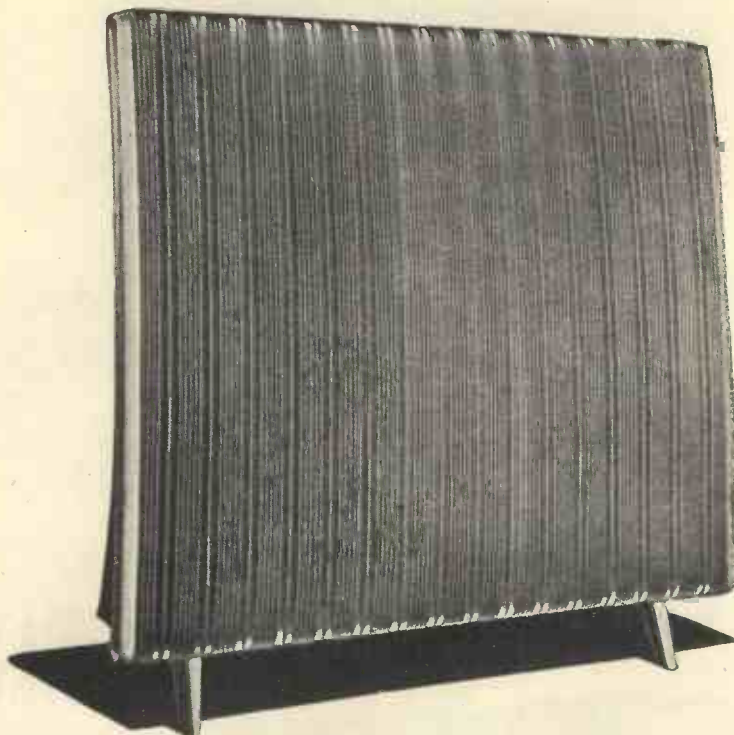
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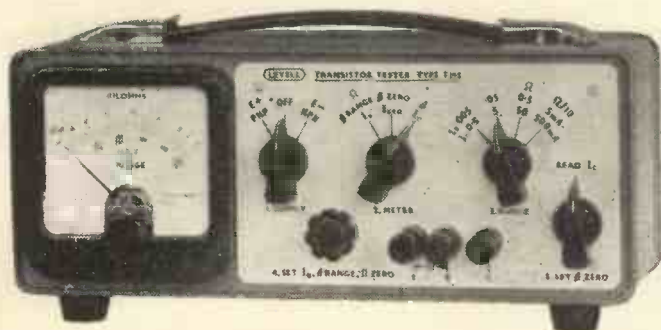
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**TRANSISTOR TESTER**

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Measures the current gains of PNP and NPN transistors, the values of resistances, and the leakage currents of diodes, transistors and low voltage electrolytic condensers.

Collector Current Ranges: 0.5, 5, 50, 500 mA.

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Price with batteries: **£17.0.0**

**A.C. MILLIVOLTMETER**

TYPE TM2A

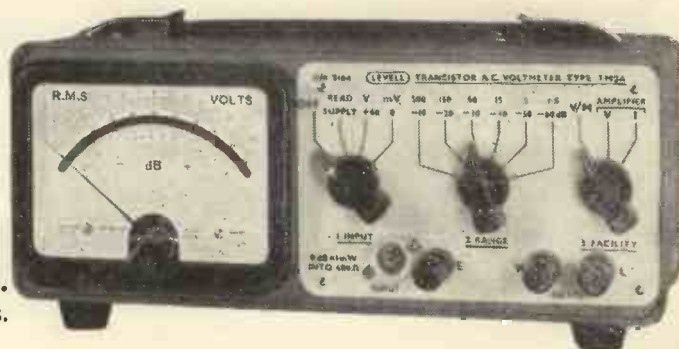
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## Special Features

- Automatic Ranging and Polarity
- High Accuracy and Resolution
- Fast Reading Time
- Complete Reliability

### SPECIFICATION

<b>Display</b>	Three digit plus automatic polarity indication and automatic decimal placement.
<b>Automatic Ranges</b>	D.C. Volts in 3 ranges 0.01 — 9.99 V 10.0 — 99.9 V 100V — 999 V
<b>Accuracy</b>	0.1% of full scale reading on any range.
<b>Average Reading Time</b>	0.7 seconds.
<b>Input Impedance at Balance</b>	10 Megohms.
<b>Input</b>	110 — 250V A.C.50—60 c/s 50W.
<b>Weight</b>	50 lbs. approximately.
<b>Style</b>	Bench cabinet 17" x 13" x 10½" high with optional brackets for standard rack mounting.

*In view of continuing development, the right is reserved to alter the specification or design of this instrument.*

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ES/T64

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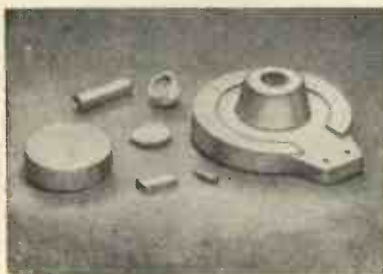


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## Model W3

Fitted with linear suspension 12" unit of advanced design with open mounted 5" and 3" units giving wide treble dispersion without "boxiness".

**SIZE:** 28" x 14" x 12".

**Weight** 48lb. complete.

**IMPEDANCE:** 12-15 ohms only. **Max. input:** 15 watts.

**Complete with separate middle and treble controls.**

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## MODEL L10 HIGH FIDELITY 10 WATT AMPLIFIER

WITH SEPARATE PRE-AMPLIFIER

Supplied complete only (i.e. Main Amplifier and Pre-amp.) **15** Retail Price **GNS.**

Size of main amplifier 9in. x 7in. x 5in., Pre-amp. 11in. x 4½in. x 2½in. Front Plate 12in. x 3½in. Stoved Gold hammered finished chassis. Front Plate Polychromatic Gold. Weight of main amplifier 10lb. Pre-amp. 3lb. For 50/60 c.p.s. A.C. mains 200-230-250 v. or to order for export.

The Following Outstanding Test Figures include Pre-amplifier.

**Sensitivity (for 10 watts)**

L.P. 25 m.v.

78 r.p.m. 20 m.v.

Radio, 35 m.v.

Microphone, 2.5 m.v.

**Input Impedance**  
All inputs 500k. Plus 10pfd.

**Frequency Response**  
±2 d.b. 30—25,000 c.p.s.

**Power Consumption**  
90 watts.

**Maximum Power Output**  
In excess of 12 watts.

**Negative Feedback**  
Total 32 d.b.

**HARMONIC DISTORTION**  
(Inc. Pre-amplifier)  
0.09% measured at 10 watts.  
**Damping Factor 35**

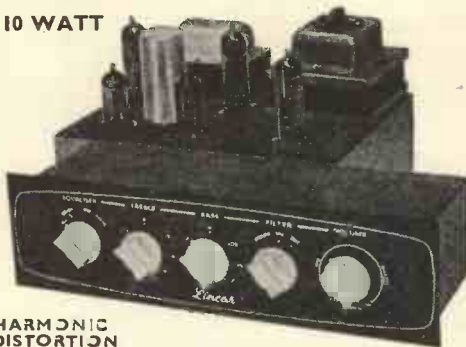
**Bass Control**  
+9 d.b. to -9 d.b.  
at 50 c.p.s.

**Treble Control**  
+9 d.b. to -9 d.b.  
at 12,000 c.p.s.

**Hum Level**  
-70 d.b.

**Filter**  
-7 d.b. at 9 Kc/s.

-10 d.b. at 5 Kc/s.



For **HIGH SENSITIVITY!**  
**HIGHEST FIDELITY!**  
**MAXIMUM RELIABILITY!**  
**REASONABLE COST!** Also Available

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Size approx. 7-5½in. high. Sensitivity is 28 millivolts so that the input socket can be used for either microphone or gram., tape, radio tuner, etc. B.V.A. valves used are ECC83, EL84, EZ80. Controls are: Vol. Treble and Bass with mains switch. The Tone controls provide full compensation for long playing records. Output matching for 3 ohm loudspeaker. Retail price £5/19/6.

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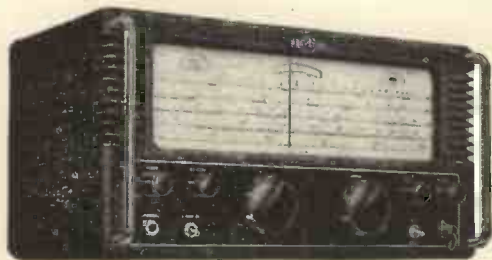
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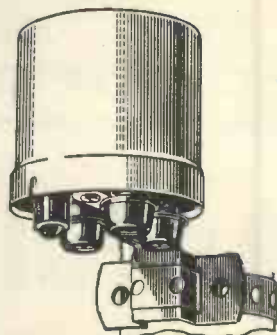
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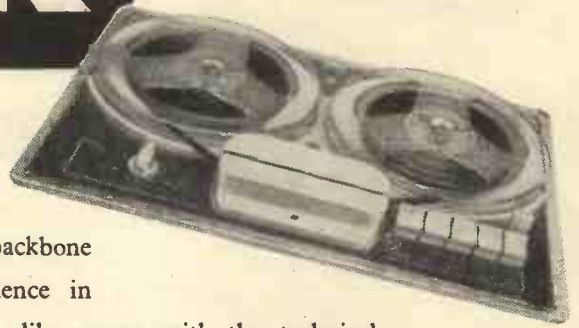
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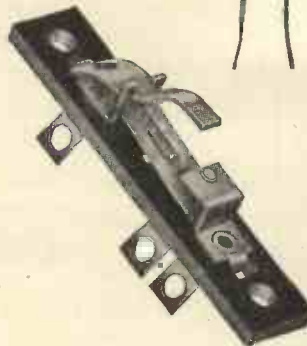
T.626: Double pole 3-AMP switch  
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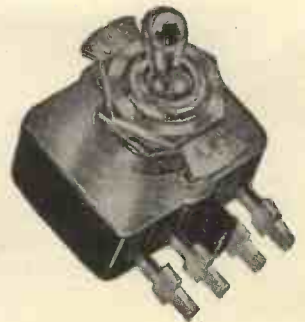
S.L.166



T.225



T.280



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Vacuum formed controlled edge bass diaphragm, with plastic termination.

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Plastic terminated vacuum formed low frequency diaphragm, free edged.

Automatic mechanical crossover to high stability mid-range radiator.

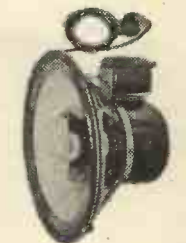
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H.F. unit precision built ; pressure driven, horn loaded ; with aluminium coil and diaphragm in self-aligning assembly with air chamber.

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FMT/1

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JSA/2



EM/10



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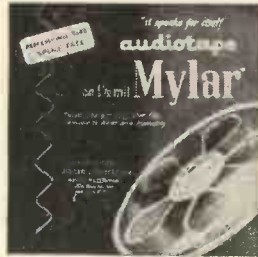
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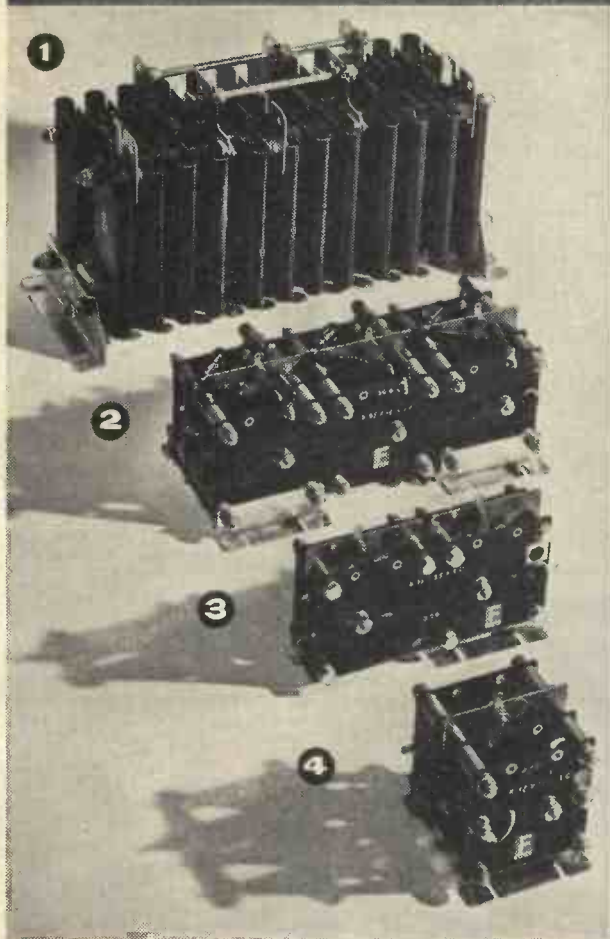
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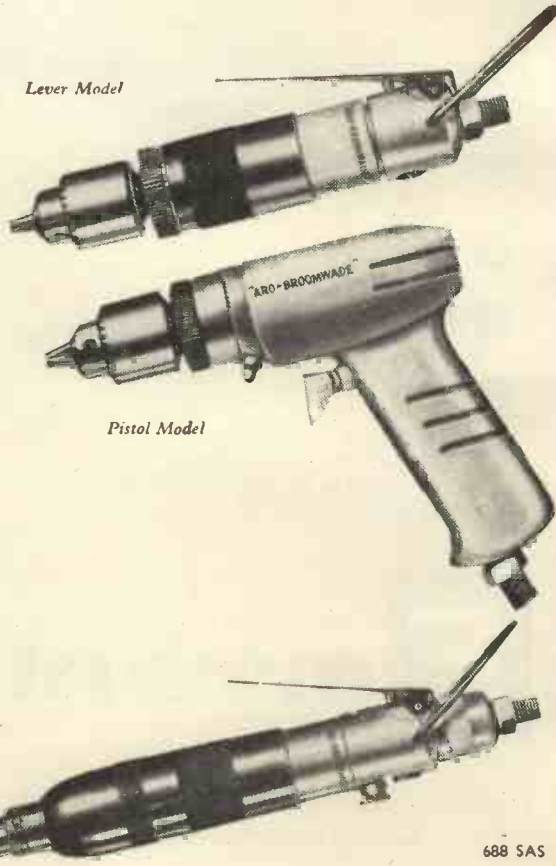
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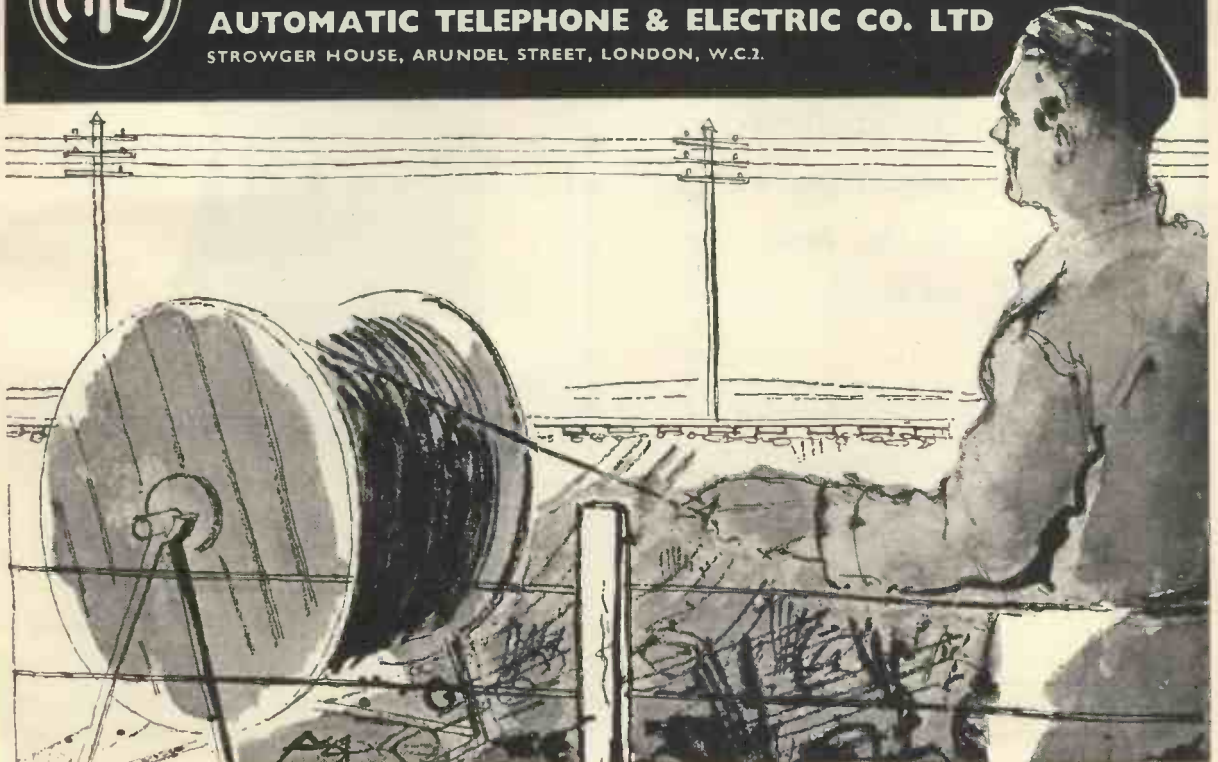
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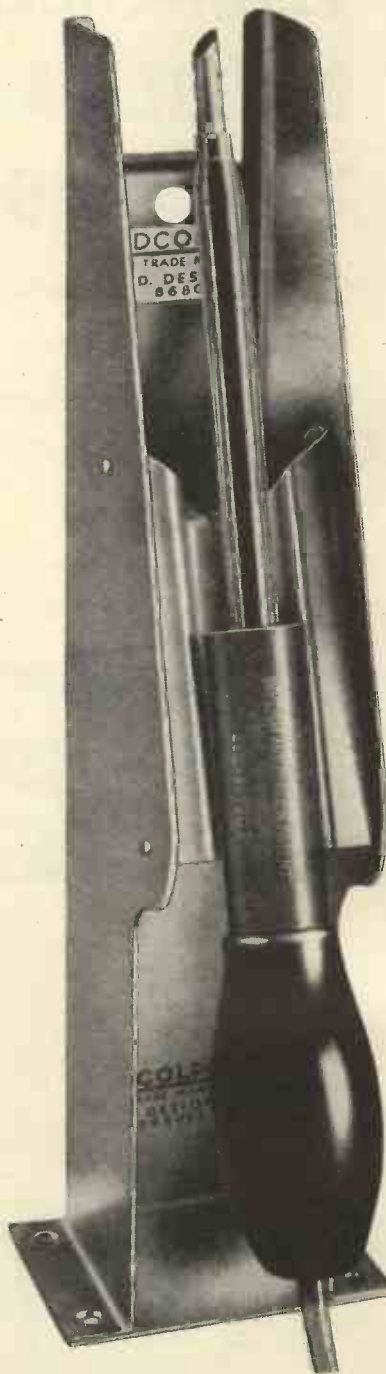
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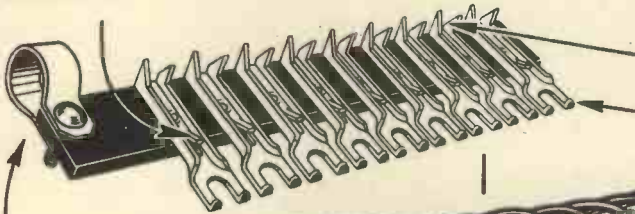
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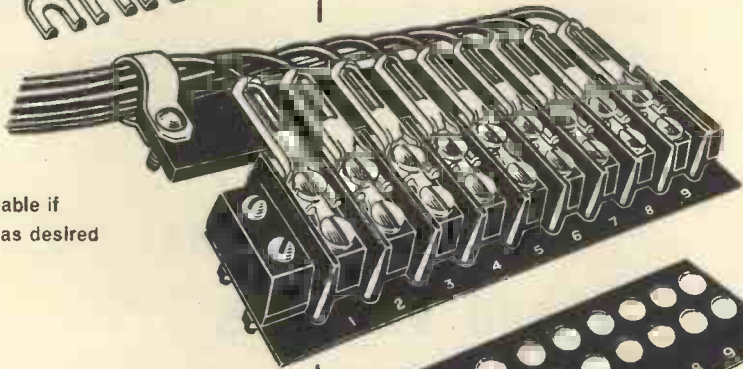
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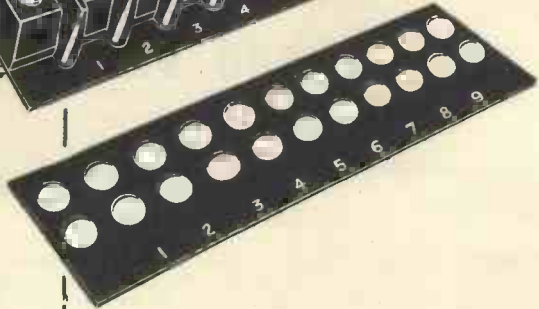


(c) Cable secured by crimping

(d) Upturned ends hold terminal under screws before tightening

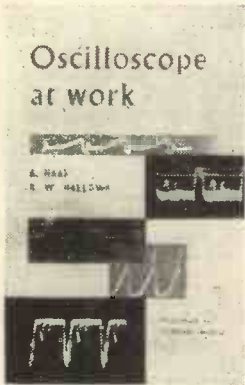
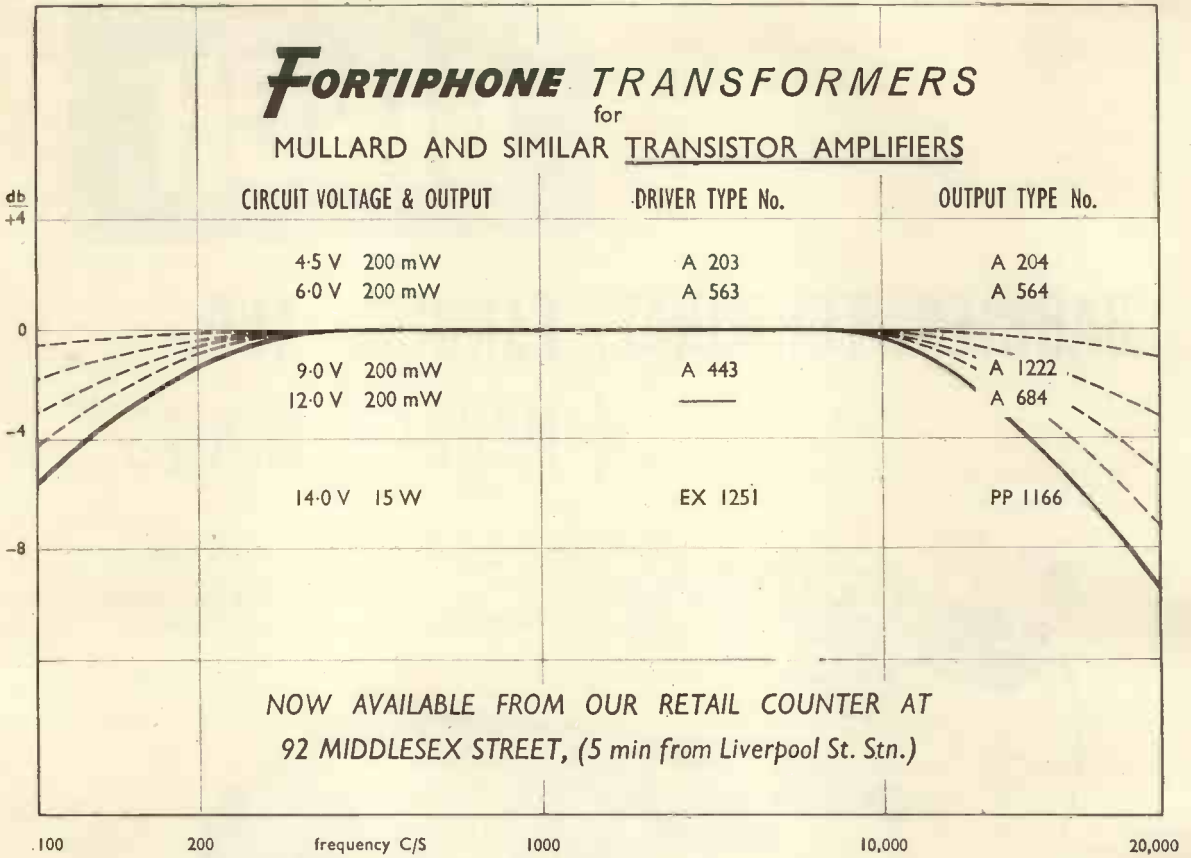


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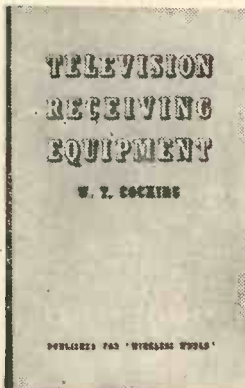
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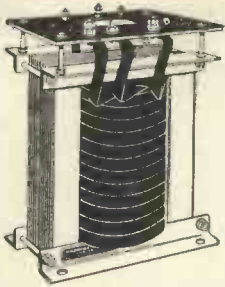
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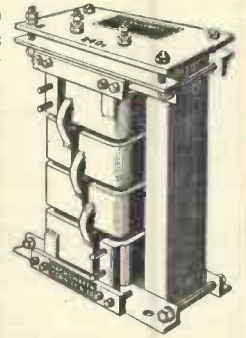
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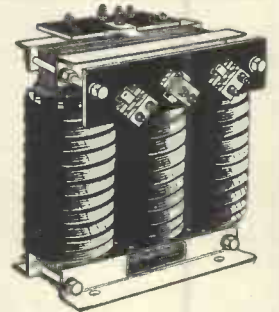
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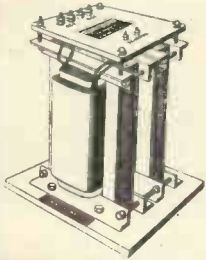
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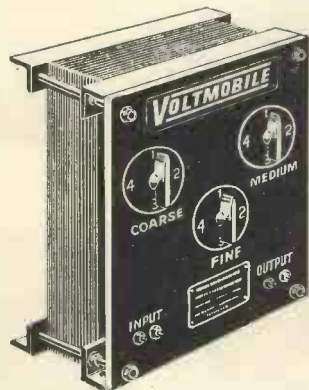
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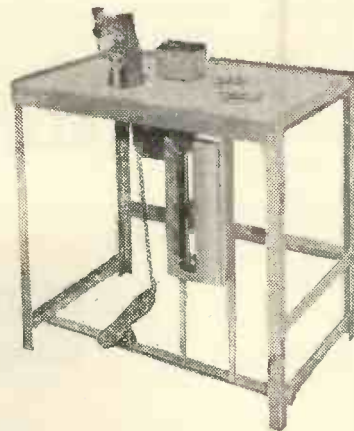
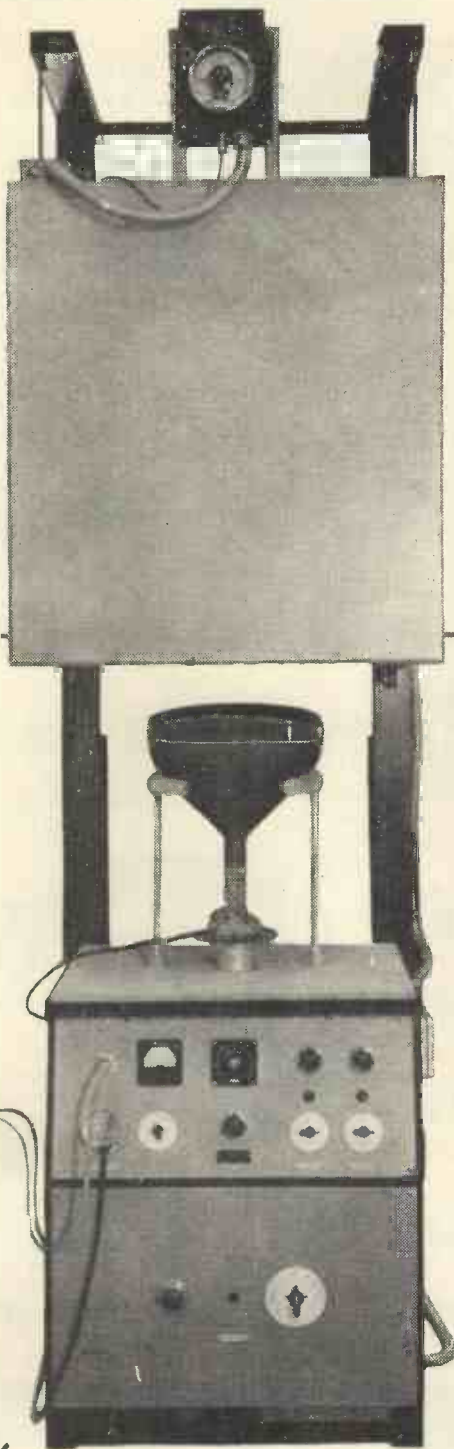
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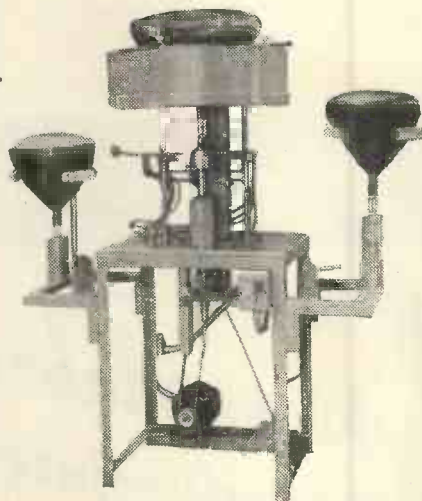
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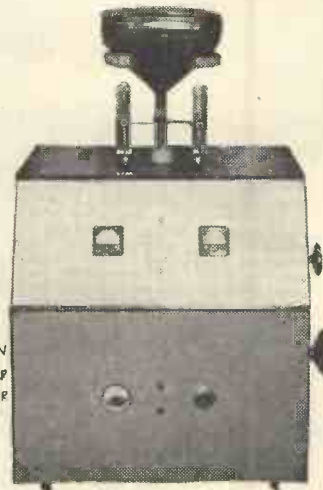
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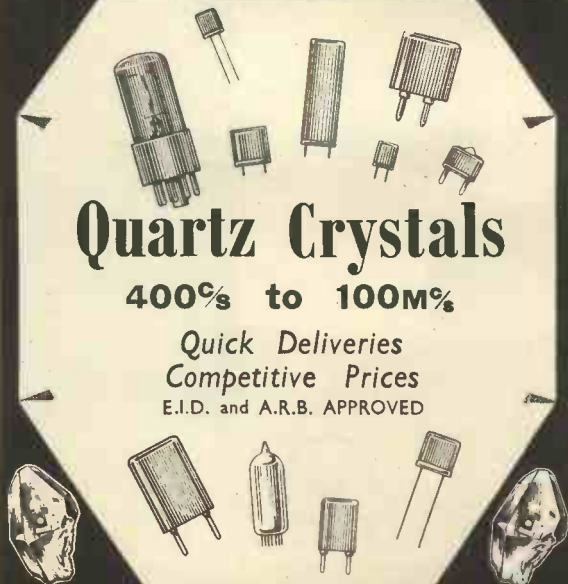
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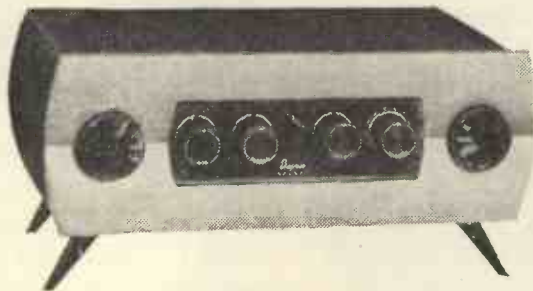
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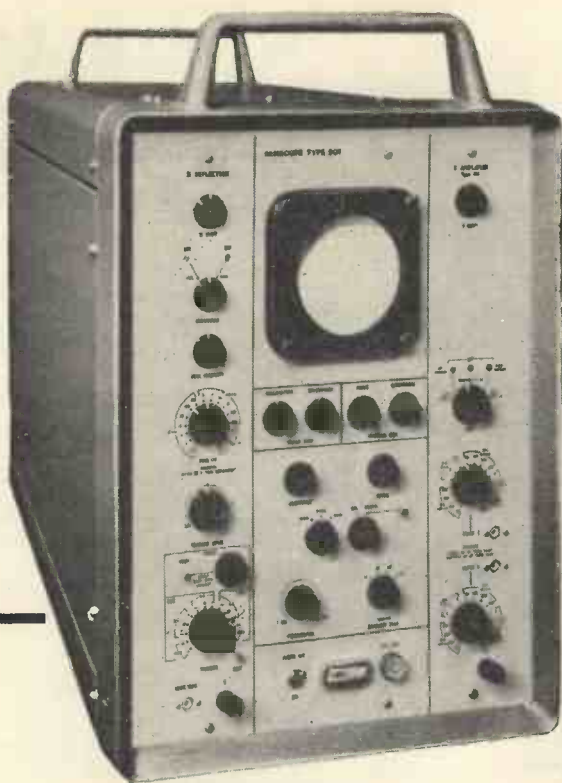
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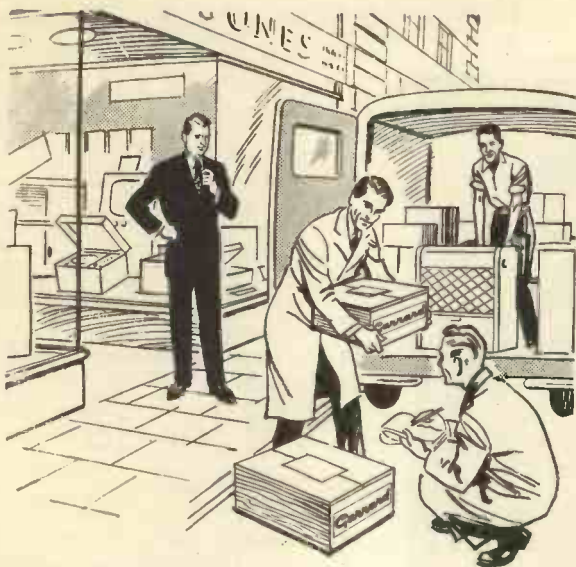
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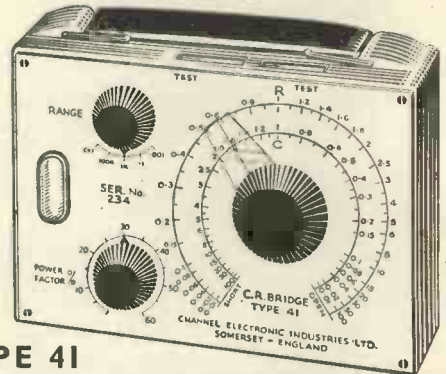
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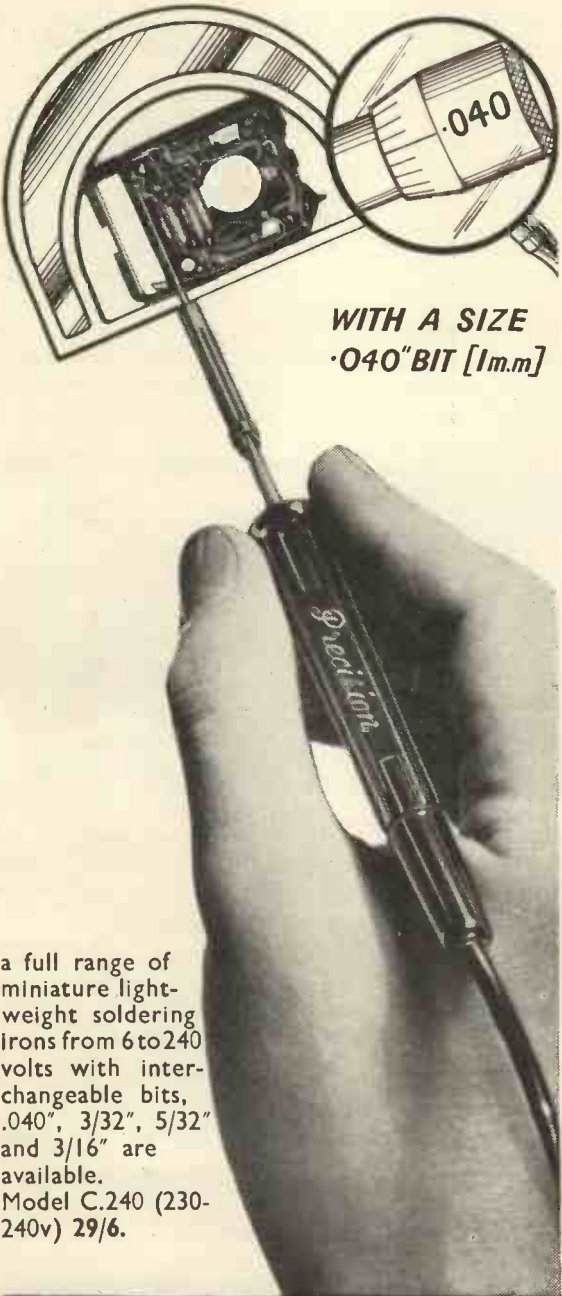
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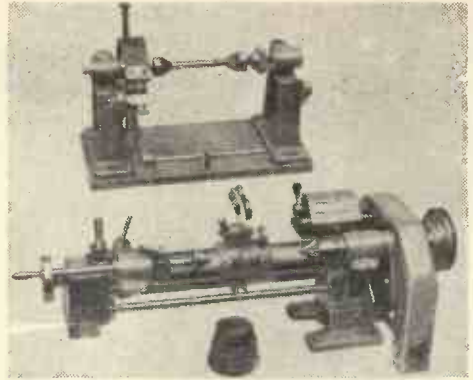


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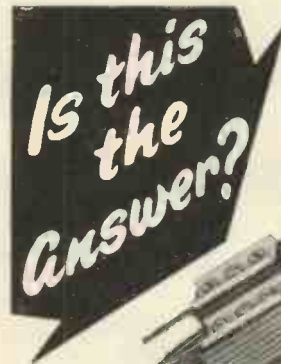
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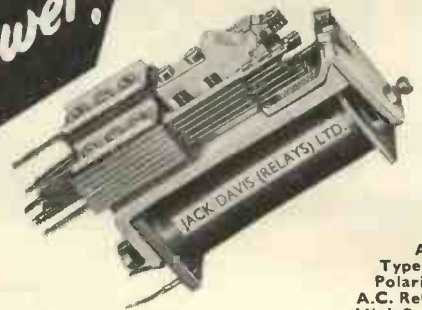
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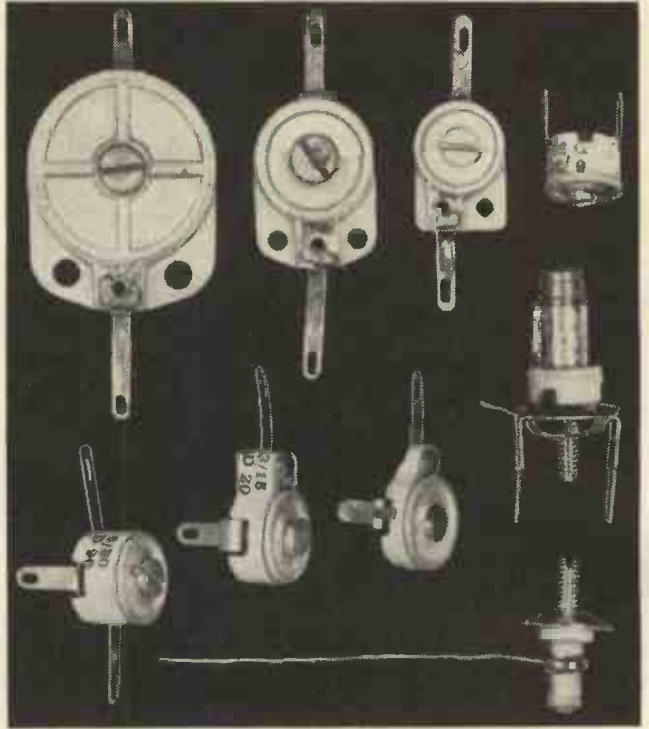
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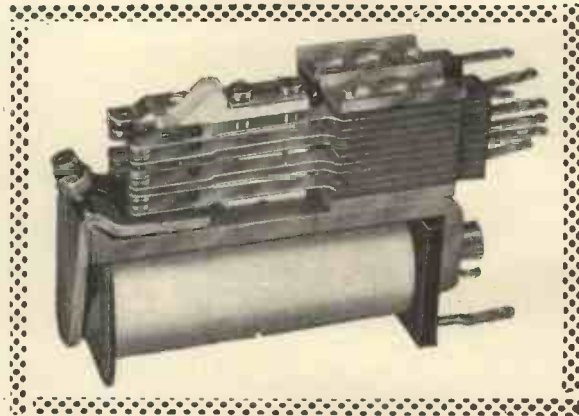
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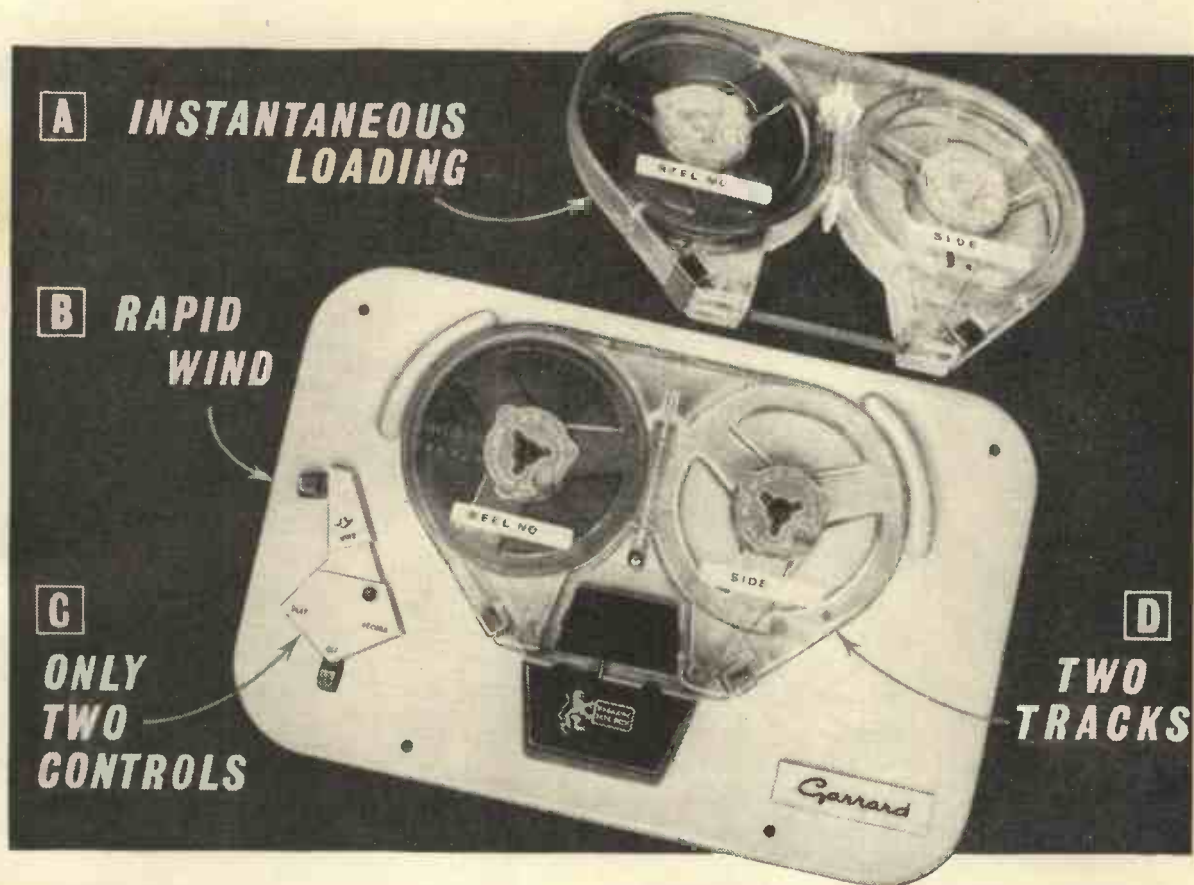
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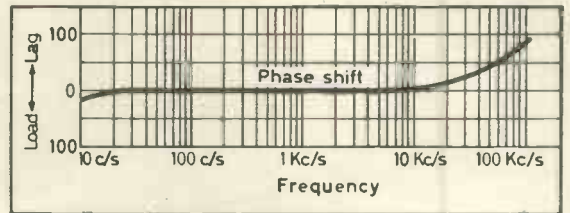
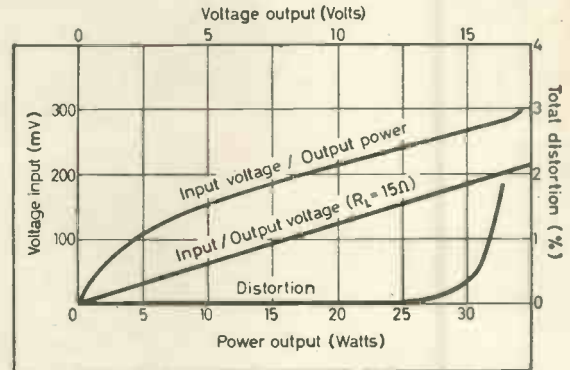
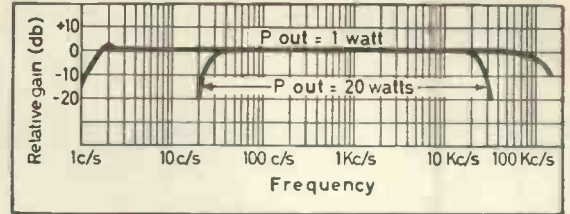
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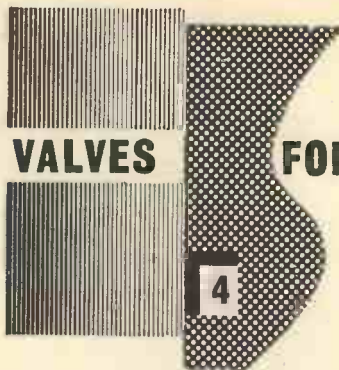
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# FRAME GRID VALVES FOR TELEVISION



The second advertisement in this series described the EF183, which is a variable- $\mu$  r.f. pentode, and discussed its use in the i.f. stages of television receivers.

When little or no control is required, a straight r.f. pentode, the EF184, is available. This valve is particularly suitable for use in uncontrolled final i.f. amplifiers, or in television systems using f.m. sound.

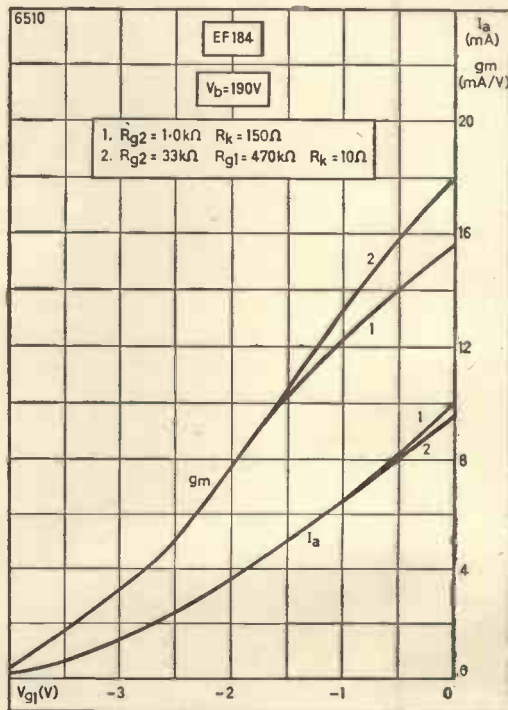
The EF184, in common with the other types in the Mullard frame grid range, has about twice the slope of its conventional counterpart. Under comparable conditions, the conventional EF80 has a slope of  $7.4\text{mA/V}$ , as against  $15.5\text{mA/V}$  for the EF184. This doubling of the slope provides a substantially improved gain per stage, of the order of 2 or  $2\frac{1}{2}$  times.

Under cathode bias conditions the EF184 shows an advantage in gain of 6dB over the EF80. If grid current bias is used, the advantage can be increased to 8dB. It should be noted that it is good practice to include a certain amount of cathode bias for these high slope valves, even when they are working under grid current bias conditions, and when a large value of sliding screen resistor is used. A suitable value for the EF184 under these conditions is about  $10\Omega$ . This value is also sufficient for input capacitance compensation with small amounts of a.g.c., or with variations in bias that might be caused by changes in signal level with large signals.

It was said above that the EF184 is suitable for use when little or no control is required. This should be interpreted to mean a control of not more than 2 or 3 times. If a

greater control ratio is required, the variable- $\mu$  EF183 should be used instead, since the variations of its tail from valve to valve are kept within narrow limits.

Typical anode current and mutual conductance characteristics under cathode bias and grid current bias conditions are shown in the graph.



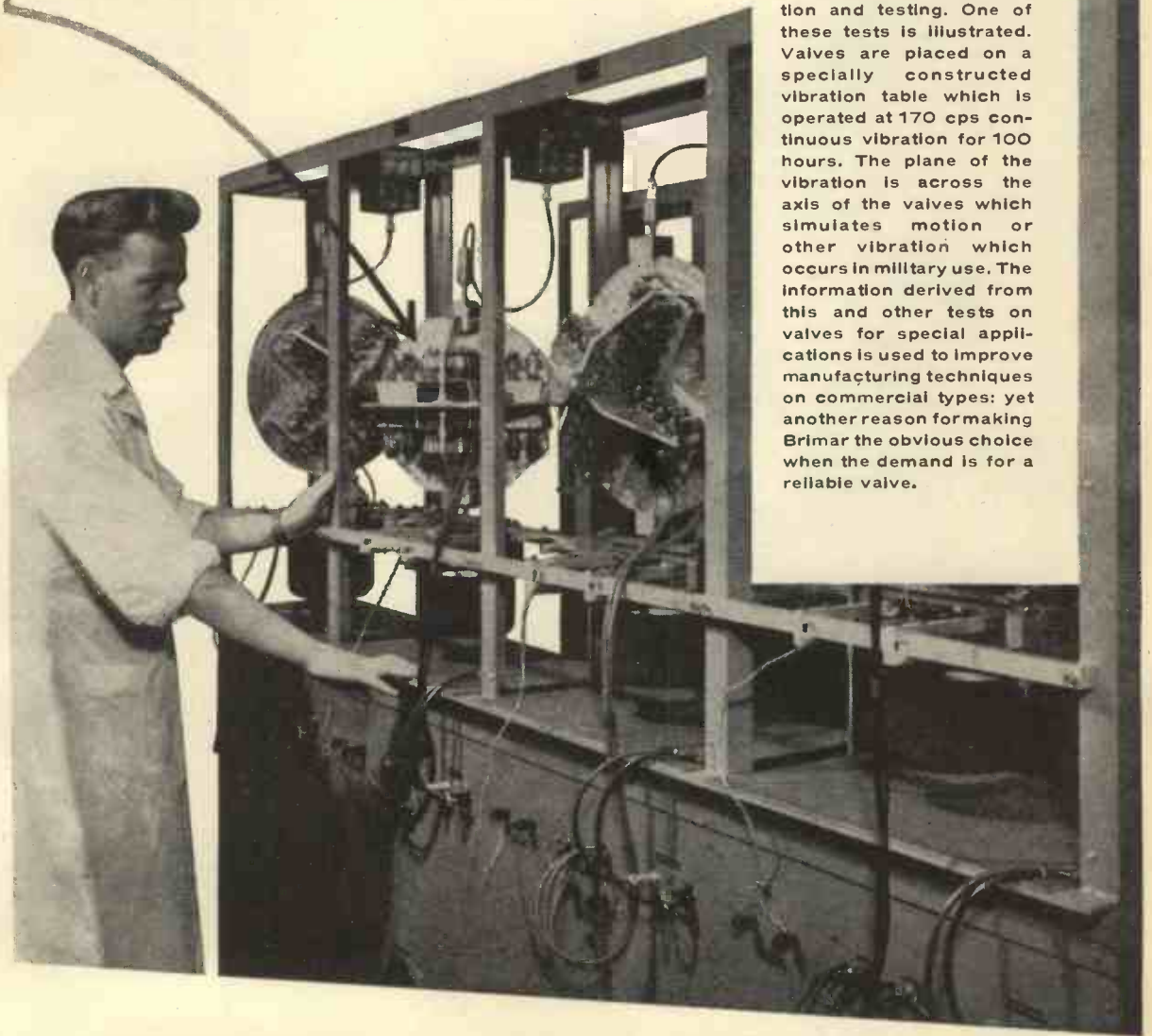
EF184



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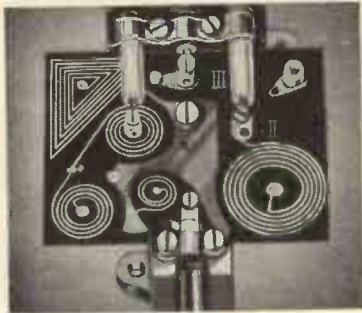
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*No. 12 of a Series*

Recently we have been fortunate in engaging the services of a very experienced electronic instrument maker who has worked with one of the bigger equipment makers. When watching him at work on our distribution amplifiers and talking to him, he volunteered the information that the quality of the printed circuit we used was very much better than anything he had experienced elsewhere. Knowing the feelings of a considerable cross-section of the industry, we became inquisitive. Why? How? Well, he said, lots of circuit boards he had used had so little copper on them and stuck so badly that it lifted if touched with a soldering iron. Open circuit occurred through invisible fractures occurring due to flexing of the board. He was emphatic that he had not come



*This photograph shows the interior of a printed circuit triplexer, L.1411. The cable connections are made through terminals which are mounted directly onto the printed circuit.*

across any of the old trouble he was used to, and had quite changed his mind about printed circuitry, provided the boards were as good as used by us. We then visited Research and asked some more questions. There are two main ways of making printed circuit boards, one, by the deposition of copper on a laminated board where it is required. The other starts with a copper clad board, and the unwanted copper is etched away. It is this last method that we use, and let it be said here and now that the gauge or thickness of the copper cladding is an important part of the specification, as is the minimum width of the conductors. We are also very interested in the adhesion of the metal to the board.

There are three accepted ways of testing for this characteristic:—

(1) Float a small square of the board face downwards in molten solder for a predetermined period.

(2) A copper disc is etched on the face of the board to the centre of which a copper wire is butt soldered. It is then pulled off and the required force measured.

(3) A one-inch strip of clad board has the copper peeled from it by a pull perpendicular to the board, and the pull monitored.

It will be seen that in a good quality board, little is left to chance.

In some boards considered by us to be unsuitable, the copper is so thinly deposited that it is only useful as a key to solder, and the whole board must be dipped to ensure a satisfactory result. With the board we use the adhesion of the cladding is so good that we can, with safety and confidence, solder to the copper, or rivet right through.

This facility will be appreciated by those who may have to change a faulty capacitor or resistor. From correspondence published in some technical journals, the inability to do just this thing is cited against printed circuits, but please do not condemn the technique because it has been used to save a few pence, without regard to its limitations.

Samples of the board we use are constantly subjected to the Admiralty test salt spray chamber where they are given the full forty-day test. At the end of that time, they are in a sorry state but still serviceable, but such a test represents a very hard life under conditions rarely met with in practice.

It will probably interest many to learn that the conditions met with in salt spray test is more severe than those experienced in areas considered to be bad through industrial air pollution, such as sulphurous fumes found in some towns.

There is no doubt that the technique of printed circuits has suffered by the use of unsuitable materials.

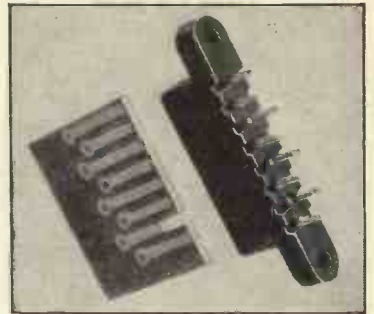


*The interior of an L.1360 TV/FM diplexer is shown in this photograph. The continuity of the outer braid is maintained through the metal body to which the board is secured.*

We at "Belling-Lee" have a wonderful reputation to keep up which we are certainly not going to jeopardise by offering poor quality printed circuits, when good ones are available at a slightly higher cost.

Advertisement of  
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Great Cambridge Rd., Enfield, Middx.  
Written 12th November, 1959

**"BELLING-LEE"  
PRINTED CIRCUIT  
CONNECTORS & GUIDES**



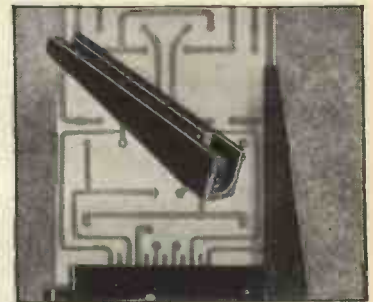
- L.1355/Au or Ag. 8-pole, 0.1" Module
- L.1369/Au or Ag. 8-pole, 0.15" Module
- L.1370/Au or Ag. 12-pole, 0.15" Module
- L.1372/Au. or Ag. 18-pole, 0.15" Module
- L.1380. Guide for printed circuit panels

This range of connectors enables the printed circuit board to be easily removed from equipment, but ensures that when the board is inserted, reliable electrical contact is made in the various circuits.

The connectors can be used with conventional or printed wiring at the solder spills. When used with printed wiring the base printed circuit can be drilled or punched with holes on a 0.1 in. grid in the case of L.1355 and on a 0.05 in. grid with the other connectors.

The plug-in board for use with these connectors should have a thickness of 0.0625 in. ± 0.005 in. and can be single or double sided.

The position of the board can be controlled by the guide L.1380 mounted either on the connector or separately. A unique contact spring construction ensures excellent contact with minimum wear on board and connector.



*Most "Belling-Lee" products are covered by patents or registered designs, or applications.*

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# Aspects of design

# 18

## "BRIGHT SPOT" SUPPRESSION IN TELEVISION RECEIVERS

This is the eighteenth of a series of special features dealing with advanced problems in television and radio circuit design to be published by The Ediswan Mazda Applications Laboratory. We will be pleased to deal with any questions arising from this or other articles, the Nineteenth of which will appear in the February 1960 issue.

The primary concern in designing a television receiver is to provide good reproduction of picture and sound with reliability. In addition to ensuring that valves and components are operating within their published ratings under normal viewing conditions, consideration must also be given to transient conditions occurring when the receiver is switched on or off which may be liable to cause damage or reduction of life in valves or cathode ray tubes.

One such transient effect which may occur on switching off the receiver is the appearance of a bright spot in the centre of the screen. If the spot is sharply focused and too bright, the screen can suffer permanent damage and a burn mark appear after a number of such switching operations. This tendency has become more apparent with recent types of cathode ray tube using a unipotential electrostatic beam focusing system without an ion trap. The sharpness of focus of these guns is not critically dependent on focus electrode voltage.

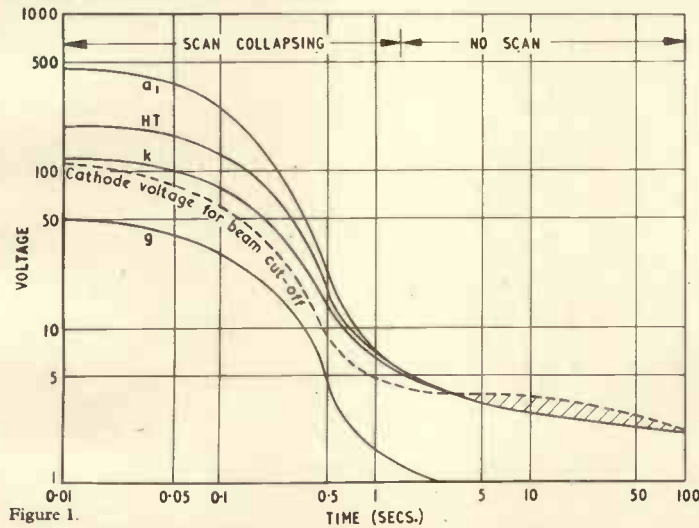


Figure 1.

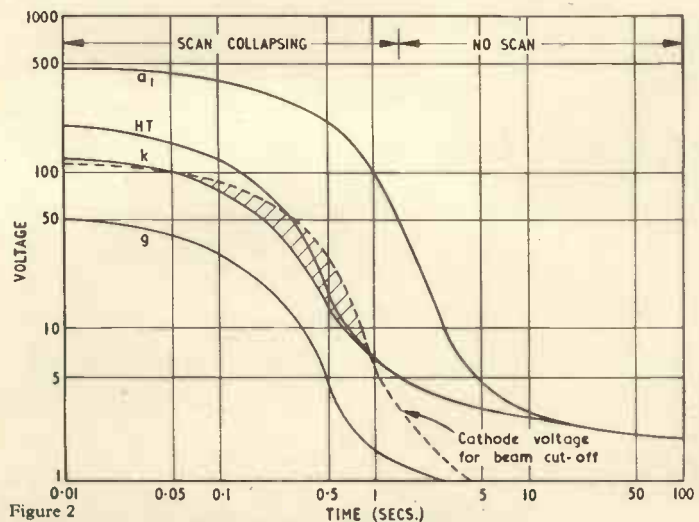


Figure 2

**Associated Electrical Industries Ltd**  
 Radio and Electronic Components Division  
 Technical Service Department  
 155 Charing Cross Road, London, W.C.2  
 Tel: GERrard 8660. Grams: Sleswan, Westcent, London

Factors controlling the intensity of the spot are:

(a) Receiver control settings

The spot brightness is generally greater if no picture is visible before switching off. Thus it is not desirable to gang the mains switch with the brilliance control.

(b) Time decay characteristics of voltage sources

The rates of fall of the voltages on the various electrodes of the cathode ray tube are controlled by the rate of fall of the H.T. line voltage on switch-off, together with the time constants of the circuits supplying the electrodes. Figure 1 shows, on logarithmic scales for both voltage and time, the decay of voltages in a typical receiver using no time constants other than the usual H.T. smoothing circuit. Initially the tube grid voltage potentiometer is assumed to have been set just below beam cut-off with no picture modulation signal, the tube cathode being directly connected to the anode of the video amplifier valve. After the initial rapid fall of H.T. voltage before the valve cathodes cool, a few volts remain and decay very slowly.

(c) Cathode ray tube characteristics

The grid to cathode voltage required to cut off the beam current decreases in proportion to the first anode to cathode voltage and in normal conditions is insensitive to second anode voltage changes. However, with zero first anode voltage and a second anode voltage of 10-15 kilovolts, a negative bias of a few volts between grid and cathode is still required to cut off the beam current. This effect is due to penetration of the electrostatic field of the second anode into the gap between first anode and grid. In Figure 1, the dashed curve shows an estimation for a typical tube of the cathode voltage required at any instant to cut off the beam current. The actual cathode voltage is seen to fall below this line about three seconds after switching off, when scanning has completely ceased. As the tube cathode can still emit due to its relatively high thermal capacity, a bright spot appears on the screen and may persist for one or two minutes as the E.H.T. capacity is gradually discharged.

### PREVENTION OF SWITCH-OFF SPOT

One method is to maintain beam cut-off until tube cathode emission ceases. This, however, is difficult as sufficient emission is maintained for at least a minute and has the disadvantage from a servicing point of view that the E.H.T. capacity is left in a charged condition.

The alternative approach is to ensure rapid discharge of the E.H.T. capacity to a comparatively low voltage before scanning entirely ceases. Three methods are generally used to effect this as follows:

- (1) A time constant of  $\frac{1}{2}$ -1 sec. may be connected in series with the first anode voltage supply to delay the decay of this voltage. The series resistance component is limited to a maximum of 2.2 Megohms from leakage considerations. Figure 2 shows similar curves to Figure 1 modified to incorporate this change. The cathode ray tube passes beam current in the shaded area which now occurs before the scanning has ceased. Thus a bright collapsing raster is seen which will not cause any damage to the screen.
- (2) A long time constant may be connected in series with the tube grid bias supply. This has a similar effect to the first method but a compromise must generally be made to avoid a slow-reacting brilliance control.
- (3) The E.H.T. capacity may be discharged by a bleed resistance to chassis. A convenient method which also improves E.H.T. regulation is to use a non-linear voltage sensitive resistance such as "Metro-sil". In this case, the E.H.T. voltage falls sufficiently rapidly for no more than a defocused moving spot to be briefly seen.

**EDISWAN MAZDA 10C14**

The 10C14 is a Triode Heptode valve combination, with separate electrode structures, for use in broadcast radio a.c./d.c. receivers. The valve is intended to be used as a frequency changer for amplitude modulated signals with the triode as local oscillator. In combined AM/FM receivers, the heptode may be switched to operate at 10.7 Mc/s. as an IF amplifier for frequency modulated signals.

Heater Current (amps)	$I_h$	0.1
Heater Voltage (volts)	$V_h$	19

**Preliminary Ratings and Characteristics.**

		Heptode	Triode
<b>MAXIMUM DESIGN CENTRE RATINGS</b>			
Anode Dissipation (watts)	$P_{a(max)}$	1.7	0.8
Screen Dissipation (watts)	$P_{g2+g4(max)}$	1.0	—
Anode Voltage (volts)	$V_{a(max)}$	250	250
Screen Voltage ( $I_a < 1$ mA)	$V_{g2+g4(max)}$	250	—
Screen Voltage ( $I_a = 7.6$ mA)	$V_{g2+g4(max)}$	125	—
Heater to Cathode Voltage (volts rms)	$V_{h-k(max)}$ rms	12.5	6.5
Mean Cathode Current (mA)	$I_{k(av)}$ max	12.5	6.5

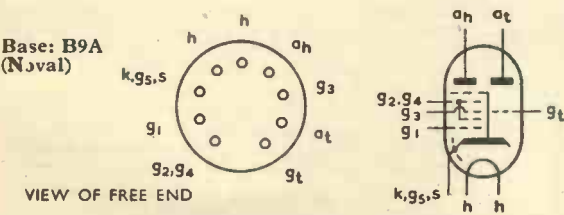
		Heptode	Triode
<b>INTER-ELECTRODE CAPACITANCES (pF)</b>			
Anode to Earth	$C_{a-E}$	7.9	2.1
Anode to Grid 1	$C_{a-g1}$	<0.006	1.0
Grid 1 to Earth	$C_{g1-E}$	4.8	2.6
Grid 3 to Earth	$C_{g3-E}$	6.0	—
Inter-electrode capacitances measured in fully shielded socket.			

		Heptode	Triode
<b>CHARACTERISTICS</b>			
Anode Voltage (volts)	$V_a$	170	100
Screen Voltage (volts)	$V_{g2+g4}$	102	—
Grid No. 3 to Cathode Voltage (volts)	$V_{g3-k}$	0	—
Grid No. 1 to Cathode Voltage (volts)	$V_{g1-k}$	-2.2	0
Anode Current (mA)	$I_a$	6.2	13.5
Screen Current (mA)	$I_{g2+g4}$	3.8	—
Mutual Conductance (mA/V)	$g_m$	2.3	3.7
Amplification Factor (Heptode, $g_1$ to $g_2, g_4$ )	$\mu$	20	22

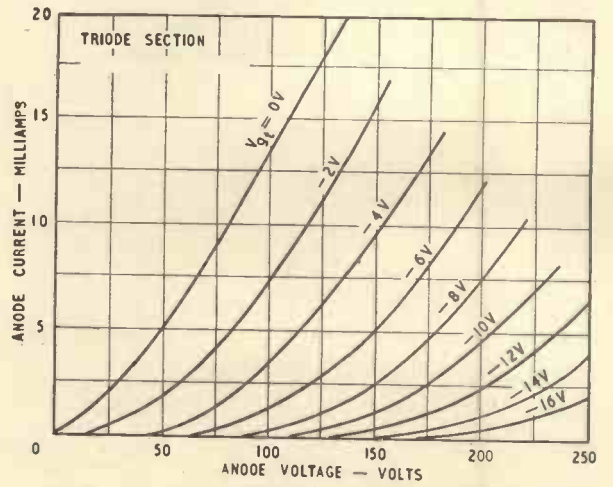
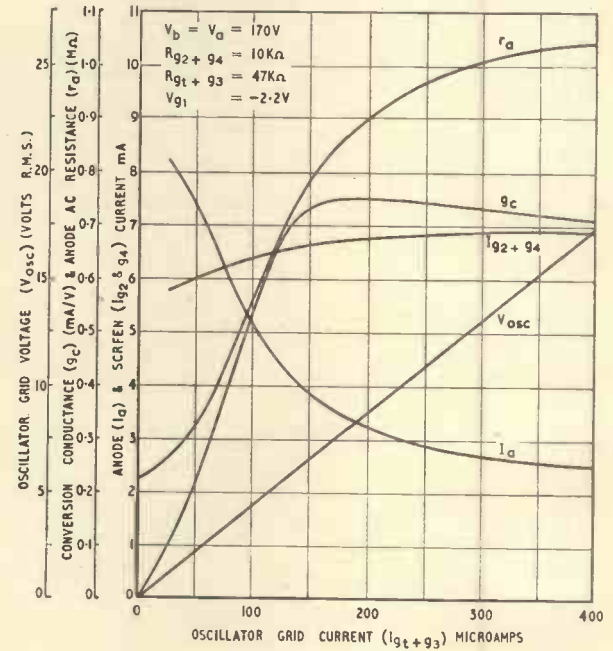
**TYPICAL OPERATION AS AM FREQUENCY CHANGER**

<b>Heptode</b>			
Supply Voltage (volts)	$V_b$	170	
Anode Voltage (volts)	$V_a$	170	
Screen Resistance (k $\Omega$ )	$R_{g2+g4}$	10	
Heptode Grid No. 3 and Triode Grid Resistance (k $\Omega$ )	$R_{g3+g1}$	47	
Screen Voltage (initial) (volts)	$V_{g2}$	102	
Grid 1 to Cathode Voltage (volts)	$V_{g1-k}$	-2.2	
Heterodyne Peak Voltage (volts)	$V_{het(pk)}$	12	
Conversion Conductance ( $\mu A/V$ )	$g_c$	750	
Anode Current (approx.) (mA)	$I_a$	3.2	
Screen Current (approx.) (mA)	$I_{g2+g4}$	6.8	
Heptode Grid No. 3 and Triode Grid Current ( $\mu A$ )	$I_{g3+g1}$	200	
Grid 1 to Cathode Voltage for $g_c$ reduction 100 : 1 (volts)		-24	
Valve Anode Resistance ( $\delta V_a/\delta I_a$ ) (M $\Omega$ )	$r_a$	0.9	
Equivalent Grid Noise Resistance (k $\Omega$ )	$R_{eq}$	70	
<b>Triode</b>			
Anode Voltage (volts)	$V_{a(t)}$	103	
Anode Current (average) (mA)	$I_{a(t)av}$	4.5	

<b>MAXIMUM DIMENSIONS (mm)</b>		
Overall Length		67.5
Seated Height		60.5
Diameter		22.2



Preliminary characteristic curves of Ediswan Mazda Valve Type 10C14



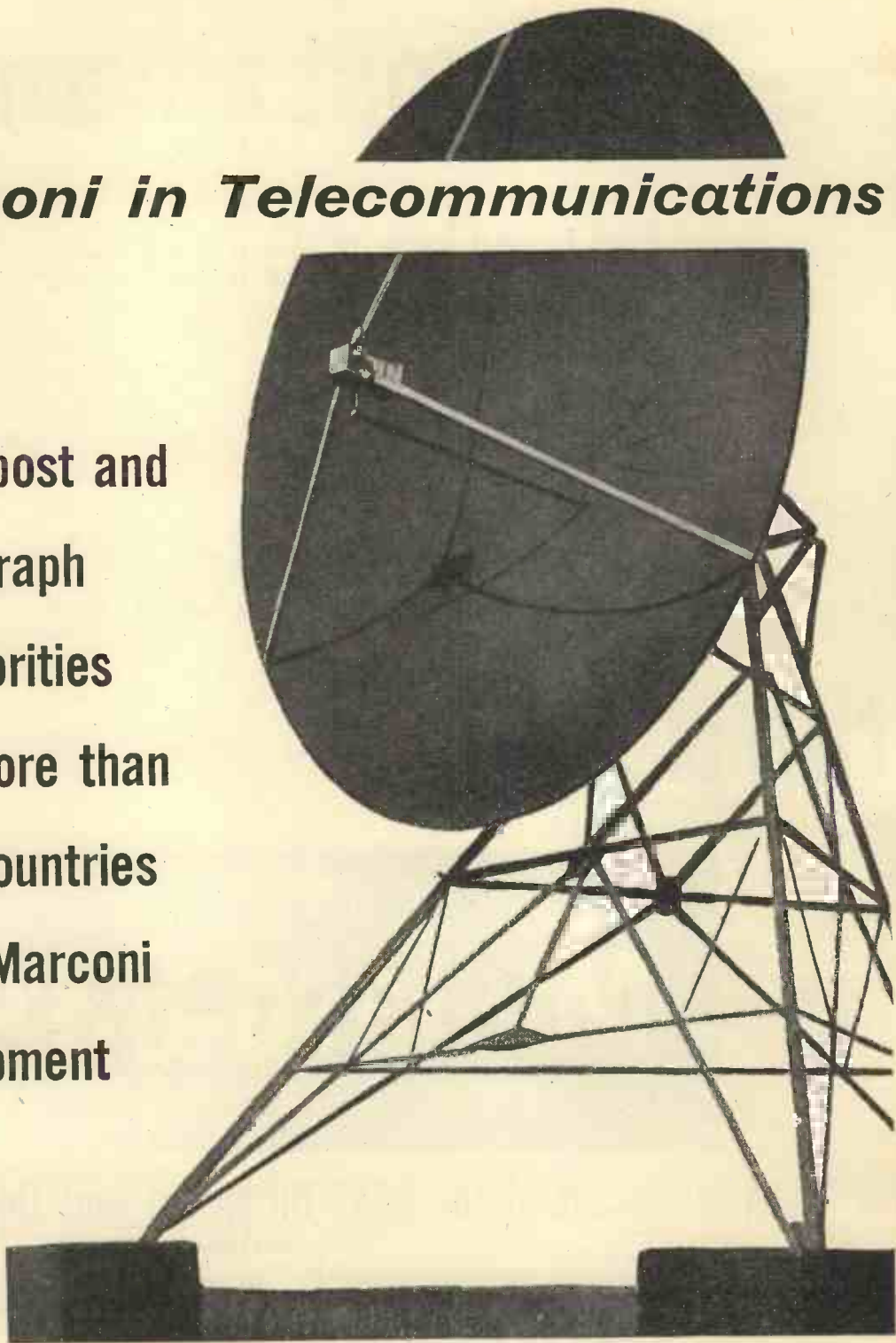
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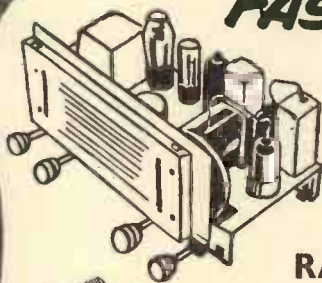
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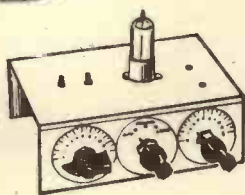
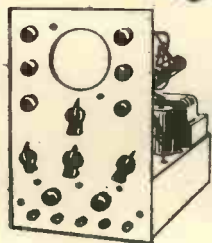
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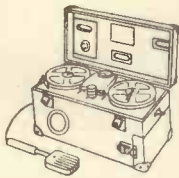
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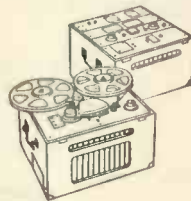
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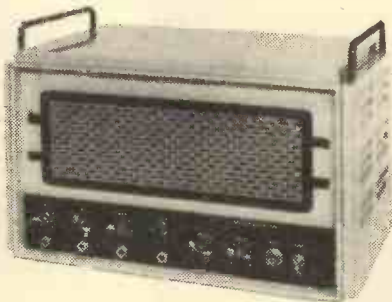
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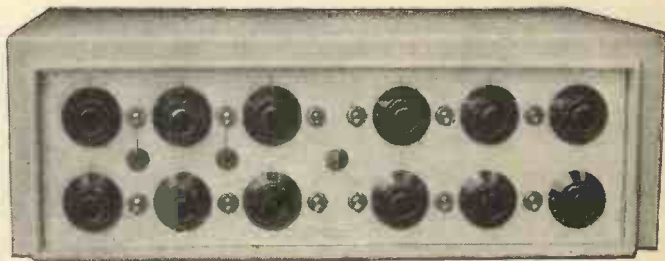
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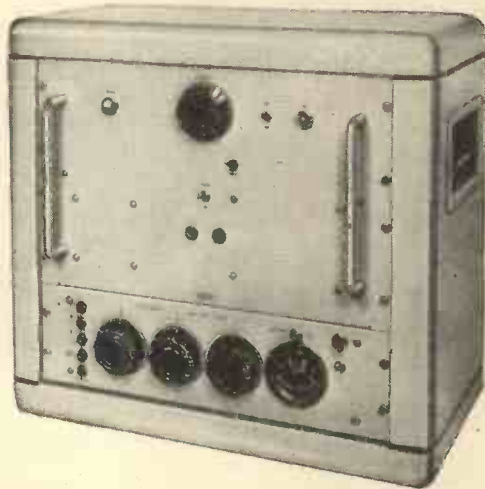
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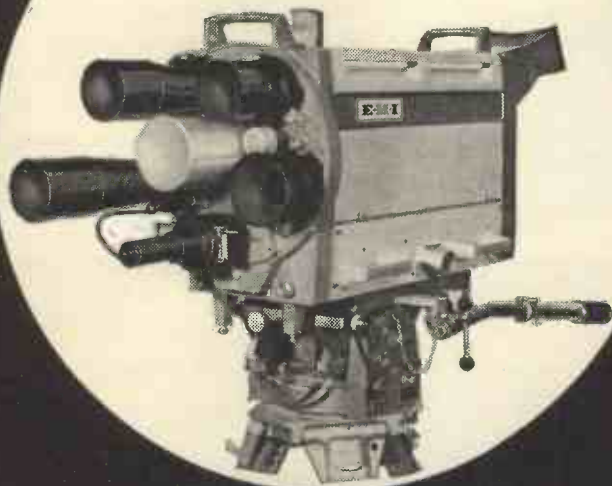
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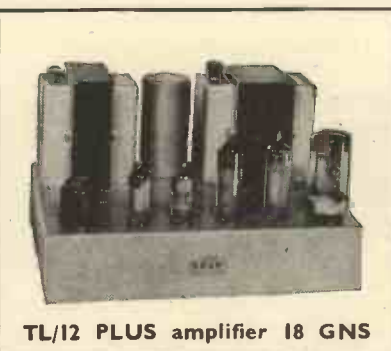
*Extract from Test Report by J. C. G. Gilbert reprinted from the Music Trades Review, February, 1959 and in our advertisement in October's "Wireless World". The full two-page Test Report and an illustrated brochure on the amplifiers will be sent to you on request.*



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American made. Dynamic type. Real bargain at 2/6, plus 6d. postage.



### Building a Scope?



3in. oscilloscope tube. American-made type No. 3FP7, octal base 6.3 v. .6 amp. heater, electrostatic deflection, brand new and guaranteed, with circuit diagram of oscilloscope. 15/- each, plus 1/6 post and ins.

### "Dim and Full" Switch

Particularly useful for controlling photoflood lamps which have only a short life at full brilliance. This toggle switch has three positions: the first position puts two lamps in series at half brilliance for setting up, the second position is off and the third position full brilliance for the operation shots. Also useful for controlling night lights, heaters, etc., etc. Price 3/9 each. Post 6d. Circuit diagram included.



**TV Masks**  
Latest type grey crystallate.  
14in., 10/-; 17in., 12/-  
Plus 1/- post.

### Dulci DPA10 Amplifier

Made by the Dulci Company. It is laboratory designed and is of the highest fidelity, has superb reproduction and complete freedom from hum, high output sensitivity, 10-watt output and ample feedback all combined to give a truly linear output. Uses all-glass miniature valves, including two EL34s in push-pull. Price £12/12/-, or £1 down, and 25 weekly payments of 10/-.



### SIX USEFUL ARTICLES

Our 1960 catalogue now ready gives constructional hints and circuits for the following items:

- Moisture operated switch
- Simple but clever signal tracer
- Versatile power pack costing only 10/-
- Instantaneous heater for workshop or den
- Six transistor pocket superhet
- Simple bed warmer
- Shock-proof controller

Send for this catalogue today—price 2/6, refundable from purchases.

### Assure your future

The ownership of a good instrument has been the turning point in many a famous career. You can own the latest Pullin Series 100 Test Set which is undoubtedly a most useful instrument by a firm long famous for fine instruments, entirely redesigned, it has a square movement with diacron plastic cover, this makes for a brighter, more readable scale, extra scale length and wider angle of vision. With the test set is included a pair of combined test prods and crocodile clips also a stand for inclining the meter at the best reading positions. Ranges A.C. Volts: 0-10, 0-25, 0-100, 0-250, 0-500, 0-1,000, ditto D.C. A.C. Current 0-100 mA. D.C. Current 0-2.5, 0-10, 0-100, 0-300 mA. Resistance: 0-1M and 0-10K. All at 10,000 ohms per volt—Price £12/7/6 or £1/4/- deposit and 26 fortnightly payments of 10/-, non callers add 5/- carr. and insurance.

**FREE GIFT.**—All purchasers of the above items this month will receive Range Extender scale and data which add. capacity 2pF—1mFd, in two ranges. Inductance 0-100 henrys, etc., etc.



### Components Would Cost More

Car Battery Charger—ready-made high output battery charger in store enamelled sheet steel louvered case. New, complete and ready to work. Rated at 12 v. 4 amps. and variable rate selector for trickle charging, also a meter to show charging rate. Suitable for 230/250 A.C. mains. Special snip price of 55/-, plus 3/6 post and ins.

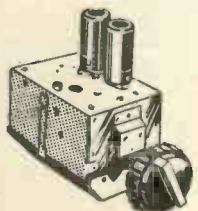


### Unique Opportunity to build Fine Transistor Set



Constructor's parcel: to build Pocket 6 Transistor Set as currently being sold at £17/17/-. Parcel comprises modified, two-tone cabinet as illustrated, tuning dial, two gang tuning condenser, combined bakelite chassis/printed circuit and easy-to-follow circuit. Costing value 37/6—offered while supplies last at only 29/6, plus 2/6 post. Suitable for your own circuit or to build original circuit. All parts available at highly competitive prices. Do not miss this tremendous bargain.

### 12-Channel Turret Tuner



Ideal for converting an old or building into new T.V. These are brand new stock not surplus, supplied complete with valves and coils for local Band I and Band III stations.

Model 1. I.F. Output 33/38 Mc/s. series heaters (parallel heaters, 5/- extra).

Model 2. I.F. Output 16/19 Mc/s parallel heaters (series heaters, 5/- extra). With instructions and circuit diagram. 79/6. knobs 3/6 extra. Postage and insurance 2/6.

### SPECIAL THIS MONTH

Battery Charger Rectifier—selenium 12-15 v., 5 amp., 12/6.

Blank Metal Chassis—all 2 1/2in. deep from 18 gauge aluminium. Sizes: 6in. x 2in., 4/6; 7 1/2in. x 6in., 6/-; 13 1/2in. x 9in., 10in. x 7 1/2in., 7/-; 11in. x 7 1/2in., 8/-.

Metal Chassis—punched for Mullard 510 Amplifier, complete with inner screening sections and stove enamelled, 12/6 set.

Geiger Counter Tubes—20th century type, Type No. G24, with circuit of geiger counter, 29/6.

Luminous Switch, double pole designed for electric blankets, neon indicators glow when appliance is switched on, 10/-.

Waterproof Heater Wire—suitable electric carpets, electric blanket, hand muffis, foot pads, etc., 7d. per yard.

Twin Twisted Lighting Flex—equivalent 14/36, rubber insulated, cotton covered. 17/6 per 100 yard coil.

Moving Coil Meters

0-500 microamp	2in. flush	17/6
250-0-250 microamp	2 1/2in. surface	27/6
750 microamp	2 1/2in. surface	17/6
5-0-5 microamp	2 1/2in. flush	17/6
0-30 milliamper	2 1/2in. flush	17/6
0-100 milliamper	2 1/2in. flush	15/6
0-300 milliamper	2 1/2in. flush	15/6
0-500 milliamper	2 1/2in. flush	15/6

Unbreakable Mains Lead type of lead fitted to electric razors makes fine lead for test meters and any other devices where subject to continuous bending. Twin figure eight construction, soft cream p.v.c. covered. Normally costs 2/- per yard. Three 6ft. leads for 2/-.

Metal Rectifier, 60/80 mA. 250/300 v., 4/6.

Filament Transformer, 6.3 v., 11 amps. 6/6

3 Amp Dropper—(tappings marked 200/220/250, 3/6)

Output Transformer—standard pentode—4/6, multi ratio 6/8

Bi-metal Strip with heavy duty contact—ideal for thermostat, fire, lamp, etc., 2/6.

Neon Lamp—mid-gate wire ended, ideal mains tester, etc., 2/-, ex Govt., 1/6-

Philips Trimmers—0-30pF, 1/- each, 9/- doz.

Set of 8 Allen Keys, 3/6.

Heavy Duty Test Prods—red and black with plug-in lead attachments, 8/6.

Install those extra points, 3,029 twin flat T.R.S. cable. Big purchase enables us to sell this at 45/- per 100 yds, carriage 3/6.

Low Resistance Head Phones. Ideal crystal sets, etc., 7/6, plus 2/6.

Goodmans Multi Ratio Output Transformer. 6 watt, 8 ratios, from 12-1 to 72-1. Centre tapped for push/pull, 7/6, plus 1/-.

Ditto, unbranded, 6/6, post 1/-.

Cold Cathode Valve CV413. Voltage regulator or trigger switch—unused but ex-equipment, 2/- each.

Tag Panels. Ideal for constructors, experimental circuits, etc., 3 of each of 12 different types, 5/-, post 1/6.

Shielding Panel Mounting Fuses with carrier, 5 amp. 2/- each, 15 amp. 2/6 each. Belling Lee 2BA fully insulated terminals for mounting through metal panels, 2/- each.

Terminal Heads, Insulated 4BA, 2/- doz. 1 mFd. 350 v. Small tubular metal cased condensers made by Duffiler 2/6 doz.

50 Assorted Resistors. Well mixed and useful values 1/2 and 1/4 watt, 5/- for 50.

Ditto, but 1 watt, 6/6 for 50.

Mains Transformer. Standard 230 v. input 250-0-250 at 80 mA., 6.3 v. at 5 A., 12/6, post 1/6.

Toggle Switch. Standard metal body, type with round dolly, fixing ring and on/off indicating plate, 1/3 or 12/- doz.

Metal Rectifier. 250 v. 60-80 milliamper, ideal for mains set or instrument or to replace that expensive valve, 5/6.

Screened Cable. Rubber covered flexible with metal braiding, ideal for microphone or gramophone extensions. 4d. per yd., 30/- per 100 yds.

Install 2-Way Switches. Our outfit comprises 30 yd. multicore cable, two 2-way switches, two wood blocks. Full instructions, 9/6 each, post and insurance, 2/6.

Long, Medium and Short Wave Coil Pack. An exceptionally well made coil pack which covers the standard long, medium and short wavebands for 616 1/2 I.F. complete with diagram of connections, 19/6, plus 1/6 postage and insurance—limited quantity only.

### For the Record Enthusiast

New-four speed playing deck by E.M.I. has the following features—

Velocity operated auto trip.

Pick-up on switch, cannot be damaged.

Remarkably low rumble achieved by single ball thrust and magnetic screen on motor.

Anti-microphony mounting.

The ideal unit to renovate old equipment or to build into new.

Size: 1 1/2in. wide, 1 1/2in. deep, 2 1/2in. high, depth 2 1/2in.

Mains model with stereo cartridge, 27/17/6. Or with monaural cartridge, 26/18/6, post and ins. 3/6.

H.P. Terms on request.

FOR ADDRESSES SEE OPPOSITE PAGE



**Cine Cameras**



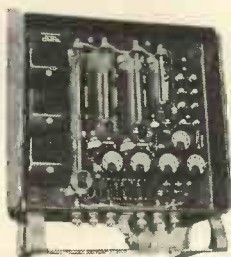
16 mm. motorised (24 VAC) for 16 frames per second, contains fine 1/8.5 triple anastigmatic lens

and spool to carry 25ft. of film—probable cost around £50, brand new and in sealed carton 26/10/- or 20/- deposit and 13 fortnightly payments of 10/-, post and insurance 3/6.

**SUPER SENSITIVE (2,000 O.P.V.) MULTIMETER KIT**

17 ranges including D.C. volts to 1,000 V. A.C. volts to 1,000 V. D.C., milliamps to 500 ohms, to 2 meg. All the essential parts, including metal case, selected resistors, wire for shunts, selected switches, calibrated scale and instructions, 32/6, plus 2/6 post and insurance.

**Charging Switchboard**



Offered at about one-twentieth of original cost. This is an ex-Government switchboard. It contains three reverse current relays, one voltmeter, one main ammeter, two secondary ammeters and three variable resistors for controlling circuits. These are original cases. Price 22/15/- Carr. 10/-.

**Band III Converters**

Suitable Wales, London, Midland, North, Scotland, etc. All the parts including 2 EF80 valves coils, fine tuner, contrast control, condensers and resistors. (Metal case available as an extra). Price only 19/6, plus 2/6 post and insurance. Data free with parts or available separately, 1/6. Please send two more kits, the one you sent last week is performing magnificently. We receive this sort of letter every day of the week, so if you have hesitated because you thought our kits too cheap you need hesitate no longer.

**Beginner's Superhet**

As supplied to many schools and colleges. A simple basic superhet—easy to understand and which can be progressively extended—ideal for students—components include—valves—metal receiver tuning condenser—I.F. transformers, etc. In fact complete superhet except speaker. Price £3 plus 3/- post and insurance. Data included free or sep., 1/6.

**Avo Prodclips**

The advantage of these test prods is that by pressing the trigger at the side they become crocodile clips and can be left in circuit. This is a great time saver when servicing. Price 15/- pair.



**Philips AG2009 Transcription Unit**

Philips AG2009 Record Player a modestly priced 4-speed unit with many outstanding features, is ideal for the enthusiast who is assembling his own equipment or modernising an older installation. The pick-up arm is wired for stereo and the Philips stereo head is available as an optional extra. Eddy Current Brake gives ±2% fine adjustment on all four speeds. Continuously variable pick-up playing weight (2-12 gms).

Supplied with Philips Hi-Fi crystal head, type AG3019 for microgroove and 78 r.p.m.

Frequency response 30-15,000 c/s.

Pick-up lifting and lowering device.

Individually balanced heavy turntable.

Muting switch fitted.

Can be used with any amplifier or radio set.

Complete with monaural pick-up, £10/10/-, or £1 deposit and 21 fortnightly payments of 10/-.

Available also with stereo head, diamond or sapphire stylus. Prices on request.



**Component Storage Drawers**

Stout board construction these drawers are ideal for small parts. Supplied complete with simple erection instructions—1/6 each or 12 drawers each 6x2 1/2 x 6 1/2 in., 13/6, post 2/-.



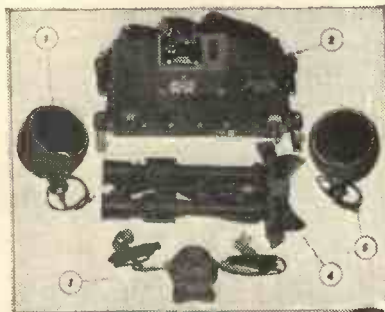
**Here is a present that will be really appreciated**

Motorised food mixer with no irksome lead hanging out and which does not have to be plugged into the mains as it works off three 1 1/2 v. cells in its handle. A really useful mixer ideal for kitchen or anywhere about the house and can also be taken on barbecues, picnics, etc. Price 35/- plus 2/6 post and packing.



**For Your Service Department**

An invaluable tool for working inside a dark cabinet or cupboard. This is a screwdriver with torch and has four interchangeable bits, two for the ordinary slotted screws and two for Phillips heads. The torch section operates from 1 1/2 v. batteries in the handle and will save its cost in frayed tempers alone. Why not treat yourself to one of these now? Only 10/6 plus 1/6 post and packing.



**TABBY EQUIPMENT COMPLETE**

Complete equipment for seeing in the dark, as fitted to Army vehicles for night driving, etc. Complete working equipment comprises: 2 Infra Red Radiators, adjustable binoculars, powerpack for 6 or 12 volts, control units and inter-connection cables. Original cost probably around £100. Unused and in perfect order—26/19/6 or 10/- deposit and 15 fortnightly payments of 10/-.

**A.C./D.C. Multimeter Kit**

Ranges: D.C. volts 0-5, 0-50, 0-100, 0-500, 0-1,000. A.C. volts 0-5, 0-50, 0-100, 0-500, 0-1,000. D.C. milliamps 0-5, 0-100, 0-500. Ohms 0-50,000 with internal batteries. 0-600,000 with external batteries. Measures A.C./D.C. volts, D.C. current and ohms. All the essential parts including metal case, 2in. moving coil meter, selected resistors, wire for shunts, range selector, switches, calibrated scale and full instructions, price 19/6, plus 2/6 post and insurance.



**Crystal Mike by Acos**

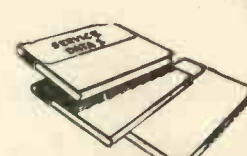


Model 39/1, this is ideal for tape or general amplifiers, complete with screened lead 39/6, plus 1/- post.

**Radio Stethoscope**

This can be slipped into the pocket rather like a fountain pen. With it in most districts a receiver can be checked from the grid of the first valve right through to the output without a signal generator, the stethoscope will operate in both L.F. and E.F. circuits without alteration. It is complete fault-finder.

All the necessary parts to make this tracer 9/6, post 1/-.



**T.V. Service Sheets**

200 sheets covering most popular post-war televisions by leading makers—Cosmor, Ekco, Ferguson, Pye, etc., £2 post free. PREVIOUS PURCHASERS OF THESE SHEETS PLEASE NOTE: WE CAN SUPPLY SHEETS NOS. 100-200 £1, or 180-200, 10/-.

**Tube Tester and Re-Activator**



We can supply all the main components for making this unit which will not only test Cathode Ray Tubes but also will re-activate them, supplied complete with full instructions. Price £3, plus 2/6 post and ins.

**Hi-Fi Snip Infinite Wall Baffle**

Nicely veneered and polished. Corner fitting (attaches to picture rail). Takes up no floor space. Gives really fantastic results with only low-priced 8in. speaker. Fitting for tweeter. Only 45/- each. Carriage and insurance 3/6.



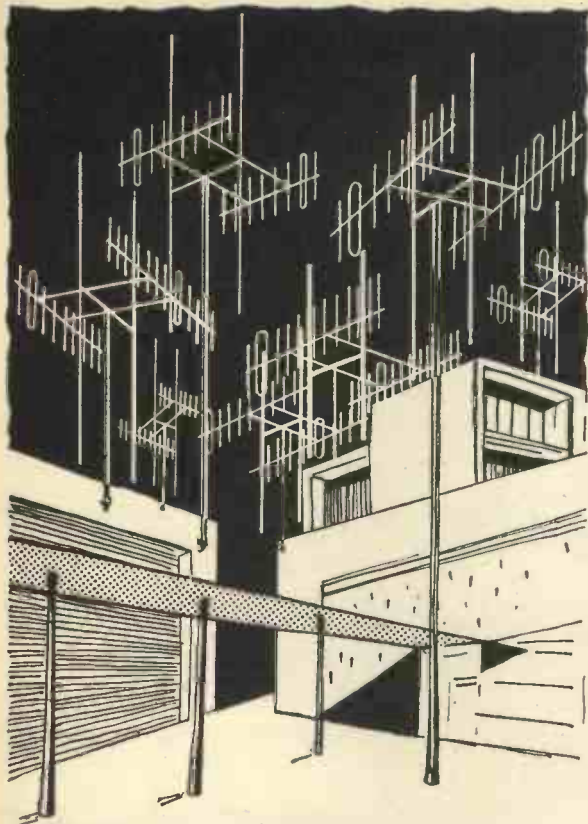
If ordering by post, address your order to the Company nearest to you. Please include postage.

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The **CR50 Bridge** covering 10pFd to 100mFd and 1 ohm to 10 Megohms in fourteen ranges has a total length of scale of over 120 inches thereby ensuring easy and accurate readings. A leakage test is incorporated for condensers. Complete with valves, instructions and ready for operation from 200/250 volt A.C. mains. £8/2/6 plus 4/6 carr./packing.

**SC30 OSCILLOSCOPE.** A 3in. 'scope for service and design purposes at an extremely low price of £17/10/- plus 6/- carr./packing.

**VV60 AUDIO VOLTMETER** measures 1 milli-volt to 100 volts in five ranges. £14 plus 4/6 carr./packing.

Further details sent by return of post on receipt of stamped addressed envelope.

TRADE supplied direct. CREDIT TERMS available

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## A.C. SOLENOID TYPES BM/T



Continuous 3½ lbs. at 1".

Instantaneous to 16 lbs.

Smaller sizes available.

Also — Transformers to 7 kVA 3 phase

Current Transformers 100/5 to 2000/5 all classes.

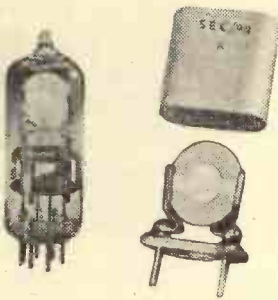
## R. A. WEBBER LTD.

18 FOREST ROAD, KINGSWOOD, BRISTOL PHONE 67-4065



# G.E.C. RUGGED quartz crystal units

PATENTS APPLIED FOR



In order to meet current and future requirements for accurate frequency control in equipment for guided missiles, mobile communications and, in fact, all other applications where extreme conditions of acceleration and vibration are encountered, it has been necessary to design quartz crystal units capable of satisfactory operation under such conditions.

G.E.C. Quartz Crystal units can now be supplied for all frequencies in the following ranges:

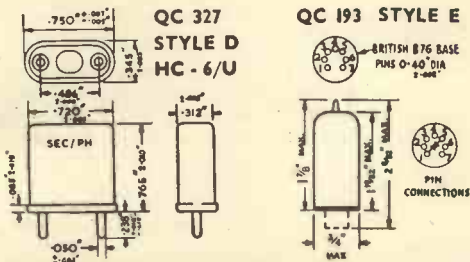
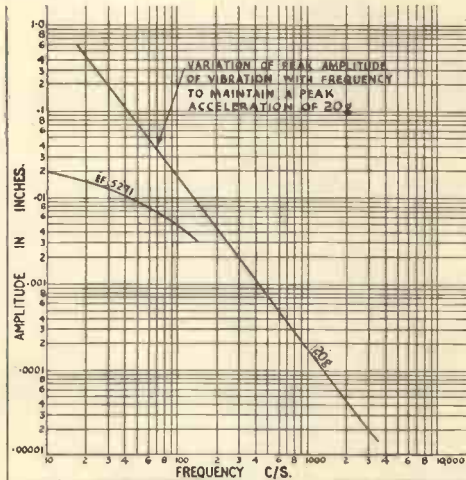
- Fundamental mode ... 1-15 Mc/s.
- Third overtone ... 15-40 Mc/s.

and will operate within the specified activity and frequency limits when subjected to the bump and vibration tests stipulated by Defence Specification DEF 5271.

## TECHNICAL DETAILS

Furthermore, the units continue to conform to the operating conditions of DEF 5271, even under more stringent test conditions during which the applied vibration is swept from 30 c.p.s. to 2,000 c.p.s., at a rate not exceeding two octaves per minute, and the peak acceleration is maintained at 20 g. This test is made in three mutually perpendicular planes.

The graph illustrates the more rigorous nature of this test in comparison with that specified in DEF 5271. The extended frequency range and general increase in the amplitude of vibration, particularly at the lower frequencies, are readily apparent.



### HOLDER STYLES AND FREQUENCY TOLERANCES

#### HERMETICALLY SEALED HOLDERS

Frequency Range (Mc/s.)	Holder Style	Frequency Tolerances at all Temperatures within the Range Specified					
		Normal			Class Tolerances		
		30°C	-20°C - 70°C	30°C	-20°C - 70°C	-20°C - 70°C	-20°C - 70°C
AT (S.E. Ref. PA, RA, SA, TA, UA, 1,000-15,000)	QC 237 Style D (Hc-6/U)	± 0.1%	± 0.1%	± 0.05%	± 0.05%	± 0.05%	± 0.05%
AT (Type D) (Overtones)	QC 237 Style D (Hc-6/U)	± 0.1%	± 0.1%	± 0.05%	± 0.05%	± 0.05%	± 0.05%
BT (S.E. Ref. SA, SA, SA, TA, UA, 4,000-15,000)	QC 193 Style C	± 0.1%	± 0.1%	± 0.05%	± 0.05%	± 0.05%	± 0.05%
BT (Type D) (Overtones)	QC 237 Style D (Hc-6/U)	± 0.1%	± 0.1%	± 0.05%	± 0.05%	± 0.05%	± 0.05%

#### EVACUATED GLASS HOLDERS

Frequency Range (Mc/s.)	Holder Style	Frequency Tolerances at all Temperatures within the Range Specified					
		Normal			Class Tolerances		
		30°C	-20°C - 70°C	30°C	-20°C - 70°C	-20°C - 70°C	-20°C - 70°C
AT (S.E. Ref. PA, SA, SA, TA, UA, 1,000-15,000)	QC 193 (Style B)	± 0.1%	± 0.1%	± 0.05%	± 0.05%	± 0.05%	± 0.05%
BT (S.E. Ref. SA, SA, SA, TA, UA, 4,000-15,000)	QC 193 (Style B)	± 0.1%	± 0.1%	± 0.05%	± 0.05%	± 0.05%	± 0.05%
BT (Type D) (Overtones)	QC 193 (Style B)	± 0.1%	± 0.1%	± 0.05%	± 0.05%	± 0.05%	± 0.05%

### DRIVE LEVEL

All units are designed to operate at the drive levels specified in DEF 5271 as follows :-

#### (a) Fundamental Oscillators

Style	Frequency Range		Drive Level (milliwatts)
	Minimum	Maximum	
B	100 Kc/s.	500 Kc/s.	5
	800 Kc/s.	9999.9 Kc/s.	10
	10 Mc/s.	20 Mc/s.	10
C & D	200 Kc/s.	500 Kc/s.	3
	800 Kc/s.	9999.9 Kc/s.	10
	10 Mc/s.	20 Mc/s.	5
E	120 Kc/s.	500 Kc/s.	0.4
	800 Kc/s.	9999.9 Kc/s.	10
	10 Mc/s.	20 Mc/s.	5

#### (b) Overtone Oscillators—All Styles

Minimum	Frequency Range		Drive Level in milliwatts	
	Maximum	Temperature Controlled	Non-Temperature Controlled	
10 Mc/s.	24 99999 Mc/s.	4	1	
25 Mc/s.	75 Mc/s.	2	1	

NB For special applications quartz crystals in the frequency range 2 Mc/s. to 5 Mc/s. can be supplied, which will operate satisfactorily when the applied vibration is swept from 30 c/s. to 2,000 c/s. while the peak acceleration is maintained at 40 g.

**SALFORD ELECTRICAL INSTRUMENTS LIMITED**  
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# HIGH FREQUENCY TRANSISTORS

FOR RADIO CONTROL AND SHORT WAVE APPLICATIONS

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SB078	10 Mc/s min.	7 to 20	10/- ea.
SB305	25 Mc/s „	9 to 50	15/- „
SB231	30 Mc/s „	20 to 70	22/6 „
SB231R	50 Mc/s „	20 to 70	30/- „

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Available to Wholesalers and Retailers from Sole Distributors

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Provide a first-class service to manufacturers of electronic valve or transistor operated equipment for

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**AND ALL PURPOSES  
WHERE RELIABILITY  
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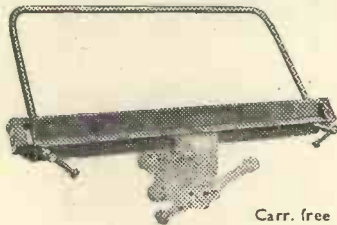
**STOCK TYPES FOR ALL  
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IMPROVED manufacturing facilities enable us to offer quick deliveries of pre-production samples and small batch production at economic prices.

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PARKERS SHEET  
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With Bevelled Former Bars

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  - No. 3. Capacity 16 gauge mild steel x 18in. wide ..... £5 5 0
- End folding attachments for Radio Chassis, Tray and Box Making...for 36in. model, 3/6 per ft. Other models 2/-. The two smaller models will form flanges. As supplied to Government Departments, Universities, Hospitals. One year's guarantee. Money refunded if not satisfied. Send for details. A. B. PARKER, Wheatcroft Works, Wellington Street, Batley, Yorks. Tel. 426.

**STABILIZE YOUR AC MAINS** with the finest equipment, at a fraction of the normal cost:—

**FERRANTI 7½-KVA MOVING COIL  
AUTOMATIC VOLTAGE REGULATORS**  
Any stabilized output voltage in the range 200-250 v. can be selected by plug-board tappings. The selected output voltage is automatically maintained constant within  $\pm\frac{1}{2}\%$ , at all loads 0 to 30/37½ amps., when the supply voltage is varying over the range +8% to -12%.

- Frequency compensated 45-55 and 54-66 c/s.
- Excellent output wave-form.
- Can also be used as a variable transformer.
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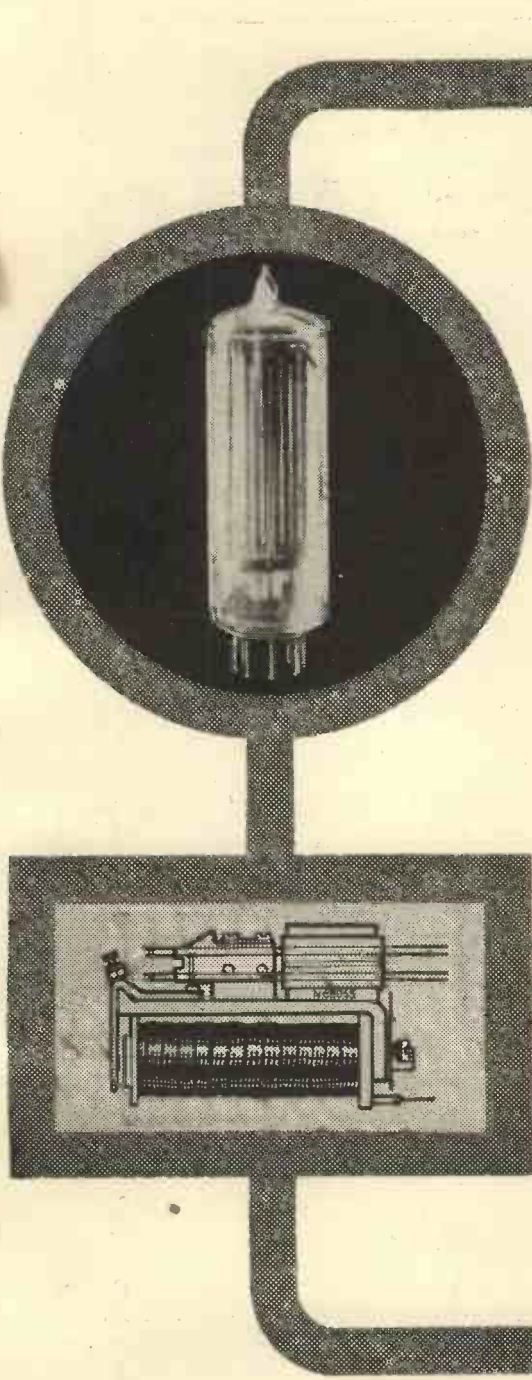
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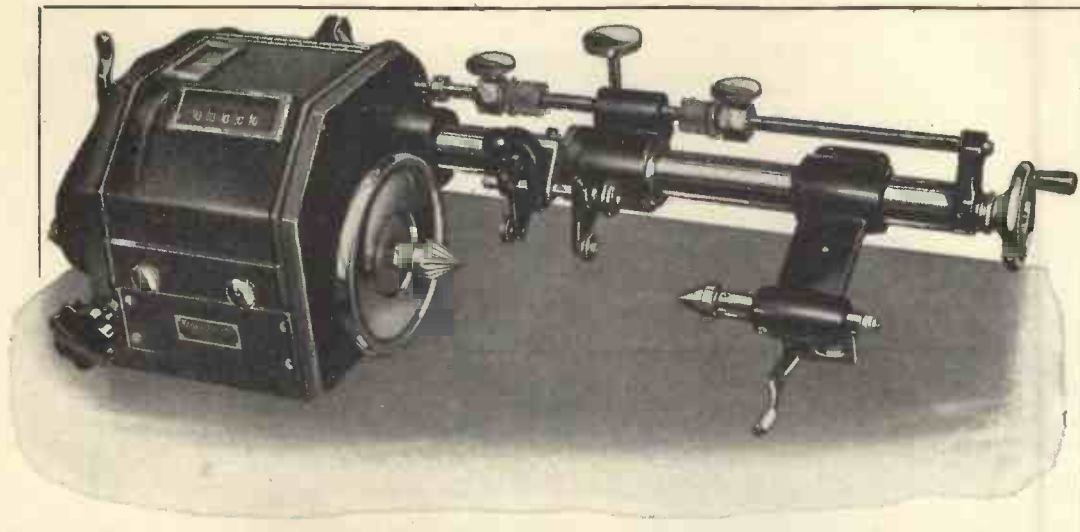
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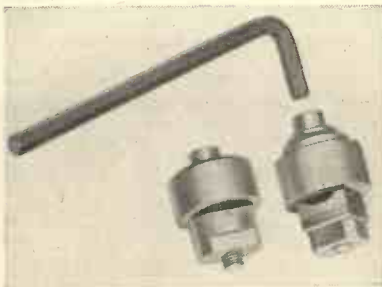
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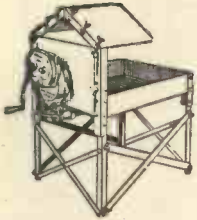
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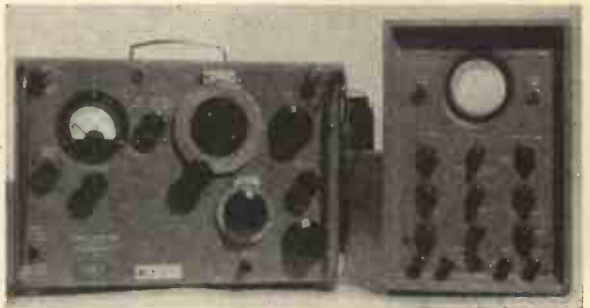
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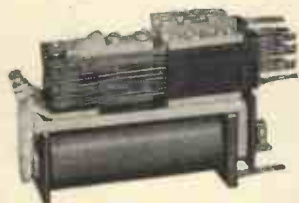
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Z.530018	2,500	1C	48	£1 2 6
Z.530019	2	2C 2K	1.3	14 6
Z.530020	2	4C	1.3	16 6
Z.530022	2	M.B.	1.3	12 6
Z.530023	2	2B 2M	1.3	12 6
Z.530024	40	2M	6	12 6
Z.530025	40	M.B.	6	12 6
Z.530027	180	2M	12	17 6
Z.530028	180	M.B.	12	17 6
Z.530031	670	M.B.	24	17 6

### S.T.C. MINIATURE SEALED RELAY

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 1/6 Post & Packing on all relays. Send for lists



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 Input 11.5 v.  
 Output 250 v. at 125 mA.

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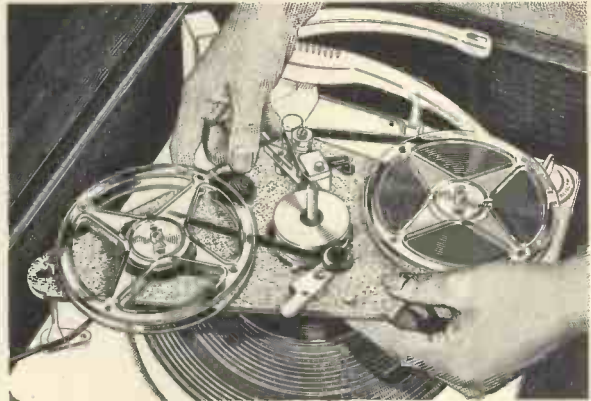


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Table listing vacuum tubes with their types and prices. Includes models like 6X4, 6X5, 6X6, etc.

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**AMERICAN L.T. TRANSFORMERS.** Potted type, finished in black crackle and very conservatively rated. (1) 230 v. input, 3 x 5 v. C.T., at 3 amps. each and 4 v. at 2 a. output, 18/6 each. (2) 230 v. input, 2 x 6.3 v. C.T., at 3 a. and 6.3 v. at 3 a. output, 18/6 each. (3) 230 v. input, 2 x 6.3 volts at 3 a., and 6.3 v. C.T., at 3 a. output, 17/6 each. (4) 230 v. input, 28 v. at 2 a., and 2 v. at 1 a., 12/6 each. (5) 230 v. input, 3 x 6.3 v. at 3 a. C.T., 1, 6.3 v. 3 a., 22/6 each. (All these transformers are new and boxed, please include postage 3/6 each.)

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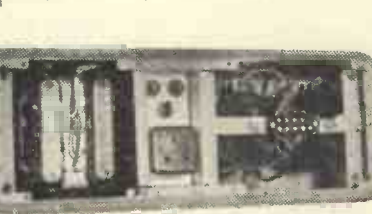
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**L.T. SUPPLY UNIT No. 19 YA 8087.** A.C. input 100-250 v. D.C. output tapped 12/24 volts, continuous tropical rating, 3 amps. Built-in metal case 17 x 7 x 6 1/2 in., with fuses and switch. An ideal L.T. supply unit for operating relays, contactors, battery charging, etc. In perfect condition. £3/17/6. Carr. 7/6.

**G.E.C. L.T. SUPPLY UNITS TYPE O.S. 1773 G.A.** A.C. input 200-240v. D.C. output 24 volts 10 amps. Tropically rated. Built-in metal case size 20 x 15 1/2 x 10 ins. Supplied Brand new in Maker's cases, £13/10/-, ex warehouse.

**HEAVY DUTY L.T. TRANSFORMERS.** All ratings Tropical and in perfect condition. No. 1 Pri. 210-230 v., Sec. 10 v. C.T., 5 a., and 5 v., 2. T. Pri. 230 v., Sec. tapped 4-6-11 v., 200 a. £8/10/6, Carr. 7/6. No. 3 Pri. 200-250 v., Sec. 50 v., 30 a. £6/10/6, Carr. 7/6. No. 4 Pri. 200-240 v., Sec. 50 v., 20 a., £4/10/6, Carr. 7/6. No. 5. Pri. 200-250 v. Sec. tapped 28-29-30-31 v., 21 a., £4/17/6 Carr. 7/6. No. 6. Pri. 100-250 v., Sec. two separate windings, tapped 15-16-17 v., 4 a., 35/-, Carr. 4/-, No. 7. Pri. 220-240 v., Sec. three separate windings, 6.5 v., 50 a., 6 v. C.T. 15 a., 5 v. C.T. 2.5 a., £4/19/6. Carr. 7/6. No. 8. Pri. 220-240 v., Sec. 6.3 v. 15 a., 25/-, P.P. 3/6. No. 9. Pri. 220-240 v., Sec. four separate windings, 5 v. C.T. 4 a., 5 v. C.T. 4 a., 5 v. C.T. 4 a., 4 v. 4 a., Potted Type, 32/6. P.P. 3/6. No. 10. Pri. 220-240 v., Sec. three separate windings, 6.3 v. C.T. 4 a., 6.3 v. C.T. 4 a., 6.3 v. 4 a. Potted Type, 29/6. P.P. 3/6. No. 11. Pri. 115-230 v., Sec. 5 v. 15 a., 15 kV. Insulation, 37/6. Carr. 5/-, No. 12. A. Pri. 220-240 v., Sec. 45 v. 2 a., 17/6. P.P. 3/6. No. 13. Pri. 200-240 v., Ser. tapped 9-15 v. 4 a., 22/6. P.P. 2/6. No. 14. Pri. 220-240 v., Sec. tapped 10-17-18 v. 10 a. £52/6. Carr. 4/-.

**OIL FILLED HEAVY DUTY L.T. TRANSFORMERS.** Pri. 420 v., 400 v., 380 v. Single phase. Sec. 19 v. 150 amps. Weight 141 lbs. Supplied dry £10. Carr. 15/-.

**ADMIRALTY THREE-PHASE TRANSFORMERS.** Pri. 400-440v. 50 cycles. Sec. 50v. 6 amp. Completely tropicalised. Size 7 1/2 x 14 x 5 in. Weight approx. 60lbs., 85/-, Carr. 7/6. Brand new in maker's cases.

**FERRANTI MOVING COIL VOLTAGE REGULATOR TRANSFORMERS.** 7.5 kva. Stabilized output between 200-250 volts can be selected. Output voltage is automatically maintained constant within 1/2% plus or minus at all loads when the supply voltage varies plus 8% to minus 12%. Freq. compensated. 45-55 and 54-66 cycles, £45, Ex warehouse.

**ADMIRALTY VOLTAGE CONTROLLERS** 1,000 ohm 0.59/0.16 amps. Rotary switch type with 32 contacts. Completely enclosed with metal control handle. New in maker's carton at a fraction of manufacturer's price, 10/6. P.P. 3/6.



**ADMIRALTY HEAVY DUTY D.P.C.O.** 15 amp. Knife switches. Metal shrouded. New, 7/6. P.P. 2/6.

**CARBON RESISTORS.** 1/3-3 watt. Carton of 100. Good selection of values, 10/- per carton. P.P. 1/-.

**MICA, SILVER MICA, TUBULAR CONDENSERS.** Good selection of values, 10/- per carton of 50. P.P. 1/-.

**SPECIAL OFFER OF BRAND NEW FIELD TELEPHONE CABLE AT A FRACTION OF MAKER'S PRICE.** D.8. Twin Coiled on heavy wood drums, £7/10/- ex warehouse. D.3, Single, one mile drums 85/-, Carr. 7/6. Commando Assault Telephone Wire P.V.C., 1,000 yard drums, very useful in the home and garden, cheaper than string, 8/11. P.P. 3/6. Five drums in maker's carton, 42/6. Carr. 7/6.

**LATEST M.O.S. RELEASE. AMERICAN SEALED RELAYS.** Brand new, 9,000 ohms. 1 CO. 1M 15/-; 7,500 ohms 1 CO. 1M 12/6; 7,000 ohms 1 CO 10/6; 270 ohms 1M 1B 7/6 all tag Eax, 5,500 ohms 2 CO. Octal Base 15/-; 270 ohms 2 CO 8/6. P.P. 1/6 each.

**BRITISH 3000 TYPE. RELAYS NEW M.O.S.** 6,000 ohms, 4M 2B 12/6; 6,000 ohms 2M 2B 10/6; 1,000 ohms 2 CO 8/6; 250 ohms 4M 4B 10/6; 100 ohms 3M 8/6; 2,000 ohms 1B 6/6, 200 ohms 1M 1B 7/6; 600 Type 750 ohms 1M, 600 ohms 2 CO, 150 ohms 1CO 5/6 each. All Relays Guaranteed and Checked Before despatch. Please include sufficient for postage.

**A.C. CHECK METERS.** 200-250v. 20 amp. 22/6. 10 amp. 19/6. Carr. 3/6. Reconditioned and guaranteed.



# CLYNE RADIO LTD.

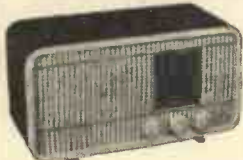


**"FAMILY FOUR."** Our supersensitive T.R.F. Receiver for home construction. Covers Long and Medium Wavebands. Is housed in very smart plastic table cabinet in Brown or Black. For A.C. Mains 200/250v Comprehensive assembly instructions

provided, including practical and theoretical diagrams, which are easy to follow and will enable you to complete this receiver which will be the envy of your friends. **ALL NECESSARY COMPONENTS ARE BEING OFFERED FOR LIMITED PERIOD ONLY AT THE REMARKABLE PRICE OF ONLY 79/6, plus 2/6 p. & p.** Instruction book available separately if you wish to look before purchase at 1/6 post free.



## NEW LOOK ECONOMY FOUR



Our very popular three valve mains T.R.F. receiver is now available with a new De Luxe cabinet with polished Walnut finish and Cream trimming (as illustrated). Brief Spec.: Valve line-up 6K7, 6J7, 6V6, and contact cooled rectifier. Ready

drilled chassis, good quality 5in. loudspeaker, Special Denco Colls. Covers Medium and Long Wavebands. Overall dimensions: 12in. x 6in. x 5in. high. A.C. 200/250 v. Simple construction with guaranteed results. Easy to follow practical and theoretical diagrams supplied. All necessary components, down to the last nut and bolt, are offered at a **SPECIAL INCLUSIVE PRICE OF £5/10/-, plus 5/- p. & p.** Instruction book available separately 1/6, post free. Also available with plastic cabinet in IVORY or BROWN if preferred at **ONLY £5/5/-, plus p. & p.**

**PRINTED CIRCUIT DE-LUXE SUPERHET**  
Housed in our Standard Economy cream or brown Bakelite cabinet and employing the latest circuitry, assembly technique and miniature valves. Incorporates ferrite aerial and covers Medium and Long Wavebands. All required components at special inclusive price of **£7/19/6 (or 5/- extra for new style cabinet) plus 5/- p. & p.** Instruction book with full description, itemised price list, etc., available separate at 1/6 post free.

## MULLARD 510 HIGH-FIDELITY AMPLIFIER



Our printed circuit version of this excellent amplifier, with **ULTRA-LINEAR PUSH-PULL** output stage, giving an exceptionally high quality output of 10 watts (max.). Built-in Controls are provided for independent bass and treble. Tone correction to suit all types of signal input. Will match all

crystal or high impedance magnetic pick-up heads, F.M., A.M. or A.M./F.M. tuners or tape recorder output. All required components of best quality to Mullard spec. are offered at a special inclusive price of **£9/9/- plus 3/6 p. & p.** Instruction book, containing full constructional details, theoretical practical wiring diagrams, itemised, price list available separately at 3/6 post free.

## SUPER TRANSISTOR/CRYSTAL RECEIVER

Our amazing extra sensitive transistor/crystal receiver for local stations, with built-in ferrite aerial, can be supplied for home construction at **ONLY 27/6** for all necessary components inc. pen torch batt. p. & p. 2/- extra. Simple to construct, excellent in performance, most attractive in appearance. Instruction envelope available separately if required at 1/- post free. Suitable Deaf-aid ear piece for above, 12/6.

**VISIT OUR FULLY EQUIPPED HI-FI SHOWROOM AT TOTTENHAM COURT ROAD FOR DEMONSTRATIONS OF THE LATEST HI-FIDELITY EQUIPMENT BY ALL LEADING MANUFACTURERS.** i.e., Leak, Quad, Armstrong, Dulci, Ferrograph, Vortexion, Linear, Wharfedale, Grundig, Goodmans, W.B., Rogers, etc., etc. A full range of high quality cabinets to suit all purposes are on show, i.e. "RECORD HOUSING," "W.B." etc. Enquire about our interesting part-exchange scheme for personal callers.

## JASON "EVEREST" TRANSISTOR PORTABLES

We are proud to be able to offer two new Jason all-transistor portable receivers designed to provide the highest possible standards of performance in their class. These are the "Everest-6" and "Everest-7" both covering Medium and Long wavebands, and incorporating ferrite rod aerial and special top grade loudspeaker. A printed circuit is employed and Mullard transistors are used throughout. An excellent quality output of 500 mw. is obtainable. Housed in a most attractive easily carried case with handle, finished in Blue/Grey "Vynaire" with Gold trimmings. The Everest 7 is exceptionally sensitive and well suited to car use (aerial socket provided) and has improved AVC action due to the additional stage. All necessary components for building these wonderful receivers are offered at the following **SPECIAL INCLUSIVE PRICES:—** EVEREST-6 (six transistor) **£13/19/9, plus 3/- p. & p.** EVEREST-7 (seven transistor) **£15/18/9, plus 3/6 p. & p.** Fully descriptive booklet with comprehensive assembly instructions available separately if required at 3/6 post free.



## THE NEW JASON FM TUNER

The latest addition to the impressive JASON range, and like all JASON equipment, can be depended upon for **QUALITY, RELIABILITY and PERFORMANCE.**



Incorporates the very latest features in design to ensure simplicity of operation and faultless performance. Housed in smart metal shelf mounting cabinet in pastel green with grey plastic dial. Built-in power supplies enable connection to any amplifier or radio fitted with Pick-up sockets, without complications. Two versions are available, i.e., Standard or Fringe Area. **ALL NECESSARY COMPONENTS SUPPLIED AT SPECIAL INCLUSIVE PRICE OF:—** STANDARD TUNER **£8/19/6**; FRINGE AREA TUNER **£10/19/6**, both plus 3/6 p. & p. Comprehensive Assembly Instructions with full description and itemised price lists are available separately if required at 2/6 post free.

Full range of JASON equipment available ex-stock

## PRINTED CIRCUIT CAR RADIO (for Home Construction)



We are proud to be able to offer this New type Car Radio employing up to the minute circuitry, special 12 volt valves and transistorised output stage. The highest degree of sensitivity is assured by the incorporation of Permeability Tuning and a tuned R.F. Stage. Covers Medium and Long Wavebands. **NO VIBRATOR PACK IS REQUIRED.** This is a really compact receiver that will fit any car. Comprehensive assembly instructions are provided with all necessary components, including valves and transistor at a Special Inclusive Price of **Only £12/19/6 plus 3/6 p. & p.** Instruction booklet with itemised price list, full description dimensions, etc., available separately at 3/6 post free.

## SUPER MAGNETIC RECORDING TAPE SPECIAL!!!

First delivery Famous American Ferrodynamic Acetate Base High Quality Recording Tape. An enthusiast's "must." Brand new (NOT SUB-STANDARD), 7in. 1,200ft. on plastic spool, 25/-; 7in. 1,800ft. on plastic spool, 35/- Post free.



## THE R.C. 3/4 WATT AMPLIFIER KIT

Compare the advantages. Treble, base AND middle controls. For crystal or magnetic pick-up. A.C. Mains 200/250 v. Valve line-up: 6V6-GT, 6SG7 metal 6X5GT. Negative feedback. Built on stove enamelled steel chassis, measuring only 8in. x 4in. x 1 1/2in. Four engraved cream knobs are included in the price of the complete kit with all necessary practical and theoretical diagrams at **£4/5/- only, plus 2/6 packing and post or Instruction Book fully illustrated for 1/- Post free.** This amplifier can be supplied assembled, tested, and ready for use at **£5/5/- plus p. & p.** Hearing is believing.



If not stated, please add postage on orders under £1. Cash with order or C.O.D. (charges extra).

# CLYNE RADIO LTD.

Open: Tottenham Court Rd.: 9 a.m. to 6 p.m. Mon. to Fri., Sat. 1p.m. Holloway Road: 9 a.m. to 6 p.m. daily. Thurs. 1 p.m., Sat. 5.30 p.m.

Our Advantageous H.P. and Credit Sale Terms are available on any single item over £5. Your enquiries invited.

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(50 yards only from Tottenham Court Road Tube)

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**COSSOR KITS!** A unique opportunity to obtain a first-class amplifier and/or the latest type VHF/FM receiver at the most reasonable price ever.

**COSSOR AUDIO AMPLIFIER KIT 562K.** This excellent amplifier supplied in kit form in manufacturer's original presentation carton comprising: Pre-assembled printed-circuit board, valves: 6V4, 6BQ5, EF86 output transformer, two loud-speakers, 4in. circular and 10 x 6in. elliptical, wiring wire, nuts, bolts, attractive escutcheon and control knobs, mounting brackets and fully illustrated assembly instructions. With negative feedback incorporated, and the high performance loud-speakers provided, a really high quality output is assured. Suitable for use with radio tuners, microphone or gramophone units. For A.C. 200/250 v. operation. **BRAND NEW AND COMPLETE AT ONLY £5/19/6 plus 3/6 P. & P.** (List price £9/15/-).

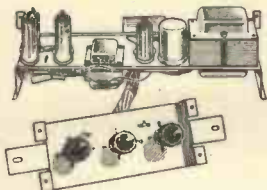


**COSSOR VHF/FM RECEIVER KIT 701K.** A first-class receiver of the latest type for the reception of B.B.C. VHF/FM programmes, and suitable for use on A.C. or D.C. mains supply, supplied in kit form, in manufacturer's original presentation carton, comprising: printed circuit (with all connections clearly marked), 6 valves: UCC85, UF89, UF89, UABC80, UL84, UY85. All necessary components including nuts, bolts, wiring wire, solder, etc., and an excellent quality Goodmans 10in. x 6in. elliptical loudspeaker. A fully illustrated step-by-step instruction book is provided with the aid of which the receiver can be completed in approx. 9-10 hours. **BRAND NEW AND COMPLETE AT ONLY £8/19/6 plus 3/6 P. & P.** (List price £15/15/-).

**Latest COLLARO STUDIO TAPE TRANSCRIBER.** 3 motors, 3-speed: 1 1/2, 3 1/2, 7 1/2 i.p.s., takes 7in. spools. Push-button controls. £15/15/- plus 5/- P. & P. Usual H.P. Facilities.

**"ROLEX" SPECIAL HEAVY DUTY MAINS/BATTERY AMPLIFIER.** Very smart unit housed in grey crackle finish case with chromed and cream fittings. For use on A.C. mains 200/250 v. or 6 v. D.C. battery. Valve line-up: 6SK7, 6SN7, 6SL7, 2-6V6, 6X5 and 629C vibrator. 20 watts output to match 4, 8, 16, 250 and 500 ohm speaker systems. Ideal for P.A. work, etc. Size: 13in. x 8 1/2in. x 7 1/2in. Mike and gram inputs with separate gain controls, tone control. Brand new, fully guaranteed. **ONLY £15/15/-, plus 7/6 P. & P.**

**A SPECIAL HIGH QUALITY PUSH-PULL AMPLIFIER**  
By famous manufacturer



Limited stocks, only of this really wonderful quality amplifier employing 4 valves: 2-EL84, ECC83, EZ80. Separate Bass and Treble Controls mounted with Volume Control upon loose panel with flying leads. Excellent quality components employed throughout. Overall dimensions: (Main chassis) 12 1/2in. x 4in. x 5in. high. Control panel: 6in. x 2 1/2in. Input to match standard high impedance crystal or magnetic pick-up. Output approx. 8 watts max. **WHILST STOCKS LAST ONLY £6/19/6, plus 3/6 P. & P.**

**DECCA PORTABLE AMPLIFIER.** As supplied in famous DECCAMATIC III. Complete with small cream knobs. Full range tone and volume controls. Employs ECL82 valve. Size 3 x 3 1/4 x 8 1/2in. **Only 59/6 plus 2/6 P. & P.**

NOTE. Supplied post free if all above items purchased together.

**SPECIAL CELESTION 8 x 6in. elliptical high flux loudspeaker 30/- plus 1/- P. & P.**

**VERY ATTRACTIVE PORTABLE CABINET** in Red and White polka dot for accommodating the above items and ancillary equipment, 75/- plus 5/- P. & P.

**EXTRA SPECIAL OFFER!!**

A small three-valve **PORTABLE RECORD-PLAYER AMPLIFIER** mounted on baffle 12 x 7in., with High Flux 6in. Loudspeaker, Valve line-up ECC83, EL84, EZ80. Incorporates separate bass and treble controls. Max. output 3 watts. Will match all types of high impedance pick-up. Ready to use, **£5/12/6 plus 3/6 P. & P.**

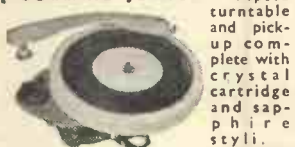


**NEW STYLE CABINET** finished in two-tone Leatherette. Will accommodate above Amplifier and Baffle without modification, also most types of Ancillary Equipment. Overall size 18 x 13 1/2 x 8 1/2in. Fitted with carrying handle, **£3/9/6 plus 5/- P. & P.**  
**NOTE:** If both items purchased together they will be supplied at a special inclusive price of **£8/7/6 plus 6/6 P. & P.**

**RECORD PLAYERS**

Full range of Changers, Single Players, Transcription Units at Usual Competitive Prices. Interesting H.P. Facilities.

**COLLARO JUNIOR.**



4-speed turntable and pick-up complete with crystal cartridge and sapphire styli.

**SPECIAL OFFER** at only 75/- plus 2/6 P. & P. or **TURNTABLE and MOTOR ONLY** at 52/6 plus 2/6 P. & P. **PICK-UP** only at 27/6 plus 1/6 P. & P.

**E.M.I. 4-SPEED STEREO SINGLE RECORD UNIT.** Complete with Stereo Head and Sapphire Styli. Brand New and Fully G'teed. **ONLY £6/19/6 plus 3/6 P. & P.** whilst stocks last.

**SPEAKER BARGAINS**

Goodmans 8in. x 2 1/2in., 3 ohms, 25/- plus 1/6 P. & P. 10in. Elac High Flux 3 ohm, 39/6 plus 2/6 P. & P. 8in. Celestion High Flux 3 ohm, 32/6 plus 2/- P. & P. 4in. Plessey Tweeter, 15/- plus 1/6 P. & P. R. & A. Type 9120, Mk. II, 12in., 10-12 watts, 3 ohm, 12,000 gauss, 55/- plus 3/6 P. & P. R. & A. Type 8120, Mk. II, 12in., 10-12 watts, 3 ohm, 10,000 gauss, 39/6 plus 3/6 P. & P. 12in. Bakers Selhurst, 15 ohms 15 watts, 30-14,000 c.p.s., £4/10/- plus 3/6 P. & P. All the above brand new and fully guaranteed.

**A QUALITY RECORDER FOR 39 GNS.**

Collaro Mark IV Tape Transcriber Deck	£17 19 6
Special amplifier	£14 14 0
8 x 6in. loudspeaker	£1 10 0
De luxe Cabinet with gilt fittings	£4 10 0
Collaro Mike (or similar)	£2 5 0
1,200ft. EMI tape	£1 15 0
<b>TOTAL</b>	<b>£42 13 6</b>

**OUR SPECIAL INCLUSIVE PRICE ONLY 39 GNS.**

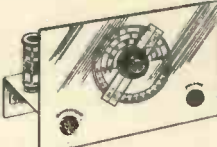
if all items purchased together. Terms: £4/19/- dep. and 12 monthly payments of £3/6/-. C. & P. 15/- extra. Full assembly instructions provided. Note: We shall be pleased to wire the tape deck switches at extra charge of £1. Send stamp for further details.



**CABINET SPECIAL!!!** Just arrived! Leading manufacturers Special Tape Equipment Cabinet—Multi-Purpose, will house all your portable tape or record-playing equipment, Speaker up to 8in. or 10in. x 6in. Size 18in. x 16in. x 14in. Dark Green Rexine covered chrome carrying handles and fittings, detachable lid. Brand New in Original Packing. **PRICE ONLY 75/-, Plus 5/- Part Packing & Carriage.** (Limited Quantity—A truly Professional Job)

**NEW! FOR THE CONSTRUCTOR**

**SUPER 1-VALVE SHORT-WAVE RADIO.** World-wide coverage at most reasonable cost. Covers 40-100 metres with the coil supplied. Can be extended to cover 10-100 metres. Provision is also made for the addition of two extra valve stages. Employs the famous Acorn-type 954 valve. All necessary components can be supplied complete with full assembly instructions at **ONLY 35/- plus 2/- P. & P.** Send 2/- for point-to-point wiring diagram and price list.



**TWO-TRANSISTOR PERSONAL PORTABLE.**

This is an amazing little receiver with built-in aerial, and small enough to be held in the palm of the hand. Medium wave reception at wonderful volume. Supplied with drilled chassis and colour coded components. Easily assembled with the aid of the easy-to-follow assembly instructions provided. Total cost of all necessary components, including transistors Deaf-aid type earpiece, wiring wire and even solder, **ONLY 69/6 plus 1/6 P. & P.** Parts price list and Easy Lay-out Plans 2/- post free.



**SUPER PERSONAL PORTABLE**

A wonderful little set that you can take anywhere. Ideal for camping, picnics, etc. Detachable aerial rod supplied. Covers Medium waveband 200-500 metres. Can be built in approx. 1 hour. All necessary components available at the following **SPECIAL INCLUSIVE PRICES:** 1-valve version **ONLY 35/-**. Super 2-valve version **ONLY 41/-**. Plus 2/- P. & P. Send for point-to-point wiring diagram and parts price list 2/- post free. Extra for use with the above DLR5 balanced armature headphones, 7/6 pair.



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and  
18 Tottenham Court Road, London, W.1

SEE OVER FOR MORE **BARGAINS** →



**JASON TEST EQUIPMENT**

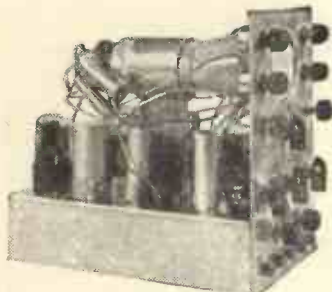
The following equipment of top quality is now available for home construction.



**AUDIO GENERATOR AG10.** Covers from 10 c/s. to 100 Kc/s. in four ranges. Max. output 10 volts. Min output 100 microvolts. Square wave output with excellent rise time makes this generator very useful for checking all Audio equipment. Housed in attractive metal shelf mounting case measuring 1 1/4 in. x 6 1/2 in. x 5 1/2 in. high. All necessary components available, including valves, at a Special Price of £14/5/- plus 3/6 p. & p. Fully descriptive booklet with comprehensive assembly instructions available at 2/- post free.

**OSCILLOSCOPE OG10.** This is a general purpose Oscilloscope based on a "Mullard" circuit employing a DG7-32 3in. cathode-ray tube. A sensitivity of 100 microvolts per c.m. with a band width of 2 c/s. to 2.5 mc/s. makes this a useful unit for T.V. servicing as well as audio amplifier checking. Housed in smart metal case complete with carrying handle. All necessary components available, including valves, at a Special Price of £22/10/- plus 5/- p. and p. Fully descriptive booklet with comprehensive assembly instructions available separately at 3/6 post free.

**CLYNE CATHODE RAY OSCILLOSCOPE for Home Construction**



The latest addition to our comprehensive stocks of quality equipment for the constructor. This is an exceptionally sound and robust instrument of the most versatile type, that will be a boon to the seriously minded amateur, serviceman or constructor. Specifications: 8-Range Time Base, switched from 20 c/s. to 160 Kc/s. Y-Plate Amplifier has a sensitivity of 50 mV, and frequency response of 20 c/s to 600 Kc/s with a gain of 150. A calibrating voltage of 6.3 v. 50 c/s is provided. Employs ECR30 2 1/2 in. Cathode Ray Tube and 4 valves: 2/ECF80, 1/EF91, 1/EZ35, 6XS. Controls: X-shift, Y-shift, Focus, Width, Brilliance. ON/OFF. Time

Base Frequency (Fine), Time Base Frequency (Course), Sync. Selector. Sync. Amplitude. Y-input Selector. X-input Selector. Amplifier Gain. Operates from 200/250 v. or 110 v. A.C. Mains. All required components for the construction of this wonderful instrument, including comprehensive assembly instructions, available at a SPECIAL INCLUSIVE PRICE OF ONLY £12/19/6 plus 5/- carriage and packing.

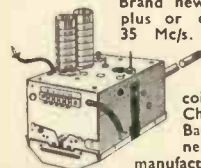
**A.M. GRAM CHASSIS SPECIAL!** (By famous manufacturer) This special offer chassis is being offered for a limited period only and represents the best possible value for money. Spec: 3 wavebands, Long, Medium and Short, 5 miniature valves—6C7, 6F15, 6LD20, N108, U107. Attractive vertical glass dial (13in. x 3 1/2 in.) in red, green and gold on black background. Two-speed dial drive. Full range tone control. Output approx. 4 watts to match 3 ohm speaker. For A.C. mains 110/250 v. Overall size 13in. x 6 1/2 in. x 6 1/2 in. high. WHILST STOCKS LAST, £7/19/6 ONLY, plus 7/6 p. & p.

**VALVES.** We have perhaps the most up-to-date valve stocks in the trade. New imported valve types fully guaranteed and P.T. paid and all the usual surplus types at special prices. We also carry a comprehensive stock of all B.V.A. types at current list prices. Send stamp for NEW list now available. Note: Certain American special purpose types can be supplied. Enquiries invited.

**RE-GUNNED CATHODE RAY TUBES.** (As new.) Guaranteed 12 months. 12in., 14in., and 15in., £5/10/-; 17in., £6; 21in., £7/19/6, plus 10/- c. and p.

**★ BARGAIN CORNER ★**

**12 CHANNEL T.V. TURRET TUNER** (By famous manufacturer). Brand new, NOT surplus or ex-equipment. 35 Mc/s. I.F. PCC 84 and PCF 80 valves. Complete with coils: Band I Channels 1 to 5. Band III Channels 8 to 11. In manufacturers original carton. Fully guaranteed at only 39/6 plus 2/6 p. & p.



**ACOS MIC 39-1.** Crystal stick microphone with stand. List price 5gns. Our price 39/6 plus 1/6 p. & p.

**DEAF AID TYPE EARPIECES.** Standard magnetic type complete with lead and plug. As new. ONLY 12/6 plus 1/- p. & p.

**3-SECTION WHIP AERIALS.** Ideal for fishing rods, etc. Each section 4ft. ONLY 7/6 set, plus 2/6 p. & p.

**EX-W.D. DON MK. V FIELD TELEPHONE SET.** Complete with handset, buzzer, hand generator, Morse key. £3 each or £5/10/- pair. (Both above plus 2/6 p. & p.)

**WIRING WIRE.** 5 coils 10 yards each in different colours contained in cellophane bag, 5/- plus 9d. postage.

**TRANSFORMER SPECIAL.** Superior quality half shrouded drop thro' Mains Transformer. Input 200/250 v. Output 350-0-350 v. 80 mA. 6.3 v. 3 amps. 5 v. 2 amps. Ex-equipment but guaranteed O.K. ONLY 9/6 plus 1/- p. & p.

**8in. LOUDSPEAKER.** Ex-equip. as new. Less transformer. 3 ohm speech coil. 13/6 plus 1/6 p. & p.

**BARGAIN! REPLACEMENT PICK-UP INSERTS.** All brand new and fully guaranteed. Complete with Sapphire Styli. PHONOFLUID 21/- each. B.S.R. TC8 (less bracket) 15/- each. B.S.R. Hi-G with bracket, 18/- each. B.S.R. Hi-G (less bracket) 15/- each. E.V. POWER POINT in Garrard plug-in shell, 18/6 each. E.V. CARTRIDGE only 11/6 each. All plus 9d. p. & p.

**A COMPACT TEST METER FOR HOME CONSTRUCTION.** This is a very sensitive multi-range test meter (500 microamp basic movement) covering the following ranges: A.C./D.C. voltage: 0-10 v., 0-50 v. and 0-500 v. Current: D.C. 0-10 mA., 0-50 mA. and 0-500 mA. Resistance (on internal battery) 2 K.ohm. to 100K.ohm. Housed in a smart grey stove enamelled case measuring 3 1/2 in. x 7 in. x 1 1/2 in. overall. Brand new best quality components and High Stability resistors are used throughout, resulting in a thoroughly reliable, accurate instrument.

**NOTE:** Meter is supplied with calibrated scale fitted, and all components, including shunt, are prepared for immediate soldering into position. Comprehensive assembly instructions with practical and theoretical diagrams are supplied together with all necessary components at a SPECIAL INCLUSIVE PRICE OF ONLY 59/6 plus 1/6 p. & p. The instruction envelope is available separately if required at 1/6 post free.

**PRECISION TEST METER**

(To build yourself) Nineteen ranges, D.C./A.C. Current and resistance. Designed and produced for us by the famous Pullin Company. All necessary components at Special Inclusive Price of only £5/19/6 plus 2/6 p. & p. Illustrated leaflet with full description available on request.

**CABY UNIVERSAL TEST METERS**

These pocket-size multi-range test meters are of excellent quality and cover all the most useful ranges (A.C. Volts, D.C. Volts, resistance and current). Supplied complete with test prods, instruction book and batteries. Model A.10 (2,000 ohms per volt) £4/17/6

Model B.20 (10,000 ohms per volt) £6/10/-.

Plus P. & P. 3/6 on each. Fully detailed and illustrated leaflet available on request.

**ALFA POCKET TESTMETER**

A most versatile test meter covering 15 ranges. 3,333 o.p.v. basic movement. Ohms ranges: 0-20K, 0-2 Meg. Volts: A.C. and D.C. 6 v., 12 v., 60 v., 300 v., 1,200 v. Current: D.C. 300 microamps, 30 mA., 300 mA. Size only 3 1/2 in. x 5 in. x 1 1/2 in. overall. Supplied complete with instructions and test prods. ONLY £5/19/6 plus 2/6 p. & p.

**DLR5 BALANCED ARMATURE HEADPHONES.** Complete with headband and leads, 7/6 pair, plus 1/6 p. & p.

**HIGH IMPEDANCE LIGHT-WEIGHT HEADPHONES.** Brand new imported type finished in cream. Complete with leads, 15/- plus 1/6 p. & p.

**ALLAN DOUGLAS ELECTRONIC ORGAN**

Readers will no doubt be pleased to know that our working model of this amazing organ for home construction, may now be heard and seen, at our Hi-Fi Showroom in Tottenham Court Road, W.1. For the benefit of constructors all components, keyboards, chokes, etc. are available ready made. Full constructional details are available in book form at 15/- plus 1/6 p. and p. We shall be happy to forward a complete price list on receipt of a stamp. Please address all organ enquiries for the attention of Mr. L. Roche.

**—TRANSISTORS!!!—**

**SURPLUS—P.N.P.**  
**RED SPOT** (Audio/Experimental Application) ..... 5/- ea.  
**WHITE SPOT**, R.F. up to 2.5 Mc/s. .... 7/6 ea.  
**STANDARD—**  
**BRIMAR**  
 TSB ..... 18/6 ea.  
**MULLARD**  
 OC16 Power 3 watt ..... 54/- ea.  
 OC44 ..... 18/6 ea.  
 OC45 R.F. up to 6 Mc/s. .... 18/6 ea.  
 OC70 ..... 10/- ea.  
 OC71 ..... 10/- ea.  
 OC72 ..... 14/6 ea.  
 OC72 matched pair ..... 27/- pr.  
 OC73 ..... 12/6 ea.  
 OC77 ..... 18/6 ea.

**NEWMARKET**  
 V6/2R R.F. up to 4 Mc/s. .... 19/6 ea.  
 V6/4R R.F. 4-8 Mc/s. .... 23/- ea.  
 V6/8R R.F. up to 8 Mc/s. .... 26/- ea.  
**Audio**  
 V10/15A ..... 12/- ea.  
 V15/10P (Power) ..... 15/- ea.  
**MAZDA**  
 XA104 R.F. up to 6 Mc/s. .... 18/- ea.  
 XA103 R.F. up to 4 Mc/s. .... 15/- ea.  
 XB104 Audio up to 1 Mc/s. .... 10/- ea.  
 (Mazda and Newmarket Data sheets available.)  
**(ALL POST FREE)**

**METERS.** We carry large stocks of Meters from 25 microamps to 1,500 v. A few of the most popular types are: 25 microamps 2 1/2 in. Flush Round, 65/-; 100 microamps 2 1/2 in. Flush Round Moving Coil at 45/-; 500 microamps 2 in. Flush Round Moving Coil at 18/6; 1 mA. 2 in. Flush Square Moving Coil "Elliott" 1954 man., 25/-; 50 mA. 2 in. Flush Square Moving Coil 8/6; 1 mA. 2 1/2 in. Flush Round 35/-. Send stamp for complete list. We shall be pleased to quote for special meters to your own specification.

**AERIAL TUNING UNIT ZA0841.** This well made ex-W.D. unit contains a host of useful components including: 1 mA. 2 in. flush round M/C meter, 1 mA. Westinghouse full-wave meter rectifier, 5-pole 5-way heavy-duty silver plated wchange switch, 3 in. dia. silver plated rotary tuning Indicator, 350 pF. tuning condenser with insulated coupler and 3 in. calibrated dial (0-180 deg.) etc., etc. Contained in strong metal carrying case 9 in. x 9 in. x 8 in. with hinged lid. ONLY 27/6 plus 5/- c. & p.

**No. 38 AFV WALKIE-TALKIE.** A wonderful offer. This famous trans-receiver unit, with relay operated SEND/RECEIVE switch, covering 7.4-9 Mc/s. band, range approx. 5 miles. In new condition. ONLY 22/6 plus 2/6 p. & p. per unit (less accessories). Quantity Export inquiries welcomed.

**No. 17 Mk. II TRANSMITTERS RECEIVER.** Built into strong wooden cabinet 15in. x 14in. x 9in. Complete with headphones and microphone. Range 5-8 miles with simple aerial. Freq. range 44-61 Mc/s. (5-7 meters). Uses standard 120 v. H.T. and 2 v. L.T. batteries. Brand new. Complete with full operating instructions, 45/-. (Secondhand 30/-). Batteries not included.

**CLYNE RADIO LTD.**

162 Holloway Road, London, N.7  
 and  
 18 Tottenham Court Road, London, W.1.

ALSO SEE PAGES 128 & 129



# MULLARD DESIGNS

*Still by far the finest value*

## COMPLETE KIT OF PARTS

Designed by MULLARD—presented by STERNs strictly to specification

### MULLARD "5-10" MAIN AMPLIFIER

For use with the MULLARD 2 stage preamplifier (described below) with which an undistorted power output of up to 10 Watts is obtained. This combination is thoroughly recommended for "HI-FI" enthusiasts who contemplate a versatile and very high quality home installation. We supply SPECIFIED COMPONENTS AND NEW MULLARD VALVES including PARMKO MAINS TRANSFORMER (which has extra Power available to drive Radio Tuner) and the choice of the latest Ultra-Linear PARMKO or the PARTRIDGE Output Transformer.

Price: COMPLETE KIT (Parmko Output Trans.) **£10.00**  
Alternatively we supply ASSEMBLED AND TESTED **£11.10.0**



ABOVE INCORPORATING PARTRIDGE OUTPUT TRANSFORMER £11/6/0 extra

### MULLARD'S PRE-AMPLIFIER TONE CONTROL UNIT

Employing two EF81 valves, and designed to operate with the Mullard 3-3 and 5-10 MAIN AMPLIFIERS, but also perfectly suitable for other makes.

Our kit is strictly to MULLARD'S SPECIFICATION and incorporates:  
 ● Equalisation for the latest R.I.A.A. characteristics.  
 ● Input for Crystal Pick-ups, and variable reluctance magnetic types.  
 ● Input. (a) Direct from High Imp. Tape Head. (b) From a Tape Amplifier or Pre-Amplifier.  
 ● Sensitive Microphone Channel.  
 ● Wide range BASS and TREBLE Controls.



Alternatively we supply ASSEMBLED AND TESTED **£8.00**  
(Carriage and Insurance 5/- extra.)

### MULLARD 3-3 MAIN AMPLIFIER

with the more expensive "HI-FI" equipment. We recommend it as the IDEAL SMALL HOME INSTALLATION where very high quality is desired at the lower volume level (up to 3 watts). We supply completely to MULLARD'S SPECIFICATION INCLUDING the latest PARMKO Output Transformer, specified Valves and Components. Has Power available to drive a Radio Tuning Unit.

Based entirely on the very popular "3-3" model and designed to operate with the 2-stage PRE-AMPLIFIER (shown here) thus providing all the facilities associated with the more expensive "HI-FI" equipment. We recommend it as the IDEAL SMALL HOME INSTALLATION where very high quality is desired at the lower volume level (up to 3 watts). We supply completely to MULLARD'S SPECIFICATION INCLUDING the latest PARMKO Output Transformer, specified Valves and Components. Has Power available to drive a Radio Tuning Unit.



Price for COMPLETE KIT OF PARTS **£7.00**  
Alternatively we supply ASSEMBLED AND TESTED **£8.00**  
(Carriage and Insurance 5/- extra.)

### COMPLETE MULLARD 5-10 AMPLIFIER

The popular and very successful complete "5-10" incorporating Control Unit providing up to 10 Watts high quality reproduction. Input channels for high output pick-ups and all modern Radio Tuning Units only. Specified Components and new MULLARD VALVES are supplied including PARMKO MAINS TRANSFORMER and choice of the latest PARMKO or PARTRIDGE ULTRA Linear Output Transformers. Adequate power available to drive Radio Tuner. Price: COMPLETE KIT, Parmko Transformer **£11.10.0**  
Alternatively we supply ASSEMBLED AND TESTED **£13.10.0**  
Hire Purchase (Assembled Amp. only). Deposit £2/14/-, 12 months at 19/10. ABOVE incorporating PARTRIDGE OUTPUT TRANSFORMER £16/- extra.



THE COMPLETE ASSEMBLY MANUAL AVAILABLE FOR 1/6.

### COMPLETE MULLARD 3-3

A VERY HIGH QUALITY AMPLIFIER DEVELOPED FROM THE VERY POPULAR 3-VALVE 3-WATT AMPLIFIER DESIGNED IN THE MULLARD LABORATORIES.

Price for COMPLETE KIT **£7.10.0**  
(Plus 6/6 carriage and insurance.)

Alternatively supplied ASSEMBLED AND FULLY TESTED (Plus 6/6 carriage and insurance.) **£8.19.6**

H.P. Terms Deposit £2 and 8 monthly payments of £1.

Our kit is complete to the MULLARD specification including supply of specified components, valves and PARMKO OUTPUT TRANSFORMER. We also include switched inputs for 78 and L.P. records plus a Radio position. Extra power to drive a Radio Tuning Unit is also available.

# MULLARD—STERN STEREO DESIGNS

Model 3-3 M/S

### DUAL "3-3" MAIN AMPLIFIER

Comprises two "3-3" MAIN AMPLIFIERS (described above) on one chassis and is designed to operate with our DUAL CHANNEL PREAMPLIFIER for both STEREO or MONAURAL operation.



Price: COMPLETE KIT OF PARTS **£10.0.0**  
Alternatively ASSEMBLED AND TESTED **£11.15.0**

H.P. Terms Deposit £2/7/-, 12 months at 17/4. Its output power is 6 Watts (3 watts per channel) and together with our PREAMPLIFIER provides a very acceptable STEREO installation.

### DUAL CHANNEL PRE-AMPLIFIER

This model incorporates two 2-Valve Pre-Amplifiers (described above) combined into a Single Unit enabling it to be used for both STEREO or MONAURAL operation. It is designed primarily to operate with our range of MULLARD MAIN AMPLIFIERS but will also operate equally well with any make of Amplifiers requiring an input of 250 mV.



Price: COMPLETE KIT **£12.10.0**  
Alternatively ASSEMBLED AND TESTED **£15.0.0**

H.P. Terms £3 Deposit and 12 months of £1/2/-.  
Perfectly suitable for MONAURAL only operation, with one "3-3" or one "5-10" MAIN Amplifier to which the second Main Amplifier can at any time be added thus very easily providing for both STEREO or MONAURAL reproduction.  
Recommended combination for STEREO operation.  
(a) THE DUAL CHANNEL PRE-AMPLIFIER together with the Dual "3-3" MAIN AMPLIFIER.  
(b) THE DUAL CHANNEL PRE-AMPLIFIER together with two "5-10" MAIN AMPLIFIERS. Assembly Manual is available for 3/- or send S.A.E. for Descriptive Leaflet.  
When ordering please advise MAKE and MODEL OF AMPLIFIER in use.

Only New HIGH GRADE Specified Components and MULLARD VALVES are supplied in all these models.

Please enclose S.A.E. if ILLUSTRATED and DESCRIPTIVE LEAFLETS are required... alternatively the COMPLETE ASSEMBLY MANUALS containing component Price Lists and practical Drawings, etc., are available at 1/6 each.

### COMPLETE STEREO AMPLIFIER

A thoroughly recommended design that very effectively meets the many requests for a low priced but good quality DUAL CHANNEL STEREO PHONIC AMPLIFIER.



Price: COMPLETE KIT OF PARTS **£8.10.0**  
Alternatively ASSEMBLED AND TESTED **£10.10.0**

Two Mullard ECL 82 Triode Pentode Valves are incorporated in the design, they form a "CLASS A" single ended output stage in each channel. The input sensitivity is 300 mV/volts, therefore when used with most STEREO Crystal Pick-Ups, or Radio Tuning Units, an output of 2 Watts per channel is achieved, or similarly when switched to MONAURAL Pick-up position a combined output of 4 Watts is produced.

DEPT. W. 109 FLEET ST., LONDON, E.C.4  
Telephone: FLEET STREET 5812/3/4

Each Model incorporates the highly successful HF/TR3 Amplifier (described opposite), thus ensuring truly "HI-FI" record and playback facilities.

All prices quoted provide for the COMPLETE RECORDER including CRYSTAL MICROPHONE and I-200ft. Spool of Tape.

There are no "better value for money" Tape Recorders on the market—if you can't call and hear them—send S.A.E. for fully descriptive leaflets.



# Stern's "fidelity" TAPE RECORDERS

**BEFORE YOU BUY—YOU SHOULD HEAR THESE RECORDERS—THEY ARE COMPARABLE TO THE MUCH HIGHER PRICED MODELS**

- MODEL CR3/S. Incorporates the New COLLARO "STUDIO" TWIN TRACK 3-speed Deck. H.P. Terms: Deposit £8/4/- and 12 months of £3/0/2. **£41.0.0**
- MODEL CR3/T. Incorporates the very popular 3-speed COLLARO Mk. IV "TRANSCRIBTOR" Deck, which has both upper and lower tape tracks. H.P. Terms: Deposit £9/18/- and 12 months of £3/12/7. **£49.10.0**
- MODEL TR3/MK. VI. Incorporates the New TRUVOX Mk. VI TWIN TRACK 2-speed Tape Deck. H.P. Terms: Deposit £9/18/- and 12 months of £3/12/7. **£49.10.0**

## !! RECORD PLAYERS !!

The LATEST MODELS are in Stock. Many at REDUCED PRICES !!! Send S.A.E. for ILLUSTRATED LEAFLET

- B.S.R. MONARCH UA8 4-spd. Mixer Autochanger with Crystal Pick-up. **£6.12.6**
- The COLLARO "CONQUEST" 4-spd. Autochanger, Studio "Q" Pick-up. **£7.10.0**
- The latest COLLARO "CONTINENTAL" 4-speed MIXER Autochanger, Studio "C" Pick-up. **£8.10.0**



- The NEW COLLARO model RP594, 4-speed Single Record Player, Studio Cartridge **£9.18.9**
- The COLLARO model 4 564 4-speed Single Record Player, Studio Pick-up **£6. 6.0**
- THE NEW B.S.R. model UA12 is in stock. A 4-"SPEED" MIXER AUTOCHANGER **£8. 7.6**
- UA12 is also available incorporating the B.S.R. STEREO Pick-up, plays L.P. and 78 records **£10.10.0**
- GARRARD RC121/4 4-speed Autochanger fitted with latest Crystal Pick-up **£10. 0.0**
- The latest GARRARD TRANSCRIPTION MOTOR "301" with Stroboscopically marked turntable **£23.18.4**
- The new GARRARD Model 4HP High Quality Single Record Player fitted with the latest T.P.A. 12 Pick-up arm and G.C.S. Crystal Cartridge **£18. 7.6**
- GARRARD Model TA/MK. II Single Record Player fitted with high output Crystal Pick-up, detachable head. **£8.10.0**

HIRE PURCHASE TERMS available on all units £8/19/6 and over. Carriage and insurance on each above 5/- extra.

## STERN'S MK. II "fidelity" F.M. TUNING UNIT

(Plus 5/- carr. and ins.)  
HIRE PURCHASE: Deposit PRICE **£14.5.0**  
£2 and 12 months at £1/0/9. Incorporates the latest MULLARD PERMEABILITY TUNING HEART and the corresponding MULLARD VALVE LINE UP comprising EC285, 2 type EF85a (or EF89a), EM84, Tuning Indicator, plus 2 type O.A. 79a Germanium Diodes. A really first-class Tuner very attractively presented and comparable to many offered at much higher prices. Power consumption is only 1.6 amps. at 6.3 volts and 25 m.a. at 250 volts.



## HOME CONSTRUCTORS !

YOU CAN BUILD THIS TUNING UNIT FOR ONLY **£10.10.0**  
(Plus 5/- carr. and ins.)  
Please send S.A.E. for fully descriptive leaflet, or the Assembly Manual is available for 1/6.

## !! HOME CONSTRUCTORS !!

A RANGE OF "EASY TO ASSEMBLE" PREFABRICATED CABINETS Designed by the W.B. "STENTORIAN" COMPANY for "HI-FI" Loudspeaker systems or to accommodate high-quality equipment. The acoustically designed Bass Reflex Cabinets containing the very successful "Stentorian" Speakers give really first-class reproduction and are well recommended. Models are also available to accommodate high-quality Amplifiers, Pre-amplifiers, Tuning Units, Record Players, etc. All models are very easily assembled, in fact only a screwdriver is required. Fully illustrated leaflets are available including complete specifications of the various STENTORIAN LOUDSPEAKERS. Please enclose S.A.E.

## CAR BATTERY CHARGER

A COMPLETE KIT OF PARTS FOR ONLY **£2.19.6**  
Will charge 6 or 12 volt batteries at max. 2 1/2 amps. The design incorporates Bellant Resistor and Fuse and we supply complete with Metal Box container. EASY-TO-FOLLOW ASSEMBLY INSTRUCTIONS ARE INCLUDED.

## SPECIAL CASH ONLY BARGAIN

A bulk purchase enables us to offer this very useful INTERCOM SET or BABY ALARM For only **£5.5.0**

Consists of MASTER UNIT (illustrated) and one EXTENSION, providing 2-way TALK-LISTEN facility. Complete in polished wood cases, size of each only 7 1/4 x 4 1/2 x 6 in. high.



## !! RADIOGRAM CHASSIS !!

- ARMSTRONG MODEL A F 208 Complete AM/FM chassis producing 5 watts. Separate Bass and Treble controls. **£23.2.0**
- ARMSTRONG "STEREO TWELVE" The most complete A.M./F.M. unit yet produced. For Stereo, giving 6 watts high fidelity push-pull output on each channel, 12 watts for Monaural **£37.16.0**
- ARMSTRONG "JUBILEE" An AM/FM chassis with nine valves and with push-pull output stage providing 6 watts. **£29.8.0**
- ARMSTRONG AM/FM "STEREO 44" Provision is made for Stereo and Monaural playback from pick-up or tape. Outputs provided for Stereo or Monaural tape recording. **£28.7.0**

## RADIO TUNING UNITS

- The JASON "MERCURY" Switched F.M. TUNER. PRICE ASSEMBLED AND TESTED. Complete Kit of Parts £9/19/6. **£13.10.0**
  - DULCI Model FMT/2 A complete self-powered FM Tuner incorporating automatic frequency control. **£19.17.6**
  - ARMSTRONG "S.T.3." AM/FM Tuning Units. A self-powered high fidelity tuner covering full VHF, medium and long wavebands with automatic frequency control on VHF. **£27.6.0**
  - DULCI "H4/T" AM/FM Tuning Units. A 4-waveband self-powered high fidelity tuner covering the VHF/FM transmissions plus the long, medium and short wavebands. **£23.15.8**
- NEW HIRE PURCHASE TERMS are available on all above. Illustrated leaflets available—send S.A.E. (Carr. and Ins. 5/- extra.)

## Hi-Fi LOUDSPEAKERS

WE HAVE IN STOCK THE COMPLETE RANGE BY GOODMAN'S-WHARFEDALE-W.B.



- And will be pleased to send you illustrated and Priced Leaflets.
- Recommended Types are:
- GOODMANS "AXIOM 300." The best 12in. Seller. 15 ohms V/coil, Freq. Resp. 30 c/s., 16,000 c/s. **£11.5.9**
  - GOODMANS "AXIETTE" 8-inch (as illustrated). 3 or 15 ohms. Freq. Resp. 40-15,000 c/s. **£6.12.0**
  - W.B. "STENTORIAN" H.P.816, 8in., 3 or 15 ohms. Freq. Resp. 50-15,000 c/s. **£6.10.6**
  - W.B. "STENTORIAN" H.F.1016, 10in., 3 or 15 ohms. Freq. Resp. 30-15,000 c/s. **£7.12.3**
  - W.B. "STENTORIAN" H.F.1214, 12in., 15 ohms. Freq. Resp. 25-14,000 c/s. **£9.15.6**
  - WHARFEDALE "SUPER 8 FS/AL" 8in., 3 or 15 ohms. **£6.19.11**
  - WHARFEDALE "GOLDEN FSB." 10in., 3 or 15 ohms Voice Coil. **£7.13.3**
  - WHARFEDALE "W12/FS," 12in., 15 ohms Voice Coil. **£10.5.0**
  - WHARFEDALE "SUPER 12/FS/AL" 12in., 15 ohms Voice Coil. LOUDSPEAKER ENCLOSURES—TWEETER UNITS—CROSSOVER UNITS **£17.10.0**  
*are also available.*

## SPECIAL CASH ONLY OFFER !!

This very attractive PORTABLE AMPLIFIER CASE together with a good quality GRAM AMPLIFIER and a matched P.M. SPEAKER. ALL FOR ONLY **£8.7.6** (plus 7/6 carr. and ins.). The Amplifier consists of a 2-stage design incorporating the 3 modern BVA valves and has separate BASS and TREBLE CONTROLS. The Portable Case will also accommodate almost any make of Autochanger and is attractively finished in Grey colour Resine—WE ALSO SUPPLY SEPARATELY:—

- (a) The 2-stage (plus Rectifier) AMPLIFIER **£4 2 6**
- (b) The PORTABLE CARRYING CASE **£3 17 6** (Carriage and insurance 4/- extra)
- (c) 12in. P.M. SPEAKER **£18 9**



**STERN RADIOD. DEPT. W. 109 FLEET ST., LONDON, E.C.4**  
Telephone: FLEET STREET 5812/3/4



# Stern's "fidelity" TAPE EQUIPMENT

## THE FINEST RANGE OF TAPE EQUIPMENT FOR THE HOME CONSTRUCTOR

### A SELECTION OF HIGH FIDELITY PORTABLE TAPE PRE-AMPLIFIERS

Adds "HI-FI" Tape Recording to your existing Audio Installation.

IN ALL MODELS WE INCORPORATE THE

#### TYPE "C" PRE-AMPLIFIER

and offer it complete in portable case with . . .

- (a) The new "COLLARO" STUDIO 3 speed Deck. Deposit: £7/6/-, 12 months £2/13/6 **£36.10.0**
- (b) The COLLARO Mk. IV "Transcriptor" 3 Speed Deck. Deposit: £8/6/-, 12 months £3/0/11 **£41.10.0**
- (c) The new TRUVOX Mk. VI Tape Deck. Deposit: £8/14/-, 12 months £3/3/10 **£43.10.0**
- (d) The BRENNELL Mk. V 3 Speed Deck. Deposit: £10/6/-, 12 months £3/15/7 **£51.10.0**
- (e) The WEARITE MODEL 4A Tape Deck. Deposit: £12/4/-, 12 months £4/9/5 **£61.0.0**



### YOU CAN BUILD A COMPLETE HIGH QUALITY TAPE RECORDER for £36.0.0

H.P. TERMS . . . Deposit £7/4/-, 12 months £2/12/10.

FOR THIS WE SUPPLY:—

COMPLETE KIT OF PARTS TO BUILD THE HF/TR3 TAPE AMPLIFIER.

THE NEW COLLARO "STUDIO" TAPE DECK.

PORTABLE CARRYING CASE (as illustrated)

ROLA/CELESTION 10in. x 6in. P.M. LOUDSPEAKER. ACOS CRYSTAL MICROPHONE 1200ft. SPOOL E.M.I. TAPE.

Alternatively for those who prefer another type of TAPE DECK we will supply precisely as above—but IN PLACE OF THE COLLARO "STUDIO" DECK—WE INCLUDE:—

- (a) The Mk. IV COLLARO "TRANSCRIPTOR" DECK. . . . . **£39.15.0**  
H.P. TERMS . . . Deposit £8, 12 monthly payments of £2/18/2 (£1 extra if we are required to wire up the Transcriptor Switch Banks).
- (b) The new TRUVOX Mk. IV DECK . . . . . **£45.0.0**  
H.P. TERMS: Deposit £9, 12 months of £3/6/- (Carr. and Ins. on all above is 12/6 extra).

For constructors with their own Cabinet—WE OFFER:—

- (a) COMPLETE KIT to build the HF/TR3 Amplifier, together with the COLLARO "STUDIO" DECK . . . . . **£28.0.0**
- (b) As above but HF/TR3 ASSEMBLED and TESTED . . . . . **£31.10.0**  
H.P. TERMS: Deposit £6/6/-, 12 months of £2/6/2.
- (c) COMPLETE KIT to build the HF/TR3 together with the Mk. IV COLLARO "TRANSCRIPTOR" DECK (£1 extra if we are required to wire up Deck Banks) . . . . . **£30.15.0**
- (d) As above but HF/TR3 ASSEMBLED and TESTED . . . . . **£34.10.0**  
(£1 extra if we are to wire up Deck Switch Banks)
- (e) COMPLETE KIT to build the HF/TR3 together with the NEW TRUVOX Mk. IV TAPE DECK . . . . . **£36.0.0**
- (f) As above but HF/TR3 ASSEMBLED and TESTED . . . . . **£39.10.0**
- (g) COMPLETE KIT to build the HF/TR3 AMPLIFIER with the BRENNELL Mk. V TAPE DECK . . . . . **£41.10.0**
- (h) As above but HF/TR3 ASSEMBLED and TESTED . . . . . **£45.0.0**  
H.P. TERMS: Deposit £9, 12 months of £3/6/-.
- (i) THE ASSEMBLED and TESTED HF/TR3 AMPLIFIER with the WEARITE MODEL 4A DECK, incorporates Wearite Head Lift Transformer, etc. . . . . **£55.0.0**  
H.P. TERMS: Deposit £11, 12 months of £4/0/8.  
(Carriage and Insurance on each above is 10/- extra.)

Attractive PORTABLE CASE is available to accommodate the TRUVOX or COLLARO TAPE DECKS and we offer it together with ROLA/CELESTION 10 x 6in. LOUDSPEAKER—ACOS CRYSTAL MICROPHONE—AND 1200ft. SPOOL E.M.I. TAPE—ALL FOR . . . . . **£9.0.0**  
(Carriage and Insurance 5/- extra.)

#### WE HAVE THE NEW 2-SPEED TWIN TRACK

**TRUVOX Mk. VI Tape Deck in stock £26.5.0** Deposit £5/5/-, 12 months £1/18/6  
It incorporates PRECISION REV. COUNTER and PAUSE CONTROL and fully maintains the general high standard of all Truvox equipment. The very popular COLLARO Tape Decks and the BRENNELL Mk. V Decks are also available.

### THE MODEL HF/TR3 TAPE AMPLIFIER

Incorporating 3-SPEED TREBLE EQUALISATION by means of the latest FERROX-CUBE POT CORE INDUCTOR.  
PRICE FOR COMPLETE KIT OF PARTS FULLY ASSEMBLED AND TESTED **£12/15/-**  
**£16/10/-**



HIRE PURCHASE: Deposit £3/6/6 and 12 months at £1/4/2. A very high quality amplifier based on the very successful Type "A" design completed in the MULLARD LABORATORIES. ONLY NEW HIGH-GRADE COMPONENTS are incorporated including MULLARD VALVES and a GILSON OUTPUT TRANSFORMER . . . other features are: Magic Eye Recording Head Indicator—Effective Tone Control—Monitoring and Extension Speaker Sockets—has own Power Supply and can be used as independent Amplifier for direct reproduction of Gram. Records or from Radio Tuner. Overall size 11 x 8 x 6in.—Truvox—Collaro—or Brennell—please specify which. Send S.A.E. for leaflet or 2/6 for Assembly Manual.

PLEASE ENCLOSE S.A.E. WITH ALL CORRESPONDENCE

#### STERN'S MULLARD TYPE "C" TAPE PRE-AMPLIFIER—ERASE UNIT

INCORPORATING THE NEW FERROX-CUBE POT CORE PUSH-PULL OSCILLATOR and 3 SPEED TREBLE EQUALISATION by means of the latest FERROX-CUBE POT CORE INDUCTOR.



PRICES INCLUDING SEPARATE SMALL POWER SUPPLY UNIT COMPLETE KIT OF PARTS **£14.0.0** ASSEMBLED AND TESTED **£17.0.0**

Deposit £3/8/- and 12 months of £1/4/11. Assembled unit only. ALSO AVAILABLE EXCLUDING POWER SUPPLY UNIT FOR **£11.15.0** and **£14.10.0** respectively. (Carr. and Ins. 5/- extra)

Send S.A.E. for leaflet or 2/6 for Complete Assembly Manual. WHEN ORDERING PLEASE STATE MAKE OF TAPE DECK TO BE USED We present this "Hi-Fi" Pre-amplifier strictly to Mullard's specification etc., incorporating ONLY NEW HIGH GRADE COMPONENTS and the SPECIFIED NEW MULLARD VALVES. It comprises a COMPLETELY SELF-CONTAINED UNIT, all components and valves being contained in a well ventilated Box—Chassis neatly finished in Hammered gold with a very attractively engraved PERSPEX FRONT PANEL.

#### FOR PERMANENT HIGH QUALITY INSTALLATIONS

WE ALSO OFFER (excluding Case) the following

- (a) The COLLARO "STUDIO" TAPE DECK and our Mullard Type "C" PRE-AMPLIFIER and Power Unit Assembled and Tested . . . . . **£32.10.0**  
H.P. Terms: Deposit £6/10/- and 12 months at £2/7/8.
- (b) As above but TYPE "C" PRE-AMPLIFIER supplied as complete Kit of Parts . . . . . **£29.0.0**
- (c) The COLLARO Mk. IV TAPE DECK and the MULLARD Type "C" Pre-amplifier and Power Unit assembled, tested . . . . . **£35.0.0**  
H.P. Deposit £7 and 12 months £2/11/4.
- (d) As in (a) above but the Type "C" supplied as COMPLETE KIT OF PARTS . . . . . **£32.0.0**
- (e) The TRUVOX Mk. IV TAPE DECK and the assembled Type "C" Pre-amplifier and Power Unit . . . . . **£40.0.0**  
H.P. Deposit £8 and 12 months £2/18/8.
- (f) As above but the Type "C" supplied as complete KIT OF PARTS . . . . . **£36.10.0**
- (g) The BRENNELL Mk. V Deck and the assembled Type "C" PRE-AMPLIFIER and POWER UNIT . . . . . **£46.0.0**
- (h) As above, but the Type "C" supplied as complete KIT OF PARTS . . . . . **£43.0.0**
- (i) The WEARITE 4A DECK with Type "C" assembled and tested . . . . . **£56.0.0**  
H.P. Deposit £11/4/- and 12 months £4/2/1.  
(Carriage and Insurance on above quotes 10/- extra)

## STERN RADIO LTD.

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Telephone: FLEET STREET 5812/3/4



# LASKY'S RADIO

**H.P. TERMS AVAILABLE**  
on certain items. Please give details of your requirements.



**"INSTANT" BULK TAPE ERASER**  
and Head Demagnetiser. Erases a complete reel of magnetic tape in few seconds.  
27/6 post free.

**UNIVERSAL SOUND MIXER**  
3 channels. For use with all tape recorders and audio amplifiers. Size 4 1/2 x 3 1/2 x 3 1/2 in.  
**LASKY'S PRICE** 35/- Post 2/6.



**TV CHASSIS BRAND NEW, BY WELL-KNOWN MAKERS**

For 200-250 v. A.C./D.C. mains. Wide angle. Complete with brand new Mullard valves and C.R. Tube. 12-channel turret tuning covering all B.B.C. and I.T.V. channels. Limited number, factory sold only. Full data and circuit diagram supplied.

21in. **39 GNS.**  
**WORTH DOUBLE**

Also a few chassis less valves and C.R. Tube at various prices for callers.

**SPECIAL OFFER RECORDING TAPE**

Famous make. P.V.C. base on latest type plastic spools. Brand new, perfect, boxed and guaranteed.

- 1,800ft. on 7in. spool ..... 32/6
- 1,200ft. on 7in. Spool ..... 21/-
- 1,200ft. on 5 1/2in. Spool ..... 22/6

**GEVAERT L.P. PLASTIC**  
1,700ft. on 7in. spool ..... 35/-  
850ft. on 5in. spool ..... 18/6  
210ft. on 3in. spool ..... 6/6  
Post: 1 spool, 1/6  
Orders over 60/- post free

**TRANSCRIPTION TURNTABLES**

COLLARO 4-spd., type 4T200/PX, with Studio transcription pick-up. LIST £19/10/-.

- LASKY'S PRICE £16. 19. 6**  
Carr. paid  
In carrying case, 25/- extra.
- GARRARD 301 ..... £22 7 3
  - GARRARD 301 (Strobe) ..... £23 18 4
  - GARRARD 4HF (Stereo) ..... £19 4 8
  - GARRARD 4HF (G.C.8) ..... £18 9 9
  - LENCO GL.56, stereo, binofluid diamond ..... £23 17 0
  - PHILIPS ..... £10 10 0

**PLASTIC TAPE SPOOLS**

- |      |     |          |      |          |
|------|-----|----------|------|----------|
| 2/9  | 3/6 | 4/3      | 4/-  | 5/6      |
| 3in. | 5in | 5 1/2in. | 7in. | 8 1/2in. |
- 7in. Metal Spools, 1/9 each.  
Post extra.

**NEW YEAR RECORDER SCOOP!**



**"MAESTROVOX MAJESTIC" ALMOST HALF-PRICE!**

Brand new and unused. Brief specification:—Collaro Tape Transcriber, twin track, instantly reversible. Incorporates 4 heads (two for each track). 3-speed—3 1/2, 7 1/2 and 15 i.p.s. Takes 7in. spools. Mixing facilities for recording and play-back. Magic eye recording level indicator. Record monitoring and feed to amplifier. Extension I.S. socket. Handsomely designed cabinet, 18in. x 15 1/2in. x 9in.

**LIST 65 GNS. LASKY'S PRICE 35 GNS.**  
Including Tape and Take-up Spool. Mike extra.  
Carr. and Insur. 21/-.

**ANOTHER NEW YEAR SCOOP!**

**MAGNAVOX 10-12 watt HIGH FIDELITY AMPLIFIER AND PRE-AMPLIFIER**



LIST 22 GNS.  
**LASKY'S PRICE £12. 19. 6**  
Carr. & Ins. 7/6

Built to latest Mullard circuit and complete with Mullard valves: two EL84 p.p. two EF86, one ECC83 and EZ81 rectifier. Main Amplifier chassis size 7 1/2in. x 10in., maximum height 5in., gold hammer finish. Separate Pre-Amplifier in polished wood case, walnut veneered, with smart maple and gold escutcheon, size 10 1/2in. x 3 1/2in. x 4in. Brand new and unused.

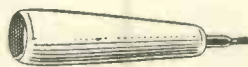
**SPECIAL OFFER**

**12-CHANNEL TURRET TUNERS**

Complete with PCC84 and PCF80 valves. I.F. 33-38 Mc/s. Complete with 8 sets of coils: 5 Band I channels and channels 8, 9, 10 Band II. New and unused. Today's value over £7.

**LASKY'S PRICE 49/6**  
Post free.

**MICROPHONE BARGAINS**



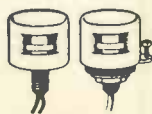
**ACOS CRYSTAL STICK MIKE**, type MIC.39/1, complete with cable. Listed at £8/5/-.

**LASKY'S PRICE 39/6**  
Post free.  
Desk Stand 2/6 extra.

**ACOS type 33/1. Crystal hand or table Microphone**. Incorporates specially designed acoustic filter. Flat response 30-7,000 c.p.s. Omni-directional. Attractive dark brown plastic. LIST 50/-.

**LASKY'S PRICE 29/6**  
Post 1/6.

**HIGH FIDELITY TAPE RECORDER HEADS**



Leading make, new and unused upper or lower track RECORD/PLAY-BACK, high impedance. Double wound and will reproduce up to 12,000 c.p.s. at 7 1/2 i.p.s. Azimuth adjustments. Output 5 millivolts at 1 Kc. at 7 1/2 i.p.s. ERASE, low impedance.

**LASKY'S PRICE 39/6** Post 1/3  
Per pair  
Worth double. Please specify upper or lower track.

**TAPE DECK OFFERS!**



Latest B.S.R. **"MONARDECK," SINGLE-SPEED TAPE DECK**, 3 1/2 i.p.s., takes 5 1/2in. spools. Simple controls.  
**LASKY'S PRICE £9.19.6**

Tape extra. Carr. & Insur., 12/6.



Latest **COLLARO STUDIO TAPE TRANSCRIBER**, 3 motors 3-speed, 1 1/2, 3 1/2, 7 1/2 i.p.s. takes 7in. spools. Push button controls.

**LASKY'S PRICE £15.15.0**  
Tape extra. Carr. & Insur., 12/6

**TAPE RECORDER AMPLIFIER** for use with Collaro Tape Deck. Manufacturer's surplus complete with 4 valves and power pack.  
Post 3/6. **£7.19.6**

**COLLARO TAPE TRANSCRIBER**, Mk. IV, fitted with digital counter. Limited quantity.  
LIST £25.

**LASKY'S PRICE £17.19.6**  
Carr. & Insur 21/-.

**FINEST RANGE OF GRAM AMPLIFIERS IN GT. BRITAIN**

Over a dozen models, portable and miniature Gram Amplifiers to choose from 1, 2, 3, or 4 valve. Prices from **35/-**

We have the type you need. Come and see our range or write for special Amplifier List. Two examples:—

**3-WATT GRAM AMPLIFIER**

2 valve, ECL 82 and EZ80 rectifier, double wound mains transformer 100-250 A.C., tone control, record equalisation switch. Size 7½ x 3½ in. max. height 4½ in. Controls mounted separately. **LASKY'S PRICE** complete with knobs. **55/-** Post 3/6.

**MATCHED PAIR FOR STEREO** ..... 5 Gns. Post 5/-

**2-WATT GRAM AMPLIFIER**, uses UCL83, contact cooled rectifier. **LASKY'S PRICE** **35/-** Post 2/6.

**"LINEAR" AMPLIFIERS**

- "DIATONIC" 10-14 watt 12 Gns.
  - "CONCHORD" 30 watt 15 Gns.
  - L45 4-5 watt Amplifier 25/19/6
  - LT45 Tape Deck Amplifier 12 Gns.
  - L50 50 watt Amplifier 19 Gns.
  - L10 10-12 watt with pre-amplifier 15 Gns.
  - L3/3 Stereo Amplifier 7 Gns.
- Details on request.

**MULLARD 510 AMPLIFIER KIT**

All specified components and your choice of transformers and chokes by Partridge, Haddon, W/B, Ellison or Gilson. **COMPLETE KIT** and printed circuit as low as **£9.9.0** Details on request. Printed Circuit separately 22/0. Also available built ready for use. Price according to transformers used.

**BUILD THE 3-3 AMPLIFIER**

Complete kit of parts with 3 Mullard valves EL84, EF86 and EZ81, £8/19/6. Post free. All components available separately.

**BARGAINS IN 4-SPEED MIXER AUTO-CHANGERS**



B.S.R. 4-spd. mixer Auto-Changer type UAB, complete with latest B.S.R. "ful-fi." Carr. & Pkg. 5/-. **£6.19.6**

Ditto, wired for Stereo and with Stereo cartridge, £7/19/6.



**COLLARO**. Incorporating auto and manual control. Complete with Studio crystal p.u. and sapphire stylus. LIST £13/17/-. **LASKY'S PRICE** **£7.19.6** Post 3/6.

**B.S.R. Latest Type UAI2**



4-spd. Wired for STEREO, complete with stereo cartridge. Post 5/-. **£8.19.6** UAI2 with monaural cartridge. £7/19/6.

**GARRARD 4-SPEED MIXER AUTO-CHANGERS**

- Model 121. Mk. II ..... £10/19/6
- 121, Mk. II, STEREO ... £11/19/6
- 121, Mk. II, with monaural and Stereo heads £12/10/0
- RC.88 ..... £12/19/6
- RC.88, STEREO ..... £13/19/6



**SINGLE PLAYERS**

**COLLARO JUNIOR** 4-spd. motor and separate pick-up complete with cartridge and stylus. MOTOR only ..... 55/- PICK-UP only ..... 27/6

**SPECIAL OFFER**

Motor and Pick-up **75/-** Post together free.

**COLLARO 4/564 or GARRARD**

4SP 4-spd. single player, auto stop, T.O. crystal, **£6.9.6** Post 5/-

**STEREO SINGLE PLAYER**

E.M.I. 4-speed with auto start and stop, wired for Stereo and fitted with Acos Stereo t.o. cartridge. **LASKY'S PRICE** **£6.19.6** Post 5/-

**STEREO CARTRIDGES**

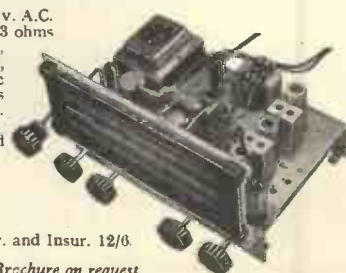
ACOS type 73-1A turnover, list 52/6. **LASKY'S PRICE** **29/6** Post 1/-  
All makes and types in stock. Write for our bargain list.

**PICK-UP CARTRIDGES**

B.S.R. "ful-fi" TC8, or ACOS type HGP.59, turnover crystal cartridge with L.P. and standard styli. List 39/7. **LASKY'S PRICE** **18/-** Post free.

**7-VALVE AM/FM RADIOGRAM CHASSIS**

Famous make. For 200-250 v. A.C. Output 4 watts matched to 3 ohms speaker. 7 valves: ECC85, ECH81, EF89, EABC80, EL84, EZ80, EM81, magic eye tuning indicator. Covers medium, long and FM bands. Length 12in., height 7½ in. front to back 8½ in. Limited number only.



LISTED AT 22 GNS.

**LASKY'S PRICE**

**£16.19.6** Carr. and Insur. 12/0

Available on H.P. terms. Brochure on request.

**LASKY'S RADIO**

**CONVERT YOUR ALL-DRY PORTABLE RADIO TO MAINS 200-250 v.**

with the **CO880R BATTERY ELIMINATOR**. Two separate units identical in size to the B126 and AD85 batteries. 1.5 v. L.T., 90 v. H.T. Suitable for the latest low consumption valves, fully stabilised. New in original cartons. Listed at 63/-. **LASKY'S PRICE** **37/6** Post 1/6

**A TRANSISTORISED RADIO FOR 25/10**

The "DIODEON"—a high-efficiency 2-stage receiver using crystal diode detector and transistor in cascade. Covers 200-500 meters (medium wave). Chassis shows pictorially all components and connections. Built in minutes! Complete parcel including two U16 batteries. **25/10** Post free.

**EARPHONES**. High imp., 14/6. Low imp., 7/6. Post 1/6.

**COMBINED AM/FM TUNER, CONTROL UNIT AND PRE-AMPLIFIER**

(Self-powered)

Famous make Mdl. H11. See December issue or send for brochure LIST £29/3/10.

**LASKY'S PRICE** **20 GNS** Carr. and Ins., 12/6. Available on H.P. terms.

**AN INVITATION FROM LONDON'S HI-FI SPECIALISTS!**

Visit either of our addresses for selective Demonstrations of the very latest HI-FI Equipment

- AMPLIFIERS**  
QUAD, ROGERS, LEAK, RCA, JASON, LINEAR, PAMPHONIC, DULCI, W/B, AVANTIC, ARMSTRONG, etc.
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WHARFEDALE, GOODMANS, LOWTHER, G.E.C., LORENZ, PHILIPS, TANNOY, etc.

- PICK-UPS**  
COLLARO, GARRARD, CONNOISSEUR, LEAK, B/J, ORTOFON, GOLDRING, etc.
- TRANSCRIPTION TURNTABLES**  
COLLARO, GARRARD, LENCO, CONNOISSEUR.

- TAPE RECORDERS**  
GRUNDIG, ELIZABETHAN, BRENELL, TRUVOX, SOUND, VORTEXION, FERROGRAPH, FIDELITY, HARTING, KORTING, SIMON, REFLECTOGRAPH, STUZZI, TANDBERG, TELEFUNKEN, STELLA, WALTER.

- F.M. TUNERS**  
DULCI, QUAD, LEAK, JASON, ROGERS, etc.
- CABINETS**  
Wide choice including G-PLAN, NORDYK and CAPRIOL.
- Our Technical and Mail Order Depts. are at your service.

**SEE OVERLEAF FOR MORE NEWS FROM LASKY'S RADIO**



# LASKY'S RADIO

## LASKY'S HIGHLY EFFICIENT EASY-TO-BUILD SETS : TUNERS : AMPLIFIERS

### C.R. TUBE BARGAINS

NEW, UNUSED AND TAX FREE



16in. Metal Cone. Famous make. Type T901/B. 6.3 v. 3 amp. heater, ion trap, 12-14 Kv. E.H.T. Wide angle, standard 38 mm. neck. GUARANTEED. LIST £16.

**LASKY'S PRICE £6.9.6**

Carr. and Insur. 21/-.  
Masks, Anti-Corona, Bases and Ion Traps available.

FERRANTI 9in. type T9/3. 4 v. heater, triode, octal base, standard deflection LIST 9 GNS.

**LASKY'S PRICE 50/-**

Carr. & Insur., 12/6.

FERRANTI 12in., types T12/44 and T12/44.

LIST #12. **LASKY'S PRICE 84/-**  
Carr. & Insur., 12/6  
Many others. List on request.

### RE-GUNNED C.R. TUBES

Guaranteed for 12 months.

Type	Price	Carr. & Ins.
12in. round	£6 10 0	12/6
14in. rect.	£6 10 0	12/6
15in. round	£6 19 6	21/-
17in. rect.	£6 19 6	21/-
21in. rect.	£7 19 6	25/-

### MINIATURE INSTRUMENT SOLDERING IRONS

Famous make, 230/250 v. 25 watts with pencil bit and 3-core flex. Warning light in handle. LIST 22/6.

**LASKY'S PRICE 16/6**

Post 1/3.

### SPECIAL OFFER OF SOLDER

1lb. reels of Erin 5-core "Bavbit" SOLDER. List 15/-.

**LASKY'S PRICE 10/-**

Post 1/6.

### 20,000 VALVES IN STOCK

Mullard, Brimar, G.E.C., Mazda, Cossor, E.M.I., Philips, Pinnacle, Telefunken, etc.

Send for our New List of manufacturers' surplus, ex-Govt. and imported Valves at lowest prices. We save you money.

5-millamp **METER RECTIFIERS**. Special offer of limited number at only **8/6**

Post 9d.

### SPEAKER COVERINGS

Large stocks of "Tygan" and "Stomewave." Any size piece cut. Sample and prices post free.

Circuit Diagram and Building Instructions, 1/6 each, post free.

COMPLETE PARCEL

**7-TRANSISTOR PORTABLE**, 250 milliwatts p.p. output. NEW CIRCUIT, medium and long wave.

**£10.10.0**  
Post 3/6

**TRANSISTOR SUPERHET TUNER**, uses 3 R.F. transistors, 1 germanium diode, etc. Printed Circuit 3 1/4in. x 3 1/4in.

**£5.12.6**  
Post 3/6

**4-TRANSISTOR AUDIO AMPLIFIER**, Mk. II, 200/250 milliwatts, with 2 OC72 and 2 yellow/green. Size: 5 1/4 x 2 x 1 1/4in.

**£3.19.6**  
Post 3/6

**8-VALVE SUPERHET PORTABLE**. Medium and long wave. Mains/battery version, £8/19/6. Battery version

**£7.7.0**  
Post 3/6

**MIDGET T.R.F.** for 200-250 v. A.C. mains. Uses two latest double-purpose valves. Plastic case, 8 1/4 x 4 1/4 x 5in.

**£4.19.6**  
Post 5/-

**LASKY'S F.M. TUNER**. Printed Circuit version of the G.E.C. 912 "F.M. Plus," using 5 valves.

**£7.19.6**  
Post Free

**PORTABLE GRAM AMPLIFIER**, 2 watts. Uses EL84 output and 6X4 rect. Size 6 1/4in. x 3 1/4in. x 5in. high.

**49/6**  
Post 2/6

ALL JASON KITS IN STOCK. Send for Brochures



**LASKY'S CAR RADIO**  
CAN BE BUILT  
ABSOLUTELY COMPLETE  
FOR **£12.19.6**

- Note these star features:
- ★ 12 volt operation
  - ★ New Hybrid circuit
  - ★ Transistor output
  - ★ New type Brimar valves
  - ★ No Vibrator, 12 volt H.T. & L.T.
  - ★ T.C.C. Printed Circuit and Condensers
  - ★ Tuned R.F. stage
  - ★ Medium and long waves
  - ★ Permeability tuning
  - ★ Small size. Will fit any car
- Send 1/6 for Instruction Booklet giving full details, illustrations, dimensions, circuit diagram and shopping list.

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### THE FINEST COMPONENTS CATALOGUE

produced for the "ham" or service man. OVER 100 PAGES, SIZE 8 1/2in. x 5 1/2in. WITH HUNDREDS OF UP-TO-DATE ILLUSTRATIONS.

Price 2/- Post 6d.

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### MULTI TEST METER BARGAIN

Limited number only.

SEND TODAY



AK/20. Pocket size Microtester. An accurate 18-RANGE Test Meter for all purposes. 5,000 ohms per volt A.C. and D.C. In black leatherette-covered case, 3 1/2 x 3 1/2 x 1 1/2in. deep. LIST 9 GNS. **LASKY'S PRICE £5.19.6**  
Post 3/6. Leads 3/8 extra

### ALL TYPES OF CHASSIS

Leading makes, including ARMSTRONG, DULCI, EMPRESS, etc., A.M./F.M. chassis (1, m. s.) from 7 GNS. A.M./F.M. chassis from 14 GNS. A.M./F.M. STEREO from 22 GNS.

### P.M. SPEAKERS

ROUND				
3 1/2in.	4in.	5in.	6 1/2in.	8in.
17/6	19/6	14/6	18/-	16/6

ELLIPTICAL				
7 x 4	9 x 6	10 x 2 1/2	10 x 6	10 x 7
15/6	27/6	27/6	25/-	32/6

Post Extra

### TRANSISTORS

AUDIO P.N.P. Junction Types suitable for high gain and low freq. amplifiers, and for output stages up to 250 milliwatts. **7/6** (Double spot—yellow and green). 3 for 20/-; 6 for 37/6 post free. B.F. P.N.P. Junction Type suitable for medium and low freq. oscillators, freq. changers and I.F. amplifiers **15/-** (1.5 to 8 Mc/s). (Double spot—yellow and red.) 3 for 40/-; 6 for 75/-.  
Special prices for larger quantities.

**SPECIAL OFFER.** P.N.P. Junction type Transistors suitable for all audio applications. Each **5/-**

OC44 and OC45, 21/-; OC70 and OC71 12/6; OC72, 17/- (Matched Pair 30/-); OC73, 15/-; OC16, 54/-.

**BRIMAR TRANSISTORS.** TS1, TS2, TS3, 12/6; T84, 14/-; TP1 and TP2, 20/-; T31, T32, T33, 13/6.

**EDISWAN MAZDA TRANSISTORS.** The very latest types. XB/102, 10/-; XB/103, 14/-; XC/101, 16/-; XA/101, 23/-; XA/102, 26/-.

**SPECIAL OFFER.** Set of 7 Ediswan Transistors: XA/101, XA/102, 2 XB/102 XB/103, 2 matched XC/101. Price 79/6.

**CRYSTAL DIODES.** General Purpose GEX00, each 1/- Per doz. 9/- . All other types in stock.

### "GOLDTOP" POWER TRANSISTORS

All types in stock. Example—V15/10P. Ideal or output stage of car radio, will give approx. 3 watts operating from 12 v. Each 15/- post free. Suitable Output Transformer for above, correct ratio, matched to 3 ohms, 9/6. Post 1/-.  
Driver Transformer, 9/6. Post 1/-.

PLEASE NOTE 2 ADDRESSES FOR PERSONAL SHOPPERS

**42 TOTTENHAM COURT ROAD, W.1**

Nearest Station Goodge Street.

MUSEUM 2605

**207 EDGWARE RD., W.2**

Opposite Edgware Road Tube Station

Few yards from Praed Street

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**OPEN ALL DAY SATURDAY**

Early Closing Thurs., 1 p.m.

(Both addresses)

Please address Mail Orders to Lasky's (Harrow Rd.) Ltd., Dept. W, 207 Edgware Rd., London, W.2

SEE OVERLEAF FOR MORE NEWS FROM LASKY'S RADIO





**RECORD PLAYER BARGAIN OFFER**

A self-contained Portable unit comprising the latest Collaro 4-speed Auto Changer Record Player, incorporating the famous High Fidelity Studio "O" Xtal Pick-up with Turnover Cartridge and fitted with L.P. and 78 Sapphire styli. An internal 2 valve amplifier of modern design with variable tone and volume controls is fitted. This, together with a quality 6in. P.M. speaker, ensures a high standard of reproduction. The whole is housed in a robust wooden cabinet attractively styled in a maroon contemporary leather cloth with contrasting polka dot relief. A fortunate bulk purchase enables us to offer this commercially styled Player at the following attractive breakdown Unit prices:

- Collaro 4-speed autochanger, £6.19.6 + 4/6 carr.
- 2-valve, 2-stage amplifier, ready wired, complete with speaker, etc., £3.7.6 + 2/6 carr.
- Cabinet with mounting board, etc. Size 18 1/2 in. - 13 1/2 in. - Ht. 8 1/2 in. £2.12.6 + 3/6 carr.

**RECORD PLAYER BARGAINS—Latest 4-speed models**  
**NEW RELEASE by E.M.L.—4-speed Single Player Unit fitted with latest stereo and monoaural Xtal cartridge and dual sapphire styli. Auto stop and start. A fidelity unit and bargain buy at only £6/19/6.**  
**SINGLE PLAYERS. BSR (UAS), 90/-; COLLARO 4(564), 6 gns.; GARRARD (48P) £7/10/- Carr. and ins. 3/6.**  
**AUTOCHANGERS. BSR (UAS), £6/19/6. COLLARO £7/19/6. GARRARD (RC121 4D Mk II) plug-in head, stereo adapted, 10 gns. Stereo head £2 extra.**  
**RECORD PLAYER CABINETS**  
 Contemporary styled 18in. x 13in. x 8in., 3 gns., Carr. and ins., 3/6.

**2-VALVE 2-WATT AMPLIFIER**  
 Twin stage ECL82 with vol. and neg. feedback. Tone controls AC. 200/250 v. with double-wound Mains trans. Complete with knobs, etc., ready wired to fit above cabinet.  
**£12.7.6 P. & P. 14/-**  
 6-in. Speaker and matching trans., 22/- P. & P. 1/6.

**COSSOR VHF/FM CONSTRUCTORS KIT (Model 701K).**  
 This is a 6-valve (UC885, 3UF89, UA080, UL84, UY85) FM Radio Kit of high quality design and superb reproduction, with pre-aligned coils and printed circuit complete with Power Pack for AC/DC 200/250 v. operation. Kit includes High Performance 10in. x 6in. Goodman Speaker for quality response. Complete in every detail, including calibrated Tuning Dial, Slow Motion Drive and Pilot Lamp and comprehensive instruction details and circuit diagram this Kit is a genuine recommended buy.

**BARGAIN OFFER**  
 Listed at 15 gns. Only £8.19.6 Carr. and Ins. 4/6  
**TRANSISTOR 'ONE-WATT' AMPLIFIER**  
 6 v. Battery operated  
 Latest Push-Pull, 4 Transistor circuit giving full 1 watt Output into standard 3 ohm speaker. Good sensitivity and improved freq. response. Neg. feedback. Var. Tone and Volume Controls. Chassis Size 6 1/2 in. x 3 1/2 in. x 1 1/2 in. Current consumption 10 mA quiescent—250 mA at 1 watt.  
 2 matched GEC 6ET15 Transistors 42/- pr. 2 GEC 6ET3 Transistors ..... 22/- pr.  
 Driver Trans. (to 3 ohms) ..... 8/6  
 Output Trans. (to 3 ohms) ..... 10/6  
 Complete Kit of Parts incl. circuit etc., less speaker, ONLY 99/6 P. & P. 2/6.

**Now! The TOURIST Portable**  
 4 valve, Med. & L.W., it weight battery Radio. Size only 8in. x 5 1/2 in. x 4in. Weight 3 1/2 lb. with battery: ..... P. & P. Complete receiver component kit 57/6 1/6 Set 4 miniature valves (96 series) 35/- 9d. 5in. Speaker & O/p Trans. .... 21/- 1/6 Cabinet, Dial and Knobs, etc., 22/6 2/- Latest superhet circuitry, delayed AVC and A.F. Neg. feedback.  
**Complete kit—BARGAIN—only £6.10.0, post free**  
**Terrific performance—**  
**Remarkable size—**  
**Staggering Value**  
 Send for Booklet NOW! 1/6 post free

**COAX 80 OHM CABLE.**  
 Stand 1/4 in. diam. Low Loss Semi-Air Spaced Aeraxial.  
 Special Reduced Prices  
 20 yds. 12/6. p. & p. 1/6; 60 yds. 32/6 p. & p. 3/-; 40 yds. 22/6. p. & p. 2/6; All other lengths 8/6 per yard.  
 Coax Plugs 1/-, Sockets 1/-. Connectors 1/3, Cable End Sockets 1/6. Outlet Boxes 4/6.

**JASON FM TUNER UNITS (87-105 Mc/s)**  
 Designer-approved kits of parts for these quality and highly popular tuners available as follows:  
**STANDARD MODEL (FMT)**—as previously extensively advertised. COM- PLETE KIT, 5 gns., post free. Set of 4 spec. valves, 30/-, post free.  
**LATEST MODEL (FMT2)**—attractively presented shelf mounting unit to enclosed Metal Cabinet with Built-in Power Supply. COMPLETE KIT, 57, p. & p. 3/6. Set of 5 spec. valves, 39/6.

**NEW JASON COMPREHENSIVE F.M. HANDBOOK, 2/8 post free. 48hr. Alignment Service. 7/6. p. & p. 3/6.**

**MULLARD "3-3" AMPLIFIER**  
 Quality built to Mullard's specification, with special specialised O/P Trans.  
 Complete kit with front panel only 28/19/6. P. & P. 3/6.

**2 WAVEBAND CAR RADIO KIT**  
 12 v. operation Med. & Long Waves  
 Modern development of the famous Brimar Hybrid vibratorless car radio circuit. Five latest type Brimar low voltage valves and power transistor. R.F. stage and permeability pre-aligned Cyclon Tuner Unit provide extremely good sensitivity and signal/noise ratio. Printed circuit for easy construction and 7 x 4in. elliptical speaker for fidelity output. Self-contained in neat metal cabinet 8 x 7 x 2 1/2 in. with attractive calibrated dial. Speaker and power transistor stage mounted separately approx. 8 x 5 x 3 in.  
**Recommended Buy Complete Kit Bargain Price £12.19.6**  
 Instruction booklet and parts list available 3/6 post free. P. & P. 3/6.



**G.R.T. Heater Isolation Transformers**  
 New improved types—mains prim. 200/250 v. tapped  
 All Isolation Transformers now supplied with alternative no boost, plus 25% and plus 50% boost taps at no extra charge.  
 3V 2A type ..... 19/6 (P. & P. 1/6)  
 6.3V. 6A type ..... 32/6 (P. & P. 1/6)  
 10.5V. 3A type ..... 12/6 (P. & P. 1/6)  
 13V. 3A type ..... 12/6 (P. & P. 1/6)  
 Small size and tag terminated for easy fitting. Other voltages available.

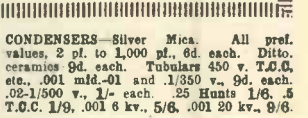
**RE-GUNNED TV TUBES NEW REDUCED PRICES**  
 ... and now 12 months guarantee!  
 All tubes rebuilt with new heater, cathode and gun assembly—reconditioned virtually as new.  
 12in. £6, 14in. £7, 17in. £8.10.0, etc.  
 10/- part exchange allowance on old tube  
 Carr. and ins. 10/-. Comprehensive stocks—quick delivery.

**Manufacturer's Surplus Bargain**  
**7 VALVE AM/FM RADIOGRAM CHASSIS**  
 Valve Line-up: ECC85, ECH81, EF89, EABC80 EL84, EM81, EX80.  
 Three Waveband and Switched Gram positions. Med. 200-500 m., Long 1,000-2,000 m., VHF/FM 88-95 Mc/s. Philip's Continental Tuning Insert with permeability tuning on FM and combined AM/FM FM transformers, 460 Kcs and 10.7 Mc/s. Dust core tuning all coils. Latest circuitry including AVC and Neg. Feedback. Three watt output. Sensitivity and reproduction of a very high standard. Chassis size 13 1/2 x 6 1/2 in. Height 7 1/2 in. Edge Illuminated glass dial 1 1/2 x 3 1/2 in. Vertical pointer. Horizontal station names. Gold on brown background. A.C. 200/250 v. operation. Aligned and tested ready for use £13.10.0 Carr. & Ins. 5/-  
 Complete with 4 Knobs—walnut or ivory to choose.  
 Three ohm P.M. speaker only required. Recommended quality speakers. 21/6  
 10in. Rola (Heavy Duty) ..... 30/-  
 Post & Pkg. 1/6.

We design and manufacture MAINS AND O/P TRANSFORMERS to individual spec. Winding capacity available for Prototypes and small production runs.  
**ONLY A FEW ITEMS ARE LISTED FROM OUR COMPREHENSIVE STOCK. WRITE NOW FOR FULL BARGAIN LISTS, 3d.**  
 Terms: C.W.O. or C.O.D. post and packing up to 1/6. 7d.: 1lb. 1/1; 3lb. 1/6; 5lb. 2/-; 10lb. 2/9.

**TRS RADIO COMPONENT SPECIALISTS**  
 70 BRIGSTOCK RD., THORNTON HEATH, SURREY  
 Established 1946. Tel: THO 2188 Hours: 9 a.m.—6 p.m. 1 p.m. Wednesday

This is a recommended bargain buy and when present stock is exhausted cannot be repeated. Originally built to be sold at 17 gns.  
 This complete 3 unit "Do-it-yourself" Record Player Kit offered at amazing bargain price of  
**£12.19.6**  
 carriage free



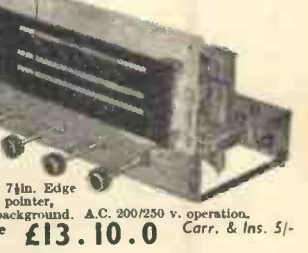
**CONDENSERS**—Silver Mica. All pref. values, 2 pl. to 1,000 p.f., 6d. each. D.T.O. ceramics 9d. each. Tubulars 450 v. T.T.C. etc., .001 mid-01 and 1/350 v., 9d. each. .02-1/500 v., 1/- each. 25 Hunts 1/6. 5 T.O.C. 1/9, .001 6 kv., 5/6. .001 20 kv., 9/6.  
**RESISTORS**—FULL RANGE 10 ohms—10 megohms 20% 1 w. and 1 w., 3d., 1 w., 5d. (Midget type modern rating), 1 w., 6d., 2 w. 9d., 10% HI-Stab, 1 w., 5d., 1 w., 7d., 5% 1 w., 9d., 1% HI-STAB. 1 w., 1/6 (10-100 ohms 2/-).

**PRE-SET W/W POTS. T/V Type, 25 ohms—50 K ohms, 3/-, 50K—2 Meg. (Carbon, 3/-).**  
**SPEAKER FRET**—Expanded Bronze anodized metal 8 x 8in., 2/3; 12 x 8in., 3/-; 12 x 12in., 4/6; 12 x 16in., 6/-; 24 x 12in., 9/-; 36 x 12in., 13/6, etc., etc.

**TYGAN FRET (Contemporary pat.)**, 12 x 12in., 2/-; 12 x 18in., 3/-; 12 x 24in., 4/- etc  
**LOUDSPEAKERS**—P.M. 3 ohms, 2 1/2in. Elac., 17/6. 3 1/2in. Goodmans 18/6; 5in. Rola, 17/6. 6in. Elac 18/6; 7 x 4in. Goodman Elliptical, 18/6; 8in. Rola, 20/-; 10in. R. and A., 25/-; 10in. W.B.-HF1012, 99/9; 12in. Plessey 16 ohms with 6/4in. Tweeter and Cross Over Filter, 97/6.

**Electrolytics All Types New Stock**  
**TUBULAR CAN TYPES**  
 25/25 v. 50/12 v. 1/9 8+8/450 v. 4/6  
 50/50 v. 100/25 v. 2/- 32+32/275 v. 4/6  
 8/450 v. 2/3 50+50/350 v. 6/6  
 16+16/450 v. 2/6 60+250/275v.12/6  
 32+32/450 v. 6/6 100+200/275v.12/6  
 Comprehensive range in stock

**VOLUME CONTROLS**—10K—2 Megohms. ALL LONG SPINDLES, MOCANITE MIDGET TYPE, 1 1/2 in. diam. Guar. 1 yr. LOG or LIN Ratio less 8w. 3/-. D.F. 8w. 4/6. Twin gain controls 1/2 Meg. 1/2 Mex 1 Mex. less 8w., each 8/6.



Complete with 4 Knobs—walnut or ivory to choose.  
 Three ohm P.M. speaker only required. Recommended quality speakers. 21/6  
 10in. Rola (Heavy Duty) ..... 30/-  
 Post & Pkg. 1/6.

We design and manufacture MAINS AND O/P TRANSFORMERS to individual spec. Winding capacity available for Prototypes and small production runs.  
**ONLY A FEW ITEMS ARE LISTED FROM OUR COMPREHENSIVE STOCK. WRITE NOW FOR FULL BARGAIN LISTS, 3d.**

Terms: C.W.O. or C.O.D. post and packing up to 1/6. 7d.: 1lb. 1/1; 3lb. 1/6; 5lb. 2/-; 10lb. 2/9.  
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 Established 1946. Tel: THO 2188 Hours: 9 a.m.—6 p.m. 1 p.m. Wednesday

# SCOPE FOR A BARGAIN

## DOUBLE-BEAM OSCILLOSCOPE TYPE 13A



Made for the Ministry by leading manufacturers (e.g., Erskine & Hartley Electromotives) this fine instrument is suitable for the examination of waveforms from two cycles to ten megacycles. It is extremely well designed and incorporates such desirable features of construction as potted "C" core transformers and paper smoothing capacitors for complete reliability. No electrolytic condensers are used.

TIME BASE 2 cps. to 750 Kcs.  
 Y PLATE AMPS. 5 Mc/s. bandwidth (3 dB).  
 CAL. MARKERS 1μ sec. and 10μ sec.  
 SIZE & WEIGHT 13in. x 10in. x 22in. 58lbs.  
 EXTERNAL PROBE For RF measurements  
 POWER SUPPLIES Internal (AC mains)

All instruments are in first class condition and are carefully checked and tested before despatch. Mains connector, test leads, probe and circuit diagram are neatly contained in the detachable front cover.

**£25** Carr. 30/-



### VIDEO OSCILLATOR TF885A

Frequency coverage in two ranges: 25 cps. to 30 Kc/s. and 30 Kc/s. to 5 Mc/s. (sinewave) and 50 cps. to 150 Kc/s. (squarewave). Output 1 watt into 1000Ω (sinewave) and 64 volt peak to peak (squarewave). Operates from A.C. mains. MODERN equipment in first class electrical and mechanical condition. £100 carr. paid.

### SPECTRUM ANALYSER TF984/1

For viewing the spectra of "S" band transmitters in the range 2,900-3,150 Mc/s. These are in virtually new condition but are NOT tested. Operation is from 180 volts 500 cps. power supplies. £30 carriage paid.

### MARCONI VIDEO OSCILLATOR TF410C

An earlier design of video oscillator having the same frequency coverage as the TF 885. The output meter is a circular 3½in. instrument. For AC mains operation. In good condition and working order. £35. Carriage paid.

### MARCONI B.F.O. TF602A

Frequency range 10 cps. to 12,000 cps. Operation is from AC mains. Output indication by magic eye. Incorporates 50 cycles check. A reasonably compact instrument useful for general audio testing. Fair condition, tested and working perfectly. £6/19/6. Carriage 10/6.

### MARCONI BRIDGE TF868

Measures L. C. & R. each in 7 steps; L. & C. at 1,000 c/s. and R at D.C. L: 1μH to 100H; C: 1μμF to 100μF. R: 0.1Ω to 10MΩ. Power factor 0.001 to 0.995. AC mains operation. First class MODERN equipment in virtually new condition. Perfect working order. £65. Carriage paid.

### FERRANTI TESTMETER TYPE Q

Volts 0 to 30, 150, 600 A.C./D.C. with additional 0-3 v. D.C. and 0-15 v. A.C. ranges; milliamps 0 to 7.5, 30, 150 and 750 D.C.; ohms 0-25K. Accuracy BSS 1st grade. 500 ohms per volt. With leads, prods, battery and instructions. In velvet lined 4x7x3in. case. Brand new condition, perfect working order 52/6. Post 2/6.

### UNIVERSAL IMPEDANCE BRIDGE TF373

An excellent bridge of earlier design having an almost identical specification to the TF868. Those we offer are in very good electrical and mechanical condition and are in perfect working order. £35 carriage paid.

### OUTPUT POWER METER TF340



Impedance from 2.5Ω to 20,000Ω in 40 steps. 100 W. to 5 watts. Four ranges: 0-5 mW., 0-50 mW., 0-500 mW., and 0-5 Watts. First class condition. Tested. £9/19/6. Carriage 7/6.



### AVOMETER MODEL D.

£8.19.6 (P. & P. 3/6)

D.C. Volts	A.C. Volts	D.C. Current	A.C. Current
150 mV.	7.5 V.	15 mA.	75 mA.
300 mV.	15 V.	30 mA.	150 mA.
1.5 V.	75 V.	150 mA.	750 mA.
3 V.	150 V.	300 mA.	1.5 Amps.
15 V.	300 V.	1.5 Amps.	7.5 Amps.
30 V.	600 V.	3 Amps.	15 Amps.
150 V.	750 V.	15 Amps.	
300 V.	1.5 KV	30 Amps.	
750 V.			
1.5 KV			

Resistance 0-1000 ohms. 0-10 K ohms.  
 Thoroughly overhauled. Complete with batteries and instructions. An extremely robust meter at a very reasonable price.

### G.E.C. SELECTEST DIII



This testmeter has exactly the same ranges as the Avo "D." The scale is even larger. Those we offer are in first class condition, completely overhauled and carefully tested prior to despatch. Complete with battery, test leads and instructions. £7/10/- P & P. 3/6.



**FERRANTI VOLT METERS NS.**

0-300 volts, 25-100 c/s. Moving iron, 6in. scale. Fl. mtg. Hermetically sealed, grade IN. Made 1955. **BRAND NEW.** Boxed. 79/6, post 3/6.



**MARCONI CR100**

Completely overhauled. In perfect working order. **LOOK LIKE NEW. £21.**  
Later model with Noise Limiter, **£25.**  
Carr. Eng. and Wales 30/-. Send S.A.E. for full details.

**RCA AR-88 SPEAKERS**

A high quality 3 ohm unit fitted into heavy gauge black cracked steel cabinet, size 10½ x 11½ x 6in. Fitted with rubber feet and 6ft. lead. Ideal for extension speaker, CR100, etc. In original cartons. **BRAND NEW. 45/-.** Carr. 3/6.

**CRYSTAL CALIBRATOR No. 10**

A crystal controlled heterodyne wave-meter covering 500 Kc/s to 10 Mc/s. (Harmonics up to 30 Mc/s.) Requires 15 m/a. and 12 v. 0.3 A. d.c. but can be easily modified for 120 v. and 1.4 v. working. Size 7 x 7½ x 4in. First class condition, complete with valves, crystal, instruction manual and circuit. **ONLY 59/6.** Post 3/6.

**CHOKES.** Parmeko 5 H., 200 m/amps., 6/6. HRO chokes, 17 H., 80 m/amps., 7/6. AR-88 chokes, 15 H., 90 m/amps., 8/6. Parmeko 8 H., 100 m/amps., 7/6. Postage any type, 1/6.

**Q'SER (BC-453)**

This Command Receiver covers 190-550 Kc/s.-(I.F. 85 Kc/s.) and is ideal for double superhet conversion etc. Supplied **BRAND NEW** in original cartons, with all 6 valves and **CIRCUIT. 89/6.** Post 3/6.

**SELENIUM BRIDGE RECTIFIERS.**

Funnel cooled. A.C. input 45 v. RMS. D.C. output 30 v., 10 amps. **BRAND NEW.** Boxed. 45/-. Post 3/6.

**HEAVY DUTY L.T. TRANSFORMERS.** (Gresham.) Latest type potted, oil filled, Pri. 230 v. 50 c/s. Sec. 0-70-75-80 v. 4 amps. Size 5½ x 4½ x 6½in. high. Wt. 19 lb. **BRAND NEW. 42/6.** Carr. 5/-. Gardner's Transformer. Tapped mains input. Secondary 12 volts RMS (C.T.). 30 amps. Housed in sheet metal case 9½ x 8½ x 6½in. high. **BRAND NEW. 72/6.** Carr. 7/6.

**DUAL PURPOSE TRANSFORMERS** (Gresham.) Pri. 230/250 v. Secs. 240-0-240 v. 1.5 amps., 5 v. 12.5 amps., 5 v. 1.75 amps. Ideal for ISOLATING TRANSFORMER, to obtain TWO 240 v. 360 watt lines. Potted, oil-filled, 7 x 7½ x 10½in. high. Wt. 50 lb. **BRAND NEW. £13/10.** Carr. 10/-.

**ADVANCE CONSTANT VOLTAGE TRANSFORMERS.** Input 190-260 v., 50 c/s. A.C. mains. Output 230 v. 150 watts. **£8/10/-.** Carr. 5/-.

**STANDARD TRANSFORMERS**

Vacuum impregnated, interleaved, E.S. screen, universal mounting. Size 4 x 3½ x 2½in. **ALL BRAND NEW. 18/6** each. Post 1/6.  
Type 1. 250-0-250 v. 80 m/a., 6.3 v. 3 A., tapped at 4 v. 4 A., 6.3 v. 1 A. tapped at 4 v. and 5 v. 2 A.  
Type 2. As above, but 350-0-350 v. 80 m/a.  
Type 3. 30 v. 2 A., tapped at 12, 15, 20 and 24 v., to give 3-4-5-6-8-9-10 v., etc. Ideal for models, trains, etc.

**6-VOLT VIBRATOR PACKS.** HRO type, 180 v. D.C., 65 m/amps. **BRAND NEW. 29/6,** post 3/6. Type PU2, 200 v. D.C. 100 m/amps. with OZ4 rectifier. **BRAND NEW. 25/-.** Post FREE.

**CRYSTALS.** 200 Kc/s. American GEC, 10/- each. 100 Kc/s. RCA bars, 15/-.

**ADMIRALTY HT TRANSFORMERS**

Pri. 230 v. 50 c/s. Secs. 620-550-375-0-375-550-620 v. (620 and 550 v. 200 m/amps., 375 v. 250 m/amps.), plus two 5 v. 3 Amp. rectifier windings. Total rating 278 VA. Upright mtg. Wt. 25 lb. Made 1953. **BRAND NEW.** Original boxes. 45/-. Carr. 5/-.

**INSTRUMENT TRANSFORMERS.** 230 v. A.C. input. Outputs 0-65-130-195 v. 85 m/amps., 6.3 v. 5 amps., 6.3 v. 0.3 amps. Shrouded. Size 3½ x 3½ x 3½in. high. 15/-, post FREE.

**AR88D MAINS TRANSFORMERS.** Input 110-240 v. Output 345-0-345 v. 125 m/amps., 6.4 v., 4.5 amps., 5 v. 2 amps. 4½ x 4½ x 5½in. high. Wt. 12 lb. Potted. Tag ends. **RCA BRAND NEW.** Boxed. 29/6, post 3/6.

**CR150 COMMUNICATIONS RECEIVERS**

Covers 2-60 Mc/s. in 5 ranges. Double superhet, with 2 EF50 R.F. stages, 500 Kc/s. crystal calibrator H.T. stabiliser, "S" and valve-check meter, audio filter, etc. Variable selectivity, using TWO double-crystal band-pass filters. External power supply required, 300 v. D.C. 65 m/Amps, and 6.3 v. 3.7 Amp. Size and appearance similar to CR100. In superb condition and working order, **£45.** Carr. 30/-.

**LOUD HAILER EQUIPMENT**

IDEAL FOR CROWD CONTROL, FACTORIES, FETES, ETC. CONSISTS OF 4 SPEAKER UNITS AND CONTROL UNIT, COMPLETE WITH MICROPHONE, HEADPHONES AND SPARES. OPERATES FROM 12 VOLTS D.C. (OR 6 VOLTS D.C. WITH SLIGHTLY REDUCED OUTPUT), CONSUMING ONLY 3 AMPS. OUTPUT POWER 8 WATTS ALL TESTED AND WORKING, BUT SLIGHTLY SOILED. A GENUINE BARGAIN. **£4/19/6.** CARRIAGE 25/6.

**MORE METER BARGAINS**

Range	Type	Size	Flush Circ. Scale	Price
25 Microamp.	D.C. M/C	2½in.	Flush Circ. Scale "Rontgens"	69/6
25 Microamp.	D.C. M/C	2½in.	Proj. Circ. Scale "Rontgens"	59/6
50 Microamp.	D.C. M/C	2½in.	Flush Circ. Scale "Tolerance"	79/6
50 Microamp.	D.C. M/C	2½in.	Flush Circ. scaled 0-100 v.	59/6
100 Microamp.	D.C. M/C	2½in.	Flush Circ. Scale 0-50/0-1,000 v.	62/6
100 Microamp.	D.C. M/C	2½in.	Flush Square	48/6
1 Millamp.	D.C. M/C	3½in.	Flush Circular	50/-
1 Millamp.	D.C. M/C	3½in.	Flush Squ. Scaled 0-200v.	89/6
200 Millamp.	D.C. M/C	3½in.	Flush Circular	10/6
1 Amp. Thermocouple		2½in.	Projecting Circular	6/9
300 Volts	A.C. M/I	6in.	Flush Circular. Made 1955	79/6
300 Volts	A.C. M/I	2½in.	Flush Circular	25/-
500 Volts	A.C. M/I	2½in.	Flush Circular	25/-
40 Amperes	D.C. M/C	2in.	Flush Circular	7/6

METER RECTIFIERS. Full wave bridge. **BRAND NEW.** Salford 1 m.A. 8/6, 5 m.A. 8/6. STC 2 m.A. 5/6.

**MINIATURE 373 IF STRIPS.** For FM tuner described in "Practical Wireless." Complete with 3 of EF91, 2 of EP92 and 1 of EB91. A fresh release enables us to offer these once again. **BRAND NEW.** Complete reprint of conversion instructions and circuit supplied free. 35/- OR less valves, 12/6. Post, either, 2/6.

**T.C.C. VISONCON CONDENSERS.** 8 mFd. 800 v. D.C. wkg. at 71 deg. C. CP152V. Size 3 x 1½ x 5in. high. **BRAND NEW.** Boxed. 8/6 each post paid.

**MINIATURE RELAYS (ALL BRAND NEW and BOXED)**

G.E.C. sealed, wire ends, 670Ω, 2 H/D makes, M1099..... 15/-  
G.E.C. sealed, wire ends, 670Ω, 4 C/overs, platinum, M1092 19/6  
G.E.C. sealed, wire ends, 5000Ω, 2 C/overs, platinum, M1052 17/6  
Siemens High Speed, 1K+1KΩ, 1 C/over..... 10/6

**HRO SENIOR RECEIVERS**



Complete with ALL NINE general coverage plug-in coils for 50 Kc/s. to 30 Mc/s. Instruction booklet, and circuit, but less external power supply unit. Table models, as new condition, 21 GNS. Rack mounting, 18 GNS. Packing and carriage 22/- extra. Send S.A.E. for further details. **HRO POWER PACKS.** 115/230 v. A.C. mains input. Tested, and in good condition. Table or rack, 69/6. Post 4/-.

**CHARLES BRITAIN (Radio) LTD.**

11 UPPER SAINT MARTIN'S LANE LONDON, W.C.2 TEMple Bar 0545

One minute from Leicester Sq. Station (Up Cranbourne St.) Shop Hours: 9-6 p.m. (9-1 p.m. Thursday.) Open all day Saturday



**SANGAMO-WESTON VOLT METERS**

S61. Dual range 0-5 and 0-100 v. D.C. FSD 1 m/A. 3in. scale. Recent manufacture. Ideal for schools. Complete in super quality canvas carrying case, with test prods and leads.

**BRAND NEW.** Boxed 27/6. Post 2/6.

**ELECTROSTATIC METER** Dia. 6½ ins.

reads 5-18.5 Kv. Manufactured 1953. Contained in wooden case 10 x 10 x 9 ins. high. **£9/19/6.** Post paid.

**SANGAMO-WESTON ANALYSER E772.**

A useful multi-range meter. Thoroughly overhauled and in perfect working order. For full details see previous adverts. **£7/10/-.** Carr. 4/6.

**AVO LC & R BRIDGES.** Capacity 5 pFd to 50 mFd. Resistance 5 ohms to 50 megohms. Inductance can be measured against external standard. Balance is indicated on a meter, which can be used as a valve voltmeter from 0.1 to 15 v. Leakage test and Power Factor scale. For use on A.C. mains. Tested and guaranteed. **£8/10/-.** Post 3/6.

**HICKOCK I-177 VALVE TESTERS.**

Checks dynamic mutual conductance, shorts, emission, gas, and noise. For UX4, UX5, UX6, UX7, Octal, Localt, B7G, and Acorn types. Portable, in wooden carrying case 15½ x 8 x 5½in. Wt. 13½lb. **BRAND NEW.** Complete with instruction book and valve testing charts. For 117 v. A.C. 10 gns. Carr. 7/6. Matching auto. transformers for 230 v. A.C. 12/6.

**MARCONI SIGNAL GENERATORS**

85 Kc/s. to 25 Mc/s. A.C. mains operation. In fair condition and good working order. **TF144F. £40.** **TF144G. £50.**

**RI155 RECEIVERS.** With latest type super slow-motion drive. In good condition and perfect working order. Re-aligned and air tested. Model "B" **£7/19/6.** Model "L" (covers trawler and shipping bands) **£12/19/6.** Carr. (either) 10/6. Send S.A.E. for details of sets and power units, or 1/3 for illustrated booklet.

**SCR522 TRANSMITTER/RECEIVERS.**

100-150 Mc/s. Comprises BC624A rec., and BC625 trans. with valves, and in good condition. BC624A, less relay 19/6. With relay, 25/- BC625 22/6. These two, on rack 47/6. Carr. 7/6.

**MOVING COIL PHONES.** Finest quality Canadian, with chamois ear-muffs and leather-covered headband. With lead and jack plug. Noise excluding and supremely comfortable. 19/6. Post 1/6.

**VITAVOX PRESSURE UNITS TYPE N.** 20 watts. P.M. Heavy duty. **BRAND NEW,** boxed. 89/6. Carr. 5/6.

**RESISTORS**

Morgan "T" (½ watt) and "R" (1 watt). Latest types, all **BRAND NEW.** 100 assorted, 10/- Post 1/-.

**HEAVY DUTY SLIDER RESISTORS.** 1.25Ω 20 A., 12A., post 3/6. 1Ω 12 A., 8/6. **ZENITH ADJUSTABLE 25Ω 4 A., 8/6.** Post 2/6.

**PRECISION RESISTORS.** 1 Megohm ½ watt wire wound. Ex-U.S.A. **BRAND NEW.** 10/6 per dozen.

**DC/AC CONVERTERS.** Input 12 v. D.C. Output 230 v. 50 c/s. A.C. at 135 watts. Fitted with 0-300 v. A.C. 2½in. meter and slider resistor for voltage adjustment. In stout wooden carrying case with lid. Perfect working order, **£9/19/6.** Carr. 10/6.

**RADIATION METERS.** Portable dose-rate meter, containing modern type rectangular 50 microAmp meter, CVX494 electrometer valve, etc. **BRAND NEW.** In canvas carrying case. **£3/19/6.** Post 2/6. For details of other equipment, see our previous adverts.



# G.W. SMITH & CO (RADIO) LIMITED

Phone: GERRARD 8204/9155  
Cables: SMITHEX LESQUARE  
3-34 LISLE STREET, LONDON, W.C.2

## UNIVERSAL AVOMETER MODEL "D"

D.C. VOLTS	A.C. VOLTS	D.C. Current	A.C. Current
150 mv.	7.5 v.	15 ma.	75 ma.
300 mv.	15 v.	30 ma.	150 ma.
1.5 v.	75 v.	150 ma.	750 ma.
3 v.	150 v.	300 ma.	1.5 amp.
15 v.	300 v.	1.5 amp.	7.5 amp.
30 v.	600 v.	3 amp.	15 amp.
150 v.	750 v.	15 amp.	Resistance
300 v.	1,500 v.	30 amp.	1,000Ω
750 v.			10,000Ω



Supplied reconditioned as new, with internal battery, instructions and leads £8/19/6 each. P/P. 3/6.

## WESTON MODEL 772 TESTMETER



A.C. VOLTS	D.C. CURRENT	A.C. CURRENT
2.5 v.	100 micro/a.	500 ma.
10 v.	1 ma.	1 amp.
50 v.	10 ma.	5 amp.
250 v.	50 ma.	RESISTANCE
1,000 v.	100 ma.	100 ohms
D.C. VOLTS	500 ma.	1,000 ohms
2.5 v.	OUTPUT METER	100k. ohms
10 v.		10 megohms
50 v.		
250 v.		
1,000 v.		

Supplied in perfect working order complete with internal batteries. £7/10/- P/P. 4/-.

**FIELD TELEPHONE TYPE F.** Generator bell ringing. Supplied complete with batteries, fully tested, and complete with wooden carrying case. 59/6 each. P/P. 3/6.

**24 AMP. VARIAC TRANSFORMERS.** 230 v. input. Variable output 185-250 volts or 185-250 volts input, 230 volts out. £12 10/- each. P/P. 10/-.

**MUIRHEAD PRECISION STUD SWITCHES.** 4 bank, 4 pole, 24 positions. New, boxed, 17/6 each. P/P. 1/3.

**OSCILLOSCOPES TYPE II.** Compact little scope utilizing 3in. CRT with all standard controls, switched time base, etc. 200/250 volts A.C. operation. Not brand new but in good condition, fully checked. These require no modification. £5/19/6 each. P/P. 7/6.

**E.M.I. POTTED MIC. INPUT TRANSFORMERS.** High quality, 50 : 1 ratio, 4/6 each. P/P. 9d.

**LEACH 12 VOLT AERIAL CHANGE-OVER RELAYS.** Double pole, 7/6 each. P/P. 9d.

**AMERICAN H.T. BATTERIES.** Tapped 90 v., 67½ v., 45 v., 22½ v. New, 5/- each. P/P. 2/-.

**8 RANGE SUB-STANDARD D.C. AMMETERS.** Ranges, 1.5, 3, 7, 15, 30, 60, 300 and 450 amps. 8in. mirror scale. Meter housed in polished teak case. Supplied complete with all shunts and leather carrying case. £15 each. P/P. 7/6.

**1,000 WATT MAINS ISOLATION TRANSFORMERS.** 230 to 230 volts. Heavy duty, ex-Admiralty. New boxed, £5 each. P/P. 10/-.

**750 WATT AUTO TRANSFORMERS.** Tapped from 110 to 230 volts. Fine heavy duty type, 69/6 each. P/P. 5/-.

**DEAF-AID EAR-PIECES.** 250 ohm imp. 4/6; 1,000 ohm imp. 7/6. P/P. 6d.

**R.C.A. PLATE TRANSFORMERS.** Input 200/250 volts 50 cycles. Output 2,000/1,500/1,500/2,000 volts 500 m/a. Supplied brand new in transit cases, £6/10/- each. P/P. 10/-.

**R.1155 RECEIVERS MODEL B.** Perfect working order, fully tested, £7/19/6 each. P/P. 7/6. Combined power pack and output stage, 85/- extra.

**AR.88 WAVE CHANGE SWITCH ASSEMBLY.** Brand new with screens. 17/6 each. P/P. 2/6.

**R.1155 N TYPE DRIVES.** Improved geared version new, 12/6 each. P/P. 1/6.

**POST OFFICE TELEPHONE HANDSETS.** Std. type, new boxed, 12/6 each. P/P. 1/6.

### METER BARGAINS

25 microamp D.C. M/C flush rd. 2½in.	60/6
25 microamp D.C. M/C. proj. rd. 2½in.	50/6
50/0/50 microamp D.C. M/C. flush rd. 3½in.	70/6
50 microamp D.C. M/C. proj. rd. 2½in.	40/6
100 microamp D.C. M/C. flush rd. 3½in.	62/6
500/0/500 microamp D.C. M/C. proj. rd. 2½in.	19/6
1 milliamp D.C. M/C. flush rd. 2½in.	22/6
1 milliamp D.C. M/C. flush rd. 2½in.	25/-
1 milliamp D.C. M/C. flush rd. 3½in.	50/-
1 milliamp D.C. M/C. flush rd. 4in.	60/6
200 milliamp D.C. M/C. flush rd. 2½in.	9/6
30 amp. D.C. M/C. flush rd. 2½in.	9/6
15 volt D.C. M/C. flush rd. 1½in.	10/6
120 volt D.C. M/C. flush rd. 3½in.	32/6
300 volt A.C. M/C. flush rd. 2½in.	25/-
300 volt A.C. M/C. rect. flush rd. 2½in.	25/-
500 volt A.C. M/C. flush rd. 2½in.	25/-

**CR.100 SPARES KIT.** Contains 15 valves, resistors, pots, condensers, output trans., etc. All brand new, 59/6. P/P. 3/6.

**DYNAMO EXPLODER UNITS.** For detonating explosive charges. Hand generator operation. Brand new 29/6 each. P/P. 3/6. Hide leather cases 19/6 extra.

**MARCONI TF.428 B/I VALVE VOLT-METERS.** 5 ranges A.C. and D.C. 1.5, 5, 15, 50 and 150 volts. Operation 200/250 volts A.C. Supplied brand new complete with internal HF probe. £17/10/- each. P/P. 10/-.

**EX-ADMIRALTY 12 VOLT D.C. MOBILE AMPLIFIERS.** Std. mic. or gram. input. Push pull 10 watt, output matched to 3 or 15 ohms. Good working order. £8/19/6 each. P/P. 6/6.

**MARCONI TF-373 IMPEDANCE BRIDGE.** Reconditioned to maker's specification, 1,000 c/s. Ranges: 100 henry; 100 mfd.; 1 megohm; 100 Ω. 200/250 volts A.C. operation. £35 each.

**CRYSTAL MICROPHONE INSERTS, 4/6 each.** P/P. 6d.

**MARCONI STANDARD SIGNAL GENERATOR TF-144G.** 85 Kc/s. to 25 Mc/s. Output 1 microvolt to 1 volt. 200/250 volts A.C. operation. Reconditioned to maker's specification. £55 each.

**UNIVERSAL AVO METERS MODEL 7.** Reconditioned perfect order, £12/19/6 each. P/P. 3/6.

**FURZEHILL BEAT FREQUENCY AUDIO OSCILLATORS.** Frequency range 0-10,000 c.p.s. Output 10 or 600 ohms. Separate 50 c.p.s. check. Set zero control. 200/250 volt A.C. operation. Supplied in perfect working order. £9/19/6 each. P/P. 10/-.

**CV.967 1 IN. CR. TUBES.** 4 volt heater suitable for scope, new. 19/6 each. P/P. 1/6.

**230 VOLT A.C. MOTORS.** Ideal for fan or blower. 15/6 each. P/P. 1/3.

**R.1294 V.H.F. COMMUNICATION RECEIVERS.** 500 to 3,000 mc/s. Perfect condition with handbook. £25. P/P. 10/-.

**MARCONI TF-329 "Q" METERS.** Range 0 to 500 Ω. Frequency 50 kc/s. to 50 mc/s. Re-conditioned to maker's specification. 200,250 volts A.C. operation. £65 each.

**GRESHAM POTTED L.T. TRANSFORMERS.** 230 volts input. Secondary tapped 70, 75 and 80 volts 4 amps. New boxed, 42/6 each. P/P. 3/6.

**FERRANTI FILAMENT TRANSFORMERS.** Two types, both 200/250 volt input. Type 1: 6.3 volt CT. 5.6 amp., 6.3 volt CT. 4.8 amp., 6.3 volt CT. 1 amp., 19/6. Type 2: 6.3 volt CT. 3.3 amp., 6.3 volt CT. 1 amp., 6.3 volt CT. .9 amp., 6.3 volt CT. .6 amp. 15/6. P/P. 2/-, both types.

## G.E.C. SELECTEST MULTI-RANGE TESTMETERS



D.C. Volts	A.C. Volts	D.C. Current	A.C. Current
150 mv.	7.5 v	15 ma.	75 ma.
300 mv.	15 v.	30 ma.	150 ma.
1.5 v.	75 v.	150 ma.	750 ma.
3 v.	150 v.	300 ma.	1.5 amp.
15 v.	300 v.	1.5 amp.	7.5 amp.
30 v.	600 v.	3 amp.	15 amp.
150 v.	750 v.	15 amp.	Resistance
300 v.	1,500 v.	30 amp.	1 K. ohm
750 v.			10 K. ohm

Incorporated overload trip and special safety interlocking switches. Supplied in perfect condition with leads and battery at £7/10/- each. P/P. 3/6.

## AMERICAN MULTI-RANGE TESTMETERS



1,000 ohms per volt, 400 microamp basic movement.	A.C. VOLTS	D.C. VOLTS
	2.5 v.	2.5 v.
	10 v.	10 v.
	50 v.	50 v.
	250 v.	250 v.
	1,000 v.	1,000 v.
	5,000 v.	5,000 v.
D.C. CURRENT	RESISTANCE	
1 ma.	500 ohms	
10 ma.	100 k. ohms	
100 ma.	1 megohm	
1 amp.	DECIBELS	
	-10 to +69	

ALL BRAND NEW. COMPLETE WITH INTERNAL BATTERY TEST PRODS AND INSTRUCTIONS. £3/19/6 EACH. P/P. 3/-.



**UNREPEATABLE OFFER**  
 DUE TO LARGE PURCHASE  
 FROM GOVERNMENT  
**COSSOR 339**  
**DOUBLE BEAM**  
**OSCILLOSCOPES**  
 PERFECT WORKING CONDITION  
 WITH HANDBOOK  
**ONLY £15 EACH**  
 Carriage 10/- extra.

**MARCONI TYPE TF-340 OUTPUT POWER METERS.** Meter calibration 50 MW/17DB F.S.D. Meter multipliers, 0.1-1-10-100. Impedance values, 25-30-40-50-60-80-100-125-150-200 ohms. Impedance multipliers, 0.1-1-10-100. Perfect condition. £9/19/6 each. 7/6 carriage.

**SURPLUS HEADPHONES.** R.C.A. chamois padded, moving coil, fitted jack plug, 19/6 pr. P/P. 1/6. AMERICAN HS.30 super light weight, 50 ohms, 15/- pr. P/P. 1/6. 4,000 ohms light duty, 12/6. P/P. 1/6.

**DON MK. V FIELD TELEPHONES.** Ideal for all inter-communication. Buzzer calling. Supplied fully tested complete with batteries and instructions. 39/6 each. P/P. 3/6 each.

**PARMEKO TABLE TOP TRANSFORMERS.** Input 230 volts. Output 620/550/375/0/375/550/620 volts 250 m/a. Also 2.5 volt 3 amp. windings. Size 6½ x 6½ x 5½ in. New, boxed at 45/- each. P/P. 5/-.

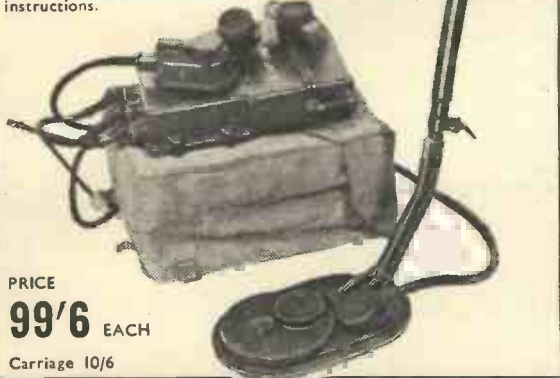
**24 VOLT ROTARY CONVERTERS.** Input 24 volt D.C. Output 230 volts A.C. 50 cycles, 100 watts. Housed in metal case with inlet/outlet plugs. Brand new. 92/6 each. P/P. 7/6.

**VORTEXION PORTABLE AMPLIFIERS** Operation from 200/250 volts A.C. or 12 volts D.C. Separate inputs for microphone or gram. Push-pull 10 watt output matched to 7.5, 15, 250 or 500 ohms. Incorporate volume control and full switch tone control. Not brand new but good working order. 10 guineas each. P/P. 6/-.

**MINE DETECTORS No 4a**

Complete equipment comprises Search Head, Amplifier Headset, Control Box, Telescopic Rods for Search Head, Search Head Test Unit and Test Depth Measure and Haversack. Operation is from a standard 60 v./1.5 v. combined dry battery. The unit will detect ferrous or non-ferrous metals to a depth of 24in. giving maximum signal but can be used at greater depths giving lower output. Ideal for tracing underground pipes or cables and any hidden metallic objects. Complete equipment supplied brand new in original transit cases complete with circuit and operating instructions.

PRICE  
**99/6** EACH  
 Carriage 10/6



**CRYSTAL CALIBRATORS NO. 10.** Range 500 Kc/s. to 30 Mc/s. Compact size, 7 x 7½ x 4in. Utilise 2-1T4, 1R5 and CV286 valves and 530 Kc/s. crystal. Supplied in perfect condition with instructional handbook. 59/6 each. P/P. 3/6.

**MARCONI TF868 UNIVERSAL IMPEDANCE BRIDGES.** Ranges 1pf-100 mfd. 1µh.-1h., 1Ω-10 megohm, 200-250 v. A.C. Perfect as new 665 each.

**PARMEKO TRANSFORMER.** Input 230 volts. Output 350/0/350 volts 150 m/a. 6.3 volts 3.5 amp. 5 volts 4 amp. New, boxed, 32/6 each. P/P. 2/6.

**PHOTO VOLTAGE AMPLIFIERS.** These special instruments incorporate a 1 microamp mirror galvanometer and a double selenium photo-electric cell. Housed in aluminium case complete with 12 volt lamp and housing. Brand new. £9/19/6 each. P/P. 7/6.

**MARCONI TF-517 SIGNAL GENERATORS.** 10-18 Mc/s.; 33-58 Mc/s.; 150-300 Mc/s.; 200/250 volts operation. 65/- each for callers only.

**6 VOLT VIBRATOR PACKS.** Output 120 volts 30 m/a. Fully smoothed. New, boxed 12/6 each. P/P. 2/-.

**POTTED TRANSFORMER.** Primary 230 volts. Secondary 350/310/0/310/350 volts. 220 m/a. 6.3 volts 13 amps., 5 volts 3 amps. 49/6 each. P/P. 3/-.

**HOOVER ROTARY TRANSFORMERS.** Miniature type. 12 volt D.C. input. Output 310 volts 30 m/a. New, boxed 12/6 each. P/P. 1/3.

**PORTABLE PRECISION VOLTMETERS**

Brand new and boxed instruments by famous manufacturer. Housed in polished teak case. Moving iron movement reading A.C. or D.C. volts on 2 ranges, 0-160 v. and 0-320 v. 8in. mirror scale. Accuracy within 2%. Supplied at a fraction of original cost. Only £5/19/6 each. P/P. 3/6.



**12 VOLT ROTARY CONVERTERS.** Input 12 volt D.C. Output 230 volt A.C. 150 watts, 50 cycles. Housed in wooden case and fitted with voltage control slider resistance, switch, plugs and A.C. mains voltage output check meter. Supplied in perfect condition fully tested, £9/19/6 each. P/P. 10/-.

**MARCONI TF410c VIDEO OSCILLATORS.** Ranges 20 c/s-30,000 c/s, 30 Kc/s-5Mc/s. Variable attenuator. 200/250 v. A.C.

**AVO POWER PACKS.** 230 volts input. Output 6½ volts, 5 m/a. and 1.5 volts 250 m/a. Fully smoothed. New, boxed 19/6 each. P/P. 2/6.

**FIELD TELEPHONES TYPE L.** Generator bell ringing, light and very portable. Supplied complete with batteries. Fully tested. As new, 59/6 each. P/P. 3/-.

**POST OFFICE JUMPER LEADS.** 4ft. fitted with two std. jack plugs. 3/- each. P/P. 9d. Standard jack sockets 9d. each.

**SOUND POWERED TELEPHONE HANDSETS.** No batteries required to use. Ideal for inter-com. New boxed 15/- each. P/P. 1/6.

**BATTERY CHARGING OR MODEL RECTIFIERS AND TRANSFORMERS.** Rectifiers. All full wave and bridged. 12/18 volt 1.5 amp., 4/3; 12/18 volt 2.5 amp. 6/9; 12/18 volt 4 amp. 9/9; 12/18 volt 6 amp. 18/6; 24/30 volt 1 amp. 12/6; 24/30 volt 4 amp. 22/6; 24/30 volt 15 amp. 62/6.

**Transformers.** All primaries tapped 200/250 volts. 3.5, 9 or 17 volt 1 amp. 9/9; 3.5, 9 or 17 volt 2 amp. 14/3; 3.5, 9 or 17 volt 4 amp. 16/6; 9 or 17 volt 6 amp. 26/-; 3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30 volt 2 amp. 18/6. Please add postage.

**EDDYSTONE MAINS POWER PACKS.** 200/250 volts input. Output 175 volts 60 m/a and 12 volts 2.5 amps. Double choke and condenser smoothed, 5Z4 rectifier. Supplied new and unused only 22/6 each. P/P. 3/6.

**ROTARY TRANSFORMERS.** Two models, either 6 or 12 volt input D.C. Output 250 volts 80 m/a. 22/6 each. P/P. 2/6.

**SPECIAL OFFER OF P.V.C. RECORDING TAPE.** Brand new, boxed on 7in. universal spools. 600ft. std., 12/-; 1,200ft. std., 19/6; 1,800ft. long play, 30/- P/P. 1/-.

**BRAND NEW R.C.A. EXTENSION LOUDSPEAKERS**

8in., 3 ohm Quality 5speaker mounted in attractive black crackle case to match AR88 Receivers, etc.

45/- each. P/P. 3/6.



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 Phone: GERRARD 8204/9155  
 Cables: SMITHEX LESQUARE  
 3-34 LISLE STREET, LONDON, W.C.2



**R.S.C. HI-FI TAPE RECORDER KIT**

Build a high quality recorder in the £70 class for only

**29 1/2** G.V. Carr. 17/6

INCORPORATING THE LATEST MK. IV COLLARO TAPE TRANSCRIPTION. THE LINEAR LT45 HIGH QUALITY TAPE AMPLIFIER. A HIGH FLUX 7 x 4in. LOUDSPEAKER, Reel of Best Quality TAPE. Spare Tape Spool, a Portable Cabinet, size approx. 18 x 13 x 9in., finished in veneered walnut or sapsle, and connection diagram for wiring amplifier to transcription.

**FEATURES INCLUDE**

- ★ 3 SPEEDS. ★ FREQUENCY RESPONSE 50-11,000 c.p.s. ★ SWITCHED NEGATIVE FEEDBACK EQUALIZATION FOR EACH SPEED. ★ OUTPUT 4 WATTS. ★ MAGIC EYE RECORDING LEVEL INDICATOR. ★ TWIN TRACK OPERATION. Both bottom and top tracks can be recorded or played back without removing tape. ★ INSTANTANEOUS CHANGES can be made from one track to another. Fast rewind in either direction. ★ TAPE MEASURING AND CALIBRATING DEVICE. ★ TAKES FULL 7in. DIAMETER REELS OF TAPE. ★ NEGLIGIBLE HUM. ★ ENTIRELY EFFECTIVE ERASURE. Full descriptive leaflet supplied on receipt of S.A.E.

OR DEPOSIT 3 GNS. and 12 monthly payments of 53/9. Cash price is settled in 8 months.



**HI-FI 10 WATT AMPLIFIERS**

BRAND NEW BUT IN SLIGHTLY SOILED CONDITION

**£5-15-9**

Carr. 7/6

**A REMARKABLE OPPORTUNITY**

Push-pull output. Latest high efficiency Mullard valves. Dual separately controlled inputs for mike and gram. Separate bass and treble controls. High sensitivity. Output for 15 ohm loudspeaker. Guaranteed, tested, and in perfect working order.

**VALVES!** Full range at really competitive prices. All guaranteed

REPANCO CONSTRUCTIONAL ENVELOPES AND COMPONENTS ALWAYS IN STOCK

All parts for: One Transistor Receiver 25/-; Two Transistor Receiver 42/-; 3 Dec 3 Transistor Receiver £31/9/6; Mini 7 Seven Transistor Pocket Portable Receiver £9/19/6; Major 7 Seven Transistor Portable Receiver 15 gns. Only Mullard, Ediswan, or Brimar Transistors supplied for Mini 7 and Major 7 Receivers. Constructional Envelopes. 3 Dec 9d., Mini 3 Pocket Portable 1/3, Mini 7 1/8. Major 7 1/6.

**THE SKY FOUR T.R.F. RECEIVER**



A design of a 3 valve 200-250 v. A.C. mains. L and M. wave T.R.F. receiver with selenium rectifier. Full inclusion in cabinet illustrated or walnut veneered type. It employs valves 6K7, 6F6, 6P6 and is specially designed for simplicity in wiring. Sensitivity and quality are well up to standard. Point-to-Point wiring diagram. Instructions and parts list 1/9. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite or veneered walnut.

designed for simplicity in wiring. Sensitivity and quality are well up to standard. Point-to-Point wiring diagram. Instructions and parts list 1/9. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite or veneered walnut.

**R.S.C. BATTERY TO MAINS CONVERSION UNITS**

Type BM1. An all dry battery eliminator. Size 5 1/4 x 4 1/4 x 2in. approx. Completely replaces batteries supply 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s is available. Suitable for all battery portable receivers requiring 1.4 v. and 90 v. This includes latest low consumption types. Complete kit with diagram 35/9 or ready for use 46/9.

Type BM2. Size 8 x 5 1/4 x 2 1/2in. Supplies 120 v. 90 v. and 80 v., 40 mA. and 2 v. 0.4 a. to 1 amp. fully smoothed. THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND H.T. v. ACCUMULATORS when connected to A.C. mains supply 200-250 v. 50 c/s. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator. Complete kit with diagrams and instructions. 49/9 or ready for use 59/6.



**PHILIPS CONCENTRIC (Dual Cone) P.M. SPEAKERS**

10 in. Diameter. 29/9

**R.S.C. TR2 PORTABLE TAPE RECORDER**

A fully assembled unit housed in attractive two tone rexine covered portable cabinet.

- ★ Single Speed 3 1/2 in. per sec.
- ★ Negative Feedback Tone Compensation.
- ★ Excellent Frequency Response.
- ★ Takes 5 1/2 in. Tape Reel.
- ★ Fast rewind.
- ★ Magic Eye Recording Level Indicator.

Complete with Reel of best quality Tape, Spare Spool, and Microphone. **19** Carr. 10/6 GNS. H.P. TERMS, DEPOSIT 2 Gns. and 12 monthly payments of 33/6. ★ Twin Track. ★ Automatic Erasing. ★ High Sensitivity. ★ High Flux 7 x 4in. P.M. Speaker. ★ Output 3 watts. ★ For 230/250 v. 50 c.p.s. A.C. mains.

**ACOS HI-FI CRYSTAL 'MIKES'**

- 33-1 hand or Desk type **35/9** (Listed) 50/-
  - 30-1 Stick type **39/6** (Listed) 50/-
- Limited number.

**R.S.C. TRANSFORMERS**

FULLY GUARANTEED INTERLEAVED AND IMPREGNATED

<b>MAINS TRANSFORMERS</b>	
Primaries 200-230-250 v. 50 c/s.	
<b>FULLY SHROUDED UPRIGHT MOUNTING</b>	
330-0-350 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a.	17/6
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	25/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	25/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	25/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a., c.t.	33/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	33/9
425-0-425 v. 200 mA. 6.3 v. 4 a., c.t. 5 v. 3 a.	49/9
<b>TOP SHROUDED DROP-THROUGH TYPE</b>	
280-0-280 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	16/9
350-0-350 80 mA., 6.3 v. 2 a., 5 v. 2 a.	18/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	29/9
<b>ELIMINATOR TRANSFORMERS</b>	
Primaries 200-250 v. 50 c/s.	
120 v. 40 mA., 5-0-5 v. 1 a.	14/9
90 v. 15 mA., 6-0-6 v. 250 mA.	9/11
<b>FILAMENT TRANSFORMERS</b>	
Primaries 200-250 v. 50 c/s.	
4.3 v. 1.5 a.	5/9
6.3 v. 2 a.	7/6
0-4-6-3 v. 2 a.	7/9
12 v. 1 a.	7/9
6.3 v. 3 a.	8/11
6.3 v. 6 a.	17/6
<b>OUTPUT TRANSFORMERS</b>	
Midget Battery Pentode 68 : 1 for 334, etc.	3/9
Small Pentode 5,000 Ω to 3 Ω	3/9
Standard Pentode 5,000 Ω to 3 Ω	5/9
Standard Pentode 8,000 Ω to 3 Ω	5/9
Push-pull 8 watts 6V8 to 3 ohms	8/9
Push-pull 8 watts EL84 to 15 ohms	8/9
Push-pull 10-12 watts 6V8 to 3 Ω or 15 Ω	16/9
Push-pull 10-12 watts to match 6V8 to 3-5-8 or 15 Ω	17/9
Push-pull EL84 to 3 or 15 ohms	17/9
Push-pull Ultra Linear for Mullard 610	27/9
Push-pull 15-15 watts, sectionally wound, 6L6, KT88, etc., or 3 or 15 ohms	23/9
Push-pull 20 watt high quality sectionally wound, 6L6, KT88, etc. to 3 or 15 Ω	47/9



**EXTENSION SPEAKERS**

Limited number in hand - some walnut veneered cabinets. 2-3 ohms speech coils, 6in. 29/9. 8in. 35/9. 10in. 56/9.

**DRY SHAVERS.** Brand new in carrying case. Operation from 3 U2 batteries, fitted in case. Just the thing for travel. Only 59/6 (approx. half price).

**RECORDING TAPE. GEVASONOR** Best quality 5in. 600ft. 15/11. L.P. 6in. 850ft. reels 22/6. 7in. 1,700ft. reels 35/-.

**SUPERHET RADIO FEEDER UNIT**

Design of a high quality Radio Tuner Unit (especially suitable for use with any of our Amplifiers. A Triode Heptode F/changer is used. Pentode I.F. and double Diode Second Detector, delayed A.V.C. is arranged so that A.V.C. distortion is avoided. The W. Ch. Sw. incorporates Transposition. Controls are Tuning, W. Ch. and Vol. Output will load most Amplifiers requiring 500 mV. input depending on Ae. location. Only 250 v. 15 mA. H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-6-7in. high. Send S.A.E. for illustrated leaflet. Total building cost is £4/15/-. Point-to-Point wiring diagrams and instructions 2/6.

**GARRARD BATTERY OPERATED RECORD PLAYING UNITS.** Complete with Pick-up to take 46 r.p.m. records. Used by leading manufacturers in Transistorised Record Players. Require 6 v. battery. Only £3/19/6. Carr. 3/6.

**PORTABLE CABINET**

Two Tone Rexine with all cut outs to take above unit, amplifier and speaker. 29/6.

**B.S.R. MONARCH AUTO-CHANGERS**

Type UAR, 4 speed. T/O Pick-up with sapphire stylus £7/19/6. Carr. 4/6.

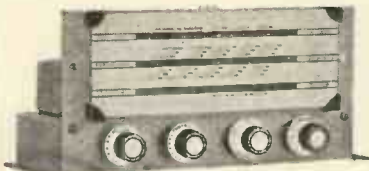
Collaro AC4/984 4-speed single players with hi-fi turnover crystal pick-up head £6/12/6. Carr. 4/6.

**R.S.C. A12 STEREO AMPLIFIER KIT**

A complete kit of parts to construct a good quality 3 + 3 watt (total 6 watt) stereo amplifier providing really life-like reproduction. Suitable for use with all stereo pick-up heads at present available. Ganged volume and tone controls. Preset balance control. Outputs for matched 2-3 ohm speakers. For 200-250 v. A.C. mains. Astonishing value. **£3-19-6** Carr. and packing 7/6

**W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS**

HF1012, 10 watts 15 ohms (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. £4/10/9. Please state whether 3 ohm or 15 ohm required.



**AM/FM RADIOGRAM CHASSIS, HIGH QUALITY. PUSH-PULL. 6-8 WATT OUTPUT.** Current manufacture. 12 months guarantee. For 200-250 v. mains. Covers L. and M. wavebands plus F.M. Includes 8 latest type miniature B.V.A. valves. Only 22 gns. plus 7/6 carr. Or deposit £2/12/- and 9 monthly payments of £2/12/-.

E.M.I. 4-speed Single Players with hi-fi T/O crystal pick-up head for Stereo and Monaural. £6/19/9. Carr. 5/6.

**GARRARD 4-SPEED AUTO-CHANGERS**

Type BC/120H. Limited number of £9/19/6 (approx. half price). Carr. 5/6. Brand new.

80 mA., 10 H., 350 Ω	5/6
60 mA., 10 H., 400 Ω	4/11
100 mA., 10 H., 200 Ω	8/9
1 amp. 0.5 Ω LT type	6/6

**A.M./F.M. RADIOGRAM CHASSIS**

A 6 valve unit by a leading manufacturer. Covers L. and M. wavebands plus V.H.F./F.M. Excellent quality output. High sensitivity. Built in Ferrite aerial. For 200-250v. A.C. mains. 12 months guarantee. Only **13 1/2** GNS. Carr. 10/-

Or deposit 45/- and 12 monthly payments of 22/6.

A beautifully designed and finished walnut veneered table cabinet made to suit the chassis can be supplied for only 35/9.



# 30 WATT AMPLIFIER R.S.C. A.10 ULTRA LINEAR

**HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES.** EF86, EF86, EOC83, 807, 807, GZ34. Tone Control. Pre-Amplifiers are incorporated. Sensitivity is extremely high. Only 12 millivolts minimum input is required for full output. **THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP.** Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. An extra input with associated vol. control is provided so that two separate inputs such as "mike" and gram, etc., can be simultaneously applied for mixing purposes. **AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 v. 1.5 A. FOR A RADIO FEEDER UNIT.** Price in kit form with easy-to-follow wiring diagrams.

**ONLY 11 Gns.** Or Factory built with 12 months' guarantee £13/19/6. **TERMS ON ASSEMBLED UNITS. DEPOSIT 24/9 and 12 monthly payments of 24/9.**

Carr 10/-  
Cover as Illustrated  
Type 807 output valves are used with High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response  $\pm$  3 D.B. 30-20,000 c/c. Tone Controls  $\pm$  12 D.B. at 50 c/c.  $\pm$  12 D.B. to -6 D.B. at 12,000 c/c. hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue hammer. Overall size 12 x 9 x 8 in. approx. Power consumption 150 watts. For A.C. mains 200-250 v. 50 c/s. Outputs for 3 and 15 ohm speakers. **EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS OR OUTSIDE FUNCTIONS. IDEAL FOR USE WITH MUSICAL INSTRUMENTS SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GAREISON THEATRES, etc., etc.** We can supply Microphones, Speakers, etc., at keen cash prices or on terms with amplifiers. **EXPORT ENQUIRIES INVITED.**

**LINEAR "DIATONIC" 10 WATT HIGH FIDELITY AMPLIFIER.** A compact attractively finished unit. 12 gns. Cash. Send S.A.E. for leaflet. H.P. Terms. Dep. 22/3 and twelve monthly payments of 22/3.

**LINEAR L1/10 10 WATT HIGH FIDELITY AMPLIFIER,** with 3 position equalisation switch. 13 Gns.

**LINEAR L5/5 HIGH QUALITY STEREO AMPLIFIER.** Total output 10 watts. Handsome Perspex Facia Plate. All controls ganged. Only 11 Gns.

**LINEAR L45 MINIATURE 4/5 W. QUALITY AMPLIFIER.** Suitable for use with any record playing unit and most microphones. Negative feedback 12 D.B. Bass and Treble controls. For A.C. mains input of 200-250 v. 50 c/s. Output for 2/3 ohm speaker. Three miniature Mullard valves. Size only 6 x 5 x 5 1/2 in. high. Chassis fully isolated from mains. Guaranteed 12 months. Only **£5/19/6** Or Deposit 22/- and 5 monthly payments of 22/- Send S.A.E. for leaflet.

**L63 MINIATURE 3 WATT GRAM AMPLIFIER**  
For 200-250 v. 50 c/s. A.C. mains. Overall size only 6 1/4 x 4 1/2 x 2 1/2 in. Fitted Vol. and Tone Control with mains switch. Designed for use with any kind of single player or record changing unit. Output for 2-3 ohm speaker. Guaranteed 12 months. Only 57/9.

**R.S.C. A7 3-4 WATT QUALITY AMPLIFIER.** Spec. exactly as A5 below with exception of output wattage. Complete kit of parts, diagrams and instructions £3/15/-, carr. 3/6.

**R.S.C. A5 4-5 WATT HIGH GAIN AMPLIFIER**  
A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum-level is negligible being 71 D.B. down. 15 D.B. of negative feedback is used. E.T. of 300 v. 26 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-250 v. 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish, and point-to-point wiring diagrams and instructions. Exceptional value at only 24/15/- or assembled ready for use 25/- extra, plus 3/6 carriage. Or Deposit 22/- and five monthly payments of 22/- for assembled unit.



**P.M. SPEAKERS.** 2-3 ohm 2 1/2 in. Perlio 21/9. 5 in. Goodmans 17/9. 7 x 4 in. R.A. Elliptical 19/9. 8 1/2 in. Belsa 19/9. 8 in. Goodmans 21/9. 8 x 6 in. Elac with high flux magnet 25/9. 10 in. R.A. 28/9. 10 x 6 in. Elliptical Goodmans 29/6. 12 in. R.A. 29/11. 12 in. K.A. 3 or 15 ohms. 10 watts. 12,000 lines, 59/6.

**TWEETERS.** 4 in. Plessey, 3 ohms, 18/9. R.A. 15 ohm 25/9  
**COLLARO CONQUEST 4-SPEED AUTO-CHANGERS.** With studio pick-up with turnover head. **BRAND NEW.** Carried latest model. For 200-250 v. A.C. mains. 27/19/6. Carr. 4/6.

**ACOS Crystal Microphone Inserts.** Brand new. Only 5/11 ea. Ex. Equip. 4/11 ea.  
**ACOS HGF59 Hi-Fi Crystal Cartridges.** (Turnover type, with sapphire stylus.) Standard replacement for Garrard and Collaro. Only 19/9. B.S.B. Ful-8 19/9. Garrard GC2 19/6.

**CONSON V.H.F. F.M. RADIO RECEIVER KITS** Brand New Boxed with valves, printed circuit and 10 x 6 in. Speaker. For 200-250 v. A.C. mains. Pre-aligned I.F.T.s. Normal price 15 Gns. Our price 28/19/6.

# R.S.C. MANCHESTER, LEEDS & BRADFORD

(LEEDS) LTD.  
Open to callers at following branches —  
5-7 County (Mecca) Arcade, Leeds, 1.  
54-56 Morley Street (above Alhambra), Bradford.  
8-10 Brown Street, (Market St.) Manchester, 2.

**TERMS: C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/9 extra on all orders under £2, 2/9 extra under £5 unless carriage stated. Trade supplied. Post orders to Mail Order Dept., 29-31 Moorfield Road, Leeds, 12.**

# HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

**PUSH-PULL  
ULTRA LINEAR  
OUTPUT  
"BUILT-IN"  
TONE CONTROL  
PRE-AMP  
STAGES**



Two input sockets with associated controls allow mixing of "mike" and gram, as in A10. High sensitivity. Includes 6 valves, EOC83, EOC83, EL84 B184 8Y3. High Quality sectionally wound output transformer specially designed for Ultra Linear operation and reliable small condenser of current manufacture. **INDIVIDUAL CONTROLS FOR BASS AND TREBLE** "Lift" and "Cut." Frequency response  $\pm$  3 D.B. 30-30,000 c/c. Six negative feedback loops. Hum level 60 D.B. down. **ONLY 22 millivolts INPUT required for FULL OUTPUT** Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs. For **STANDARD or LONG PLAYING RECORDS.** For **MUSICAL INSTRUMENTS** such as **STRING BASS, GUITARS, etc. OUTPUT SOCKET with plug provides 300 v 30 mA and 6.3 v. 1.5 a.** For supply of a **RADIO FEEDER UNIT.** Size approx 12-9-7 in. For A.C. mains 200-250 v. 60 c/c. Output for 3 and 15 ohms speakers. Kit is complete to last out. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. (Or factory built 45/- extra.) **Only 8 Gns.** Carr. 10/-

If required louvered metal cover with 2 carrying handles can be supplied to 18 9. **TERM. ON ASSEMBLED UNITS. DEPOSIT 18/9, and 12 monthly payments of 18/9** send S.A.E. for illustrated leaflet detailing Ready-to-assemble Cabinets, Speakers, Microphones etc., with cash and credit terms

# R.S.C. PORTABLE GUITAR AMPLIFIERS



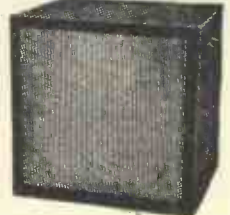
**JUNIOR 5 WATT High Quality Output.** Separate Bass and Treble "cut" and "boost" controls. Sensitivity 15 mv. High Plus 9 in. /speaker. Input sockets for Radio/Tape or Gram Pick-up and Microphone. Pick-up Handsome strongly made cabinet (size approx. 14 x 14 x 7 in.). Finished in satin enamel and fitted carrying handle. **£8/19/6** Carr. 7/6. Or Deposit £1 and nine monthly payments 21. Send S.A.E. for leaflet.

**SENIOR 10 WATTS.** High Fidelity Push-Pull output. Separate Bass and Treble "cut" and "boost" controls. Twin separately controlled high gain inputs so that two instruments such as Guitar and String Bass can be used at the same time. Two Loudspeakers are incorporated, a 12 in. P.M. for Bass notes and a 7 x 4 in. elliptical for Treble. Cabinet is well made and finished satin enamel. Size approx. 18 x 18 x 8 in. **15 Gns. Plus 10/- carr. H.P. TERMS. DEPOSIT 26/9 and 12 monthly payments 28/9.** Both models for 200-250 v. A.C. mains.

**STAR GALAXY 4-SPEED MIXER AUTO-CHANGERS** Brand New, cartoned. Turnover sapphire stylus. Many exclusive features. Unique design virtually free from rumble. For 200-250 v. A.C. mains. Limited number tested and guaranteed **£5/19/6.** Carr. 4/6.

# PORTABLE CABINETS

For Record Players or Tape Recorders. Revene covered. Wide selection of attractive designs and colour combinations. **PRICES FROM 15/9**



**12 in. 10 WATT HIGH QUALITY LOUDSPEAKER IN POLISHED WALNUT FINISHED CABINET**

Gauss 12,000 lines. Speech coil 3 ohms or 15 ohms. Only 24/19/6. Carr. 5/-  
Terms. Deposit 11/- and 9 monthly payments of 11/-  
12 in. 20 WATT 15,000 line /speakers 15 ohms, in Cabinet finished as above. Size 18 x 18 x 6 in. 27/19/6 or Deposit 13/10 and 12 monthly payments 13/10.

**PORTABLE CABINETS.** Attractive design. Two-tone revere covered. Will take Collaro. B.S.B., Garrard or Stuar Auto-Changer. Carr. 10/-. Or with Collaro Conquest changer in lieu of Stuar, 12 Gns. Carr. 10/-

**ACO'S HIGH FIDELITY PICK-UPS.** GP54 with HGF59/82 Cartridge. Turnover sapphire stylus. cream finish. Limited number at approx. half price. Only 29/11. Slightly soiled. Only 49/6.

# SPECIAL OFFER

Above cabinet Stuar Changer, Gram amplifier, and 5 in. or 6 in. x 4 in. speaker 29/19/6. Carr. 10/-. Or with Collaro Conquest changer in lieu of Stuar, 12 Gns. Carr. 10/-



# PLESSEY DUAL CONCENTRIC 12 in. P.M. SPEAKERS

(16 ohms), consisting of a high quality 12 in. speaker of orthodox design supporting a small elliptical speaker ready wired with choke and condensers to act as tweeter. This high fidelity unit is highly recommended for use with our A11 or any similar amplifier. Rating is 10 watts. Gauss 12,000 lines. Price only 25/17/6. Or Deposit 10/6 and 12 monthly payments of 10/6.

# R.S.C. MANCHESTER (LEEDS) LTD.,

For addresses and terms see page 143

**TANNOY RE-ENTRANT LOUDSPEAKERS** 8 watt  
7.5 ohms ..... 19/6  
Or a pair for ..... 35/-

**HIGH FIDELITY 10 watt PUSH-PULL AMPLIFIERS**  
Separate Bass and Treble controls. Inputs for Gram. and Mike. Mullard latest type valves. Brand New. Guaranteed in perfect order but slightly store soiled. Very limited number. £8/15/- Carr. 7/6.

**ELECTRIC BELLS.** 3in. diameter. 4.5 v. to 12 v. Battery or Mains operation. Only 4/9.

## SELENIUM RECTIFIERS

We can quote special prices for quantities of 12 to 10,000 of most types. Special types made to order.

L.T. Types	E.T. Types H.W.
2 1/2 v. 1 a. h.w. .... 1/9	120 v. 40 mA. .... 3/9
6/12 v. 1 a. h.w. .... 2/9	250 v. 50 mA. .... 3/11
Following F.W. (Bridge)	250 v. 60 mA. .... 4/11
6/12 v. 1 a. .... 3/11	250 v. 80 mA. .... 6/11
6/12 v. 2 a. .... 6/11	250 v. 250 mA. .... 12/9
6/12 v. 3 a. .... 9/9	Contact Cooled
6/12 v. 4 a. .... 12/3	350 v. 80 mA. .... 6/11
6/12 v. 5 a. .... 14/6	250 v. 75 mA. .... 8/11
6/12 v. 6 a. .... 15/8	F.W. (Bridge).
6/12 v. 10 a. .... 25/9	
6/12 v. 15 a. .... 35/9	

**JACK PLUGS.** Standard type complete with 4ft. screened lead. 1/11 each.

**JUNCTION TRANSISTORS.** R.F. Type, 12/8. Audio type 6/8. Power type Goltp V15/10F 2 watts 17/8. OC71, 10/-, OC72 17/-, XB102 10/-, XB104 10/-, XA101 OC44 22/6.

**VIBRATORS.** Oak and Wearthle, synchronous 7-pin. 2 v. 7/9, 6 v. 8/3, 12 v. 4-pin non-synchronous 7/8.

2 v. 16 A.H. EX. GOVT. ACCUMULATORS. New Boxed. Only 5/6 each, 3 for 15/-, plus 3/6 carr.

## EX. GOVT. MAINS TRANSFORMERS

All 200-250 v. 50 cps input.  
Pr. 0-110-200-230-250 v., 275-0-275 v. 100 mA., 6.3 v. 250 v. 60 mA., 6.3 v. 2 a. .... 10/11  
300-0-300 v. 80 mA., 6.3 v. 2 a. .... 11/9  
285-0-285 v. 150 mA., 6.3 v. 11 a., 5 v. 3 a., 5 v. 3 a. 29/11  
350-0-350 v. 100 mA., 6.3 v. 2 a., 5 v. 2 a. .... 18/9  
350-0-350 v. 160 mA., 6.3 v. 5 a., 5 v. 3 a. .... 27/9  
400-0-400 v. 250 mA., 5 v. 2 a., 5 v. 2 a. .... 18/9  
450-0-450 v. 250 mA., 6.3 v. 3 a., 6.3 v. 1 a., 5 v. 6 a. 49/9  
0-24-28-28 v. 15 amps. A.C. conservative Govt. rating (marked with D.C. rating after rectification) 69/9. Carr. 15/-  
0-10-20-20 v. 24 a. (Govt. rating) 79/8. Carr. 15/-  
AUTO 500 watts, 0-215-220-226-230-235-240 v. 29/9. Carr. 7/8. 50 watts, 0-110/120-230/250 v. 8/11.

**ARDENTE DEAF AID EARPIECES** with lead and plug. Brand New. Only 15/6.

**SPECIAL OFFER, Brand New Ex Govt. 24 v. 15 amp. F.W. Bridge Selenium Rectifiers. Only 29/9 ea.**

**D.C. SUPPLY KITS.** Suitable for electric trains. Consists of mains trans. 200-250 v. 50 cps., 12 v. 1 amp. selenium rect. (F.W. Bridge); 2 fuseholders, 2 fuses, change direction switch, variable speed regulator, partially drilled steel case, and circuit. Very limited number, 33/9.

**EX. GOVT. SMOOTHING CHOKES**  
200 mA., 3-5 H., 50 ohms.  
Farmeko 5/9; 100 mA., 5 H., 100 ohms 3/11; 150 mA., 10 H., 50 ohms 6/9; 80 mA., 20 H., 900 ohms 5/9; 120 mA., 12 H., 100 ohms 8/9; 50 mA., 35 H., 1000 ohms 6/9; 100 mA., 10 H., 100 ohms 6/9; 60 mA., 5-10 H., 250 ohms 2/11.

**EX. GOVT. CASES.** Well ventilated, black crackle finished, undrilled cover. Size 14 x 10 x 8 1/2 in. high. IDEAL FOR BATTERY CHARGER OR INSTRUMENT CASE, COVER COULD BE USED FOR AMPLIFIER. Only 9/8, plus 2/9 post.

# BATTERY CHARGING EQUIPMENT

Trade supplied. Discounts according to quantity.

## HEAVY DUTY CHARGER KIT

6/12 v. variable charge rate up to 6 amps. Consisting of Mains Trans., F.W. (Bridge) Selenium Rectifier, 0.7 amp. meter, multi-position switch with knob, fuses, fuseholders, panels, plugs and circuit. Only 59/6 Post 4/6.

**ASSEMBLED CHARGERS**

6 v. 1 a. ....	19/9
6 v. 2 a. ....	29/9
6/12 v. 1 a. ....	29/9
6/12 v. 2 a. ....	38/9
6/12 v. 4 a. ....	56/9

Above ready for use with mains and output leads. Cases well ventilated and finished in stoved blue hammer. Carr. & pkg. 3/6.

**CHARGER TRANSFORMERS**  
200-230-250 v. 50 cps.

0-9-15 v. 11 a. ....	12/9
0-9-15 v. 24 a. ....	15/9
0-9-15 v. 3 a. ....	16/9
0-9-15 v. 5 a. ....	19/9
0-9-15 v. 8 a. ....	23/9

## BATTERY CHARGER KITS

Consisting of Mains Transformer F.W. Bridge, Metal Rectifier, well ventilated steel case. Fuses, fuse-holders, grommets, panels and circuit. Carr. 2/9 extra.

6 v. or 12 v. 1 amp. ....	24/9
As above, with ammeter ....	32/9
6 v. or 12 v. 2 amps. ....	25/9
6 v. or 12 v. 2 amps. ....	31/6
6 v. or 12 v. 2 amps. ....	42/9
(inclusive of ammeter)	
6 v. or 12 v. 4 amps. ....	53/9
6 v. or 12 v. 4 amp. with variable charge rate selector and ammeter ....	59/9

**CHARGER AMMETERS**  
0-1.5 amp., 0-3 amp., 0-4 amp., 0-7 amp., 0-25 amp., 0-60 amp 8/9

## ASSEMBLED CHARGER

6 v. or 12 v. 2 amps. Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads. Double Fused. Only Carr. 3/9. **49/9**

As above, but for 3 amp. charging. Only 59/6. Carr. 3/9



**Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish. Ready for use with mains and output leads. Carr. 5/- Or Deposit 13/3 and 5 monthly payments of 13/3. As above but for 6 amp. charging. 4 GNS. Carr. 5/- Or Deposit 16/- and 5 monthly payments of 16/- The 6 amp. model only, is slightly store soiled and is being offered at well below usual price.**



## ANOTHER SNIP OFFER SLIGHTLY SOILED AT THE LOW PRICE

**29/6**  
and 4/-  
post and packing.  
Surplus to manufacturer's requirements, well made 2-tone colour portable player cabinets, will take non-auto player. Amplifier and 4in. or 5in. speaker. The above portable cabinet, B.S.R. T.V.9 and Acos pick-up, 4-speed player and 2-watt amplifier and 6 x 4 elliptical speaker making an ideal portable player, at the special price of £8/5/- plus 7/6 Post and Pkg.

**3 NEW RECEIVERS FOR CONSTRUCTORS.** One valve SW radio, 24-40 metres. All components, 35/- P. & P. 2/-  
Beginners' transistor pocket radio, miniature components, 30/- complete. P. & Pkg. 2/-  
Personal portable radio. All parts, complete, 35/- P. & Pkg. 2/-

## BUILD THIS YOURSELF

The Transette Medium Wave, 2 transistor, pocket portable. Neatly designed, using 2 transistors and diode. Simple to assemble. Enlarged working diagram. All components colour coded. Ferrite wound aerial. Will play indoors and outside with self contained aerial. All components and diagram complete, 62/6. Post & Pkg. 1/6.  
Plug-in ear piece ..... 12/6  
Single phone ..... 4/6  
Battery ..... 2/-  
All components available separately  
Stamped addressed envelope for details

## THE FAMOUS COSSOR 3 watt AUDIO AMPLIFIER KIT

All components for this 3 watt printed circuit amplifier, negative feedback. Valve line-up: 6BQ5, 6V4, 10in. x 6in. speaker, 4in. tweeter, giving high quality output. 200/250v. A.C. mains. All components including easy to follow instructions in Cossor's original carton. Original price £9/15/- OUR PRICE £5/19/6, Post & pkg. 2/6.

## A GIFT FOR THE SERVICE MAN



## BRAND NEW IN WOODEN CASE

The Weston Model 772 Type 6 super sensitive analyser. This precision designed multi-range test instrument has a large visible finely divided scale giving some of the range shown.  
Range: D.C. volts 20,000 ohms per volt or 1,000 per volt. 2.5 volt range 50,000 ohms. 10 volt range 200,000 ohms. 50 volt range 1 megohm. 250 volt range 5 megohms. 1,000 volt range 20 megohms. Ohms: 0-3,000 ohms, 0-30,000 ohms. 0-3 meg. 0-30 meg. D.C. milliamperes: 10, 50, 250 IMA or 50 microamps. A.C. volts: 1,000 ohms per volt. ONLY £12/10/- plus post and pkg. 7/6.

## FOUR ASTOUNDING TV TUBE OFFERS

All brand new in famous maker's cartons.  
(1) 17in. rectangular aluminized 6.3 HRTS. 3A current; max. anode voltage 16 kV. Usual price £17/5/- OUR PRICE £9/19/6. Crating and carr. 15/-  
(2) 14in. rectangular Tube, 6.3 heaters; 3 amp current; max. anode 14kV; ion trap; external conducting coating; B12A base. £8/17/6. Crating and carriage 12/6.  
(3) Ferranti T12/44 and T12/549 12in. magnetic white fluorescence; 4 v. heater; max. anode 10 kV. As used in many TV receivers. Original price £17/15/- OUR PRICE £4/4/- Crating and carr. 12/6.  
(4) Ferranti 9in. Tube, round white fluorescence, 4 v. heater, max. anode voltage 7 kV. OUR PRICE £2/10/- Crating and carr. 11/6.

## SPECIAL OFFER IN TRANSISTORS

Audio PNP transistors type TS1 5/- each  
Sensitive diodes type GD3 ..... 2/6 each  
Ediswan x B104 ..... 9/6  
" x B103 ..... 12/6  
" x A104 ..... 17/6  
General Purpose diodes ..... 10d. ea.  
Single ear phones ..... 4/6 ea., 1/- p. & p.  
Crystal Ear pieces with lead and ear plugs. Low impedance. Our price 12/6. 1/- p. & p.  
Transistor Condensers. Miniature Electrolytic Capacitors. 32 mfd. 3v., 25 mfd. 25v., 25v., 25 mfd. 6v., 16 mfd. 12v., 8 mfd. 6v., 5 mfd. 12v., 2.5 mfd. 25v., 1.6 mfd. 6v., 1 mfd. 12v. All these types of condensers are 2/6 ea.

## BARGAINS IN MICROPHONES.

Acos crystal stick mic., 39/1 complete with cable. Manufacturer's price 84/- OUR PRICE 39/6, post free.

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**HI-FI Centre**

COME AND HEAR THE LEADING MAKES IN AMPLIFIERS, TUNERS AND SPEAKER SYSTEMS

<p><b>AMPLIFIERS, STEREO AND MONAURAL, BY:</b>  <b>VERDIK ARMSTRONG ROGERS DULCI</b></p>	<p><b>BY:</b>  <b>QUAD LEAK W.B. etc.</b></p>	<p><b>V.H.F. TUNERS BY:</b>  <b>ARMSTRONG LEAK QUAD</b></p>	<p><b>T.S.L. DULCI ROGERS, etc.</b></p>	<p><b>HI-FI SPEAKERS BY:</b>  <b>GOODMAN PLESSEY WHARFEDALE LORENZ</b></p>	<p><b>W.B. T.S.L. G.E.C. etc.</b></p>
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**LOOK !! ANOTHER AMAZING SCOOP FOR THE HI-FI ENTHUSIAST**

Huge purchase of the world-famed RCA equipment enables us to offer the various units at enormous reductions.

**THE NEW RCA ORTHOPHONIC AMPLIFIER**



12-20 watt output. Distortion: harmonic less than .1% at 10 watts/700 c.p.s. Noise Level: 85 D.B. below rated output. Frequency Response: within .2 D.B., 20/2,500 c.p.s., within .5 D.B., 10/60,000 c.p.s. Feedback: 40 D.B. total. Output Impedance: 3-4 ohms, 7 ohms and 15 ohms. Spare Power: 295 v./45 M.A. and 6.3 v. 2.5 amps. for pre-amp. radio tuner and tape amp. A.C. Input: 100/150 v. and 200/250 v. Valve Line-up: two EF86, two KT66, one GZ32. Dimensions: 16½ x 8 x 7½ in. Weight: 32lb.

**PRE-AMP.**  
 Input: Mic., radio/tape high and low level, crystal and magnetic p/ups. Tape and Record: output. Bass and Treble: lift and cut continuously variable. Mixing Facilities: mic. input with radio and tape, low and high pass filter. Valve Line-up: one EF86, two ECC81. Dimensions: 12½ x 6½ x 3½ in. Weight: 7lb.

**THE COMPLETE EQUIPMENT AT 29 GNS.** Carriage 15/-.  
**RCA F.M. TUNER**  
 will match with the above amplifier or any other amplifier with radio input. Tuning range 87.5-108 m/cs. The new RCA electronic ray tuning indicator is used, A.F.C., delayed A.G.C. Power required: 230-390 v. D.C. at 40 MA. H.T. 6.3 v. at 2.25 amps. Valve Line-up: EF95, EF91, ECC81, three 6AU6, EB91, 6AL7. Attractively finished. Dimensions: 12½ x 6½ x 3½ in. Original price £33/11/-. **OUR PRICE £18/19/6.** Post and pkg. 5/-.

**RCA PANORAMIC MULTIPLE SPEAKER SYSTEM**  
 Beautifully made in walnut finish using one 15in. Hi-Fi speaker, response down to 25 c/s., two 2½ moving coil tweeters, response up to 20,000 c/s. crossover at 2,000 c/s., cabinet, ported bass reflex and acoustically damped, 250 watt rating. FEW ONLY. Original price £56/11/-. **OUR PRICE £35.**

**FOR THE CONSTRUCTOR**  
 We can offer a limited number of RCA 10-12 watt amplifiers completely assembled. Just connect assembled amplifier chassis, control unit, power pack and attractive control panel together. Frequency response: 25-20,000 c.p.s., full 10 watt push/pull output, negative feedback, low hum level. 5 valves. Variable bass and treble controls and balanced loudness control which ensures true balance of sound from lowest bass to highest treble at both high and low listening levels. All this at the very low price of £7/19/6, plus post. and pkg. 4/6.

**THE RCA JUNIOR 5-8 watt PUSH/PULL AMPLIFIER**  
 Completely assembled. Just connect assembled amplifier chassis, power pack and attractive control panel together. Frequency response 40-20,000 c.p.s. Full 5 watt push/pull, negative feedback, low hum level, 4 valves, variable bass and treble controls and balanced loudness control. **ONLY £6/19/6.** Post. and pkg. 4/6.

**RCA HIGH FIDELITY REPRODUCER**  
 Completely assembled quality equipment in well styled and beautifully finished cabinet in walnut with contemporary style legs. 5-10 watt peak power, push/pull output, low hum level, 40-20,000 c/s., separate bass and treble controls and balanced loudness control. 3-speaker system using 10 x 6 elliptical speaker and two 4in. tweeters for high frequencies dispersed through specially designed acoustic chamber. 4-speed auto-changer playing ten 7, 10 or 12in. records. Monaural switch for hand operation of pick-up. 45 centre spindle for Continental records. Dimensions of cabinet: length 20in., height 18½in., width 11½in., legs 28in. **OUR PRICE £35/-.** Post and pkg. 25/- for this remarkable player.

**NOTE:** This equipment has input socket for stereo and gram unit has stereo and monaural t/o cartridge.

**THE RCA VARIABLE RELUCTANCE PICK-UP**  
 A new design variable reluctance pick-up. Cartridge completely protected from dust, damp and mechanical shock. Embodies an 8-pole balanced design providing the advantages of sensitivity and negligible hum with smooth and extended frequency response. Pick-up arm has simple tracking pressure selector and adjustable pedestal to suit all turntable heights. Fitted with dual sapphire stylus. Tracking pressure: micro-groove 5-7 gms., 78 r.p.m. 9-12 gms. Original price £13/9/6. **OUR PRICE £7/10/-.** Post and pkg. 1/6.

**AUTO-CHANGERS**  
 Brand new snip in manufacturer's carton. RCA 4-speed auto-changers in maroon finish incorporating auto. and manual control. Complete with Ronette Studio turnover crystal pick-up with sapphire styli for L.P.s and 78 r.p.m. records and including 45 centre post for large hole records. **AT THE AMAZING PRICE OF £7/19/6,** plus 4/6 post. and pkg.

**BUILD YOURSELF A HI-FI TAPE RECORDER AT HALF THE NORMAL PRICE**

**LIMITED NUMBER AVAILABLE**  
**BRAND NEW AND GUARANTEED**

The famous COLLARO Mk. 4 Transcriber Tape Deck. Twin track, 2 record/playback, 2 erase heads on 2 levels, pause control, digital counter, 3 speeds, 2 balanced motors of low wattage input. £17/10/-.  
**WHILE STOCKS LAST.**

The Collaro pre-amp and bias oscillator complete with power pack for the above deck, with instructions. Price £12/19/6. Post and Pkg. 7/6.

The above two items at a special price of £30. Carr. and pkg. 22/6 the two units.

The Linear Tape Deck Amplifier with power pack and oscillator Incorporated. Switched for 3½, 7½ and 15in. per sec. Suitable for the Mk. 4 Deck, 12 gns. only. Post and pkg. 3/6.

**HI-FIDELITY TAPE HEADS**

Made by famous manufacturer. Brand new. Upper or lower track, record/play-back, high impedance giving up to 12,000 c.p.s. at 7½ I.P.S. output 5 mvolts at 1 KC at 7½ I.P.S. Erase heads low impedance. Only 39/6 per pair. Post 1/- State upper or lower track.

**SNIPS IN TAPE ACCESSORIES**

Brand new E.M.I. 7in. take-up spools in polythene bag, 3/9 each post free, 6 for 20/- Brand new 5in. Scotch Boy take-up spools 3/3 post free. 6 for 18/-.

1,200ft. P.V.C. tape on plastic spools made by famous manufacturer. 21/- reel. Post & pkg. 1/-, 1,200ft. P.V.C. tape on 5½ plastic spool. 22/6, plus 1/- post & pkg.

The New American Audio Tape with plastic base. Also supplied in green or blue at no extra cost.

- 3in. reel 150ft..... 6/-
  - 4in. reel 300ft..... 10/6
  - 5in. reel 600ft..... 18/-
- Post and packing, 1/- per spool.

**KLENZATAPE**, the new method for cleaning record and erase heads, 12/6. P. & P. 1/-.

**Special offers in tape by famous maker:**  
 3in. L.P. tape 225ft., 7/- post free.  
 4in. Std. tape 300ft., 10/6 post free.

**METROTABS** for identifying recorded passages on tape, 3/11 plus postage.

**THE NEW "INSTANT" BULK TAPE ERASER**

Can erase a spool of magnetic tape in a few seconds. Demagnetises oxide deposits on tape heads. Only 27/6 post free

Limited number Acos 73-1A stereo turnover cartridge, suitable for 78, microgroove and stereo records, will fit most modern p/up heads. Mfrs. price 52/10. Our price 42/6, Post free.  
 Heavy magnet 9 x 5 Elliptical speaker by famous maker, 18/6. P. & P. 1/6.



**EVERYTHING we sell may be paid for weekly at no extra cost to yourself!**

**RADIO**  
**SUPER SUPERIOR RADIO 5/4**



(plus carr. and ins.)  
initial payment and  
19 weekly payments  
of 4/2.

4 waveband, 5-valve superhet radio, 2-tone covered metal cabinet. 4 control knobs. Positions for gram p.u. and extension speaker. A.C. only. Size 24½ x 12 x 10in. deep. Ins. Carr. 8/6.

**HOME RADIO 5/1**

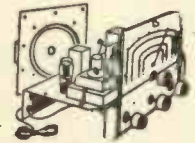
(plus carr. and ins.)  
initial payment and  
19 weekly payments  
of 3/11.

AC/DC Universal mains 5-valve octal superhet, 3 waveband receiver can be adapted to gram p.u. In attractive wooden cabinet. 9½ x 18½ x 11½in. Ins. carr. 4/6.



**SUPER CHASSIS 5/1**

(plus carr. and ins.)  
initial payment and  
19 weekly payments of  
3/11.



5-valve Superhet chassis including 8in. P.M. speaker and valves. Four control knobs (tone, volume, tuning, w/change switch). Four wavebands with position for gram p.u. and extension speaker. A.C. Ins. carr. 5/6.

**BAKELITE CABINETS 5/9**

Brand new. Colour brown. Attractive design. Size 12 x 7 x 5½in. Ideal for small receivers, converters etc. P. & P. 3/9.



**SOUND/VISION and I.F. STRIP 7/9**

Plessey. I.F.'s 10.5 Mc/s. sound. 14 Mc/s. vision. 8 valve holders. Less valves. Size 8½ x 5 x 4½in. Circuit incl. The tuner unit plugs directly into the chassis. P. & P. 2/6.

**SOUND/VISION and I.F. STRIP 2/9**

Salvaged. Complete sound and vision strip. 8 valve holders. Less valves. I.F.'s 16-19.5 Mc/s. Size 8½ x 4½ x 4½in. Drawings free with order. P. & P. 2/6.

**TIMEBASE 2/9**

Containing scanning coils, line transformer, etc. less valves. Drawings free with order. P. & P. 2/6.

**COLVERN PRESET POTENTIOMETERS 2/9**

Brand new. 200 ohms. 10K, and 20K. P. & P. 9d.

**FOCUS MAGNET 9/9**

Brand new. 38 mm. Incorporating picture shift control. P. & P. 1/3.

**SCANNING COILS 10/6**

Low impedance. 38 mm. Brand new. P. & P. 1/3.

**SCANNING COILS 15/9**

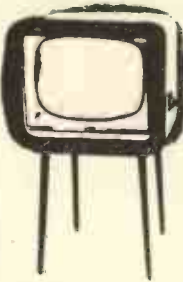
Wide angle 90 deg. 38 mm. Low impedance. P. & P. 1/3.

**CHASSIS FOR SPARES ALL THIS FOR ONLY 9/6**

56 Resis., 7 variable. Controls, conds., incl. electrolytics. Coils, 7 I.F. & R.F. transformers. 14 v/holders. 4 trans., mains—O.P.—line & frame. Chokes, metal rec., Fuse panel, scanning coil, focus magnet, plugs, sockets, etc.; I.F. strip in separate power pack can be used without dismantling. 7 pages of circuits and instructions showing position of each component. Chassis have been used, but were working when stored. Carr. 10/6.

**CATALOGUE FREE ON REQUEST**

**\* TELEVISION FOR AS LITTLE AS 11/1d**



per week  
this modern  
style 17"  
television set  
can grace your  
home!

Cash Price £19.19.0

**Details:—**

- \* Beautiful latest finish cabinet in contemporary style. Covered and washable.
- \* Polished legs 18in. optional extra for 25/-.
- \* 17in. Rectangular Tube. Guaranteed fully for 12 months.
- \* 12 channels. "Turret Tuned"—ITV/BBC. (Extra coils at only 7/6 a pair (with order).)
- \* Chassis. 14 B.V.A. Valves—Salvaged but reconditioned and guaranteed 3 months. Carr. & Ins. 30/-.

Due to overwhelming demands, some delay may occur. Please enquire when ordering.

**TERMS:** 36 weeks at 11/1 OR 20/7 and 19 weekly payments of 19/11.

(4 weekly payments required in advance, plus carr. & ins., on 36 weeks only).

**\* TELEVISION TUBES**

Pay as you view. Any size. Any type. Full allowance on your old tube.



8/6 only with order  
(plus carr. and ins.)  
Balance at 8/6 a  
week for 19 weeks.

Cash price  
£8/10/-. 12 months' guarantee.

**NO EXTRAS. NO INTEREST. NO DEPOSIT.**

Engineer available to fit. Express service same day as ordered. Write for details.

Completely rebuilt gun assembly, new cathode, heater, etc., giving the high standard required for long picture life, quality and value. Carr. & Ins. 15/6.

**MODERN 17" T.V. CHASSIS 24 GNS. COMPLETE AND WORKING or Terms**

15/3 Initial Payment. Balance at 14/3 for 35 weeks.  
29/6 Initial Payment. Balance at 25/6 for 19 weeks.  
Ins., Carr. 25/- (must be paid with Initial Payment).

Latest chassis including 17in. tube. Permanent magnet speaker. 13 channel Turret Tuner (any 2 selected channels fitted). Other channels supplied on request at 7/6 each. 13 valves. Chassis and valves guaranteed for three months. C.R.T. for 12 months' full guarantee. Sound I.F. 19.5 Mc/s. Vision 16 Mc/s. A.C. only. Ready and working to fit into your own cabinet. Carr. & Ins., 25/-.

As above with 14in. Tube, complete and working £19.19.0.

**SPARE PARTS SOLO SOLDERING TOOL 12/6**



110 v., 6 v., or 12 v. (special adaptor for 200/250 v. 10/- extra). Automatic solder feed including a 20ft. reel of Ersin 60/40 solder and spare parts. It is a tool for electronic soldering or car wiring. Revolutionary in design. Instantly ready for use and cannot burn. In light metal case with full instructions for use. Post 3/6.

**TRANSFORMERS**

**MAINS TRANSFORMER 5/9**  
Primary 200-250. Secondary 0-100-250. 150 mA. Suitable for small amplifier with .1 series valves. 2½ x 1½in. P. & P. 1/9.

**OUTPUT TRANSFORMER AND SMOOTHING CHOKE COMBINED 4/9**  
2½ x 1½in. Suitable for EL84s in single or push pull output. P. & P. 1/9.

**MAINS TRANSFORMER 7/9**  
Primary 200-250. Secondary 300-0-300. 6 v. 3.3 amps. P. & P. 1/9.

**MAINS TRANSFORMER 6/9**  
300-0-300 volt at 80 mA. Prim. 200/250v. 6.3v. @ 3a. 5v. @ 2a. P. & P. 2/9.

**FRAME OUTPUT TRANSFORMER 1/9**  
500 ohms. primary. 18 ohms. secondary. P. & P. 1/6.

**SMOOTHING CHOKE 250 mA. 5/9**  
2nd 40 ohms. D.C. Res. New. P. & P. 1/6.

**R.F. E.H.T. COIL 7/9**  
7-10 Kv. R.F. frequency approx. 22 Kc/s. Uses 6V8 or P61 as osc., suitable for Ultra model V600, W700 and many other sets or replacing E.H.T. mains transformers. Ideal when using a larger tube. Size 4½ x 2in. dia. Base 4 x 4½in. Circuit drawings available with order. P. & P. 2/6.

**T.V. MASKS 7/9**  
17in. brand new. Latest pastel shades. Pink and blue. Post 2/3.

**T.V. MASKS 7/9**

21in. as above. Post 2/3.

**T.V. MASKS 2/9**

For 15in. tubes in gold plastic. Post 1/3.

**T.V. AERIALS 23/6**  
For all I.T.A. channels. Outdoor or loft. 3 elements. P. & P. 2/6.

**AERIALS 15/6**  
B.B.C. indoor type. Folded dipole with 12ft. co-ax cable fitted. Post 1/9.

**CO-AX CABLE 6d. yd.**  
Good quality. Cut to any length. 1/6 postage on 20 yds.

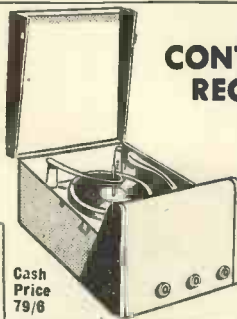


**FROM OUR EXCITING RANGE OF RECORD PLAYER CABINETS:**

**T.W.1  
5/1**

Initial payment. Balance over 19 weeks at 3/11.

Size 15½ x 19½ x 10½in. Takes B.S.R. U.A.8 4 speed autochanger. Twin speakers. 3 control amplifier. Carr. and ins. 4/6.



Cash Price 79/6

**THE NEW  
CONTINENTAL TYPE  
RECORD PLAYER  
CABINETS**

in gay  
two-tone  
colours



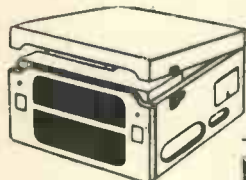
Cash price 99/6

**S.T.1 6/1**

Initial payment. Balance over 19 weeks at 4/11 a week.

Continental style cabinet including extra clip on speaker cabinet. 15½ x 10½ x 2½in. deep. Takes B.S.R. 4 speed stereo autochanger. Printed circuit amplifier. Two 8in. speakers. Carr. and Ins 12/6.

**TAPE RECORDER  
CABINETS 19/6**



Suitable for the Truvox Tape Recording deck. Less front speaker panel. Size 13½in. x 15in. x 8½in. deep. Detachable lid with compartment for spare tape. Covered in green washable plastic material. P. & P. 4/6.

When goods are bought on our interest-free credit terms, the cost of carriage and insurance must be sent with the initial payment.



Cash price 39/6.

**P.L.10 3/1**

Initial payment. Balance over 19 weeks at 1/11 per week.

Size 14½ x 12½ x 6in. Takes B.S.R. T.U.9. 4 speed record player unit. 8 x 3in. elliptical speaker, single control amplifier. Carr. & Ins. 4/6.

**R.P.2  
4/7**



Cash Price 69/6 Initial payment and 19 weekly payments of 3/5.

A beautifully styled cabinet. Made by a famous manufacturer. In polka dot cloth with clipped lid and carrying handle. Size 16 x 14½ x 8½in. deep. Will take B.S.R. Monarch 4 speed autochanger and 7 x 4in. elliptical speaker and most of the modern portable amplifiers. Carr. and Ins. 4/6.

**AMPLIFIERS**

12 months' guarantee

**PORTABLE AMPLIFIER D.1.** 4/1 initial payment and 19 weekly payments 2/11. Brand new. Latest design with printed circuit. Dimensions 7 x 2½ x 5in. A.C. only. Mains isolated. 2-3 watts output. Incorporating EL84 as high gain output valve. Volume and tone controls. Knobs 2/6 extra. P. & P. 3/6. Cash price 59/6.

**PORTABLE AMPLIFIER MK.D.2.** 5/1 initial payment and 19 weekly payments 3/11. Printed circuit. Latest design. Dimensions 7 x 2½ x 5in. A.C. only. Mains isolated 3-4 watts output. Incorporating the latest ECL82 triode pentode output valve giving higher undistorted output. Volume and tone controls. Knobs 2/6 extra. P. & P. 3/6. Cash price 79/6.

**PORTABLE AMPLIFIER MK.D.3.** 5/7 initial payment and 19 weekly payments 4/5. De luxe model. Printed circuit. Latest design. Dimensions 7 x 2½ x 5in. A.C. only. Mains isolated 3-4 watts output. Incorporating the latest ECL82 triode pentode output valve giving higher undistorted output. Volume, treble and bass control. Knobs 3/6 extra. P. & P. 3/6. Cash price 89/6.

**PORTABLE AMPLIFIER MK.D.5.** 3/1 initial payment and 19 weekly payments 1/11. Simple circuit employing ECL80 triode pentode output valve giving 2-3 watts output. A.C. only. Mains isolated. Single control for volume and on/off switch with knob. P. & P. 3/6. Cash Price 39/6.

**STEREOPHONIC AMPLIFIER** 9/1 initial payment and 19 weekly payments 7/11. Beautifully made for portable stereophonic record players. Latest design with printed circuit. Dimensions 3 x 5½ x 9½in. A.C. only. Mains isolated. Twin amplifiers each side giving 3-4 watts output. Incorporating ECL82 triode pentode valve. Full tone, volume and balance controls. Complete and ready to fit. Knobs 3/6 per set extra. P. & P. 3/6. Cash price 87/19/6.

**3 TRANSISTOR AMPLIFIER** 79/6 9 volts. 1 control. P. & P. 3/6.

**AUTOCHANGERS**

**U.A.8. B.S.R. MONARCH 4-SPEED AUTOCHANGER**

8/1 Initial payment and 19 weekly payments of 6/11. Cash price 26/19/6.

**U.A.12. LATEST B.S.R. MONARCH 4-SPEED MIXER**

9/7 Initial payment and 19 weekly payments of 8/5. Cash price 28/9/6.

**COLLARO CONQUEST 4 - SPEED AUTOCHANGER**

8/1 Initial payment and 19 weekly payments of 6/11. Cash price 26/19/6.

**COLLARO CONQUEST STEREO AUTOCHANGER**

12/6 Initial payment and 19 weekly payments of 11/6. Carr. & Ins. 5/6. Cash price 11 gns.



**EXTENSION 19/9 SPEAKERS**

Polished oak cabinet of attractive appearance. Fitted with 8in. P.M. speaker W.B. or Goodmans of the highest quality. Standard matching to any receiver. (2-5 ohms). Switch and flex included. Ins. carr. 3/9.

**IDEAL FOR STEREOPHONIC SOUND**

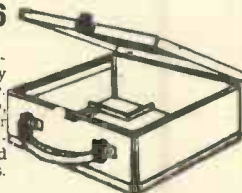
8in. P.M. Speakers 8/9. With O.P. trans. fitted 10/- Post 2/6.

7 x 4in. Elliptical speakers, 19/6.

9½ x 4½in. Elliptical speakers 22/6. Post 2/9.

**STURDY CASE 12/6**

Covered in burgundy and grey washable rexine. Strong clasp, hinges and handle. Ideal for portable radio chassis, transistor set, or can be adapted to take 18 7in. E.P. records. P. & P. 2/8.



**R.P.3 Cash price 69/6**

A delightful looking cabinet 14½ x 17½ x 8½in. in 2 tone leatherette. Will take a B.S.R. Monarch 4 speed autochanger and 6½in. round speaker. Carr. & Ins. 4/6.

Initial payment 4/7 and 19 weekly payments of 3/5.



**R.P.6 29/6**

Elegant cabinet, cloth covered in grey or red with sunken control panel and speaker fret. Size 13 x 17 x 8in. deep. Takes a B.S.R. Monarch 4 speed autochanger; 7 x 4in. elliptical speaker and most of the modern portable amplifiers. Carr. and Ins. 4/6.



**B.S.R. FUL-FI CRYSTAL TURNOVER CARTRIDGES 19/6**

Brand new. Including sapphire needles for L.P. and Standard, giving fullest range and finest tone obtainable for any player. Can be fitted to all standard pick-up arms. P. & P. 9d.

**& CO.**

621/3 ROMFORD RD., MANOR PK. E.12

Tel. ILF 6001/3





**CABY MULTI-RANGE TEST METER.** Freshly Imported.

Guaranteed Model A-10. A.C./D.C. Voltages, sensitivity 2,000 ohms per volt. Ranges: 10, 50, 250, 500, 1,000 v. Resistance: 10K ohm and 1 megohm. D.C. Current: 0.5 mA., 25 mA., 250 mA. Decibel range. Accuracy: 2 to 3%. Price £4/17/6.

P. & P. 1/6. Ask for leaflet fully illustrating and describing this and other models.

SPARE CARRYING CASES FOR AVO MULTI-MINOR WILL ALSO FIT MODEL A-10 ABOVE. NEW. Price 10/6 each, P. & P. 1/-.

**FRESHLY IMPORTED MINIATURE CONTACT COOLED RECTIFIERS**

**Half-Wave Type**

Max. A.C. In. 125 v. D.C. Out. 80 mA. 4/-  
Max. A.C. In. 250 v. D.C. Out. 50 mA. 7/-  
Max. A.C. In. 250 v. D.C. Out. 85 mA. 8/6

**Television Type**

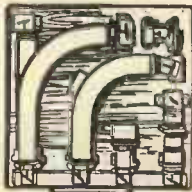
Max. A.C. In. 250 v. D.C. Out. 300 mA. 18/6  
Full-Wave Bridge Connected  
Max. A.C. In. 250 v. D.C. Out. 75 mA. 9/6  
Max. A.C. In. 250 v. D.C. Out. 150 mA. 15/-

**SPECIAL OFFER. LIMITED QUANTITY.**

**GENERAL PURPOSE CATHODE RAY OSCILLOSCOPE**

The famous model 160-B C.R. Scope, manufactured by R.C.A. of U.S.A. Best general purpose instrument of its kind, complete with 6in. cathode ray tube. Unused, guaranteed perfect. For operation on 110 v. A.C. Price £22/10/-. Carr. 10/-.  
Step-down transformer to enable the above to operate on 230 v. Price 19/6.

**SYNCHRONOUS MOTOR**, one rev. every 24 hours. 110 v. or with resistor (supplied) 230 v. Price 27/6. P. & P. 2/-.



**WAVE GUIDE**

3 cm. mounted on a carrying board consisting of: (1) directional coupler. (2) 90 degree bend. (3) co-ax to wave guide adaptor type N. (4) British to W.916. (5) Co-ax to wave guide adaptor circular flange. (6)

Circular to American adaptor. Complete in carrying case with coaxial cable. Price 60/-.  
Carr. 10/-.

**AERIAL AS ILLUSTRATED.** Ideal for Car. Overall length 33in., khaki, with flexible shaft which enables the aerial to be fixed firmly in any position. Price 8/6, plus P. & P. 1/6.

**NEW WIRE WOUND RHEOSTAT ON CERAMIC.** 58 ohms, 50 watt, complete with instrument knob. Price 8/6. P. & P. 1/6.

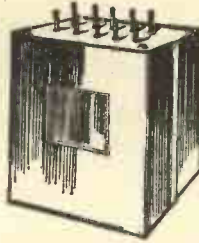
**W. W. RHEOSTAT.** New. 3.5K, 25 watts. Price 7/6. P. & P. 1/6.

**W. W. RHEOSTAT.** New. 5K, 25 watts. Price 7/6. P. & P. 1/6.

**SLIDER RESISTANCE,** 44 ohm, 1 1/2 amp. Price 18/6. P. & P. 2/-.

**EX P.O. MAGNETIC COUNTER** 3 ohms type for 4 1/2 volt D.C. operation. Price 6/6 each. P. & P. 1/-.

**AS ABOVE** 500 ohm for 24/36 volt D.C. operation. Price 6/6 each. P. & P. 1/-.



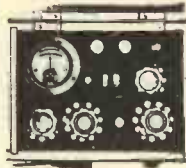
**POTTED TRANSFORMERS.** Type 2762 C Core:

Input 230 v. 45/65 cycles. Output 350-0-350 at 375 mA. 25 v. at 1 amp., 21 v. at .5 amp., 6.3 v. at 1 amp., 6.3 v. at 5 amp., 5 v. at 4 amp. Price 65/-.  
Carr. 6/6.

**Type 2759 C Core**

Input 230 v. 45/65 cycles. Output 361-0-361 at 200 mA. 361-0-361 at 65 mA. 5.16 v. at 4 amp., 5.16 v. at 3 amp., 3.25-0-3.25 at 2 amp., 6.5 v. at 5 amp., 3.25-0-3.25 at 5 amp. Price 65/-.  
Carr. 6/6.

**Type 2669 Oil filled** Input 230 v. 45/65 cycles. Output 0-70 v. 75 v., 80 v., at 4 amp. Price 42/6. Carr. 3/6.



**WHEATSTONE BRIDGE UNIT**

4 stud switches 0-10, 0-100 ohms, galvanometer centre zero, F.S.D. 2.5 mA. In oak carrying case 16 x 7 1/2 x 6in., 40/- each. P. & P. 3/6.

**EVERSHED AND VIGNOLES.** Circuit testing Ohms Meter, pattern "S" complete with testing prods, inst. book etc. Two ranges: 0-3 and 0-30ohms. Brand new, guaranteed perfect, as illus. Offered at fraction of maker's price. £4/17/6 each. P. & P. 2/6.

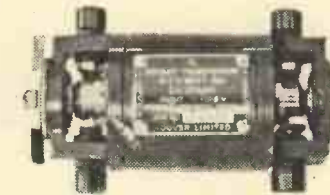
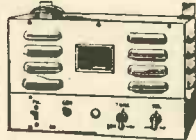


**BRIDGE MEGGER.**

Evershed and Vignoles Series 11, 250 volt. Condition as new, guaranteed perfect. Price £22. Carriage paid. Leather case available 20/- extra.

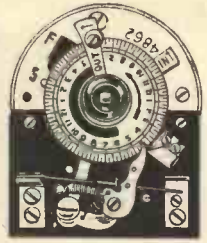
**TRIPLE RANGE VOLTMETER.** 0-5 25-250 v. D.C. M/C 3 1/2in. meter 3in. scale, mounted in bakelite carrying case 7 1/2in. x 4 1/2in. x 3in. complete with handle and test leads. 27/6 each. P. & P. 2/-.

**12 v. D.C. AMP-LIFIER,** as new, for operation on 12 v. car battery, 10 watts undistorted output, with 6L6 valves in push-pull. Mike/Gram input, tapped output 7 1/2, 15, 62, 100, 250 or 500 ohms. £12/10/- each. Carr. 15/-.



**MIDGET ROTARY TRANSFORMERS.** 2 1/2in. dia. x 4 1/2in. Input 11.5 volt. Output 310/365 volts at 30 mA. Brand new. 12/6 each. P. & P. 1/6.

**VENNER 8-day clockwork Time Switch.** Contacts 1 amp. 230 volt. 24 hour phase, 1/2 hour divisions, allows setting for one make and one break to be made every 24 hours, complete with key. Used but guaranteed perfect. Price 27/6 each. P. & P. 1/6.



**FRESHLY MANUFACTURED TRANSFORMERS.** Ideal for model makers. Input capped 200/250 volt. Output multi-tapped from P. to 3 to 30 volts at 2 ampere. Price 19/6. P. & P. 2/-.

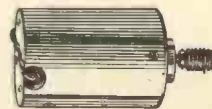
**JACK PLUGS,** cylindrical, bakelite, screw on covers, red or black as required, two contacts. Price 2/- each post free. Dozen lots 20/- post free. Three contacts same price.

**MERCURY SWITCH,** 10 amp. contacts, Single pole, New. Price 3/6. P. & P. 6d.

**METERS GUARANTEED PERFECT**

Charging Types	
2 1/2 amp. D.C. M.I. 2in. fl. rnd.	7/6
5 amp. D.C. M.I. 2 1/2in. fl. rnd.	11/6
7 1/2 amp. D.C. M.I. 3 1/2in. proj. rnd.	12/6
9 amp. D.C. Hot Wire W.R. 2 1/2in. fl. rnd.	6/6
Voltmeters	
12 v. D.C. M.C. 2 1/2in. proj. rnd.	8/6
20 v. D.C. M.C. 2in. fl. sq.	9/6
25 v. D.C. M.C. 2in. fl. rnd.	7/6
30 v. M.I. 3in. proj. rnd.	10/6
40 v. M.C. 2in. fl. sq.	9/6
150 v. D.C. M.C. fl. rnd. 2 1/2in.	10/6
250 v. A.C. rectified moving coil linear scale 3 1/2in. fl. rnd.	35/-
300 v. A.C. M.I. 2 1/2in. fl. rnd.	22/-
400 v. A.C. M.I. 4 1/2in. fl. rnd.	35/-
Milliammeters	
2 mA. M.C. 2 1/2in. fl. rnd.	14/6
5 mA. M.C. 2in. round	12/6
10 mA. M.C. 3 1/2in. fl. rnd.	30/-
30 mA. M.C. 2 1/2in. fl. rnd.	9/6
200 mA. M.C. 2 1/2in. fl. rnd.	9/6
500 mA. M.C. 2 1/2in. fl. rnd.	9/6
Microamp	
50 microamp. scaled 0-100, M.C. 2 1/2in. rnd. fl.	42/6
20 microamp. M.C. 2 1/2in. rnd. fl. (calibrated 0-50)	29/6
50 microamp. 2 1/2in. square, side fitting 3 scales	35/-
500 microamp. M.C. 2in. rnd.	16/6
Postage on all meters 1/- each.	

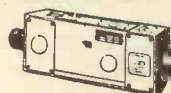
**NEW UNCHARGED UNFILLED 12 VOLT ACCUMULATOR** 9 ampere in unspillable plastic cases. Comprises 6x2 v. separate cells connected by terminal strips. 6 x 5 1/2 x 4 1/2in. over terminals. Price 19/-, plus P. & P. 2/9. Wooden carrying case for strap with lid and frame price 3/6.



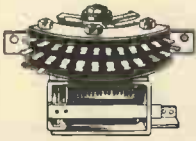
**MINIATURE P.M. MOTOR.** 12/24 volt, reversible. 1 1/2in. dia. New. Price 9/6 each. P. & P. 1/-.

**AIRCRAFT CINE CAMERA G45B Mk. III**

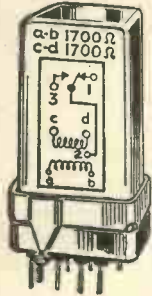
Fully modified, fitted with f/3.5 triple anastigmatic lens, takes 25ft. of 16 mm. film, fitted with 24 v. motor. 16 exposures per sec. Brand new, original packing, £4/10/- each. P. & P. paid.



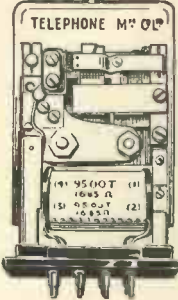




**MINIATURE UNISELECTOR SWITCH.** Two banks of ten plus home contacts one bank continuous of normal. 30 ohms coil for 24 volt operation. Brand new, manufacturer's packing. Price 22/6 each. P. & P. 2/6. As illustrated.



**SIEMENS H.S. RELAY.** Very latest type, sealed. H96E. 1,700 ohms plus 1,700 ohms, single C.O. contacts. Brand new with fixing clip. In maker's cartons. Price 16/6 each, plus 1/- P. & P.



**NEW CARPENTER'S TYPE POLARIZED RELAYS.** 2 x 9,500 turns at 1,685 ohms. Price 22/6 each. P. & P. 1/-.

**MINIATURE MOVING COIL DIFFERENTIAL RELAY.** Two coils 350 ohms each. Operating current minimum 140 micro-amp, nominal 400 microamp, maximum 8 milliamp. One pole two way, or centre stable. Two way contact current 100 mA. at 50 V. A.C. or D.C. Size 1 1/2 x 3/4 x 3/8 in. Price 22/6 each.

**HIGH SPEED RELAY.** Siemens, two bobbins, 1,000 ohms each. New, 10/6 each. P. & P. 1/-.

**SOLENOID OPERATED MAGNETIC RELAY.** Type S. 5CW/3942 with 4 make, 4 break 25 Amp. contact D.C. coil resistance 160 ohms, 24 v. operation. Housed in metal screening can 2 1/2 in. x 1 in. x 1 1/2 in. Brand new. 7/6 each. P. & P. 6d.

**U.S.A. 27-volt 4-pole CHANGE-OVER RELAYS.** Brand new and boxed, 5/6 each. P. & P. 6d.

**ROTARY RELAY, 12 volt.** Heavy duty change-over contacts and one low current for external circuit, plus one break set. Price 7/6. P. & P. 1/6.

**A VERY SUPERIOR BRAND NEW RELAY IDEAL FOR MODEL WORK.** 7,000 ohms coil. Will pull in at 750 microamp and out at 450 microamp. Change-over, platinum contacts. Vacuum sealed, will therefore not be affected by oil, moisture or water and never needs adjusting. Weight 2 1/2 oz. Price 18/6. P. & P. 1/-.

**MINIATURE TYPE SEALED SLAVE RELAY.** 700 ohms coil. Will work on 12 v. D.C. Single pole change-over contact. Weight 2 ozs. Ex. new equipment. Price 9/6. P. & P. 1/-.



**BRAND NEW SOUND POWER OPERATED EX ADMIRALTY HEAD AND BREAST SETS.** Two such sets connected up will provide perfect intercom., no batteries required. Will operate up to 1/2 mile. Original manufacturer's boxes. Price 17/6 each, plus P. & P. 2/-; or 32/6 per pair. P. & P. 3/-.

**AUTO TRANSFORMER**

Air cooled, very conservatively rated at 3 kVA., will handle 6 kVA. Tapped 220/230/240/250 volt, 12 amp. 105/110/115/120 volt, 28.5 amp. Brand new. Each one shrouded in a metal case and packed in original manufacturer's wooden case. Price £15. Carr. £1. Nett weight over 2 cwt.



**MUIRHEAD PRECISION, 4 bank, 1 pole, 24 position Stud Switch.** Heavy duty contacts, brand new, original boxes. Price 17/6 each. P. & P. 1/-.

**CERAMIC PRECISION SWITCH, 2 pole, 6 way, 4 banks.** New in manufacturer's boxes. Price 10/6 each. P. & P. 1/6.



**20 WAY STRIP** containing standard Post Office telephone Jack Sockets, overall size 11 x 3 1/2 x 3/8 in. New. Price 15/- each. P. & P. 1/6.  
**10 WAY STRIP** standard Post Office telephone Jack Sockets, spacing allowing Igranic Jack Plugs. New. Price 10/- P. & P. 1/6.

**LATEST MOST MODERN TYPE OF EX W.D. MINIATURE HEADPHONES**  
As Illustrated. Brand new, low impedance. Price 10/6 plus P. & P. 1/6.

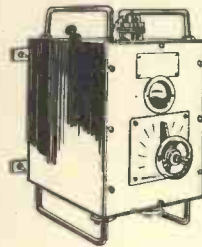


**NEW MOVING COIL HEADSETS.** Complete with Tannoy carbon hand microphone, with plug suitable for No. 19 set. Price 12/6 each, plus P. & P. 2/-.

**AUTO TRANSFORMERS.** Step up, step down, 110-200-220-240 v. Fully shrouded. New. 300 watt type £3/2/- each. P. & P. 2/6. 500 watt type £3/3/- each. P. & P. 3/9. 1,000 watt type £4/4/- each. P. & P. 6/6. Also 60 watts, 19/6 each. Plug P. & P. 2/-.

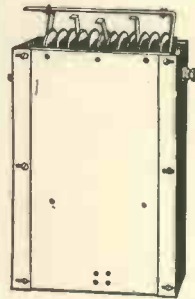
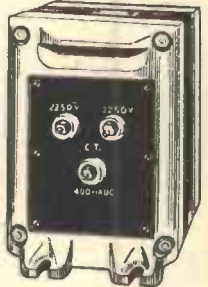
**MARCHING COMPASS Mk. I.** Brand new ex W.D. Price 14/6. P. & P. 1/-.

**NEW GALVANOMETERS**  
Solid brass, 3in. dial, in polished wooden case. 75 degree scale, 30 mA either side. 100 ohm coil. Price 12/6 each. P. & P. 1/6.



**L.T. TRANSFORMER.** Input 230 V. Output 50 V. 50 amp. Adjustable by regulator switch on primary. Steel case with mains switch Will take 100% overload. Weight 150 lb. Wound at 800 amps. per sq. inch. Brand new. Price £15. Carr. £1.

**PLATE TRANSFORMER** of very best U.S.A. make, brand new, original manufacturers cases. Input tapped at 190/210/230/250 V. Output 2250-0-2250, centre tapped 400 mA. Nett weight 76 lb., size 13 in. x 9 in. x 6 1/2 in. Price £6/10/- each plus carr. 10/-.

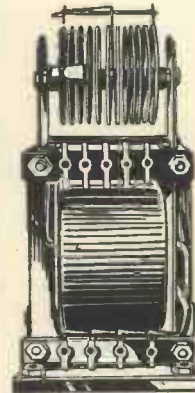


**BRAND NEW SELENIUM FULL WAVE BRIDGE TYPE RECTIFIERS,** in manufacturer's original packing. D.C. output 36 v. 10 amp., made up of 12 x 110 mm. dia. plates. These fitted in cooling funnel (removable). Size 1 1/2 in. x 8 in. x 4 1/2 in. Price 45/- P. & P. 3/3.

**TWELVE F.W. BRIDGE CONNECTED RECTIFIER** mounted on 200/250 volt A.C. input transformer. Output 36/40 volt D.C. at 1.2 amps. New, perfect. Price 16/6. P. & P. 3/6.

**SPRING LOADED FUSED TEST PRODS,** complete with wire leads and spade terminals. Price 4/6 per pair. P. & P. 1/-.

**MUIRHEAD VERNIER DRIVE.** Scaled 0-180 degrees, ratio 31/1, dia. 3in., as fitted to R.F.26 units. Complete with lampholder. In manufacturer's original packing. New. 8/6 each. P. & P. 1/6.



**WE ARE EXPERTS AT OVERSEAS PACKING & SHIPPING!**  
**SERVICE TRADING Co.**

**PERSONAL CALLERS ONLY: 9 Little Newport Street, London, W.C.2. Tel: GER 0576**  
**ALL MAIL ORDERS: 47-49 High Street, Kingston-on-Thames**  
*(Early Closing Thursday)*  
Telephone: KINGston 4585

# NEW—The "CONTINENTAL-6" (Superseding the "TRANSISTOR-8") COMBINED TRANSISTOR PORTABLE/CAR RADIO SUPERHET

## SPECIFICATION

- ★ 195 to 560 metres on medium wave.
- ★ 1,150 to 1,800 metres on long wave.
- ★ 400 mW. push-pull output.
- ★ A.V.C. and Car radio. Standard Fitting
- ★ Slow-motion tuning. ★ Size 9½ x 7 x 3½
- ★ HI-FI SPEAKER. ★ Weight 4 lbs.
- ★ 6 months' battery life. ★ EASY TO BUILD
- ★ Resistor & Condenser leads pre-trimmed.
- ★ Printed circuit board marked with component numbers.
- ★ EDISWAN TRANSISTORS
- ★ XA102, 2-XA101, XB103, 2-XC101, 2-DIODES.

**TOTAL COST OF ALL SPECIFIED COMPONENTS INCLUDING CABINET, BATTERY, ETC., ONLY £11/10/-. P.P. 3/6.**

All components available separately. Send for descriptive leaflet and prices.

A highly sensitive and selective portable fully tuneable on medium and long waves. Performs equally well as a car radio. Low running costs, good looks and ease of construction combine to produce a radio equal to any commercial receiver in the 20 gn. class.



**2-WATT POWER STAGE**  
For use with 'Continental.' Works from 12-volt supply. Overall size 4½ x 3½ x 2½in. All parts with Power transistor, less speaker. 52/6. P.P. 2/- 5in. 18/6; 7 x 4, 20/-; 6½in., 18/6.

**TRANSISTOR "8"**  
STILL AVAILABLE AT £10-19-6

### MAJOR-2 (Two-transistor Pocket Radio)



- ★ 4-stage reflex
- ★ Medium wave; tune-able
- ★ Very sensitive
- ★ No aerial or earth
- ★ Complete layout
- ★ Over 6 months on one battery
- ★ 4½ x 3 x 1½in.
- ★ Weight only 4 ozs.
- ★ Personal phone

TOTAL 69/6 POST 1/6

NEW BOOKLET FREE: All components sold separately

**GOOD RECEPTION ANYWHERE**

### MAJOR-3 (3-Transistor Radio)



- ★ 5-stage Reflex Circuit
- ★ No Aerial or Earth.
- ★ Min. Volume Control.
- ★ 3 Ediswan Transistors.
- ★ Medium Wave Tuning.
- ★ Size 4½ x 3 x 1½in.
- ★ Personal phone

(See "R.C." Sept., '59)  
All parts sold separately.

TOTAL 87/6 P.P. 1/6

**RESULTS GUARANTEED ANYWHERE  
NEW BOOKLET FREE**

### MINOR-1 (1-Transistor Radio)



- ★ 3-stage Reflex
- ★ Medium wave
- ★ Ferrite aerial
- ★ Size 3 x 2 x 2½in.
- ★ Includes personal car-phone
- ★ Layout diagrams

All components 49/6  
P.P. 1/6

Free list on request

**THE SMALLEST ON THE MARKET**

### AUDIO GENERATOR

Ideal for audio circuit checking or R.F. modulator. With XB104 transistor. All components 25/-  
★ Size 2½ x 1½ x 1in. P.P. 1/-

### R.F., I.F. GENERATOR

★ Size 2½ x 1½ x 1in. Harmonic output 450 kc/s to 2 mc/s or more. Ideal for complete receiver alignment. All components 25/- P.P. 1/-

### AUDIO, R.F., I.F. SIGNAL TRACER

★ 2 Ediswan transistors. ★ Headphone output  
★ Size 4½ x 3 x 1½in. All parts 37/6 P.P. 1/6

### 250mW "ADDON" STAGE

★ 2 Ediswan Transistors ★ Push-pull up to 250 mW. ★ 3in. ELAC speaker. ★ Cabinet 5½ x 3½ x 1½in. A unit for use with Major 2 and 3 or any carpiece pocket-portable to give full speaker output. Complete set of parts with cabinet 59/6 P.P. 1/6

### TRANSISTORS FULLY GUARANTEED

Red Spot, audio	5/-	SB305, Rad. Control	15/-
White Spot, RF	7/6	SB231, Rad. Control	22/6
Photo-Trans.....	10/-	SB231R, osc./mixer, H.F.	30/-
XB104, Audio ...	10/-	OC170, Power, HF	35/-
XC121, 500 mW. P.P.	17/-	V15/10P, Power	17/6
OC 71, Audio ...	14/-		
SBO78, H.F.	10/-		

Full list and data on request.

### TRANSISTOR TRANSMITTER

★ Top Band 150 to 160 metres.  
★ Voice modulated.  
★ 3-Transistor.  
★ Size 4½ x 3 x 1½in.  
Pocket size 1.8 to 2 Mc/s Transistor Transmitter, ideal for short range communication. All parts 57/6 P.P. 1/6  
Free Diagram and List

### CRYSTAL MICROPHONE INSERTS

ACOS 23-4, 1in. square	7/6
ACOS 19-4, 1½in. round	14/-
ACOS 14, 1½in. round	7/6
ACOS 6-9, 2in. round	12/6

P.P. 6d. any type.

### TRANSISTOR QUARTZ CRYSTAL OSCILLATOR

★ Uses crystal fundamentals between 3 Mc/s and 12 Mc/s.  
★ New 25 Mc/s Transistor.  
★ Ideal Frequency Check.  
All parts, less crystal and holder 22/6 P.P. 1/-  
Suitable Crystals from 5/-  
Send for Free Diagram and Quartz Crystal List

### CAR RADIO 2-watt Amplifier

★ 7 x 4in. high flux speaker  
★ V15/10P power transistor  
★ Overall size 6 x 4 x 3in.  
★ Works off car 12-volt battery  
May be used with any battery portable with 15-ohm or 3-ohm output transformer  
Complete set of parts ..... 65/- P. & P. 2/6  
Unit built-up and tested ..... 77/6 P. & P. 2/6  
**USE YOUR PORTABLE IN YOUR CAR!**

## "SUPER-SIX" TRANSISTOR PORTABLE SUPERHET

Size 7½ x 4½ x 2.  
Weight 20 oz.



- ★ MEDIUM AND LONG WAVES
- ★ MULLARD TRANSISTORS
- ★ PRINTED CIRCUIT
- ★ SENSITIVE AND SELECTIVE

Total cost of all components  
**£9. 10. 0**  
P.P. 2/6  
All parts sold separately

- ★ FERRITE ROD AERIAL
- ★ FULLY TUNEABLE
- ★ 3in. 150Ω SPEAKER
- ★ FULL ASSEMBLY INSTRUCTIONS
- ★ FREE LEAFLET

High sensitivity and selectivity combine to give excellent reception on both medium and long waves this set is recommended as being one of the easiest to build transistor printed circuit sets ever offered

# HENRY'S RADIO LTD.

SHOP HOURS: 9 a.m. to 6 p.m. MON. to SAT. THURS. 1 p.m.

# 5, HARROW ROAD, PADDINGTON, W.2

(AT JUNCTION OF EDGWARE ROAD AND HARROW ROAD)

PAD 1008/9





**VALVE VOLTMETER**

R.C.A. Type 165-A

**D.C. ELECTRONIC VOLTMETER.**

6-Ranges. 0-3-10-30-100-300 and 1,000 volts. Input res: 11-meg. constant on all ranges. Sensitivity: 3,666,666 ohms per volt on 3 v. scale.

**A.C. VOLTMETER.**

5-Ranges: 0-10-30-100-300-1,000 volts. Sensitivity: 1,000 ohms per volt.

**ELECTRONIC OHMMETER.**

6-Ranges, from 0.1 ohms to 1,000 megohms. Movement. 200 microamperes. D.C. accuracy  $\pm 2\%$ .

COMPLETE WITH INSTRUCTION BOOK AND TEST PRODS, BRAND NEW.

Input 110-250 volts A.C.

ONLY £12/10/- P.P. 3/6

SPECIAL PURCHASE - LIMITED STOCKS BUY NOW

**TRANSMITTER/RECEIVER**

Army Type 17 Mk. II

Complete with Valves, High Resistance Headphones, Handmike and Instruction Book and circuit. Frequency Range 44.0 to 61 Mc/s. Range approximately 3 to 8 miles. Power requirements: Standard 120 v. H.T. and 2 v. L.T. Ideal for Civil Defence and communications.

BRAND NEW

45/- P.P. 5/-

44-61 Mc/s. Calibrated. Wavemeter for same, 10/- extra. P.P. 2/-



**1933 RECEIVER CONTROL UNIT**

BARGAIN OFFER! 18 MINIATURE VALVES !!!! 8-EF91; 6-EF92; 2-EB91; EL91; IF's; RELAYS, ETC., ETC., IN CASE.

95/- P.P. 3/6.

**T/X TYPES AND SPECIAL PURPOSE VALVES**

EP91 .....	5/-	2C43 .....	50/-	872A .....	15/-	8582 .....	15/-	5829 .....	10/-
EF92 .....	5/-	725A .....	35/-	2K25 .....	65/-	1B38 .....	25/-	5839 .....	35/-
813 .....	65/-	726A .....	15/-	19G3 .....	15/-	1632 .....	6/-	5840A .....	30/-
832 .....	30/-	726B .....	15/-	WL860 .....	30/-	1644 .....	12/6	5852 .....	22/6
832A .....	35/-	723A/B .....	55/-	TZ40 .....	35/-	5638 .....	15/-	5932 .....	30/-
829B .....	40/-	2J54 .....	35/-	CV129 .....	45/-	5692 .....	30/-	5931 .....	35/-
QVO4/7 .....	15/-	803 .....	22/6	CV2161 .....	25/-	5703 .....	8/6	6004 .....	17/6
TT15 .....	45/-	805 .....	35/-	CV100 .....	15/-	5722 .....	17/6	9005 .....	15/-
446A .....	12/6	35T .....	15/-	CV85 .....	15/-	5726 .....	8/6	CK5785 .....	8/6
446B .....	12/6	807 .....	7/6	1625 .....	5/-	5800 .....	45/-		
705A .....	15/-								

**VOLTAGE STABILIZERS**

OA2 .....	10/-	VR150/30 .....	6/-	QS1208 .....	10/-
OB2 .....	10/-	QS75/20 .....	10/-	STV280/40 .....	15/-
VS70 .....	6/-	QS105/45 .....	10/-	STV280/80 .....	25/-
VS110 .....	6/-	QS150/15 .....	10/-	OD3W .....	10/-
VR105/30 .....	6/-	QS1207 .....	10/-		

Over 600 commercial and industrial valve types in stock. Send for free lists.

**V.H.F. TRANS/RECEIVER TYPE TRI920**

★ 9.72 MC/S IF ★ 4-CHANNEL CRYSTAL CONTROLLED  
★ 40 KC/S BANDWIDTH ★ 100 to 120 MC/S COVERAGE  
Unit complete with 21 valves; crystal; 24 volt rotary power unit, etc., in metal case. In new condition with full circuit diagram. Circuits separately, 1/9 post free.  
£6/10/- carr. 10/6.

**V.H.F. TRANS/RECEIVER TYPE 1986**

★ 9.72 MC/S I.F. ★ 10-CHANNEL CRYSTAL CONTROLLED  
★ 23 KC/S BANDWIDTH ★ 124.5 to 156 MC/S COVERAGE

Sub-units	Type	With valves	Less valves	P.P.
TRANSMITTER	81	60/-	25/-	2/6
RECEIVER	114	25/-	7/6	2/6
IF Amplifier	476	32/6	12/6	2/6
Modulator	105	20/-	—	2/6
24 v. Rotary unit	3	15/-	—	2/6
10-watt Control unit	382	6/-	—	9d.

All the above are in absolute new condition. Full circuits available 1/9 post free.

**MARCONI No. 19 SET CRYSTAL CALIBRATOR**

CRYSTAL CONTROLLED OSCILLATORS: 10 Kc/s., 100 Kc/s. and 1 Mc/s. ON/OFF MODULATOR. With handbook. Unused. ONLY 79/6. P.P. 2/6.

**DYNAMOTORS**

24 volt D.C. to 230 v. A.C. 50 c/s. 100 watts. £5/10/- P.P. 7/6.  
28 volts D.C. to 250 volts 60 mA. 12/6. P.P. 2/6.  
12 volts D.C. to 220 volts 165 mA. 32/6. post free.

**AN/ARN-5D GLIDE PATH RECEIVER**

3-channel U.H.F. Receiver; uses plug-in crystals (not supplied); operating on 332.6; 333.8; 335 Mc/s. Unit contains 7-6AJ5; 28D7; 2-12SN7; 12SR7; Relays etc. BRAND NEW and boxed: a bargain at 59/6 P.P. 5/-.

**QUARTZ CRYSTALS**

FROM 5/- EACH  
From 6 Kc/s-7 Mc/s. FT243, FT241, 10XJ and 87G.  
All types for all purposes. Send for free list.



**WALKIE/TALKIE TYPE 38 TRANSMITTER/RECEIVER**

Complete with 5 valves. In new condition. These Sets are sold without Guarantee, but are serviceable (7 to 9 Mc/s.) 22/6. P.P. 2/6. Headphones 7/6 pair, Junction Box 2/6. throat Mike 3/6. Canvas Bag 4/- Aerial Rod 2/6.

**R.C.A. SPEAKER**

Bin. P.M. in crackle cabinet. For AR88 and all communications receivers. 45/- P.P. 2/6.

**PACKARD BELL AMPLIFIER**

(Low Imp. Mic. Pre-amp.) Complete with screened case with 6SL7GT; 28D7; relay, leads, jack plugs; handbook, etc. Sealed in carton. Low impedance mic. pre-amp. ONLY 12/6 P.P. 2/-.

**182A INDICATOR UNIT**

COMPLETE. INCLUDES VCR97 with Mu-metal screen; 3-EF50; 4-SP61; 5U4G; POTS; TRANSFORMERS, etc. 67/6 P.P. 5/-.

**SURPLUS EQUIPMENT**

New Free List of Units, Meters, Generators and Equipment, including Vibrators, Radar Units, RX/TX etc.

**A.C., D.C., R.F. METERS**

0-15 v.	2 1/2 in.	M.I. (AC) F.R.	8/6
0-20 v.	2 in.	M.C. (DC) F.S.	7/6
0-40 v.	2 in.	M.C. (DC) F.S.	7/6
0-150 v.	2 1/2 in.	M.C. (DC) F.R.	12/6
0-200 v.	2 1/2 in.	M.I. (DC) F.R.	12/6
0-300 v.	2 1/2 in.	M.C. (AC) F.R.	10/-
0-600 v.	2 1/2 in.	M.C. (DC) F.R.	12/6
0-300 v.	5 in.	M.I. (AC) P.	50/-
0-1 1/2 kv.	2 1/2 in.	M.C. (DC) P.	15/-
0-2 1/2 kv.	2 1/2 in.	M.C. (DC) P.	15/-
0-500 UA	2 1/2 in.	M.C. (DC) F.R.	15/-
0-500 UA	3 1/2 in.	M.C. (DC) F.R.	59/6
0-400 UA	3 1/2 in.	M.C. (DC) F.R.	59/6
0-1 mA	2 1/2 in.	M.C. (DC) F.R.	22/6
2 1/2-0-2 1/2 mA	2 1/2 in.	M.C. (DC) F.R.	12/6
0-30 mA	2 in.	M.C. (DC) P.	7/6
0-50 mA	2 in.	M.C. (DC) F.S.	7/6
0-10 mA	2 1/2 in.	M.C. (DC) F.S.	10/-
0-100 mA	2 in.	M.C. (DC) F.S.	10/-
0-150 mA	2 in.	M.C. (DC) F.S.	7/6
0-500 mA	2 1/2 in.	M.C. (DC) F.R.	12/6
0-750 mA	2 in.	T.C. (RF) P.	6/-
0-500 mA	2 in.	T.C. (RF) P.	6/-
0-1 amp.	2 in.	T.C. (RF) P.	6/-
0-3 amp.	2 in.	T.C. (RF) F.S.	6/-
0-12 amp.	2 1/2 in.	T.C. (RF) P.	10/-
0-20 amp.	2 in.	M.C. (DC) P.	7/6
0-30 amp.	2 in.	M.C. (DC) F.S.	7/6
5-0-5 amp.	2 1/2 in.	M.C. (DC) P.	10/-
0-10 amp.	4 in.	M.C. (DC) P.	25/-

FREE COMPLETE LIST ON REQUEST

**CATHODE-RAY TUBES**

2AP1	2 in.	25/-
VCR139A	2 1/2 in.	35/-
3BP1	3 in.	30/-
3FP7	3 in.	12/6
3AP1	2 1/2 in.	30/-
Mullard DG7/5	2 1/2 in.	45/-
5FP7	5 in.	20/-
VCR517C	6 in.	30/-
VCR97	6 in.	40/-
Screens for VCR97		7/6

P.P. 2/- any type.

FREE LIST and Data on request.

**AVO-MINOR**



AC/DC volts.  
0-500 volts.  
D.C. mA.  
0-500 mA.  
RESISTANCE:  
0-20 K.

COMPLETE WITH LEADS AND LEATHER CASE 79/6 P.P. 2/-



# RADIO CLEARANCE LTD.

TRADE ENQUIRIES INVITED

27 TOTTENHAM COURT RD., LONDON, W.1  
The oldest Component Specialists in the trade

Telephone : MUSEUM 9188 EST. 30 YRS

ELECTROLYTIC CONDENSERS—WE HOLD THE LARGEST STOCK OF ELECTROLYTICS IN ENGLAND

ABBREVIATIONS: C. Clip mounting tag ends. P. Prong mounting. T. Tag ended. S. Sleeved. W. Wire ended. PC. Printed Circuit. R. Reversible polarity. M. Moulded with wire ends.

SINGLES						SINGLES						TRIPLES Etc.					
Capacity (Mfds.)	Wkg. Volts	Size*	Type	Price		Capacity (Mfds.)	Wkg. Volts	Size*	Type	Price		Capacity (Mfds.)	Wkg. Volts	Size*	Type	Price	
1	275	1x1 1/2	W/S	1/-		12	25	275	1x2	P	1/6	100+200	250	1 1/2 x 4	C	2/6	
2	150	13/32 x 1	M	1/4		16	18	150	1x2	T/S	1/-	100+200	275	1 1/2 x 4	C	5/-	
2	275	1x1 1/2	W/S	1/-		16	18	275	1x2	P	2/-	100+250	275	1 1/2 x 4	C	5/-	
4	150	1x1 1/2	T/S	1/-		16	18	350	1x2	C/S	3/-	100+300	275	1 1/2 x 4	C	4/-	
4	150	1x1 1/2	W	1/2		16	18	450	1x2	W/S	4/-	100+400	275	2 x 4	C	4/-	
5	25	1x1 1/2	W/S	1/3		20	20	275	1x2	P	2/-	150+30	350	1 1/2 x 4	C	5/-	
8	250	1x1 1/2	WorW/S	1/3		20	20	450	1x3	P	3/-						
8	150	1x1 1/2	T	10d.		24	24	350	1 1/2 x 2	C	2/-						
8	200	1x1 1/2	T	1/2		25	25	300	1x2	P	1/6	8+8+8	350	1x2	P	4/-	
8	250	1x1 1/2	WorW/S	1/2		30	30	150	1 1/2 x 1 1/2	W/S	1/-	16+8+4	275	1x2	P	2/6	
8	275	1x1 1/2	W	1/3		32	32	150	1x2	W/S	1/-	16+16+4	275	1x2	O	2/6	
8	350	1x2	P	1/6		32	32	150	1x2	W/S	1/-	16+16+16	275	1x2	C	2/6	
8	450	1x1 1/2	W/S	1 1/11		32	32	150	1x3	P	10d.	20+15+15	450	1x3	P/S	3/6	
8	750	1 1/2 x 4	C	5/6		32	32	250	1x2 1/2	PC	1/6	20+20+20	250	1 1/2 x 2	P	1/6	
10	4	13/32 x 1	M	1/4		32	32	275	1x2	O	2/6	25+25+25	25	1x2	C/S	1/6	
10	15	1x1 1/2	T/S/R	1/6		32	32	275	1x2	O	2/6	30+30+30	275	1 1/2 x 2	P	2/6	
10	25	1x1 1/2	T/S	1/3		32	32	350	1x2	C/S	4/-	32+8+8	275	1x2	P	2/-	
10	200	1x1 1/2	W	2/3		32	32	350	1x2	P/S	3/-	32+16+25	200/25	1x2	P	1/-	
10	450	1x2	W	1/9		32	32	450	1x3	W/S	4/6	32+32+2	275	1 1/2 x 2	C	2/-	
12	25	13/32 x 1	M/R	1/6		40	20	150	1x2	P	10d.	32+32+6	275	1 1/2 x 2	C	2/6	
16	150	1x1 1/2	T/S	1/-		40	40	150	1x3	P	10d.	32+32+8	250	1 1/2 x 2	C	2/6	
16	275	1x2	T	10d.		40	40	275	1x2	O	1/6	32+32+25	275/25	1x3	C	2/6	
16	350	1x2	P	1/6		40	40	300	1x2 1/2	PC/S	2/6	302+32+32	350	1x2	O	4/-	
20	8	1x1 1/2	W/S	1/-		40	40	450	1x3	W	3/6	32+200+50	275	1 1/2 x 4	C	3/-	
20	12	13/32 x 1	M	1/4		50	50	150	1x2	C	1/-	32+300+70	275	1 1/2 x 4	C	3/-	
20	150	1x1 1/2	T	10d.		50	50	200	1x3	P	1/-	40+30+20	150	1x2	P	1/6	
20	450	1x2	W/S	1/9		50	50	250	1x2	P	1/-	40+40+12	275	1 1/2 x 2	C	2/6	
20	500	1x2	M/R	1/6		50	50	275	1x3	P	1/9	40+40+20	275	1 1/2 x 2	P	3/6	
20	25	13/32 x 1	M/R	1/6		50	50	275	1x3	O	1/6	40+40+20	300	1 1/2 x 2	P	3/6	
20	25	13/32 x 1	M/R	1/4		50	50	275	1x3	PC	1/9	40+40+32	275	1 1/2 x 2	PC	3/6	
25	25	1x1 1/2	W	1/6		50	50	300	1x2	C	2/-	40+80+20	450	1x3	P	5/-	
25	50	1x1 1/2	T	1/6		50	50	300	1x2	C	2/-	50+24+24	275	1 1/2 x 2	P	3/6	
25	50	1x1 1/2	W	1/9		50	50	300	1x2	C	2/-	50+50+6	275	1 1/2 x 3	P	3/6	
25	360	1x1 1/2	W	1/9		50	50	350	1x4	O	5/6	50+50+10	150	1 1/2 x 2	O	4/-	
32	275	1x2	P	1/6		60	200	275	1x3	C	3/6	50+50+50	350	1x3	P	3/6	
40	150	1x2	W/S	6d.		60	250	275	1x4	O	3/6	80+300+30	275	1 1/2 x 4	O	3/6	
40	375	1x2	P	1/9		60	300	275	1x4	O	3/6	100+40+40	450/50	1 1/2 x 4	P	4/6	
50	6	13/32 x 1	M	1/4		80	80	275	1x3	C	3/6	100+100+50	300	1 1/2 x 3	P	4/6	
50	12	13/32 x 1	M/R	1/6		100	85	250	1x4	C	2/-	100+100+200	275	1 1/2 x 4	O	4/6	
50	12	1x1 1/2	W	1/6		100	100	32	1x2	C	1/-	100+100+200	275	1 1/2 x 4	O	4/6	
50	25	1x1 1/2	W/S	1/6		100	100	25/12	1x2	C	1/-	100+40+20	300	1 1/2 x 2	P	3/6	
50	50	1x1 1/2	T	1/6		100	100	275	1x3	O	2/6	100+400+16	275	1 1/2 x 4	C	4/-	
60	275	1x3	W	1/9		100	100	300	1x3	P	3/6	100+400+32	275	1 1/2 x 4	O	4/-	
60	350	1x2	T/S	2/-		100	100	300	1x3	P	3/6	200+250+250	275	1 1/2 x 4	O	6/-	
64	275	1x3	P	1/6		12+24	275	1x2	O	1/6	40+20+10+10	350	1 1/2 x 2	O	3/6		

All voltages quoted are WORKING. STAMPED AND ADDRESSED ENVELOPE with any enquiry please.

PLEASE ALLOW FULL POSTAGE AND PACKING CHARGES.

TERMS OF BUSINESS: CASH WITH ORDER OR C.O.D. ON ORDERS OVER 10/-.

**MOULDED TROPICAL PAPER CONDENSERS**  
 Small, non-inductive, insulated, high-grade Capacitors  
 150 wkg. 15 Mfd. 5% 10d. 22 Mfd. 10% 9d. 1 Mfd. 10% 1/3. 2 Mfd. 1/9. 2 Mfd. 10% 1/10. 250 v. Wkg., .068 Mfd. 9d. 1 Mfd. 1/11. 22 Mfd. 2% 1/4. 1 Mfd. 10% 1/7. 500 v. Wkg., 680 pF. 1,000 pF., 1,500 pF., 2,200 pF. 7d. each. 3,300 pF. 8d. 5,000 pF., 6,800 pF. .01 Mfd. 6d. each. 8,200 pF. 1/- .022 Mfd., .03 Mfd. 10d. each. .047 Mfd. 2%. .05 Mfd. 11d. each. 1 Mfd. 11d. 5/12. 2 Mfd. 5% 1/5. .25 Mfd. 1/6. .5 Mfd. 1/3 & 1/9. 750 v. Wkg. 470 pF. 10%. 820 pF., 1,500 pF., 2,000 pF. 8d. each. 5,000 pF., 6,800 pF. 9d. each. .022 Mfd. 10d. 1,000 v. Wkg. 1,500 pF. 9d. 6,800 pF. 10d. .01 Mfd. 1,500 v. 1/- .12 Mfd., .15 Mfd. 1/1 each. 3 Mfd. 1/4. .3 Mfd. 10% 1/5.

**VALVE HOLDERS**  
 4 pin UK. 7d. 5 pin Brit. Pax. 9d. 7 pin Brit. Pax 3d. 7 pin Brit. Amp. 4d. Int. Octal Pax. 3d. Mazda Octa Pax. 3d. Locals Amp. 6d. B7G Pax. 6d. B7G P.T.P.E. 8d. B7G Cer. with saddle and valve retaining spring 1/-. B8A Pax. 4d. B8A Amp. 6d. B8A Cer. 6d. B9A Pax. 6d. B9A Amp. 6d. B8A Cer. 10d. B9A Cer. with saddle and valve retaining spring 1/-. B9A ceramic with skirt 1/-. B9A printed circuit 10d. B7G Valve Canns 6d. EY86 High voltage holders 1/3.

**VARIABLE GANG CONDENSERS**  
 Twin Gang 20 pF. Ideal for F.M. 2in. x 1 1/2in. x 1in. 2/-.  
 Twin Gang .0005 MFD. 2 1/2in. x 2in. x 1 1/2in. Spindle 1/4. 4/-.  
 Min. Twin Gang .0005 MFD. 2 1/2in. x 1 1/2in. x 1 1/2in. Spindle 1/2. 5/6.  
 Min. Twin Gang .0005 MFD. 2 1/2in. x 1 1/2in. x 1 1/2in. Spindle 1in. with trimmers. 6/6.  
 Twin Gang .0005 MFD. Geared with S.M., 3/6.  
 AM/FM 2-Gang Condensers, 500 + 20 pF., 3/6.

**DISC CERAMIC CONDENSERS 500 v. Wkg.**  
 500 pF. .001 MFD. .0025 MFD., .008 MFD., .003 MFD. .005 MFD. 6d. each. .01 MFD. 9d.

**TRANSISTOR COMPONENTS**  
**SUB MINIATURE ELECTROLYTIC CONDENSERS**  
 —SLEEVED—All at 2/3 each.  
 .1 Mfd. 12 v., 2-6-8-10 Mfds. 3 v., 2-6-8-10-12-16-30-50 Mfds. 6 v. 1 Mfd. 10 v., .1, .5/30 Mfd. 12 v., .25 Mfd., 2 Mfds., 8 Mfds., 15 v., 8 Mfds., 16 Mfds., 30 v., 2 Mfds. 70 v.

**SUB MINIATURE TRANSISTOR COILS**  
 Set of 3 I.F. Transformers 470 Kcs plus Oscillator coil.  
 As specified for Mullard Circuits 23/6 complete.  
 As specified for Mazda Circuits 23/6 complete.  
 WTC oscillator Coils for Jackson or Plessey Gang, 4/8 each. WTC 470 kc/s I.F. Transformers, 4/- each, 7/6 pair.

**SUB MINIATURE CARBON POTS**  
 5K, 50K, 220K, 330K, 1M, 2/- each. 5M with switch 4/6. 5K, 1/6. 500K preset 1/-. 1M Transistor Pots, 2/-. 5K Transistor Pots, 1/6.

**SUB MINIATURE METALISED PAPER CONDENSERS** (in. x 1/2in. 100 v. working.  
 .005 MFD., .0025 MFD., .002 MFD., .001 MFD., 8d. each. .01 MFD., .02 MFD. Price 9d. each.

**TRANSISTOR GANG CONDENSERS**  
 With intermediate screen as specified for MULLARD Transistor circuits, 9/6.  
 As above with switch for L.W. pre-selection, 11/-.

**MIN. POLYSTYRENE CONDENSERS**  
 10 pF., 100 pF., 500 pF., 1,000 pF. 125 v. wkg. 6d. each.

**TV PRESET CONTROLS**  
 Knurled knob and 6BA fixing holes. Diam. 1in. 5K, 25K, 50K, 100K, 250K, 500K, 2M, 1/3 each 25K, wirewound 1/6.

**SWITCHES ROTARY**  
 Size 1 1/4in. dia.-2in. spindles. Price 2/11 each.  
 1 pole 10 way. 1 pole 12 way. 2 pole 2 way. 2 pole 3 way. 2 pole 4 way. 2 pole 5 way. 2 pole 6 way. 3 pole 3 way. 3 pole 4 way. 4 pole 3 way.

**POTMETERS CARBON—HI-GRADE**  
 Moulded Tracks. Diam., 1in., 2 1/2in. spindles, 5K, 10K, 25K. Linear only. 50K, 100K, 250K, 500K, 1M, 2M, Log or Linear, less switch, 2/6 each. With switch, 4/6.

**TRANSFORMERS**  
 Audio Output Types. 8,000Ω to 3Ω, 3/6. 10,000Ω to 3Ω, 3/9. 13,000Ω to 3Ω 4/4.  
 Universal OET Boosters with tapped primaries 2 v. 6.3 v. 13 v., 25% boost all taps, 10/6. Filament transformers, centre tapped, 6.3 v. output, 1.5 amp., 5/9; 3 amps., 9/6.

**MODERN TV COMPONENTS**  
 FerroX Line O/P transformers, 16 Kv. U25 19/6. Frame O/P transformers to match 4/6. Scanning Coils to match 15/-.  
 Panel containing 6 preset pots. 5/-  
 Smoothing Chokes 2 Hy. 250 mA. 3/11. 1.9 Hy. 250 mA. 2/11. 1.3 Hy. 250 mA. 2/6.  
 G.E.C. Metal Rectifier 250 v. 250 mA. 10/-.  
 34 Meg. I.F.T. 1/6 ca. 38 Meg. I.F.T. (link) 2/- ca. Masks 14in., 17in., and 21in. 2/6, 3/6, 4/6 (plus 2/6 p.p.).

**MISCELLANEOUS**  
 Genuine OCT7 Transistors 6/6. Crocodile clips 4d. Coax. Plugs and Sockets 2/2 per pair. Condenser clips 1in. and 1 1/2in. 6d. ea. Farmeko Smoothing Choke 8/9 Hy. 100 mA. 6/6. 500 pF. 15 Kv moulded Condensers 2/6. WX2a Westector 6d. Ethylalox Speakers 7in. x 4in. 12/6. 100 assorted first class resistors 12/6. Transistor twin gang condensers 287+166 pF., ex equip. 4/6. Vibrator Gas Chokes 1/-. Ext. Loudspeaker bank with switch 1/4.

We have an extensive range of Waxed Paper Condensers (average price 5d. ea.), Metallised Paper Condensers (average price 11d. ea.) and Wirewound resistors 0/6-7-watt types (average price 1/- ea.).

**C.R.T. ISOLATION TRANSFORMERS**

For Cathode Ray Tubes having Heater/Cathode short-circuit and for C.B. Tubes with falling emission. Full instructions supplied.

Type A. Low Leakage windings. Optional Boost 25% and 50%. Tapped mains primaries.  
 2 volt ..... 12/6 each  
 4 volt ..... 12/6 each  
 6.3 volt ..... 12/6 each  
 10.8 volt ..... 12/6 each  
 13.3 volt ..... 12/6 each

**OUR LATEST SUPERIOR PRODUCT. Type A2.**  
 High Quality. Low capacity, 10/15 pf. **16/6** each  
 Optional boost 25%, 50% 75%.  
 Type B. Mains input. Low capacity. Multi Output 2, 4, 6, 7.3, 10 and 13 volts. Optional boost 25% and 50%. Suitable for all Cathode Ray Tubes. 21/-

**RESISTORS.** All preferred values. 20% 10 ohms to 10 meg. 1 w., 4d.; 1/2 w., 4d.; 1 w., 6d.; 1 1/2 w., 8d.; 2 w., 1/-.  
**HIGH STABILITY.** 1 w., 1s.; 2/- Preferred values 100 to 5 meg. Ditto 5%, 9d., 100Ω to 5 meg.

**WIRE-WOUND RESISTORS**  
 15,000 ohms—50,000 ohms 5 w. 1/9; 10 w. 2/3  
 10 watt ..... 1/3  
 15 watt ..... 2/16  
 25 ohms—10,000 ohms

**WIRE-WOUND P.T.S.** **WIREWOUND POTS.** 4 w.  
 Pre-set Min. T.V. type Standard size Pots, long  
 Knurled Slotted knob. Spindle High Grade. All  
 All values 25 ohms to 25K., 100 values 100 ohms to 50 K.,  
 30 k., 30 K., 50 K., 4/-  
 6/8; 100 K., 7/2

Ditto 1 w. Carbon Track 7/6; 2 w. **SPEAKER**  
 3/-. ea. to 2 Meg. 3/-  
**CONTROL 10/2**  
**OP TRANSFORMERS.** Heavy Duty 50 mA., 4/6. Multi-  
 ratio push-pull, 7/6. Miniature 3V4, etc., 4/6. Hygrade  
 Push-pull 10 watts, 1/6. **MULLARD** 510 " 6k or 8k 30/-  
**F.F. CHOKES** 15/10H 60/65 ma., 5/- 10H 85 ma., 10/6  
 10H 150 ma., 14/-

**MAINS TRANSFORMERS** 200/250 v. A.C.  
**STANDARD** 250-0-250, 90 mA., 6.3 v. 3.5 a.  
 Tapped 4 v. 4. Rectifier 5.3 v. 1 a., tapped, 5 v.  
 or 4 v. 2. Ditto 350-0-350. 22/6

**MINIATURE** 230 v. 20 mA., 6.3 v. 1 a. .... 10/6  
**MIDGET**, 250 v. 45 mA., 6.3 v. 2 a. .... 15/8  
**SMALL**, 250-0-250 100 mA., 6.3 v. 3.5 a. .... 19/6  
**STANDARD**, 250-0-250, 65 mA., 6.3 v. 3.5 a. .... 17/6

**HEATER TRANS.** 6.3 v. 1 a., 7/6; 2 amp., 10/6  
**GENERAL PURPOSE LOW VOLTAGE.** Outputs 3, 4, 5,  
 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 A. .... 22/6

**ALADDIN FORMERS** and cores. 1in., 8d.; 1 1/2in., 10d.  
**3in. FORMERS** 5937 or 8 and Cans TV1 or 2, 2in. sq. x  
 2 1/2in. or 2in. sq. x 1 1/2in., 2/- with cores.

**6-W MOTION DRIVES.** Epicyclic ratio 6:1, 2/3.  
**TYANA.** Midget Soldering Iron, 230 v. 40 w., 16/9.  
**REMPLOY INSTRUMENT IRON.** 230 v. 25 w., 17/-  
**HEATER PROTECTORS** 3 x 1 1/2in. Three Adl. Sliders, 3 amp.  
 75 ohms, 4/3. 2 amp., 1,000 ohms, 4/3.

**LINES CORD.** 3 amp., 60 ohms per foot, 2 amp., 100 ohms  
 per foot, 2 way, 6d. per foot, 3 way, 7d. per foot.

**CRYSTAL MIKE INSERT** by Acos 6/6  
 Precision engineered. Size only 1/4 x 1 1/8 in.  
**ACOS CRYSTAL DESK MIKE.** Bargain! 35/-

**MIKE TRANSF.** 50:1, 3/9 ea.; 100:1 Potted, 10/6.  
**LOUDSPEAKERS** 2 M. 3 OHM. 7in. Rola, 17/6  
 6in. x 4in. Rola, 18/- 5in. x 4in. R.A.A., 21/-  
 10in. x 6in. Rola, 27/6 8in. Plesey, 19/6  
 6in. Rola, 18/6 8in. Rola, 21/- 10in. R.A.A., 30/-

**HI-FI TWEETERS.** 4in., 25/- 12in. Plesey, 30/-  
 12in. Baker 15 w. 3 ohm and 15 ohm models, 105/-  
 12in. Baker foam suspension 15 w. 15 ohm, 28.  
 12in. 15 ohm Plesey 10 wt., 45/-

**I.F. TRANSFORMERS** 7/6 pa ir  
 485 kΩ, slug tuning miniature can 2 1/2 x 1 in. High  
 Q and good bandwidth. By Fye Radio. Data sheet supplied.  
 Wearie N800 I.F. Miniature 485 kΩ, 12/6 pair.  
 Wearie 550 I.F. Standard 865 kΩ, 12/6 pair.

**CRYSTAL DIODE G.E.C.** 2/-, GEX34, 4/-, 40 Circuits, 3/-  
**H.R. HEADPHONES,** 4,000 ohms, brand new, 16/6 pair.  
**SWITCH CLEANER** Fluid, squirt sprout, 4/3 1in.  
**TWIN GANG CONDENSERS.** 365 pf. Miniature, 11in.  
 x 1 1/2in. x 1 1/2in., 10/- .0005 Standard with trimmers, 9/-  
 9/-; less trimmers, 8/- Midget, 7/6; Single 50 pf., 2/6;  
 100 pf., 1/6; 2 w. Solid dielectric 100, 300, 500 pf., 3/6.  
**VALVE HOLDERS.** Pa. Int. Oct. 4d. EP50 EA50, 6d.  
 B12A, CRT, 1/3. Eng. and Amer. 4, 5, 7 pin, 1/-

**Moulded Mazda** and Int. Oct. 6d., B7G, B8A, B8G, B9A,  
 9d. B7G with can, 1/6; B12A, 1/3. B9A with can, 1/9.  
**CERAMIC** EP50, B7G, B9A, Oct., 1/-; B7G, B9A Cans 9d.  
**SPEAKER FRET.** Gold Cloth 17m. x 25in., 5/- 25in. x  
 35in., 10/- Tygan 5 1/2in. wide, 10/- 2 1/2in. wide, 5/-  
 Samples, S.A.E.

**WAVECHANGE SWITCHES.**  
 2 p. 2-way, 3 p. 2-way, short spindle ..... 2/6  
 5 p. 4-way, 2 w. valve, long spindle ..... 6/6  
 2 p. 6-way, 4 p. 2-way, 4 p. 3-way, long spindle ..... 3/6  
 3 p. 4-way, 1 p. 12-way, long spindle ..... 3/6  
 Wave change "MAKITS" 1 w. 8/6; 2 w. 12/6;  
 3 w. 16/6; 4 w. 19/6; 5 w. 23/6; 6 w. 26/6

**TOGGLE SWITCHES.** S.P., 2/-; D.P., 3/6; D.P.D.T., 4/-  
**MORSE KEYS.** Good quality, 2/6.  
**SUB-MINIATURE ELECTROLYTICS** (15 v.), 1, 2, 4, 5, 8, 35,  
 50 mfd., 3/- each.

**EDISWAN TRANSISTORS**  
**JUNCTION TYPE P.N.P.**  
**AUDIO** XB102, for amplifiers and output stages up  
 to 250 milliwatts in push-  
 pull. **PRICE 10/-**  
**GoTop Power V16/10P,** up to 10W with heat sink, 20/-

**R.F.** XA104 frequency  
 changer up to 4 Mc/s., 18/-  
**XA103 IF amp.**  
 up to 2 Mc/s. **15/-**

**THREE WAVEBANDS**  
 8 W. 16 m. — 50 m.  
 L.W. 200 m. — 550 m.  
 L.W. 800 m. — 2,040 m.  
 12 month Guarantee. A.C. 200/250 v. 4-way switch.  
 Short-Medium-Long-Gram. A.V.C. and Negative  
 Feedback, 4.2 watts. Chassis 13 1/2in. x 5 1/2in. x 2 1/2in.  
 Glass Dial Size 10 x 4 1/2in. horizontal or vertical. 2 Pilot  
 Lamps. Four Knobs. Walnut or Ivory, aligned and  
 calibrated. Chassis isolated from mains.

**FIVE VALVES**  
 LATEST MULLARD  
 ECH81, EF89, ECH81,  
 EL84, EZ80.  
 12 month Guarantee. A.C. 200/250 v. 4-way switch.  
 Short-Medium-Long-Gram. A.V.C. and Negative  
 Feedback, 4.2 watts. Chassis 13 1/2in. x 5 1/2in. x 2 1/2in.  
 Glass Dial Size 10 x 4 1/2in. horizontal or vertical. 2 Pilot  
 Lamps. Four Knobs. Walnut or Ivory, aligned and  
 calibrated. Chassis isolated from mains.

**BRAND NEW £9. 10. 0.** Carr. 4/6.  
**TERMS:** Deposit £5/5/- and 6 monthly payments of £1.  
**MATCHED SPEAKERS** 8in. 17/6; 10in. 25/-; 12in. 30/-

**SUPERIOR FM-AM MODEL**  
 Six Mullard Valves, ECC85, ECH81, EF89, EABC80, EL84,  
 EZ80. V.H.F. 105-87 Mc/s. Med. 180-550 m. Long 1000-  
 1800 m. Gram input. Ready for use. A.C. Mains 200/  
 250 v. Isolated chassis. Output port for use as Hi-Fi  
 Tuner. 12 month guarantee. Circuit supplied.  
 Leaflet S.A.E.

**£18. 19. 6.** Carr. 5/6.

**GARRARD 4-SPEED RECORD**  
**CHANGERS RC121/D MKII MODELS** ★  
 Brand new and fully guaranteed 12 months.

**AUDIO PERFECTION**  
 Designed to play 16, 33, 45, 78 r.p.m. Records 7in., 10in.,  
 12in. With plug-in NORMAL HEAD.  
**OUR PRICE £10. 10. 0.** STEREO HEAD £2 extra

**LATEST GYLLARO AUTOCHANGER**  
**STUDIO 'O'**  
 Pick-up  
 4 Speeds—  
 10 Records  
 Or With Cabinet, Amplifier and Speaker  
**£11.19.6.** Carr. 5/6.

**B.S.R. MONARCH UA8 4-SPEED**  
**AUTOMATIC RECORD CHANGERS**  
 Brand new and fully guaranteed 12 months.  
**OUR PRICE £6.19.6.** post free

**STEREO MODELS UA8. £7/19/6. UA12. £10/10/-**

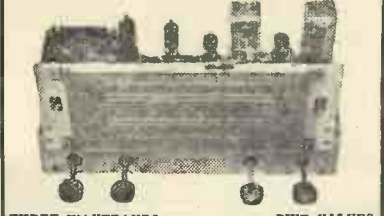
**AUTOCHANGER ACCESSORIES**  
 Suitable player cabinets (uncut boards)..... 49/6  
 Amplifier player cabinets with cut boards 63/-  
 2 valve amplifier and 6 1/2in. speaker for above 79/6  
 3 valve amplifier and 6 1/2in. speaker for above 95/-  
 Wired and tested ready for use.

**GARRARD 4-SPEED SINGLE**  
**RECORD PLAYER** ★  
**AUDIO PERFECTION** POST FREE  
**MODEL 2A MK II £8/10** {Stereo Heads  
**MODEL 4 HF £18** { £2 extra

**BATTERY-MAINS POWER PACK**  
 Same size as batteries B126 and AD35, 90 v. H.T., 1 1/2 v.  
 L.T. only 1/- a year to run on A.C. 200/250 v. Made by  
 COSSOR. List 63/-, our price 39/6.

**THE HI-GAIN BAND 3 PRE-AMP**  
 Cascode circuit using Valve ECC84. 17db  
 gain. Kit 29/6 less power; or 49/6 with  
 power pack. Plans only 6d.  
 Also Band 1 version same prices.

**1960 RADIOGRAM CHASSIS**



**THREE WAVEBANDS**  
 8 W. 16 m. — 50 m.  
 L.W. 200 m. — 550 m.  
 L.W. 800 m. — 2,040 m.  
 12 month Guarantee. A.C. 200/250 v. 4-way switch.  
 Short-Medium-Long-Gram. A.V.C. and Negative  
 Feedback, 4.2 watts. Chassis 13 1/2in. x 5 1/2in. x 2 1/2in.  
 Glass Dial Size 10 x 4 1/2in. horizontal or vertical. 2 Pilot  
 Lamps. Four Knobs. Walnut or Ivory, aligned and  
 calibrated. Chassis isolated from mains.

**BRAND NEW £9. 10. 0.** Carr. 4/6.

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**SUPERIOR FM-AM MODEL**

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 EZ80. V.H.F. 105-87 Mc/s. Med. 180-550 m. Long 1000-  
 1800 m. Gram input. Ready for use. A.C. Mains 200/  
 250 v. Isolated chassis. Output port for use as Hi-Fi  
 Tuner. 12 month guarantee. Circuit supplied.  
 Leaflet S.A.E.

**£18. 19. 6.** Carr. 5/6.

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Brand new and fully guaranteed 12 months.

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Designed to play 16, 33, 45, 78 r.p.m. Records 7in., 10in.,  
 12in. With plug-in NORMAL HEAD.  
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**LATEST GYLLARO AUTOCHANGER**



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 10 Records  
 Or With Cabinet, Amplifier and Speaker  
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 Amplifier player cabinets with cut boards 63/-  
 2 valve amplifier and 6 1/2in. speaker for above 79/6  
 3 valve amplifier and 6 1/2in. speaker for above 95/-  
 Wired and tested ready for use.

**GARRARD 4-SPEED SINGLE**  
**RECORD PLAYER** ★

**AUDIO PERFECTION** POST FREE  
**MODEL 2A MK II £8/10** {Stereo Heads  
**MODEL 4 HF £18** { £2 extra

**BATTERY-MAINS POWER PACK**

Same size as batteries B126 and AD35, 90 v. H.T., 1 1/2 v.  
 L.T. only 1/- a year to run on A.C. 200/250 v. Made by  
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Cascode circuit using Valve ECC84. 17db  
 gain. Kit 29/6 less power; or 49/6 with  
 power pack. Plans only 6d.  
 Also Band 1 version same prices.

**LATEST "E.M.I." 4 SPEED SINGLE**

**RECORD PLAYER**  
 Acos 73 Hi-Fi Stereo and normal xtal pick-up for  
 7in., 10in. and 12in. records. Silent motor,  
 heavy turntable.  
 Special offer £6/19/6. Post 3/6.

**VOLUME CONTROLS**

Midget size:  
 Long spindle. Guaranteed  
 1 year. All values 5 K.  
 ohms up to 2 Meg.  
 No switch ..... 3/-  
 Linear or Log Tracks ..... 4/9

**80 ohm Coaxial**

Semi-air spaced, 1/4 in. dia  
 Ideal Band III ..... 6d.  
 Losses cut 50% ..... 9d  
 Post 1d. per yard.  
**FINE QUALITY**  
**AIRSPACED** ..... 1/- yd.

**COAXIAL PLUGS** ... 1/-  
**LEAD SOCKETS** ... 2/-  
**PANEL SOCKETS** ... 1/-  
**OUTLET BOXES** ... 4/6  
**BALANCED TWIN FEEDER** per yd. 6d., 80 Ω or 300 Ω  
**TWIN SCREENED BALANCED FEEDER** 1/6 yd., 80 ohm

**ALUMINUM CHASSIS.** 18 s.w.g. Plain, undrilled  
 with 4 sides, riveted corners and lattice fixing holes,  
 with 2 1/2in. sides, 7 x 4in., 4 1/2in.; 9 x 7in., 5/9; 11 x 7in.,  
 6/9; 13 x 9in., 8/6; 14 x 11in., 10/6; 15 x 14in., 12/6  
 and 18 x 3in., 16/6.

**BLACK CRACKLE PAINT.** Air drying, 3/- tin.  
**P.V.C. COGN. WIRE.** 8 colours, single or stranded, 2d. yd.  
**NEON MANS. PESTER SCREWDRIVERS.** 5/-  
**DORÉD SOLDER RADIOPH.** 48, 49, 11b, 2/-  
**PAXOLIN** 1/15in. 8in. x 10in., 1/8. **ION TRAPS** 5/-

**"GEVAERT GEVASONOR"**

50% Extra Long Play Plastic Tape.  
 1,700ft. 7in. Reel 35/-, 850ft. 5in. Reel 21/-  
**SUPERIOR** 1,200ft. 7in. Plastic Tape 24/-  
**600ft. 5in. 15/-.** All Spare Reels 3/- each.

**LONG PLAY** 5 1/2in., 1,200ft. 28/-, 3in. 225ft. 7/6.

**"INSTANT" Muk Tape Eraser and Head**  
 Demagnetiser: 200/250 v. A.C. 27/6.

**MAINS TYPE.** RM1, 125 v., 60 mA., 5/-; RM2, 100 mA.,  
 6/-; RM2, 120 mA., 8/-; RM4, 250 v., 275 mA., 16/-  
**MINIATURE CONTACT COIL RECTIFIERS.** 250 v.  
 50 mA., 7/6; 60 mA., 8/6; 85 mA., 9/6; 200 mA., 21/-;  
 300 mA., 27/6; Full Wave 120 mA., 15/-  
**CELLS.** Wearie "E" type, 3/- each. Ommor Midget "Q"  
 type ad. just core from 4/- each. All ranges.  
**TELETRON.** L and M T.R.F. with reaction, 3/6.  
**FERRITE ROD AERIALS.** M.W. 6/8; M & L, 12/6.  
**T.R.F. COLLS.** A/H/F. 7/- pair. H.F. CHOKES, 2/6.

**JASON F.F. TUNER COIL SET, 26/-.** H.F. coil, aerial  
 coil, Oscillator coil, two I.F. transformers 10.7 Mc/s.,  
 Detector transformer and heater, choke. Circuit and  
 component book using four 6AM6, 2/6. Complete kit  
 with Jason Calibrated dial and 4 valves, £6/15/-.  
 With new Jason Cabinet, 20/- extra.

**CONDENSERS.** New Stock. .001 mfd. 7 kV. T.C.C., 5/6.  
 .20kV., 9/6. 1 mfd. 7 kV., 9/6. 100 pf. to 500 pf. Micas, 6d.  
 Fuji 500 v. .001 to .01 mfd., 9d.; 0.5, 1, 1.2, 2.5, 1/6;  
 5 1/8; 1/350 v. 200, 1/1,000 v., 1/8; 0.1 mfd., 2,000 v.,  
 3/6; .001 mfd. 2,000 v. 1/8.  
**CERAMIC CONDS.** 500 v., .3 pf. to .01 mfd., 9d.  
**SILVER MICA CONDENSERS.** 10% 5.0 pf. to 500 pf., 1/-;  
 600 pf. to 3,000 pf., 1/3.

**CLOSE TOLERANCE** (±1 pt.) 1.5 pf. to 47 pf., 1/8. DITTO  
 1.5, 50 pf. to 815 pf., 1/9; 1,000 pf. to 5,000 pf., 2/-  
**TRIMMERS.** Ceramic, 30, 50, 70 pf., 9d.; 100 pf., 150 pf.,  
 1/3. 250 pf., 1/8. 600 pf., 750 pf., 1/8. Phillips, 1/- ea.

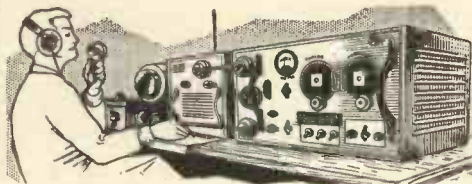
**NEW ELECTROLYTICS. FAMOUS MAKES**

TUBULAR	TUBULAR	CAN TYPES
1/350v. 2/3	64/350 v. 5/6	8/500 v. 3/-
2/480 v. 2/3	100/25 v. 2/-	18/500 v. 4/-
4/480 v. 2/3	250/25 v. 1/-	32/350 v. 4/6
8/500 v. 2/3	500/10 v. 1/8	190/250 v. 5/6
8/500 v. 2/3	8/8450 v. 4/6	2,500/3 v. 4/-
16/450 v. 3/6	8/8500 v. 5/6	6,000/6 v. 5/-
16/500 v. 4/6	8/16450 v. 5/-	8/16500 v. 5/-
32/450 v. 5/6	8/16500 v. 5/6	32+32/450 v. 6/6
25/28 v. 1/9	16+16/450 v. 5/6	60+50/250 v. 7/-
50/250 v. 2	16+16/500 v. 5/6	64+120/350+11/6
50/50 v. 2/6	32+32/350 v. 4/6	100/200/275/12/6
		<b>FULL WAVE BRIDGE-SELENIUM RECTIFIERS.</b> 2, 6 or 12 v. 11 amp., 8/9; 2 a., 11/3; 4 a., 17/8; 6 a., 22/6. <b>CHARGER TRANSFORMERS.</b> Tapped input 200/250 v. for charging 2, 6 or 12 v. 1 1/2 a., 15/6; 2 a., 17/6; 4 a., 22/6. Charger circuit free. AMPMETRES, 4 a. and 5 a., 14/6.

**NEW AND BOXED VALVES**

NEW AND BOXED	VALVES	90-day guarantee
1R5	8/6 EL6G 10/6	EA50 10/6
1R5	8/6 6N7M 7/6	EA80 10/6
1R4	8/6 6Q7 10/6	EB33 10/6
2B3	8/6 6A7M 10/6	EBCC33 8/6
384	8/6 6J57M 10/6	EBCA1 10/6
3V4	8/6 6BN7 8/6	EBF80 10/6
5Y4	8/6 6V0 7/6	EBCC4 12/6
503	8/6 6X4 7/6	EBCF9 11/6
5Z4	8/6 6X4 7/6	EBCH42 8/6
6AM6	8/6 12A6 8/6	EBCL80 12/6
6BE6	7/6 12AT7 10/6	EBCL2 12/6
6BE6	10/6 12AU7 9/6	EBF39 7/6
6BW6	10/6 12AX7 9/6	EP41 10/6
6D6	7/6 12BA6 8/6	EP80 5/6
6P6G	7/6 12BE6 9/6	EP80 10/6
6HG0	3/6 12K7 8/6	EP86 14/6
6J5M	6/6 12Q7	





**WIRELESS SET No. 19. MK. II.**  
 This most famous Army Trans/Receiver covers 2.8 Mc/s. (150-37 metres) in two bands and 230-240 Mc/s. V.H.F. Has an intercom. amplifier. Designed for 12 and 24 volt operation. Uses a 6 valve superhet receiver, I.F. being 465 Kc/s., and a 6 valve transmitter designed for voice and C.W. operat on. Incorporates test and tuning meter for voltages, aerial loading and current tests. Panel Controls: Frequency tuning, P.A. tuning, Gain control, MCW, CW, R/T switch, Het-tone, netting, off-on, Quench, aerial-AVC-LT-HT-Drive tests. Supplied complete with 15 valves and instruction book.  
**Complete station (as illus.), comprising:** 19 set, Supply Unit, Control box, Headphones, Microphone, Morse Key, Variometer, Short Wave and V.H.F. Aerials and bases and full set of leads. All for only £9. Carr. 25/-.

SET ONLY  
**65/-**

Carr. 10/-



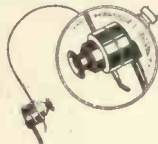
**POCKET MULTI-METER**  
 2,500 o.p.v. Multi range. 6/30/120/300/1,200 v. A.C., ditto D.C. 0-1k., 0-1 meg-ohm; 400 micro-A., 12 M.A., 300 M.A.; -00 to +64-DB, 5 ranges 3x4x1 1/2 in. Large clear dial. Leads supplied. (List price £6/19/6.) OUR PRICE £4/7/6. P. & P. 2/6.

**MILITARY & CIVIL ELECTRONICS**

**SWITCHBOARDS**  
 Manual, fully portable, 10 line.  
**MOBILE TRANSMITTER/RECEIVERS**  
 Wireless Set No. 19 2-8 Mc/s. Collins T.C.S. 1.5-12 Mc/s. Wireless Set No. 22 2-8 Mc/s. Complete equipment.  
 Wireless Set B.C. 620 20-27.9 Mc/s. F.M. 80 Channels.

**AMERICAN LIGHTWEIGHT HEAD SET**  
*They're High and Low Impedance!*

These H.S.30 phones are the smallest used by the U.S. Air Force. 250Ω imp. using soft rubber miniature ear moulds for maximum music and voice reproduction of the finest quality. Supplied free is a small transformer unit with cord and plug which steps impedance up to 4,000Ω. ONLY 15/- P. & P. 2/6.



**T.C.S. RECEIVER**  
 1.5 to 12 Mc/s. 7-valve superhet, built like a dream. 12SK7-RF, 12SA7 Mixer, 12A6 Oscillator, 1207 Detector, AVC - BFO - 1st AF, 12SK7-1.F.S. The 12A6 final

puts 1.4 watts into 500 ohms with an input modulated only 30%. Panel controls: R.F. Gain, A.F. Gain, C.W. Pitch, band-switch, mod.-C.W. switch, power switch, ground and aerial posts, M.O. or crystal frequency switch, speaker jack, card holder to log 30 stations, hand vernier tuning knob turning a large etched calibrated plate behind hair lined window, anti-backlash gears used. Used condition, £8/10/-, carriage 15/-.  
**T.C.S. TRANSMITTER** available at £9/10/-, carriage 15/-.  
 Note.—If both items purchased together, £17. Carriage 25/-.

**PORTABLE TRANSMITTER/RECEIVERS**  
 Wireless Set No. 46 3.6-9.4 Mc/s. Wireless Set No. 18 6-9 Mc/s. Wireless Set No. 38 7.4-9 Mc/s. Complete equipment.

**WALKIE-TALKIE TRANSMITTER/RECEIVERS**  
 PRC-6 Handie Talkie 47-55 Mc/s. F.M. 43 channels.

**V.H.F. STATIONS**  
 Wireless Set 348 Trans/Receiver 100-124 Mc/s.

**COMMUNICATION RECEIVERS**  
 B.C.312 1.5-18 Mc/s. Tropicalised. 12 volts. R.107 1.2-17 Mc/s. 100-250 v. A.C. and 12 v. D.C.

**HEADPHONES**  
 H.S.30, D.L.R.-5, D.L.R.-1. Complete No. 1 assembly, C.L.R.-1.

**MICROPHONES**  
 No. 7, No. 8, No. 3, No. 4, T.S.30, No. 6 (Handset). Carbon and moving coil insets.

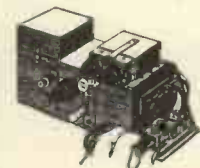
**CONVERT TO V.H.F.**

Within minutes you can extend the frequency of your receiver to cover V.H.F. by using our brand new V.H.F. Convertors. R.F.26 covers 50-65 Mc/s. vernier calibrated tuning, 20/- R.F.25 covers 40-50 Mc/s. switched tuning, 8/6. Circuits supplied. P. & P. 3/6 on each.



**COMPLETE MORSE TRAINING UNIT**

Complete Code Set, contains key, buzzer, headphones, pitch control, operating internal battery, housed in portable wooden case. Brand new, only 12/6. Carr. 5/- Battery 1/6 extra.



**U.S.A. DYNAMOTORS**



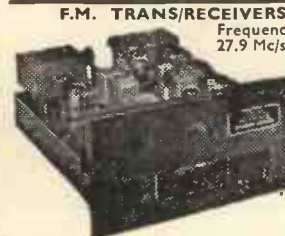
Manufactured by EICOR (as illus.). Input 12 v., output 400 v. at 180 ma. Size 7 x 4 x 4 1/2 in. Brand new 45/-. D.M.34. 12 v. in. with 220 v. out. at 80 mA. ONLY 35/-. P. & P. 3/6 on each.

**D.C. DYNAMOTORS**  
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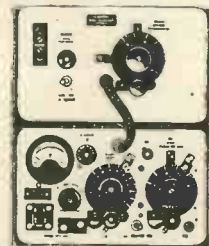


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300 mV.	15 v.	30 mA.	150 mA.
1.5 v.	75 v.	150 mA.	750 mA.
3 v.	150 v.	300 mA.	1.5 amp.
15 v.	300 v.	1.5 amp.	7.5 amp.
30 v.	600 v.	3 amp.	15 amp.
150 v.	750 v.	15 amp.	75 amp.
300 v.	1,500 v.	30 amp.	
750 v.			Resistance
1,500 v.			1,000 Ω
			10,000 Ω

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**CANADIAN MOVING COIL PHONES.** Low-resistance, fitted noise excluding chassis ear muffs, and leather covered head-band. Lead terminates to jack plug. BRAND NEW. ONLY 19/6 (Post 1/6).

**HETERODYNE FREQUENCY METERS TYPE LMI4**



Frequency range 125-20,000 kc/s in 2 bands. This is the United States Navy Model of the well-known BC-221 Frequency Meter, but have many additional features which increase their usefulness. Voltage stabilisation circuits and Crystal control ensure extreme accuracy, and in addition they are fitted with an Internal Modulation switch to allow use as a Signal Generator. Size only 8½ in. x 8 in. x 8½ in. Full information on request.

RCA 9½ in. P.M. SPEAKER, in heavy black cracked metal case, designed for use with AR 88 Receiver, or any set with 3 Ohm Output. BRAND NEW IN MAKERS CARTONS. ONLY 45/- (Post 2/6).



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Made by A. C. Cosor. Incorporates Hard Valve Time Base with speeds of 1-5-40 milliseconds, but simply converted to produce 3 cycles per second to 30 kc/s. Controls include Fine and Coarse Gain, Brightness, Focus, X and Y Shifts. Has Power Pack for nominal 115 v. and 230 v. A.C. with adequate fuse protection. Employs 2½ in. tube type ACB10. Grey and black engraved front panel, size 19 in. x 7 in. For standard rack use if required, depth of unit being 12 in. In steel transit case as illustrated. Complete with leads and suggested modification data. BRAND NEW. ONLY £12/10/- (carriage 15/-).



**R 107 RECEIVER**

9 valves, 3 wavebands, covering 1.2-17.0 Mc/s (18-250 metres), incorporating built-in speaker and power packs for 100-250 volts A.C. or 12 volts D.C. Size 24 in. x 13 in. x 17 in. Complete, ready to switch on, thoroughly tested and checked before despatch. IN NEW CONDITION. ONLY £13/10/- (carriage 20/-).

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A superb Crystal Controlled Wavemeter just released by the Ministry of Supply. Has directly calibrated dial for nominal coverage of 1.5-10.0 Mc/s, but may actually be used from 500 kc/s. up to 30 Mc/s. Complete with 500 kc/s. Crystal, 2 valves type IT4, 1 or 1R5 and 1 of CV296 (Neon Stabiliser), and Instruction Book. Size 7 in. x 7½ in. x 4 in., weight 5 lbs. Used but in first class condition. ONLY £2/19/6. Carr. 3/6.

**12 VOLTS AMERICAN DYNAMOTOR.** Delivers 220 volts at 100 milliamps. Size 5½ x 3½ in. diameter. Ideal for running Radio or Electric Shaver, etc. from car battery. ONLY 32/6.

**EHT TRANSFORMERS.** 5.5 kV. (Rect.) with 2 v. 1 a., 79/6. 7 kV. (Rect.) with 2 v. 1 a., 89/6. 2.5 kV. (Rect.) with 2-0-2 v. 1.1 a., 2-0-2 v. 2 a. (for VCR 97 tube etc.), 47/6 (postage 2/- per trans).

**6 v. VIBRATOR PACKS.** Output approx. 130 v. at 30 mA., fully filtered and smoothed. Complete, ONLY 12/6. (Post 2/6).

**HIGH FREQUENCY A.C. VOLTMETER.** A First Grade Moving Iron Instrument with 6 in. Mirror Scale, reading up to 150 volts A.C. at 400 and 1,200-2,400 cycles. In substantial Oak case with removable lid, overall size 8½ in. x 8½ in. x 2½ in. Recently made for the Air Ministry, by Everett Edgcombe, and in perfect order. Brand New and Unused. ONLY 27/10/-. Can also be supplied for 50 cycles, use either 0-150 or 0-300 volts.



**TAPPED TRANSFORMER.** Normal primary, delivering 30 v., 2 amps., which is tapped to obtain 3 v., 4 v., 5 v., 6 v., 8 v., 9 v., 10 v., 12 v., 15 v., 18 v., 20 v., 24 v. ONLY 20/- (Post 2/6).

**TRAWLER BAND R 1155s**

The latest version of this famous Communications Receiver to be released by the Air Ministry. Covers 5 wave ranges 18.5-7.5 Mc/s., 7.5-3.0 Mc/s., 3.0-1.5 Mc/s., 1.5 Mc/s., 600 kc/s., 500-200 kc/s. As used by Coastal Command, Air-sea Rescue Launches, etc. All sets thoroughly tested and in perfect working order before despatch, and on demonstration to callers. Have had slight use, but are in excellent condition. ONLY £12/19/6.

"B" Models also available. As above but instead of 3.0-1.5 Mc/s. band has 200-75 kc/s. coverage. ONLY 27/19/6.

**A.C. MAINS POWER PACK OUTPUT STAGE,** in black metal case to match receiver, enabling it to be operated immediately, by just plugging in, without any modification. Fitted with 8 in. P.M. Speaker 28/10/- DEDUCT 10/- IF PURCHASING RECEIVER AND POWER PACK TOGETHER.

Send S.A.E. for illustrated leaflet, or 1/3 for 14-page booklet which gives technical information, circuits, etc., and is supplied free with each receiver. Add carriage 10/6 for Receiver, 5/- for Power Unit.

**AR88 LF RECEIVERS**

Reconditioned as new, and in perfect order. Frequency coverage 75-140 kc/s and 1.2-30 Mc/s. ONLY £50 (carriage 25/-).

**POWER UNITS TYPE 234**

Primary 200/250 v., 50 cycles. Outputs of 850 v., 100 mA., and 6.3 v., 4 amps. Fitted double smoothing. For normal rack mounting (or bench use) having grey front panel size 19 in. x 7 in. BRAND NEW. ONLY 59/6 (carriage, etc., 7/6).



**"Q FIVER" COMMAND RECEIVER.**

The famous American BC 453 covering 190-550 kc/s. I.F.s being 85 kc/s. Complete with all 6 valves and circuit. Size 11 x 6½ x 6 in. BRAND NEW IN MAKERS CARTONS. ONLY 89/6 (Post 3/6).



**TCS RECEIVERS**

The renowned American set designed by Collins for static or mobile use. Coverage 1.5-12.0 Mc/s in 3 bands. Complete with all 7 valves. Power required 12 v. LT and 225 v. HT. Size 11 in. x 13 in. x 11 in., in black cracked case. IN NEW CONDITION. ONLY £10/10/- (carriage 15/-).

We can still supply a few of the TCS TRANSMITTER. Frequency coverage and size as above. Complete with all valves, new condition internally but externally worn. ONLY 27/19/6 (carriage 15/-).

**10,000 OHMS PER VOLT TESTMETER**

This latest Coby model is a handy pocket sized tester 5½ in. x 3½ in. x 2½ in. Reads low DC voltages at 10,000 ohms per volt, up to 1,000 v. A.C. and D.C. at 4,000 o.p.v. Resistance to 20 megs., D.C. current to 250 milliamps, and also Decibels. Complete with Test Leads, Batteries, and Instruction Book. ONLY £6/10/-.



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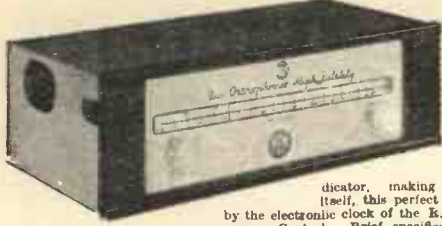
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A truly Hi-Fidelity Record Player consisting of latest type 4-speed Record Changer and 10-watt Push-Pull Amplifier with triple control system and incorporating a panoramic triple Speaker System can only result in reproduction at its best. The equipment is housed in an attractive walnut finish Cabinet standing on 4 elegant contemporary legs, overall dimensions of Cabinet 20 x 18 1/2 x 11 1/2 in. PRICE £29 p.m. 21/- p. & p. Power supply A.C. 100/150 and 200/250 volts, 50/60 c.p.s.



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Fine performance at low cost, the Sunbury is a fully automatic 4-speed Record Changer which continuously plays 10 mixed Records, it is mounted on an attractive plastic deck complete with leads for mains and for plugging into the Pick-up Terminals of a Radio Receiver or Amplifier. LIMITED PERIOD ONLY, £9/19/6, 5/- p. & p.

### THE VICE-PRESIDENT 8-10 WATTS PUSH-PULL AMPLIFIER

A compact versatile Amplifier complete with plug-in Power Pack, valve line-up HY90 2-19A05 and 12AX7, separate bass and treble control, suitable for Speakers of 15 ohms impedance and two 3-ohm tapplings for Tweeters. For use on A.C. mains, tapplings 115-150 and 210-250 can also be supplied with Power Pack suitable for A.C./D.C. mains. PRICE COMPLETE WITH ESCUTCHEON AND KNOBS, £8/19/6, 3/6 p. & p.

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The R.C.A. 20-watt Orthophonic Power Amplifier and Pre-amplifier Control Unit. Brief technical specifications: Power Amplifier distortion less than 0.1%; 40 db total feedback; noise level 85 db below rated output; surplus power 395 v./45 ma. and 6.3 v./2.5 amp. for Pre-amplifier and Tuner. A.C. input 100/150 volts and 200/250 volts 50-60 c.p.s. Pre-amplifier: accurate switch matching for Microphone, Tape and Record Inputs and also permitting the Microphone Input to be mixed with Radio and Tape; rumble filter; switched inputs for Microphone (6.5 mV), Radio and Tape (low and high levels) and Magnetic and Crystal Pick-ups; 4-position Filter with Filter Slope Control variable to 35 db per octave; power requirements 395 v./7 ma., 6.3 v./1 amp. supplied by Power Amplifier. SPECIAL PRICE FOR LIMITED PERIOD ONLY, £29 p.m., 15/- p. & p.



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A well-designed compact Amplifier with 10 watts push-pull output; specifications: valve line-up 6BR7, 12AX7, 2-19A05 and Metal Rectifier. Separate Power Pack and separate Control Panel incorporating Volume On/Off, Bass and Treble Controls, suitable for Speakers of 15 ohms impedance with separate tapplings for two 3-ohm Tweeters, for use on A.C. mains 110-150 and 200-240. PRICE COMPLETE WITH ESCUTCHEON AND KNOBS, £7/19/6, 3/6 p. & p.

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## The 'Carol' TR/1 TAPE RECORDER

INCORPORATING THE NEW B.S.R. TAPE DECK. A Quality Tape Recorder at a price that YOU can afford.

The operation of this Recorder is simplicity itself and the quality in both reproduction and finish, leaves nothing to be desired, the cost being well below present-day prices.

**STAR FEATURES:**  
Deck Controls, Record/Playback Switch and rewind switch with interlocking device to prevent accidental erasure.  
Speed, Single 3 1/2 in. per sec.  
Playing Time, 5 1/2 in. Standard Tape 1 1/2 hrs. L.P. Tape 2 hrs. 8 mins.  
Inputs, Sockets for Microphone, Radio, Gram, etc., with extension Speaker Socket.

Amplifier Controls, On/off, Tone and Volume Controls.  
Power Output, 2 1/2 watts.  
Valve Line-up, ECC83, ECL82, EZ80.  
Overall Size, 13 1/2 x 12 x 8 in.  
Weight, 20 lb.  
Microphone, Acos crystal with stand incorporated and fitted with screened lead and jack plug.

Only 19 Gns. plus 15/- P. & F.

PRICE, including Tape and Spare Spool H.P. TERMS: £2 deposit and 12 monthly repayments at £1/12/11.

## THE COSSOR MODEL 554 Battery Operated Transistor RECORD PLAYER

This Portable Record Player incorporates the latest Garrard BA1 Turntable and Pickup and also a fully transistorised Amplifier, it is completely Battery operated, using two 4 1/2 volt AD28 Batteries. The output from the high quality 7 x 4 in. Elliptical Speaker is astounding, suitable for 7in. 45 r.p.m. Records and fitted with a speed adjusting control. The complete Unit is housed in an attractive rexine covered Cabinet with carrying handle and clips, overall dimensions being 11 x 8 1/2 x 5 in., available in two-tone, blue/cream or red/cream.

PRICE **£9.19.6**

Batteries Extra at 3/3 each.

4/- P. & P.

The Garrard BA1 Turntable and Pickup as used in the above Record Player can be supplied separately at £3/19/6 plus 2/6 P. & F. Cabinet available separately at 25/- plus 2/6 P. & F.

## SPECIAL OFFER—LIMITED QUANTITY ONLY A 5-WAVEBAND AM/FM RADIOGRAM CHASSIS

(By Famous  
Manufacturer)  
PRICE

**£17.19.6**

plus 5/- P. & P.



A really good quality Chassis with outstanding features: Valve line-up ECC85, ECH81, EF89, EABC80, 2/E134, ECC83, EZ81; waveband coverage, long, medium, two shorts and F.M. Power Pack and push-pull output stage mounted on separate chassis. Fly-wheel tuning; pickup and extension speaker sockets provided, and edge fit facilities for quality tape recording or playback. Glass Dial supplied suitable for either horizontal or vertical mounting and finished in black with gold lettering. H.P. Terms: Deposit 36/- and 12 monthly repayments at 28/8.

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Postage and packing on above units 5/- each.

Assemble it yourself and  
SAVE £££s



**COMPACT GRAM AMPLIFIER**  
2-valve printed-circuit type for use on A.C. or D.C. 200/250 v. mains incorporating modern miniature valves. Output 2 watts, overall dimensions 6 1/2 x 2 x 3 1/2 in. Price 59/6, plus P. & P. 2/6.

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ORIGINAL PRICE 20/15/-  
OUR PRICE **£5.19.6** P. & F. 2/6

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### FOR A LIMITED PERIOD ONLY

Original cost 23gns  
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This Eliminator is completely assembled and supplied with 4ft. of Mains Lead and Torpedo-type of On/Off Switch. It is housed in 2 Metal Containers approximately the same size as the AD35 and B126 Batteries, and suitable for such Receivers as the Cossor 843, 851 and 552 or Receivers operating on 1.4 volt L.T. and 90 volt H.T. for use on 200-250 v. A.C. mains. Size: L.T. unit 3in. x 2 1/2 in. x 1 1/2 in., H.T. Unit 4in. x 2 1/2 in. x 2in. Original Price 3 Gns. OUR PRICE for a limited period only, 37/6 plus 2/- P. & P.



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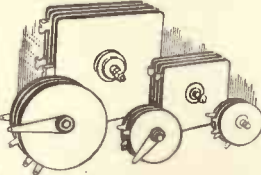
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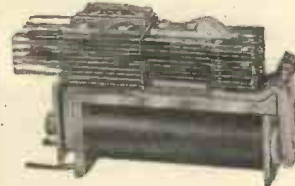
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100 Milliamps	2 1/2 in.	MC/FR	12/8
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## A LARGE AND COMPREHENSIVE STOCK OF WIRELESS AND ELECTRONIC COMPONENTS

### TELEPHONES Easy to Fix **Wiring Diagram Free**

**TELEPHONE SET TYPE "A"** Ringing and speaking both ways on a 4-core cable. Very loud and clear over any distance. The handsets are as illustrated and the set is complete except wire. 4-core at 8d. per yard or 2-core at 3d. per yard extra. Price 75/- set, post 3/6.  
**SET B.** Two headphones connected to breast microphones, with leads, plugs and fitted carrying cases. Join instruments together with two wires and 1 1/2 volt battery for a super Intercom., 25/-, post 3/6.  
**SET "C"** Similar to Set "A." Instead of P.O. Type handsets, two P.O. Desk Type Instruments are supplied with usual drawer in base. Complete ready for use. Price 150/-, post 7/-.



### 10 AMP BATTERY CHARGER

**HERE IS YOUR CHANCE TO PURCHASE A BRAND NEW UNIT WORTH £40! FOR OUR SPECIAL PRICE** ..... **£17.10.0**  
 Carriage 20/-.

Input 200/250 v. A.C. 50 cy. Output 10 amps., 22 volts D.C. Controlled by two 4-position switches for fine and coarse control which enables 6 to 24 volt bats. to be charged. Brand new with 0/12 ampeter. Fused A.C./D.C.

**ROTARY CONVERTERS.** Input 12 D.C. Output 230 A.C. 50 cy. 135 watts. In fitted case with variable resistance, 0/300 voltmeter. The ideal job for television where A.C. mains are not available. £10. Carr. 15/-.  
 Special connectors, one fitted with 6ft. heavy duty flex and clips for D.C. side. 10/- set, post 1/-.

**CONVERTORS ONLY,** 12 volt or 24 volt. £8/10/-, Carr. 7/6.

**BATTERIES.** Portable Lead Acid type, 6 volts 125 ampere hours. In metal case 16in. x 18in. x 11in. (Two will make an ideal power supply for our 12 volt Rotary Converters). Uncharged £6/10/- each, carriage 15/-.

**UNI-PIVOT GALVANOMETER** by Cambridge Instruments, 50-0-50 microamps, dia. 4in. Knife pointer, mirror scale. Complete with leather carrying case. Ideal for laboratory use. £10, carriage 3/-.

**FLIGHT TO GROUND SWITCHES.** 5C/2828 as used on aircraft. Very robust, will carry a very heavy current 25/- each, or in pairs with auxiliary switch 50/-, post 3/-.

**SIGNAL GENERATOR TYPE 52A.** Input 230 volt 50 cycles, complete with leads, dummy antenna. Brand new in transit case. 6 to 52 Mc/s. inclusive in 4 bands with calibration charts Coarse and fine attenuators. Int. and ext. mod. Output 0.5 volt to 100mv., Impedance 70 and 100Ω. £10, Carriage 10/-.

**MOTORS.** 12 volts D.C. Reversible. 2in. x 1 1/2 in. Spindle 1/2 in. x 1/2 in., 10/6 each, post 1/6.

**SYNCHRONOUS MOTOR.** 200/250 volts A.C. 60 r.p.m., suitable for electric clocks, etc., 25/-, post 2/6.

**MAINS MOTORS.** Capacitor 230 v. A.C. 1/40th h.p. 1,400 r.p.m. 55/-, post 3/6.

**MAINS TRANSFORMER WITH RECTIFIER** mounted on top. Giving a D.C. output of approx. 30 to 40 volts 1 amp. Price 27/6 each, post 2/6.

**VARIAC TRANSFORMER.** Input 230 volts. Output infinitely variable 0-230 volts and 0-270 volts. 9 amp., bench or panel mounting. £15, carr. 12/6.

**SELENIUM METAL RECTIFIERS.** Charging Rectifiers. Full Wave Bridge.

12 Volts 1 Amp	8/6 each	24 Volts 1 Amp	13/- each
12 Volts 2 Amps	13/6 each	24 Volts 2 Amps	24/- each
12 Volts 3 Amps	16/6 each	24 Volts 3 Amps	28/- each
12 Volts 4 Amps	20/- each	24 Volts 4 Amps	36/- each

Discounts for quantities of above charging rectifiers.

**MAINS TRANSFORMERS** to suit above rectifiers

12 Volts 1 Amp	12/6 each	12 Volts 4 Amps MT5	25/- each
12 Volts 2 Amps	24/- each	CT109	29/6 each
12 Volts 2.5 Amps	22/- each	MT5B	25/- each

**RESISTORS EX STOCK IN QUANTITY WIRE WOUND, HIGH STABILITY CARBON ETC., BEST MAKES AT LOWEST PRICE.**

#### ELECTRO-MAGNETIC COUNTERS

COUNTING UP TO 9999

Type 16A

2,300 ohms 75/230 v. D.C., 15/- each. Post 1/6.

Type 17A

3 ohms 2/6 v. D.C., 15/- each. Post 1/6.



**VEEDER-ROOT MAGNETIC COUNTER.** General purpose type with zero re-set. 800 counts per minute up to 999999. 48 volt D.C. 55/-, post 2/6.

**THERMOSTAT SATCHWELL,** 12in. stem 0/250 volt A.C./D.C. 15 amps A.C. 10 to 90 degrees cent. 25/-, post 2/6.

**ROOM THERMOSTAT.** Adjustable between 45 and 75 deg. Fabr., 250 v. 10 amp. A.C. Ideal for greenhouses, etc., 35/-, post 2/-.

**THERMOSTAT.** For frost protection, on at 34 deg. F., off at 49 deg. F., 14 amps. at 250 volts, adjustable, 4/6, post 1/-.

**SIMMERSTAT BY SUNVIC** Plug-in type with knob control, 15 amps 3-pin 200/250 volts, 35/-, post 2/-.

**L. WILKINSON (CROYDON) LTD.**  
 19 LANSDOWNE RD. CROYDON SURREY  
 Phone t CRO 0839 Grams: WILCO CROYDON



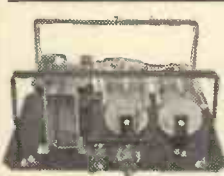
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**HEAVY DUTY  
20 AMP. L.T. SUPPLY UNIT**



Normal cost over £100  
by **S.T.C.**  
Essential equipment for Electronic Engineering, research laboratories, schools. Ideal for battery charging, etc. Guaranteed for 20 amps.  
**Output:** D.C. Variable up to 20 amps, and 24V or trickle charge 125/350/700 ampere hours.  
**Input:** A.C. 100/260 volts 45/65 cycles.  
**Size:** 16 x 24 x 32in. high.  
In attractive Grey Cabinet.

ex-Warehouse **£22-10-0**  
(Circ. diag. and instr. loaned for 10/- deposit)



**G.E.C.  
L.T. SUPPLY  
UNIT**  
**OUTPUT:** 24 volts  
10 amps D.C.  
**INPUT:** 200/250  
volts A.C.  
New and in original  
cases  
**£13. 10. 0**  
Carr. 9/6

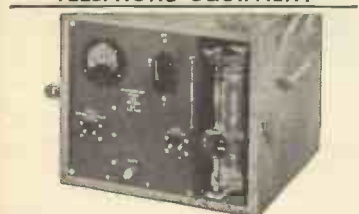
**WORLD FAMOUS TELEPHONES**

**"F" Type  
IN ATTRACTIVE  
CASE**  
The best portable telephone ever made. With a range of up to 5 miles is ideal for  
**FACTORIES, BUILDING SITES,  
FARMS, CIVIL ENGINEERING  
PROJECTS, OUTSIDE BROADCAST  
UNITS AND OFFICES.**  
2 perfect sets in individual carrying cases, complete with long life batteries, bells, magneto and 100ft. telephone cable.  
**£7.10.0** per pair. Carr. 9/6

**TELE "F" HIGH POWER** as above, but complete with amplifier, **£6/10/-** each. Carr. 12/6

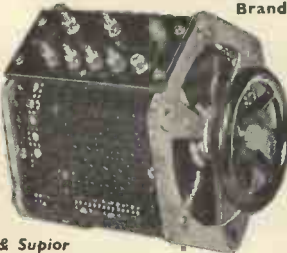
**DON Mk. V TELEPHONES.** Few remaining, complete with 100ft. telephone cable **£5/11/-** per pr. Carr. (G.B.) 9/6.

**D3 STRANDED TELEPHONE CABLE,** New Mile Drum **85/-**. Carr. 17/6.  
**ENGLAND'S LARGEST STOCKS OF  
TELEPHONE EQUIPMENT**



**ROTARY CONVERTERS.** 12 v. D.C. input. 230 volt A.C. 150 watts, 50 cycles output. Housed in wooden case and fitted with voltage control slider resistance, switch, plugs and A.C. mains voltage output check meter. Supplied in perfect condition, individually tested, **£9/19/6** each. P. & P. 10/-.

**VARIAC TRANSFORMERS**  
Brand New



& *Supior*  
**OUTPUT (2KVA) Completely Variable 0 to 270 volts, 9 amps.**  
**INPUT 230 Volts, 50/60~**  
**A SHROUDED FULLY VARIABLE TRANSFORMER FOR BENCH OR PANEL MOUNTING.**  
**SIZE:**—Approximately 8½ inches Cube.  
**WEIGHT:**—Approximately 30 lb.  
**PRICE: RIDICULOUS, ONLY £15.0.0**  
Plus 12/6 carr., supplied and boxed new.

**CONSTANT VOLTAGE TRANSFORMERS**

**FERRANTI 7½-KVA MOVING COIL**  
Stabilized output voltage in the range 200-250 v. Plug-board tapings. The selected output voltage is constant with ±1% at all loads 0 to 30/37½ amps. when the supply voltage is varying over the range +8% to -12%.  
● Frequency compensated 45-55 and 54-66 c/s.  
● Excellent output wave-form.  
● Can be used as a variable transformer.  
● Unused. Complete with spares and instruction book at a fraction of the normal cost, only **£65.**



**AUTO TRANSFORMERS**  
3 KVA Air Cooled (100% under-rated)  
**GUARANTEED 230/250 tapped, 12 amps.**  
6 KVA 105/120 tapped, 28.5 amps.  
Made by well-known manufacturer and housed in strong metal case. Weight: 2 cwt. Brand new, in 'original maker's cases.  
**PRICE £15.0.0** Carr. 25/-.

**VERY SPECIAL OFFER—  
EXPORT ONLY**

Just released by the Ministry of Supply, "88" SETS. Manufactured by E. K. Cole. Walkie Talkie and A.F.V.—3,000 available. "22" SETS ALSO—500 only.  
**TELEPRINTERS—120 Creed 7B** for immediate disposal.  
Enquiries are invited for Bulk supply at reducing low prices.



**MICRO SWITCHES**  
**BURGESS  
BRAND NEW  
MINISTRY RELEASE  
MK. 4 BR. METAL BODY  
(UNIVERSAL CONTACT)  
A.M. BeL 56/4088**  
Compare this remarkable almost half-price offer.

**78/- per Doz.** (min. quantity) **£25 per 100**

**TRUVOX**

**LOUD HAILERS**



COMPLETE WITH POWER MICROPHONE

For public address from cars, boats, etc., similar to Police Type ex-H.M. Forces. Simply connect to a 6/12-volt. car battery and use. **Amazingly powerful.** Why pay £2 a day hire charge for amplifiers. Buy this complete unit.

only **£7. 14. 6**

by return  
**TWIN SPEAKER UNIT  
COMPLETE £10/14/6.**

**EX-GOVT.**

**PUBLIC ADDRESS SYSTEM**

Complete with amplifier unit, 4 speakers, microphone, headphones and all spares packed in wooden cases. 6 or 12 volt D.C. handling capacity 8 watts. Ideal for cars, boats, factories, etc.

**£15. 15. 0** Carr. 30/-.

**AERIAL  
MASTS**

**IMPROVED TYPE 50 MK II  
36 ft. HIGH**



Kits comprise—6 2½in. dia. Tubular Steel Sections of 6ft. length, top-section and base, Pickets, Guys and Fittings. **YOU** can purchase this normally expensive MAST for a fraction of its cost. Please add £1 for (returnable) wooden carrying case. The MAST is particularly suitable to take aerials for Tx., Rx., P.M. and T.V. (especially COMMERCIAL) and has many other uses. Extra 6ft. sections can be supplied at 17/6 per section.

**£8. 10. 0 only** Carr. 15/6

**U.S.A. Type 45ft. TELECOM. AERIAL MAST.** (7 sections, 6ft. 8in. x 2½in., guys, etc.). This entirely complete set in carrying case 12½ Gns. Carr. 17/6. Or 2 sets for **£25.** Carr. extra. *British Manufacture only.*

**ARMY TYPE 32ft. MASTS** similar to above but 10 in. screw-sections, suitable for permanent lightweight installation. Kit in canvas bag, **£5/10/-**. Carriage 12/6.

**U.S.A. R-9B/APN-4  
Radio Receivers.**

First class for conversion, originally designed for B.D.F. Valve: 1-68N7GT  
4-88K7GT, 1-68A7GT, 1-V3106-30, 1-8U4G, 1-8H6-OT, 1-68L7GT, 9-6B4G, 2-879/2-2, 1-68J7GT.  
Chassis size 20 x 9 x 11in. Weight 26lb. Brand new. Component value (transformers, condensers, switchgear, etc.) far exceeds this remarkable low price. Buy note. Only 150 sets available.



**85/-**

P. & P. 12/6

**THE IRONGATE (M.O.) CO.,** Dept. (WW3)

**2/4 IRONGATE WHARF ROAD, PRAED STREET, LONDON, W.2.**

**PAD  
2231/2/3.**



**BRAND NEW  
CRYSTAL CALIBRATOR  
No. 10**



(Battery powered 1.4 v. valves.) Brand new and unused. Complete with full working instructions, circuit diagram, carrying haversack, connecting lead and spare valves. Frequency range: 1.5 to 10 Mc/s. (Nominal) but can actually be used up to 30 Mc/s. Weight 5 lb. Size 7in. x 7½in. x 4in. A miniature B.C.221 in every respect. A must for every laboratory, etc. ONLY £4/19/6. P. & P. 2/6.

**BRIDGE  
MEGGERS**

Evershed and Vignoles Series 2 in perfect condition. 250 v. £22, carr. paid. Leather case available at 20/- extra.



**EVERSHED AND VIGNOLES WEE MEGGERS.** Good condition. 500 v. £12/10/-. P. & P. 3/-. Ditto 250 v. £10/10/-. P. & P. 3/-.

**EVERSHED AND VIGNOLES MEGGER  
CIRCUIT  
TESTER** (low reading ohm meter). 2 ranges. 0-3, 0-30 ohms. The perfect meter for continuity and polarity testing. complete with test leads and ready to use. Brand new. Only £4/17/6. P. & P. 3/-.



**MULLARD  
BRIDGE**

Type GM. 4140/1. Mains operated from 100-250 v. A.C. Will test resistances from 0.1 ohm to 10 megohms and condensers from 10pf. to 10mf. Good condition and complete with instruction booklet. £6/19/6. P. & P. 2/6.



**TELEPHONE SETS (TELE "F").** Housed in bakelite cases, complete with built-in ringing generators and batteries. Ideal between two or more positions up to practically any distance. Tested before despatched. ONLY 70/-. P. & P. 3/6. 2 sent for £6/10/-. Carr. paid.

**TELEPHONE CABLE.** Twin one-mile drums (Don 8), £5. Carr. 20/-. Single one-mile drums (Don 3), 50/-. Carr. 7/6.

**GEE ros RADIO Ltd**

15, LITTLE NEWPORT STREET, LONDON, W.C.2. GER. 6794/1453  
ADJOINING LEICESTER SQUARE TUBE STATION—Open 9-6 Weekdays 9-1 Sat.

**D.C./A.C. ROTARY CONVERTERS**

**ROTARY CONVERTER.** 24 v. D.C. to 230 v. A.C. 50 cycles, 150 watts. Brand new and unused £8/10/-. Carr. 7/6. Ditto, 100 watts, £6/9/6. Carr. 7/6.

**ROTARY CONVERTER** (as illus.). Ex-Govt. 12 v. D.C. input, 230 v. A.C. Output 50 cycles at 135 watts. Complete in carrying case with lid. Voltage control, sliding resistance, mains switch and 0-300 v. A.C. flush meter. In good condition, £10. Carr. 10/-.

Motor only, without case, etc. Brand new and unused £8/10/-. Carr. 5/-.

**VARIABLE VOLTAGE TRANSFORMER.** (BERCO Regulator) Pri. 440 v. 50 cycles, sec. 0-440 v. at 6.5 amps. or can be connected for 230 v. to give 0-230 v. at 12 amps. Brand New and Unused £18/10/-. Carr. 10/-.

**HEAVY DUTY LT TRANSFORMERS.** 230 v. 50 cycles pri. 17 v. sec. at 35 amps., capable of carrying 25% over actual rating. Perfect condition. ONLY 115/- each, either type. Carr. 5/-.

**6 kV/A AUTO-TRANSFORMER.** 230/110 v. 50 cycles (fully tapped primary and secondary). Capable of 25% over actual rating. Brand new and unused. £18. Carr. 20/-.

Also 3 kV/A as above. £12/10/-. Carr. 20/-.

**20 kV/A AUTO-TRANSFORMER.** 230/115 v. 50-60 cycles, by Jefferies Transformer Co., U.S.A. Perfect condition. £20. Carr. £1.

**CONSTANT VOLTAGE TRANSFORMER.** 190-260-v. primary, sec. 115 v. at 1½ kW/A (listed at 2 kW/A). Brand new and unused. £25 or £45 per pair. Carr. 10/- each.

**MARCONI SIGNAL GENERATOR. TYPE TF517-F/1.** Covering 10-18 Mc/s. 33-58 Mc/s. 150-300 Mc/s. Used but in very good condition. Complete with full technical data and Instructions. Limited quantity. Unrepeatable at only £12/10/-. Carr. 20/-.

**ALSO MARCONI SIGNAL GENERATOR TYPE TF390G** for 200-250 v. A.C. mains input. Frequency range 4-16 Mc/s. and 32-100 Mc/s. indirect calibration. Output 1 µV to 100 M/V. 400 c/s internal modulation. In good order. Only £12/10/-. Carr. 20/-.

**VALVE TESTER. TYPE 4.** 200/230 v. A.C. input. Ex Govt., in good condition, with descriptive book containing circuit diagram of instrument and how to test valves from 1.4 v. to 40 v. With valve holders for Brit. 4, 5, 7 pin and Octal, U.S., 5 and 7 pin. 1/Octal, size contact large Brit., 4 and 9 pin. Acorn and diode. Housed in substantial wooden case with hinged lid. £7/19/6. Carr. 10/-.

**A.C.-D.C. RECTIFIER POWER SUPPLY UNITS**

110-230 v. A.C. 50 cycles input, 100/110 v. D.C. output max. 2½ amp. Brand new and unused. £4/10/-. Carr. 7/6.

230 v. A.C. 50 cycles input, 200/220 v. D.C. output at 3/4 amps. approx. Good condition. £10. Carr. 10/-.

200/250 v. A.C. 50 cycles input, secondary 24 v. at 26 amps. D.C. Capable of 25% over actual rating. Brand New and unused. £12/10/-. Carr. 20/-.

200/250 v. pri., 110 v. sec. at 4 amps. max. Brand New and unused. £8/10/-. Carr. 10/-.

**TRUVOX TANNOX LOUD-HAILERS.** With 180 ohm line transformer and condenser. Impedance 7½ ohms, handling capacity 8 watts. Complete in slope-front wooden case. In good condition 18/6. P. & P. 3/6. Brand new 25/-. P. & P. 3/6.

**AIRBORNE TRANSMITTER RECEIVER. TYPE 1986.** A mobile 10-channel crystal controlled V.H.F. Tx./Rx. covering 124.5/156 Mc/s. I.F. band width 23 kc/s. Complete (less external attachments) in metal case, with all valves and 24 v. rotary power unit. Used, but in first-class condition. ONLY £8/10/-. Carr. paid. Also, complete with control box and all necessary connecting leads, £12, carr. paid.

**RESISTORS.** Mixed parcel of ½, 1 and 2 watt sizes. Good assortment. 7/6 per 100. Post 6d.

**CONDENSERS.** Mixed parcel, good assortment of types and values. 50 for 10/-. P. & P. 1/-.

**TELEPHONE DIALS.** Standard (G.P.O.). Pattern. 0-9. Brand new. 30/-. P. & P. 1/-.



**ACCUMULATORS** 12 v. 25 A.H. New and unused. Housed in strong wooden case for extra protection, 45/-. Carr. 7/6. 2 v. 100 A.H. 75 actual. Ex Govt. New and unused. Complete with carrying handle. Size 6½ x 6½ x 3½in. 15/- each. Carr. 3/6. 3 sent for 50/-, or 6 for £5, carr. paid. Ditto 16 A.H., 5/-, P. & P. 2/-; 6 for 24/-, P. & P. 10/-; Ditto 14 A.H., less handle, 5/-, P. & P. 2/-; 6 for 24/-, P. & P. 10/-.

**RECORDING TAPE.** Send S.A.E. for money-saving price list.

**TELESCOPIC AERIAL MAST.** 20ft., 4 sections of 5ft. each. Independently locking at any height. Tapering from 2in. to ½in. (less accessories). 50/-, carr. 5/-.

**SELENIUM METAL RECTIFIERS, FULL BRIDGE**

6 or 12 v. 1 amp. 7/6; 24 v. 1 amp. 18/6; 12 v. 2 amp. 10/-; 24 v. 2 amp. 20/-; 12 v. 2½ amp. 15/-; 24 v. 2½ amp. 25/-; 12 v. 4 amp. 16/6; 24 v. 4 amp. 30/-; 12 v. 6 amp. 23/6; 24 v. 6 amp. 35/-; 12 v. 10 amp. 40/-; 24 v. 10 amp. 80/-.



**RE-ENTRANT LOUD HAILERS** (Ex-Govt.) Heavy duty 20 watts all-metal 15 ohms. Diameter 15in., length 15in. (approx) good condition. £6/10/-. Carr. 10/-.

Ditto. Brand new, £8. Carr. 10/-.

**HEAVY DUTY—ALL STEEL TRIPOD STANDS.** Adjustable every 6in. to approx. 9ft. 6in. when fully extended. (Folds up to only 4ft. 6in. for storage.) Suitable for outdoor speakers public address systems, floodlighting, etc., etc. (as illus. Dec.). OUR PRICE £3/10/-. Carr. 5/-.

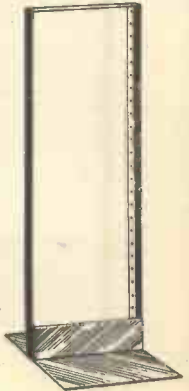
**BAKER'S SELHURST SPEAKERS**

12in. P.M. 15 ohms 15 watts, 30-14,000 c.p.s. Our price £4/10/-.  
"AUDITORIUM" 12in. 15 ohms 12 watts, 35-16,500 c.p.s. Flux density 14,500. OUR PRICE, £7/10/-.  
"SUPER-HI-FI 25" 12in., 15 ohms, 25 watts 25-20,000 c.p.s. Flux density 17,600. OUR PRICE, £9/9/-. All the above speakers are Brand new and full descriptive specification is available.

**G.P.O. RACKS.** 19in.

Heavy duty, all steel. Standard drilling. Two types: 5ft. 6in. angle uprights, £3/10/- carr. 10/-; 6ft. channel uprights, £5, carr. 10/-.

19in. x 14in. PANEL SHELF in 14 s.w.g. steel. Suitable for above racks. 15/-, P. & P. 5/-.



# EDDY'S (NOTTM) LTD

## 172 ALFRETON ROAD NOTTINGHAM

**SURPLUS NEW AND GUARANTEED VALVES**

AZ1	12/6	P61	2/3	6B16	6/6
CY31	12/6	PCC84	9/-	6C4	3/6
DAF96	8/6	PCF80	8/6	6C5	5/6
DF96	8/6	PCL82	10/-	6F33	5/6
DL96	8/6	PEN25	5/-	6J5M	4/3
DM70	7/6	PEN36C	9/6	6J5GT	3/11
EB91	4/-	PL33	9/-	6J5G	2/6
ECC81	6/-	PL81	10/6	956	2/11
ECC82	7/-	PL83	8/9	6K7G	2/3
ECC83	7/6	PY31	8/6	6P28	9/6
ECC84	9/-	PY80	7/-	6Q7G	7/9
ECC85	8/6	PY81	7/-	6SA7M	6/-
ECF80	10/6	PY82	7/6	6SG7M	5/-
ECH42	8/9	U25	12/-	6SK7GT	5/-
ECH81	8/3	U35	8/6	6SN7GT	4/9
ECL80	9/6	U31	7/9	6V6G	5/9
ECL82	11/-	955	3/11	6V6GT	6/6
EF36	2/6	UAF42	9/-	6X4	6/-
EF37	4/-	UBC41	8/3	6X5GT	6/6
EF41	8/9	UCH41	8/-	7C5	7/6
EF42	8/6	UF41	8/9	7C6	7/6
EF50	1/9	UL84	8/3	7S7	9/6
EF80	6/6	UY41	6/6	7Y4	7/6
EF86	11/-	ID5	9/6	12K7	7/6
EF89	8/6	IL4	3/9	12Q7	7/6
954	1/6	IR5	7/-	12Q7	7/6
EF91	4/-	IS5	6/6	20D1	9/6
EL41	9/3	IT4	4/9	25A6G	8/-
EL84	8/3	354	7/-	25L6GT	9/-
EY51	9/6	3V4	7/9	25Z4G	7/9
EY86	8/6	5U4G	5/9	35L6GT	9/6
EZ40	7/-	5Z4G	5/9	35W4	6/9
EZ80	6/9	6AG5	5/-	35Z3	12/6
GTIC	7/6	6B8G	2/11	35Z4	7/6
MU14	8/-	6BA6	6/6	807B	3/9

**RI585 RECEIVER.** 12 valves, 6 preset positions. Medium waves, 19/11. P. & P. 2/6.

**RECTIFIER/STABILISER** for 1.4 volt valves, Midget, 3/-. Post 6d.

**2000mfd. CONDENSERS,** 6 volts working, 1/6. Post 6d.

**NIFE ACCUMULATORS.** Midget single unit size 3 x 2 1/2, 7 amp. hours, 1/11. Post 1/6.

**DYNAMOTORS.** 200 volt D.C. to 12 volt D.C. Ideal for train sets on D.C. main, 19/11. Post 2/6.

**GERMANIUM DIODES,** 1/- each, 9/6 dozen. Post 4d.

**ACOS CRYSTAL PICK-UPS.** (Turnover 2 sapphire styli), 29/11. Post 2/-.

**DIMMER SWITCHES.** Ideal for train speed regulators, 1/11. Post 6d.

**NEON MAINS TESTER/SCREWDRIVERS,** 3/11. Post 6d.

**RECTIFIERS.** Contact cooled miniature 200 v., 60 mA., 7/6; RM1, 4/9; RM2 6/6; RM3, 7/6; RM4, 15/6; RM5, 19/6. Post 1/-.

**CONDENSERS.** Tubular Wire End (not ex-Govt.), 8 mfd., 450 v., 1/9; 8-8 mfd., 450 v., 2/6; 16 mfd., 450 v., 2/9; 16-8 mfd., 450 v., 4/-; 16-16 mfd., 450 v., 3/9; 32 mfd., 450 v., 3/9; 32-32 mfd., 350 v., 4/-. Post 1/-.

**VIBRATORS.** 12 v., 4 pin, 4/11. Post 1/-.

**MORSE TAPPERS.** Plated contacts, adjustable gaps, Heavy Duty, 3/6. Post 9d.

**RELAYS.** Siemens High Speed suitable for model control, 8/11. P.O. 3,000 type assorted values, 5/11 each. Post 1/-.

**SPEAKER GOLD GRILL.** 6 1/2 x 4 in., 1/- each. Post 6d.

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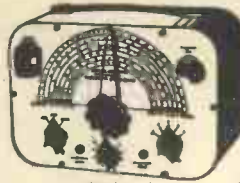


Comprising 2in. moving coil meter, scale calibrated in A.C./D.C. volts, ohms and milliamperes. Voltage range A.C./D.C. 0-50, 0-100, 0-250, 0-500. Milliamperes 0-10, 0-100. Ohms range, 0-10,000. Front panel, range switch, wire-wound pot (for ohms zero setting), toggle switch, resistors and rectifier. Basic movement, 2mA. In grey hammer finish case. Plus Built and tested 19/6 P. & P. 1/6. 7/6 extra. Point-to-point wiring diagram 1/- free with kit.

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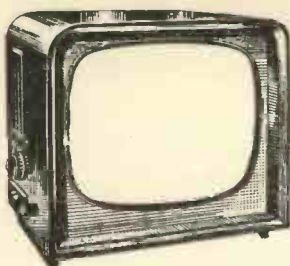
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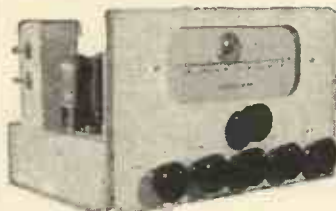
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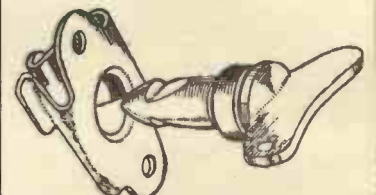
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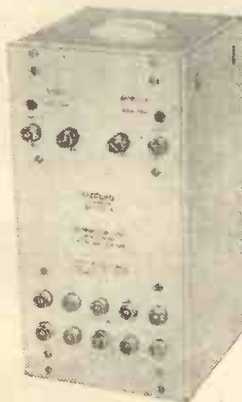
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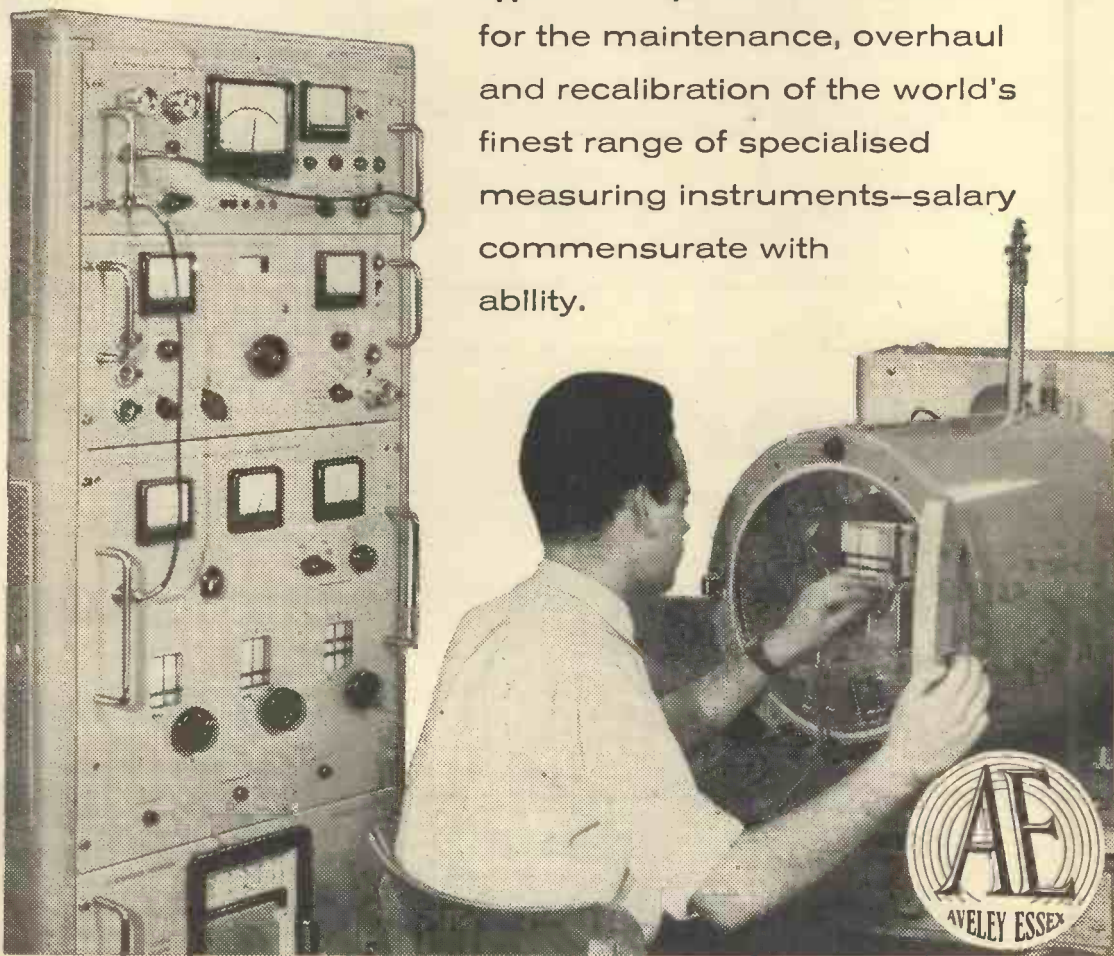
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Readers are warned that Government surplus components and valves which may be offered for sale through our displayed or classified columns carry no manufacturers' guarantee: Many of these items will have been designed for special purposes making them unsuitable for civilian use, or many have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such items purchased.

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### TEST EQUIPMENT—SURPLUS AND SECONDHAND

TINSLEY D'Arsonval galvanometer type 3038, two galvanometer suspensions, projecting telescope, stand, 100cm scale, £40 or offer. 57, Buckland Ave., Slough. [8833]

SIGNAL generators, oscilloscopes, output meters, wave voltmeters, frequency meters, multi-range meters, etc., etc., in stock.—R. T. & I. Service, Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [0056]

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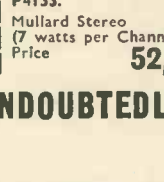
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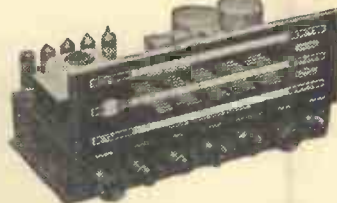
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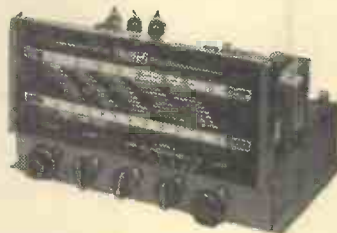
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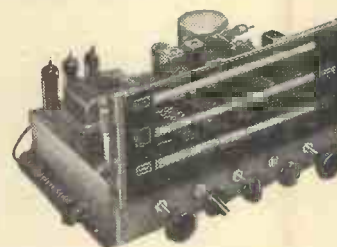
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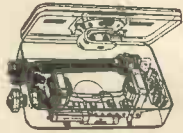


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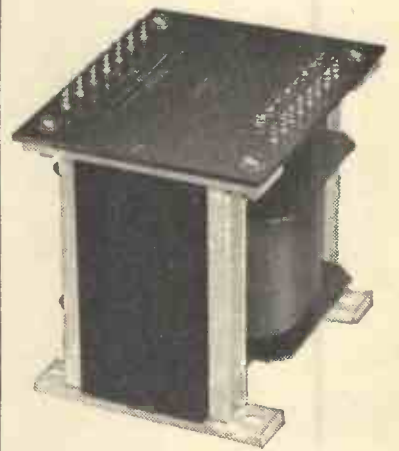
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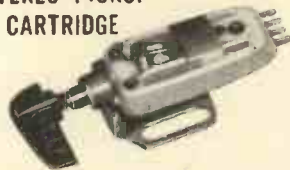
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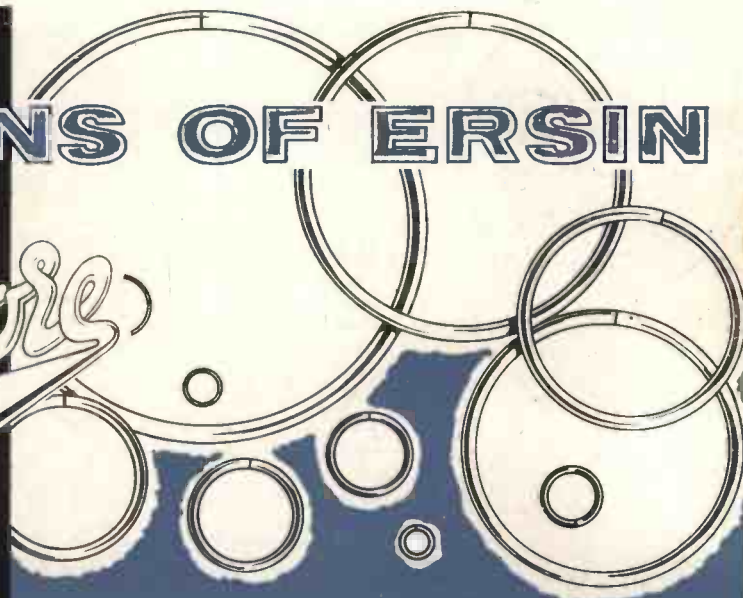
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