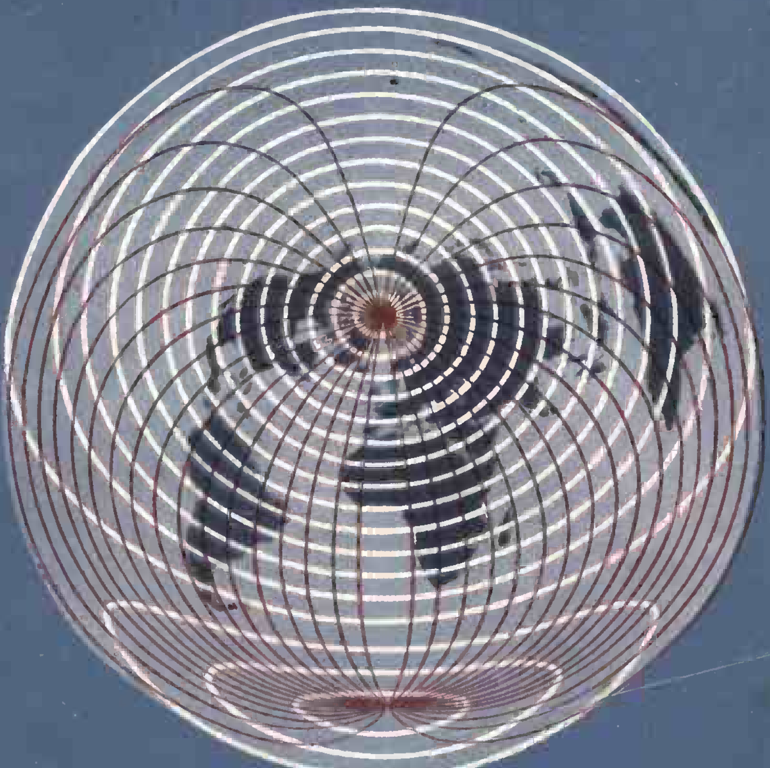
JANUARY 1960

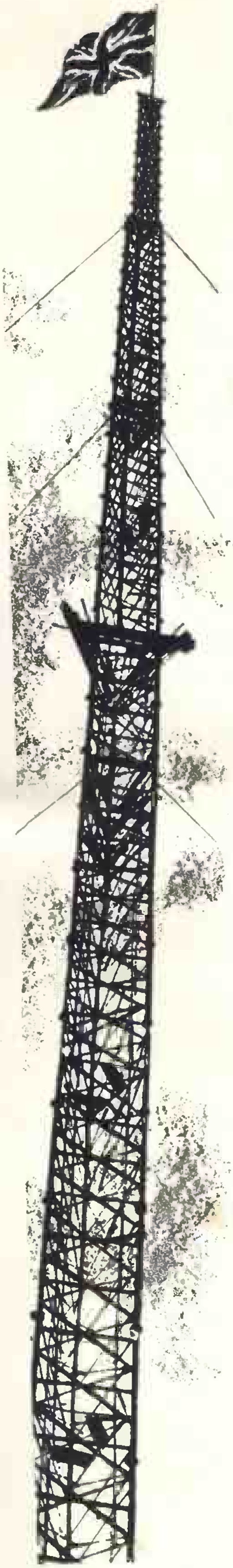
TWO SHILLINGS

# Wireless World

## ELECTRONICS
## Radio · Television



FORTY-NINTH YEAR OF PUBLICATION



# ONE THOUSAND FEET UP

## AT MENDLESHAM!

On the 27th October High Power Transmission from the Mendlesham mast commenced. Over one million televiewers will now be able to receive a first-class service from the I.T.A. Station.

A thousand feet high, this mast is the tallest structure in Great Britain, yet it is only 8ft. 6in. across each side of its triangular framework.

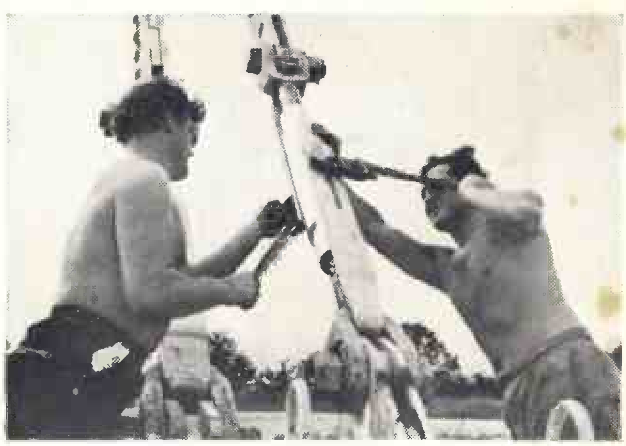
It was built in *ten weeks* to the requirements of I.T.A. and their main contractors, E.M.I. Electronics Ltd. The design and erection were undertaken by BIC Construction Company and the steelwork was fabricated and galvanised by Painter Bros. of Hereford—both members of the BICC Group.

*Other transmitting masts and towers supplied by BICC include those at:—*

CRYSTAL PALACE (London)
CHILLERTON DOWN (Isle of Wight)
SUTTON COLDFIELD (Birmingham)
BURNHOPE (Co. Durham)
HOLME MOSS (Huddersfield)
BLACK MOUNTAIN (Belfast)
KIRK O' SHOTTS (Lanarkshire)
DOVER (Kent)
BLACK HILL (Lanarkshire)
ST. HILARY (nr. Cardiff)

**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





VOLUME 66 NO. 1

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# FRAME GRID VALVES FOR TELEVISION

4

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.

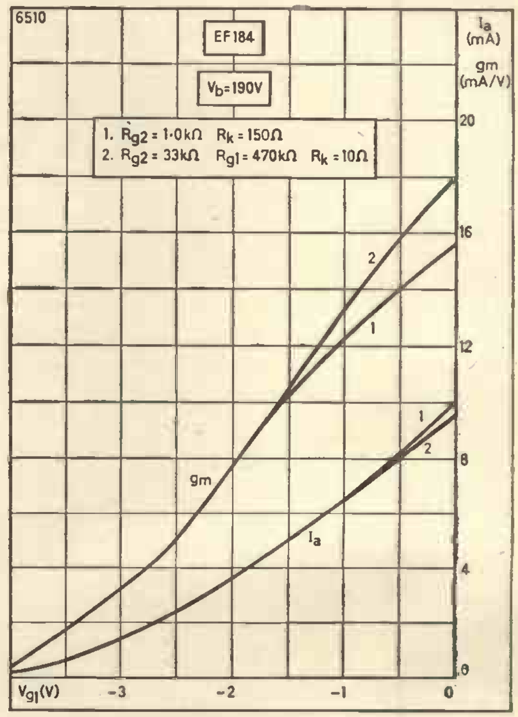
The EF184, in common with the other types in the Mullard frame grid range, has about twice the slope of its conventional counterpart. Under comparable conditions, the conventional EF80 has a slope of 7·4mA/V, as against 15·5mA/V for the EF184. This doubling of the slope provides a substantially improved gain per stage, of the order of 2 or 2½ times.


EF184

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 10Ω. 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.




Mullard

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MVM 428

JANUARY 1960
Vol. 66 No. 1

Wireless World

# 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**

THE Smith chart[1] 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[2, 3, 4] 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[5] 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° (in-phase) to ± 180° (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°, that is, in a half wavelength, the total change in phase between the two waves will be 360°.

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 antilog N/20, so that their ratio $E_r/E_i$ will change by 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°). 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:—

$$E_i = Z_o I_i$$
$$E_r = -Z_o I_r$$
$$E_l = Z_l I_l$$

The minus sign in the second equation expresses

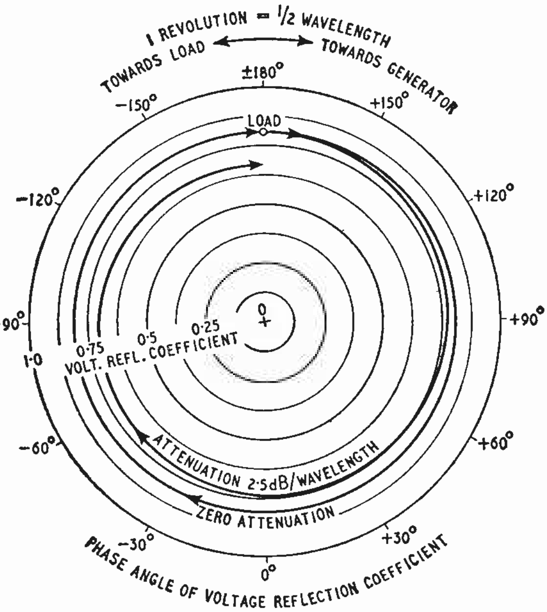
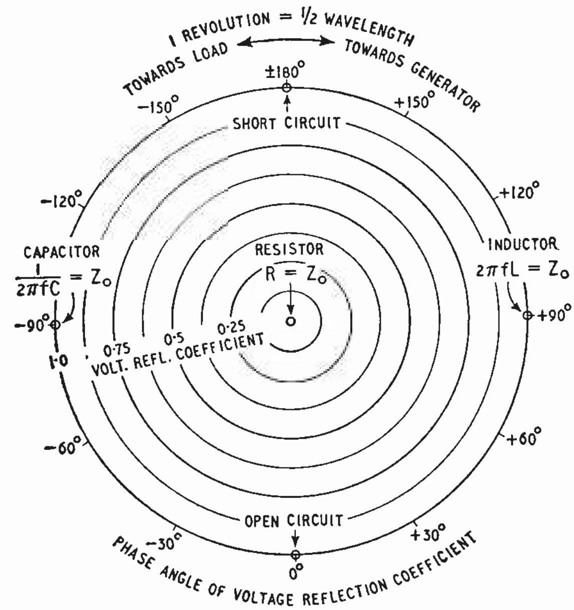



*Fig. 1. Polar diagram of voltage reflection coefficient. Effect of movement along loss-free and lossy lines.*

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




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

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

$$E_i + E_r = E_l$$
$$I_i + I_r = I_l$$

Simultaneous solution of these five equations gives:—

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

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

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

Writing K for $E_r/E_i$

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

(*a*) *Characteristic impedance $R_o$*.—By definition, see above, this will produce a voltage reflection coefficient of 0 (0°).

(*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°). Mathematically

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

This is equivalent to + 1 (180°) as can be seen by considering that the positive direction along the 0° 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 $(E_i/I_i) = Z_o = -(E_r/I_r)$, $E_i = E_r$, that is, they are in phase and the voltage reflection coefficient is 1 (0°).

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

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

$$Z_l = 0 - jR_o$$

$$K = \frac{0 - jR_o - R_o}{0 - jR_o + R_o} = \frac{-j1 - 1}{-j1 + 1}$$
$$= \frac{(-j1 - 1)(+j1 + 1)}{(-j1 + 1)(+j1 + 1)}$$
$$= \frac{-j^2 - j2 - 1}{-j^2 + 1} = -j1$$

In polar notation, K = 1 (− 90°).

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

We are now ready to derive the Smith chart.

**Derivation of the Smith Chart.**—The five points corresponding to loads of $R_o$, 0, $\infty$, $0 + jR_o$ and $0 - jR_o$, 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 zero reactance is, like zero resistance, a short circuit, so that the points ∞ 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.

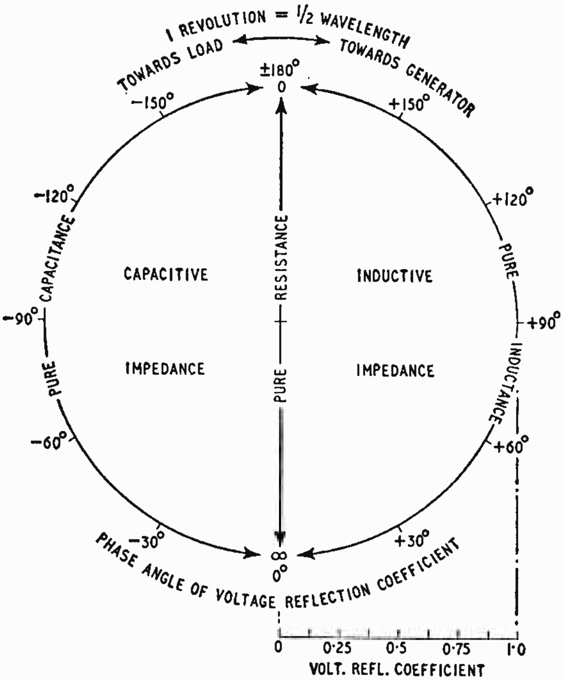
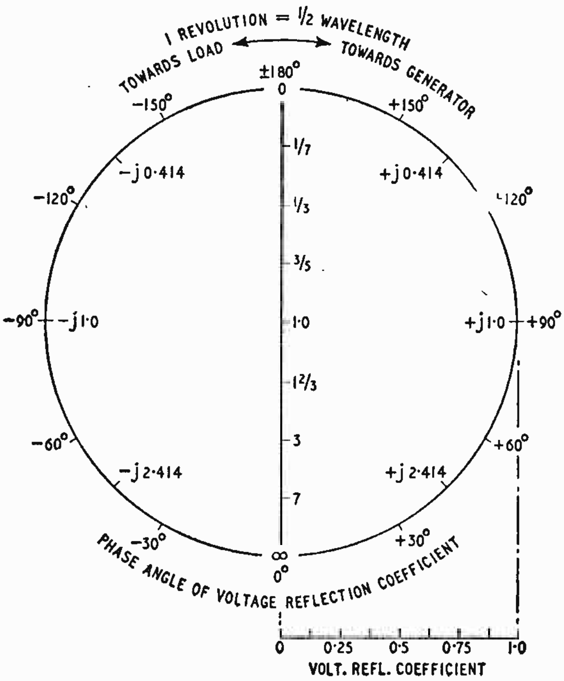



*Fig. 3. Voltage reflection coefficients produced at the load by the five possible types of load. Magnitude of the reflection coefficient is shown on an auxiliary scale.*

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



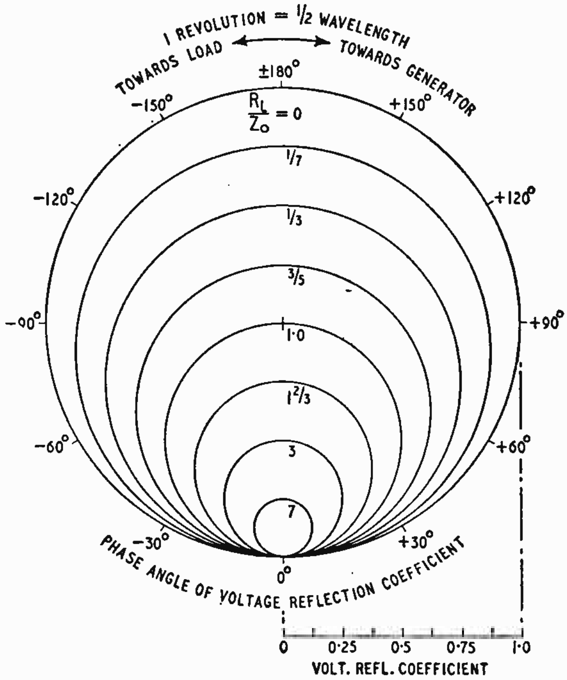
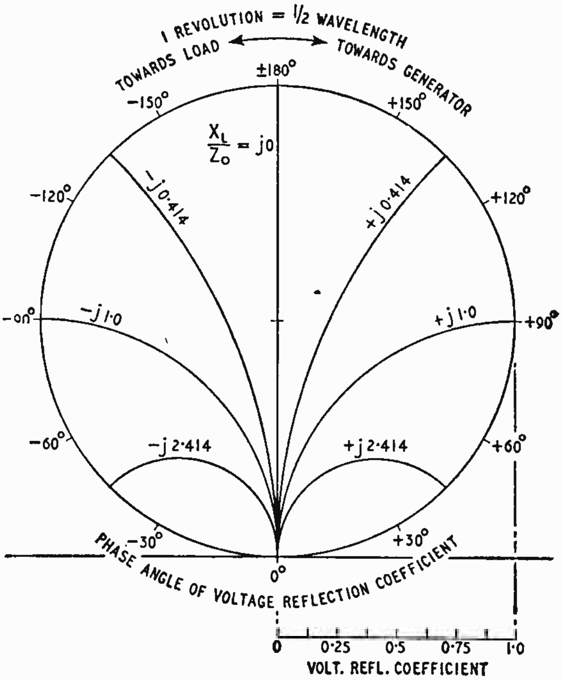




*Fig. 5. Voltage reflection coefficients produced by loads having the same normalized resistive component of load impedance lie on a circle.*

*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°). 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 (°) 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

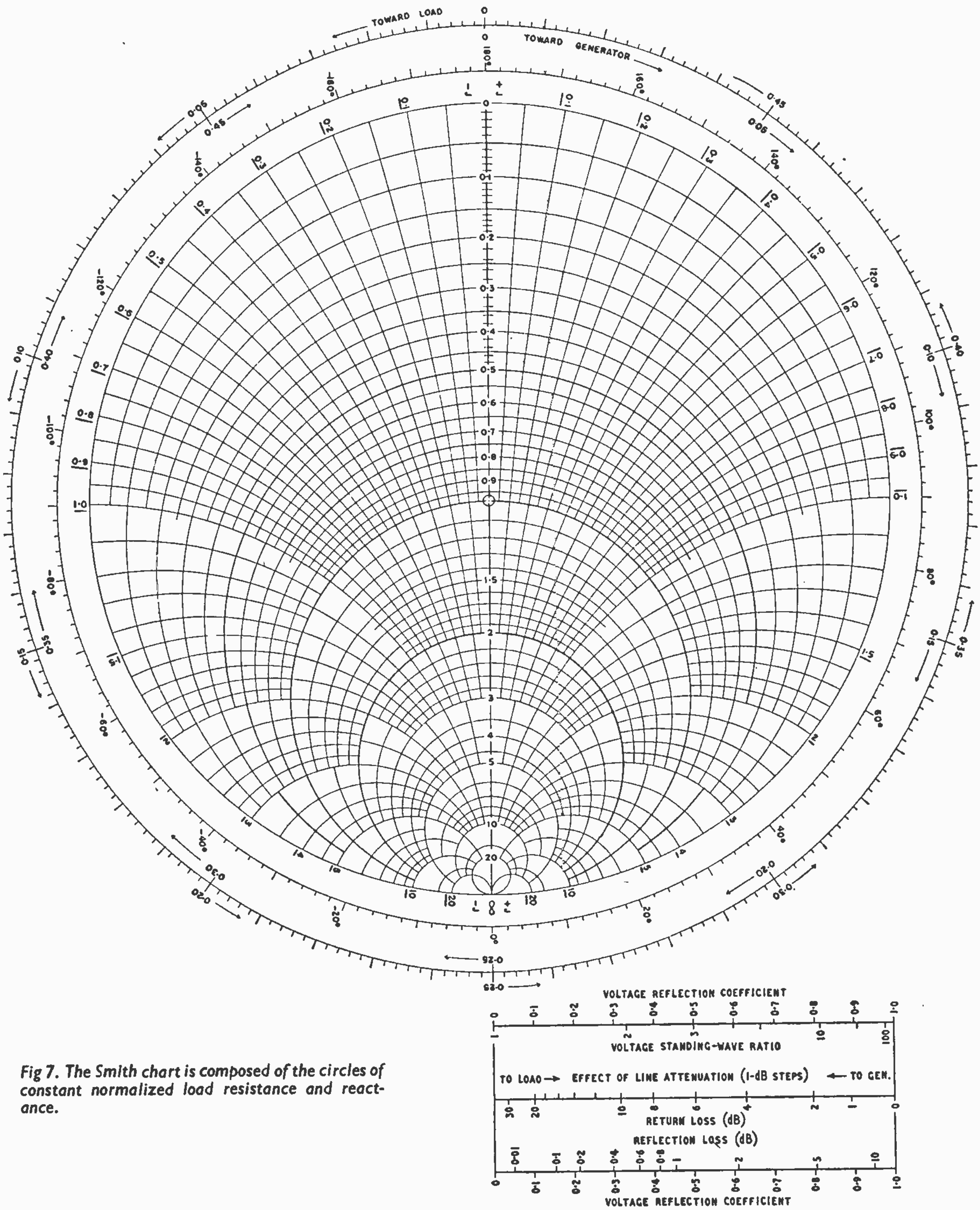



*Fig 7. The Smith chart is composed of the circles of constant normalized load resistance and reactance.*

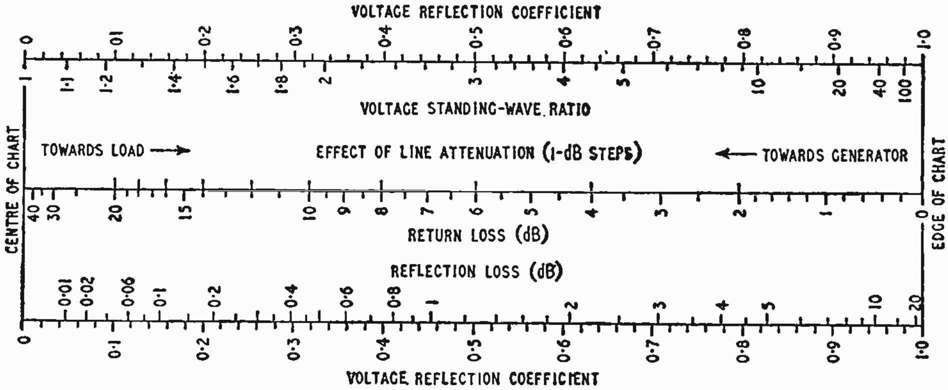



*Fig. 8. Auxiliary scales are provided for radially-scaled parameters to avoid additional circles on the chart.*

$\pm jX_l/R_o$ 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°). 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 $= 20 \log 1/K$ .. 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:—

$$P_a = P_i - P_r$$

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

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

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

(*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 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°, 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° 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 $+ 18°$ to $- 162°$, 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 $\pm 180°$ 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.

$$S = \frac{1 + K}{1 - K} \text{ and } K = \frac{Z_l - R_o}{Z_l + R_o}$$

Writing $z$ for $\frac{Z_l}{R_o}$, $K = \frac{z - 1}{z + 1}$

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

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 then 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.

$$y = \frac{1}{z}$$

$$z = \frac{1 - k}{1 + k}$$

$$y = \frac{1 + k}{1 - k}$$

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

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°.

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° 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° 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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## 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 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°): using the $u+jv$ notation it would become $0.65+j0.375$.

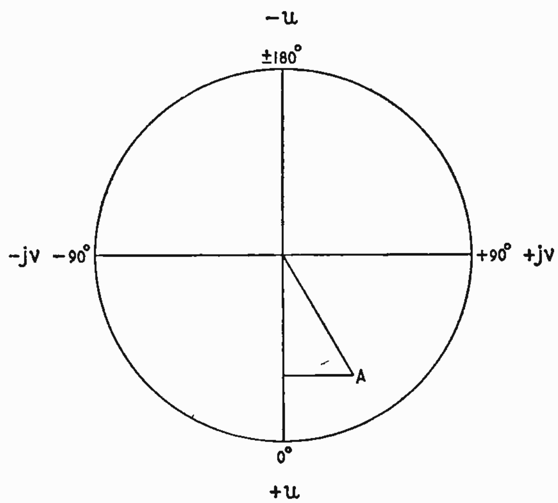



*Fig. 9. Use of rectangular co-ordinates for voltage reflection coefficient.*

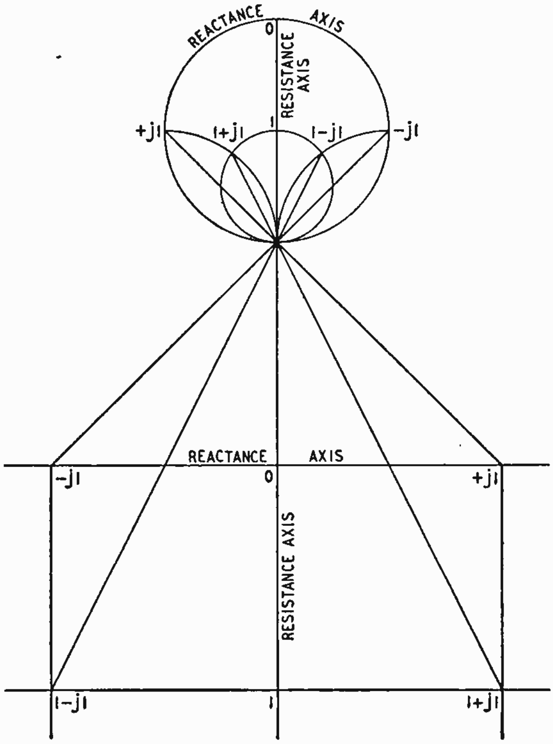



*Fig. 10. The Smith chart is geometrically related to the Cartesian impedance diagram.*

Let $K = u+jv$

$$\frac{R_l}{Z_o} = r$$

$$\frac{X_l}{Z_o} = x$$

Then $\frac{Z_l}{Z_o} = r + jx = \frac{1+K}{1-K}$

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

Rationalizing

$$r + jx = \frac{1 - u^2 - v^2 + j2v}{(1 - u)^2 + v^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

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

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

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

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

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

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

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 [2, 3, 4]. 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

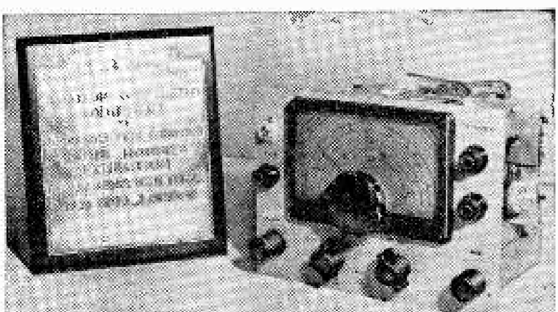
THIS year, two awards for outstanding design and construction were made. Both took the form of silver plaques; one, as in previous years, being awarded for the most outstanding home-constructed piece of equipment and, an innovation, one for the piece of commercial equipment of the greatest value to the 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 $1\mu V$ for a signal-to-noise ratio of 10dB. On show was the Collins KWM-2 which, in a cabinet $8\times15\times13$in, combines a five-band s.s.b./c.w. transmitter of 100W p.e.p. output and a receiver of sensitivity $0.5\mu V$ (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 convertor 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.*



(±0.5Mc/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 "Topbander" 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-Ω or 80-Ω twin feeder to a coaxial 80-Ω 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-Ω or 80-Ω 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.

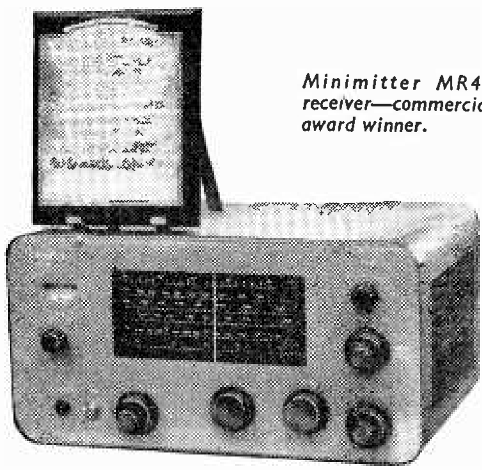
To the R.S.G.B. credit is due for another innovation—a most successful one, too. Entitled "Communications Receivers of the World," this exhibit comprised thirteen "famous name" receivers of British and foreign manufacture. In all except one case, the receivers were working and visitors to the exhibition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

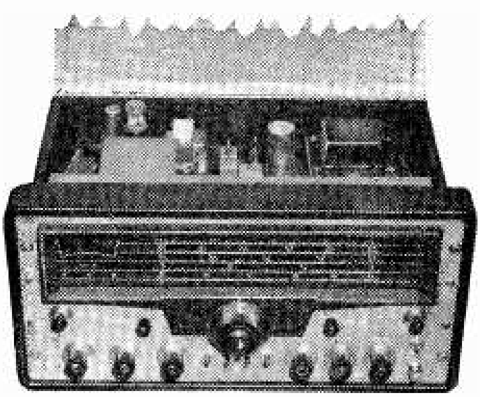
Mullard were demonstrating, for classroom use, a simple method of displaying the properties of magnetic materials using an oscilloscope.* Two coils with a large number of turns (about 3,000) are used and one coil is fed with 50c/s a.c. which provides the horizontal deflection for the c.r.o. The output 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 "wobbulator." 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

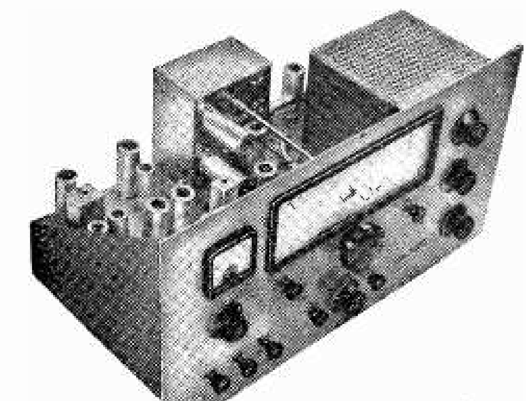
**Wireless World*, Vol. 64, p. 433 (September, 1958) (oscilloscope), and "Demonstrations and Experiments in Electronics No. 9." Mullard Educational Service (hysteresis demonstration).



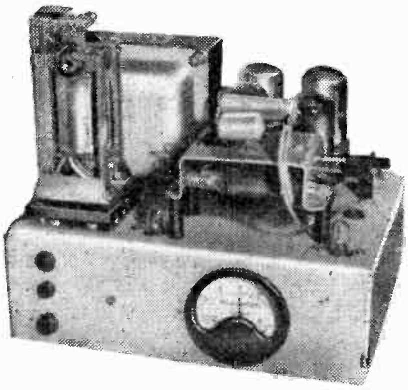
*Minimitter MR44 receiver—commercial award winner.*



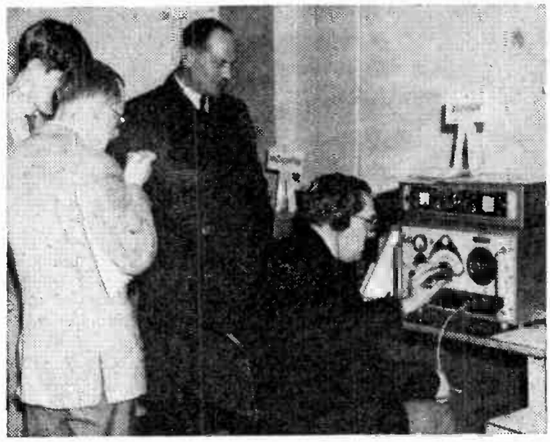
*Hallicrafters SX-101A receiver.*



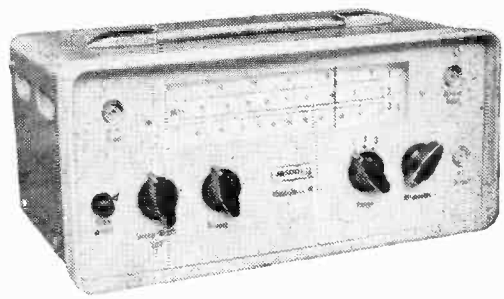
*S.s.b. transmitter by K. W. Electronics.*



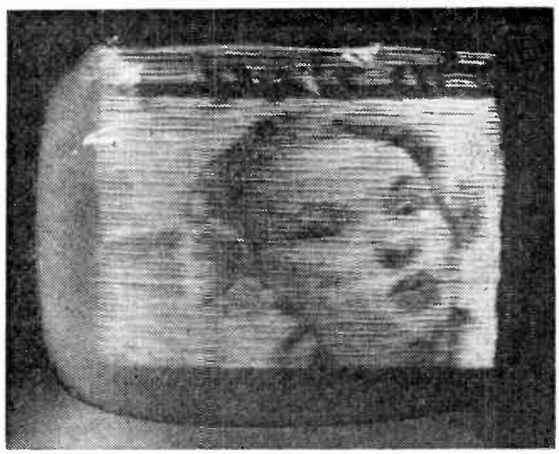
*G2UK's f.s.k. teleprinter terminal unit.*



*" 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).*

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 semi-conductor-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 Transipack, 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 exciters 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 from the receiver, converts the 860c/s frequency shift back into ±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 bandwith 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.

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

# 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.

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**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.

**Television 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, Ogden.

**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.

**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.

## OUR AUTHORS

**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 Racal Engineering.

**Joseph Poliakoff,** founder of the Multitone Electric Co. in 1931, died on November 24th at the age of 86. Mr. Poliakoff, 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.



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# 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.

**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.

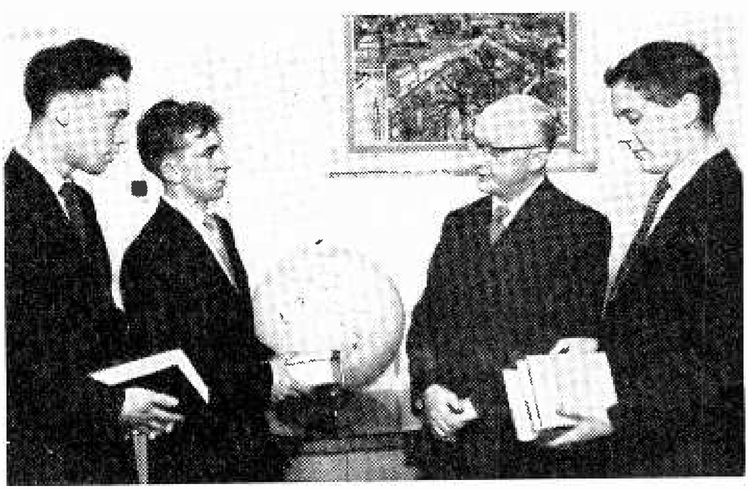
**Datum Metal Products Ltd.** (formerly Davis and Thompson), members of the J. Langham Thompson Group, have moved into a new factory on the Colne Way Trading Estate, Watford By-Pass, Herts (Tel.: Watford 22351). These new premises have trebled the production area of the company.

**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.



*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.*

# 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.

AMONG 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

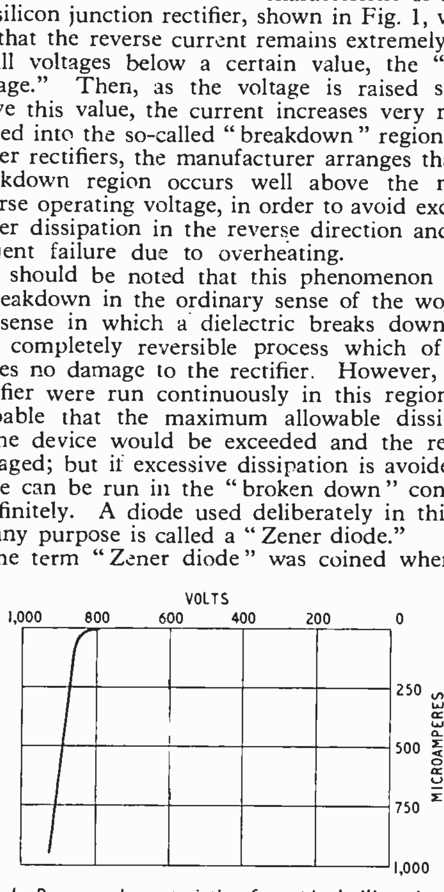
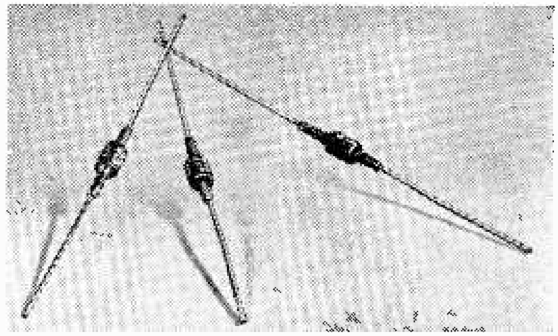



*Fig. 1 Reverse characteristic of a typical silicon junction rectifier.*

breakdown was first observed[1] because it was thought that the mechanism responsible was that proposed by C. Zener in 1934 to account for the breakdown of solid dielectrics[2]. 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.[3] 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

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

[1] 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.
[2] C. Zener. "Theory of the electrical breakdown of solid dielectrics," *Proc. Roy. Soc.*, **145**, p. 523, 1934.
[3] J. S. Townsend. "The passage of ions in gases," *Nature*, **62**, p. 340, 9th August, 1900.

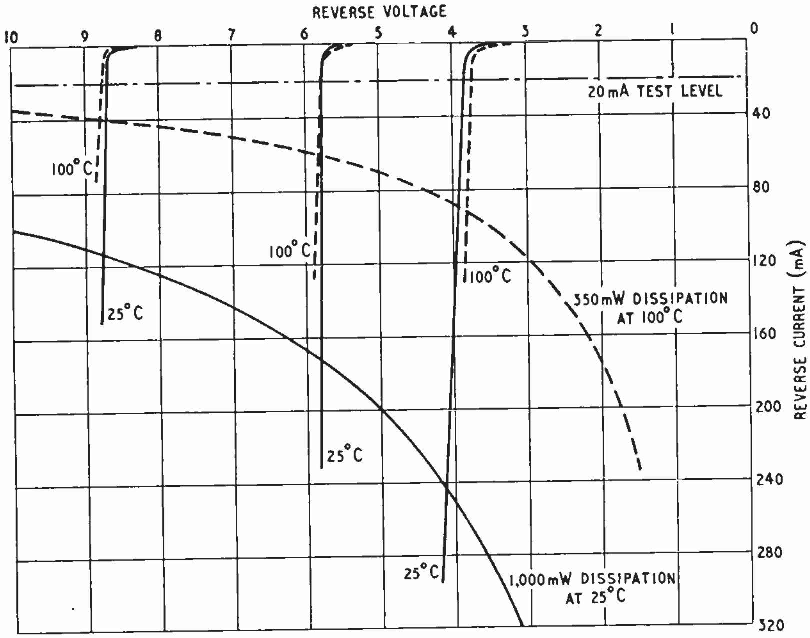



*Fig. 2 Typical characteristics of diodes specially made for Zener operation.*

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 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 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

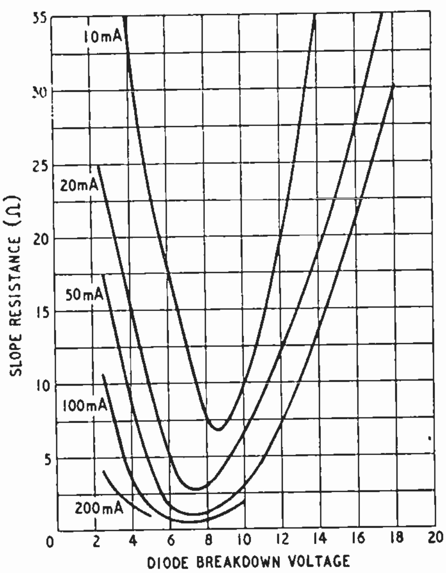



*Fig. 3 Variation of slope resistance with reverse current for a typical range of Zener diodes.*

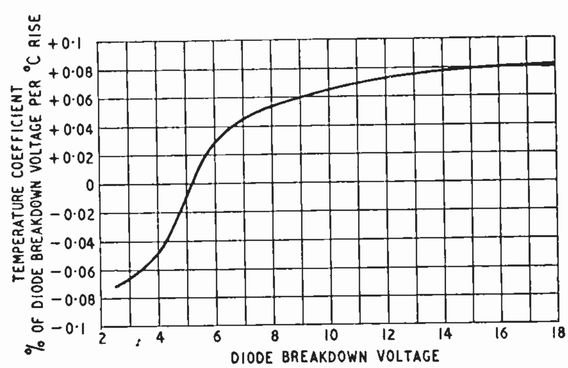



*Fig. 4 Temperature coefficient of voltage for a typical range of Zener diodes.*

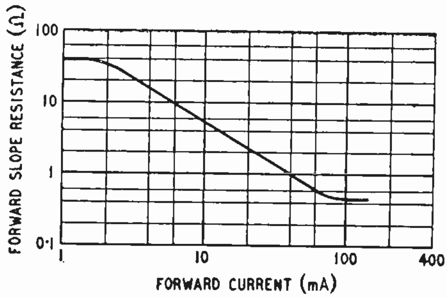



*Fig. 5 Variation of forward slope resistance for a typical Zener diode.*

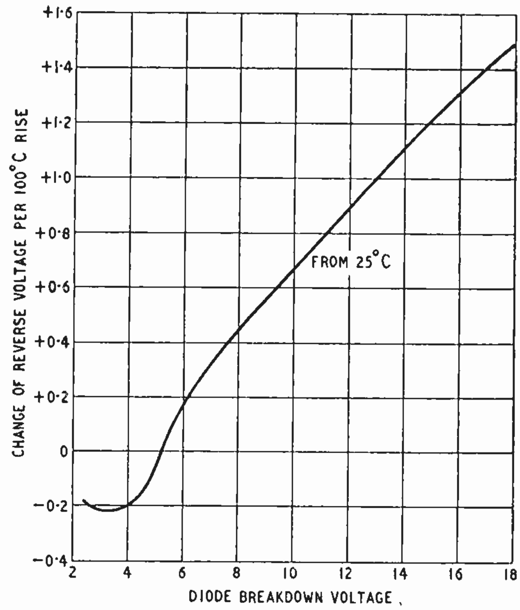



*Fig. 6 Change of reverse voltage (at constant current) for a typical range of Zener diodes.*

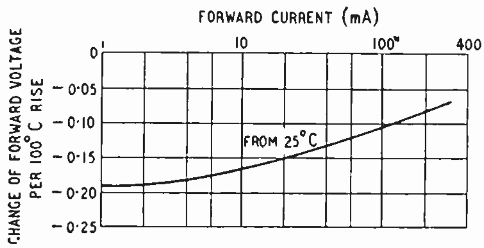



*Fig. 7 Change of forward voltage for a typical Zener diode.*

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 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

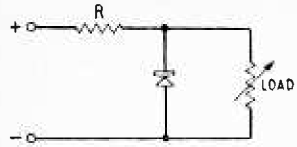



*Fig. 8 Application as a voltage regulator or reference source.*

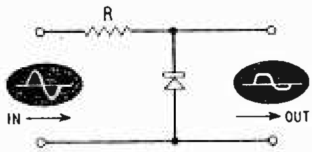



*Fig. 9 Surge limiting circuit using a Zener diode.*

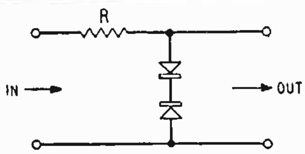



*Fig. 10 Balanced clipping circuit using back-to-back diodes.*

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 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, ±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 ±5%, ±10%, and ±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.

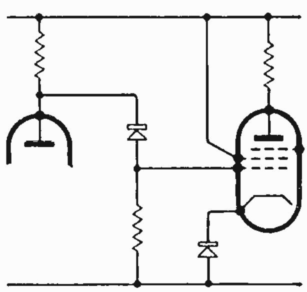


*Fig. 11 Zener diodes used for coupling elements and cathode bias in a d.c. amplifier.*

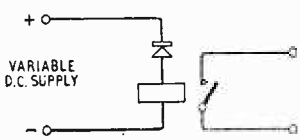



*Fig. 12 Application as a voltage-sensitive relay.*

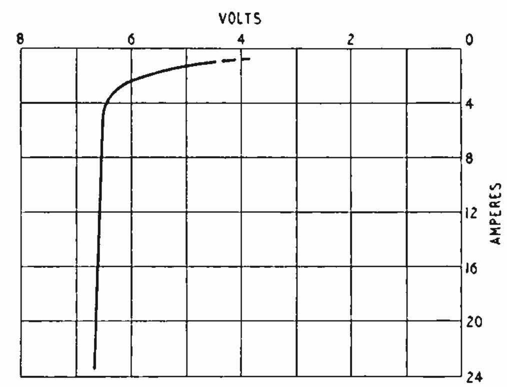



*Fig. 13 Characteristic of an experimental high-power shunt regulator Zener diode for the region 2-20 amperes.*

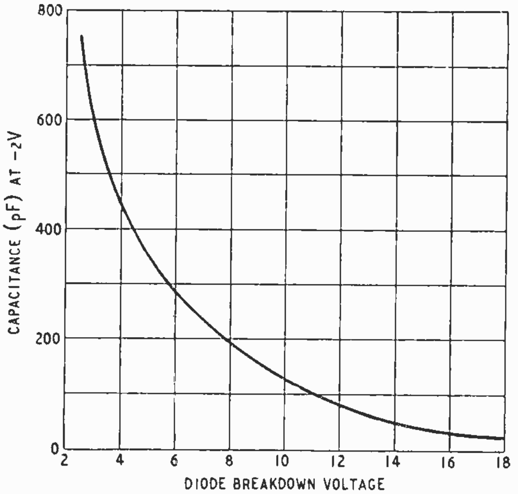



*Fig. 14 Capacitance effect over a range of Zener diodes.*

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. $\frac{dV}{dI} << \frac{V}{I}$) 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.

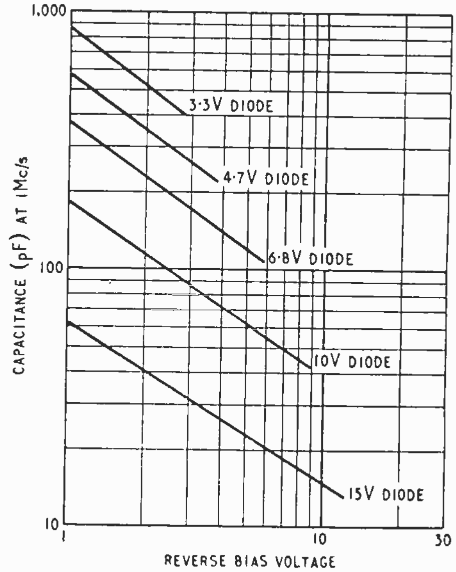



*Fig. 15 Typical values of capacitance for reverse bias voltages before the breakdown region (at 25°C).*

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.

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**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[1] a badly-written piece of work, but when a paper is well written, they should leave it alone[2].

The interference frequently consists in making alterations to the style to bring it into line with editorial policy[3]. 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[4] 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[5] reacts by asking "what paper?". The same Learned Society[4] recently allowed one of its vice-presidents to use the phrase "a whole diversity of new materials"[6]. 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[4] is the author of several books from which it is clear that he does not know how to punctuate. Yet this Learned Society[4], 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[4] 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[7]. 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. . . ."[8] And, critics, please be a little more charitable to the author[9]. 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?[10]

Chelmsford. R. A. WALDRON.

[[1] Or decline to publish.
[2] Being busy men they are usually happy to do so.
[3] This journal welcomes diversity of style.
[4] Capitals for a common noun and its adjective?
[5] Sense is shorter than sensibility and does not involve the emotions.
[6] What is wrong with this? Collectively the materials are finite and although diverse can be comprehended as a whole.
[7] Who will then permit the editor's name to appear as co-author?
[8] This is the dull mechanic trade of *sub*-editing.
[9] Touché!
[10] 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.]

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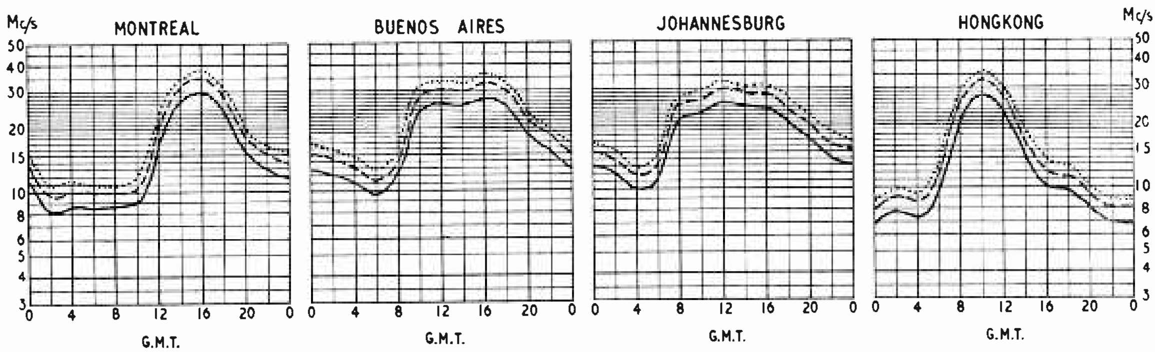
## SHORT-WAVE CONDITIONS

*Prediction for January*




•••••••••• 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

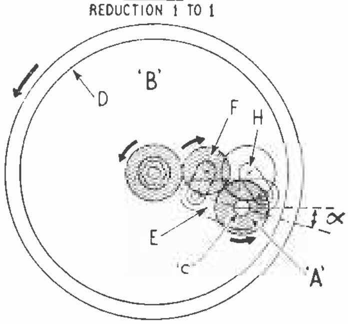
THE full-line curves indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during January.

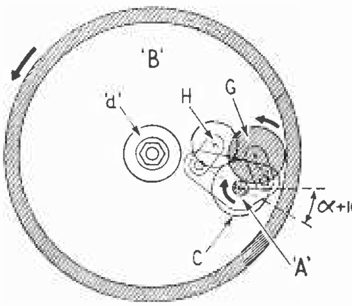
Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.

# *Technical Notebook*

**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

STATE 1
REDUCTION 1 TO 1




STATE 2
REDUCTION 1 TO 30

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 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%.

# 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 |
|---|---|
| Accles & Pollock | 75 |
| Admiralty Research Estab. | 40 |
| Advance Components | 9 |
| Armament Research and Development Estab. | 1 |
| Associated Electrical Industries | 123 |
| Atomic Energy Research Estab. | 86 |
| Atomic Weapons Research Estab. | 86 |
| Avo | 90 |
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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[1] 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 20MΩ, then it can be seen from the formula

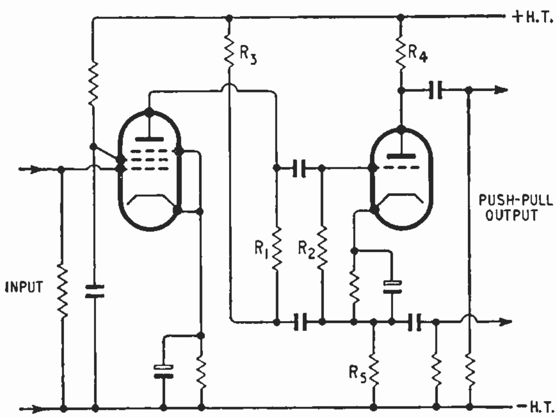



*Fig. 1. Theoretical circuit of high-gain phase-splitter.*

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

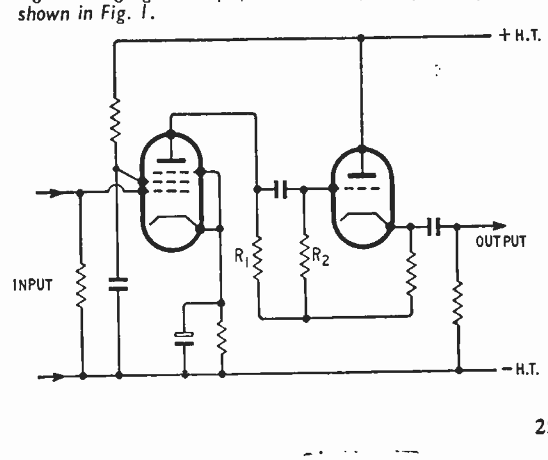
In the high-gain phase-splitter circuit the maximum amplification obtained is about 1,000 times. This compares favourably with the normal overall gain for a pentode amplifier (and "concertina" phase-splitter) of 100 to 300 times. Providing that a push-pull output is required, it is difficult to see how 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 $R_4$ 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 rearranged, 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[2]. 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 $\mu_t$V (where $\mu_t$ 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 $\mu_t R_1$. 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 100MΩ. 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.

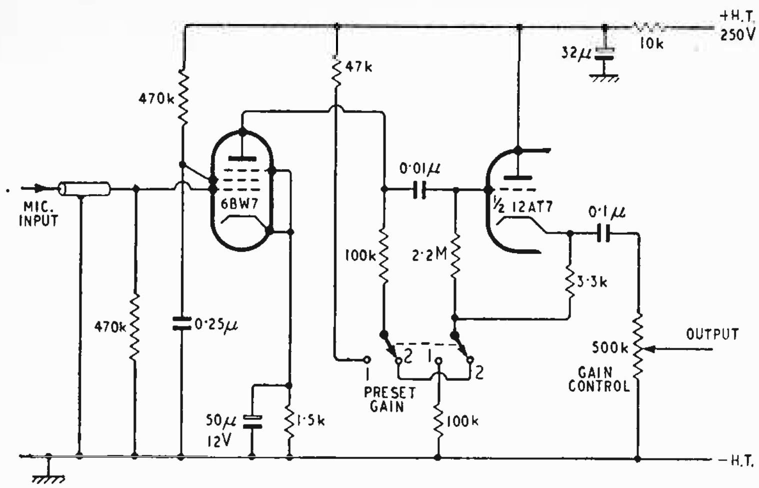



*Fig. 3. High-gain amplifier used as microphone pre-amplifier. Preset gain switch positions: 1, low gain; 2, high gain.*

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[3]. 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 $10/\pi$MΩ. 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 5MΩ, this gives a maximum pentode anode load in the order of 8MΩ. This was halved to allow for the stray capacitances that were ignored; thus a value of 4MΩ was obtained. With a 12AT7 valve a voltage amplification of 40 would be expected, hence a value of $4\times10^6/(40+1)$, or approximately 100kΩ, 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 50kΩ 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 7½in/sec speed and on accepted practice (in the absence of a standard) for the 3¾in/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 valve 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-Ω 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-

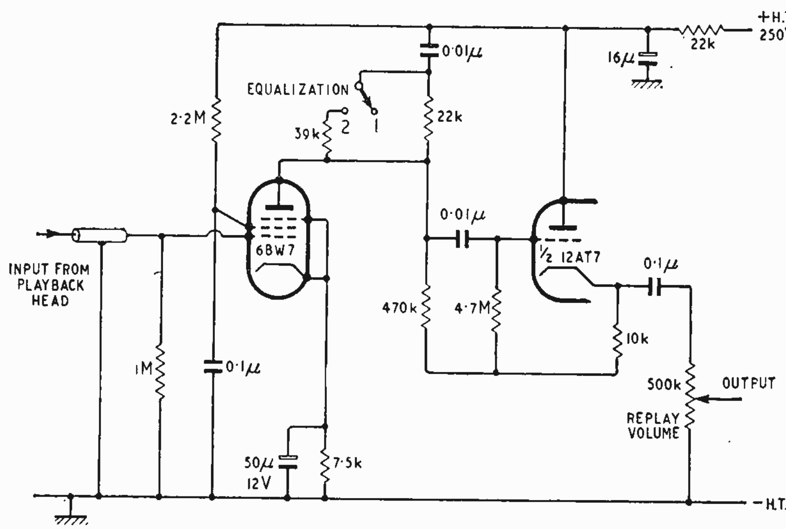



*Fig. 4. Tape-playback pre-amplifier providing equalization facilities. Switch positions: 1, 3¾ in/sec; 2, 7½ in/sec.*

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 4.7kΩ for the tape-replay amplifier and to 1kΩ 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

[1] 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.

[2] Radio Engineering (3rd Edition) by F. E. Terman, p. 308, McGraw-Hill Publishing Co., Ltd.

[3] 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 Association.—"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 (Timtape)" 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 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.

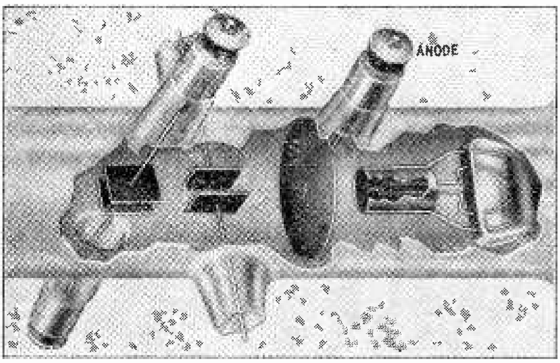



*Fig. 1. The electron gun developed in 1928 with negatively-biased control electrode and beam cross-over. This gun, which is used in most present-day electron beam appliances, is shown here in an oscillograph tube for anode voltages above 1 kV, introduced by Leybold of Cologne in 1929.*

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$\mu$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[1] 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 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

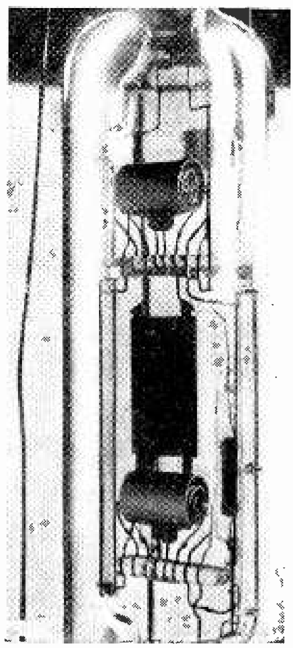


*Fig. 2. The Loewe dual tube, developed in 1925, was in fact the first wide-band amplifier, in the modern sense of the term, and had a bandwidth of 1 Mc/s. This was obtained by the combination of a particularly low-capacitance circuit with high-slope valve systems.*

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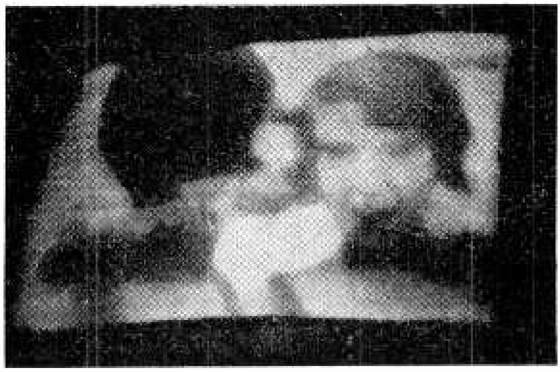
Lichterfelde laboratory, on the basis of publications by B. van der Pol and H. Frühauf[3] with the collaboration of I. Kammerloher. These gave triangular waveforms which could be synchronised by means of a cold-cathode thyraton with external control from the signal.

In the year 1930 there were available, in my laboratory in Lichterfelde, electron beam tubes with intensity modulation electrodes and high focal point brightness[4], 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[5]. 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[6]. 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[6].

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

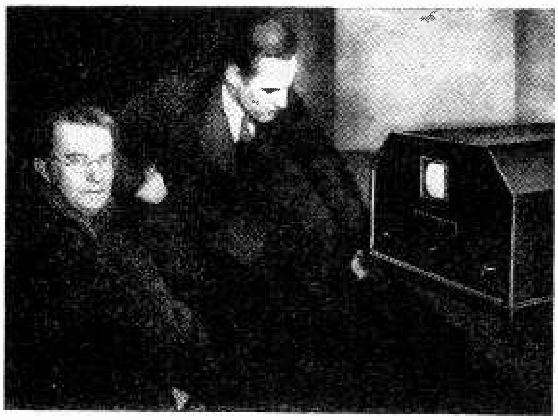


*Fig. 4. The British television pioneer J. L. Baird (left) on a visit to our television laboratory in Berlin-Lichterfelde.*

Schlesinger, using the so-called "variable speed scanning method" proposed shortly before by Richard Thun[7]. 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[8]. 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[9]. 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 measuring 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[4] 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[10], the electron-optical mode of operation had been developed by Calbrick-Davisson, Brüche, Knoll, Recknagel, Scherzer and others[11]. 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[12].

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[13]. In this type of oscillograph,

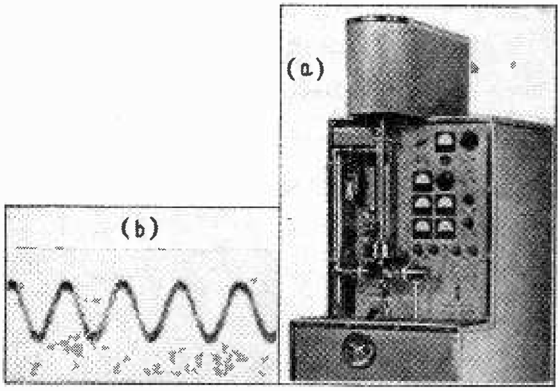



*Fig. 5. (a) The electron micro-oscillograph devised in 1939 became well known, particularly through the equipment developed by Lee shown here. At (b) is a "one-shot" oscillogram of a wave with a frequency of 3,000 Mc/s, traced with a 10-micron scanning spot.*

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[14] 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[15]. 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[16] 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 9cm × 12cm 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[17] 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-

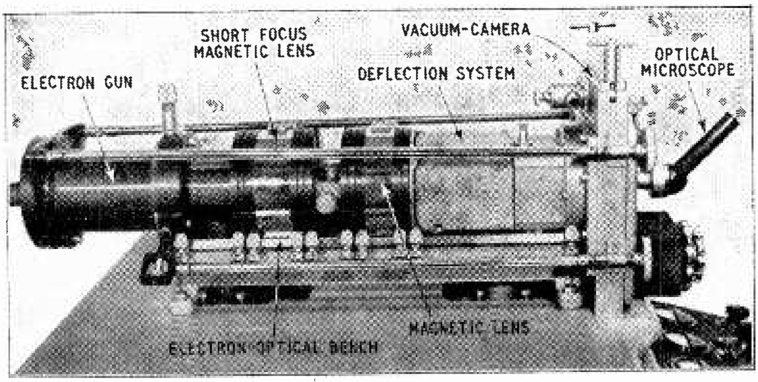



*Fig. 6. Layout of the precision electron beam oscillograph developed during the period 1952-55. In this apparatus, built by VEB Vakutronik of Dresden, the scanning spot is only 3 to 5 microns and the scanning area is about 9 cm x 12 cm.*

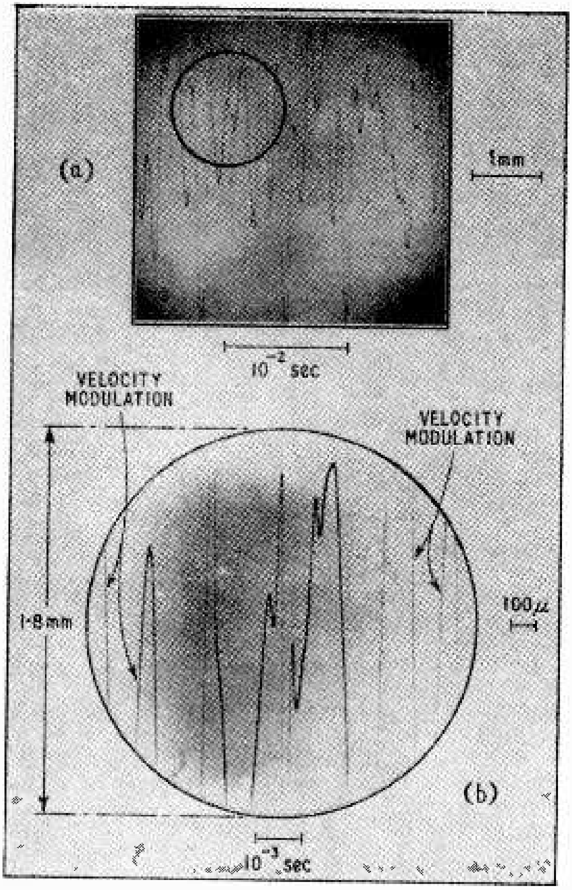



*Fig. 7. Highly-magnified sections from a precision oscillogram of a music waveform at the output of a radio receiver: (a), section magnified 15 times (approx. 1/900 of the area of the 9 cm x 12 cm photographic plate); (b), section magnified 56 times, showing velocity modulation of the scanning line 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[18].

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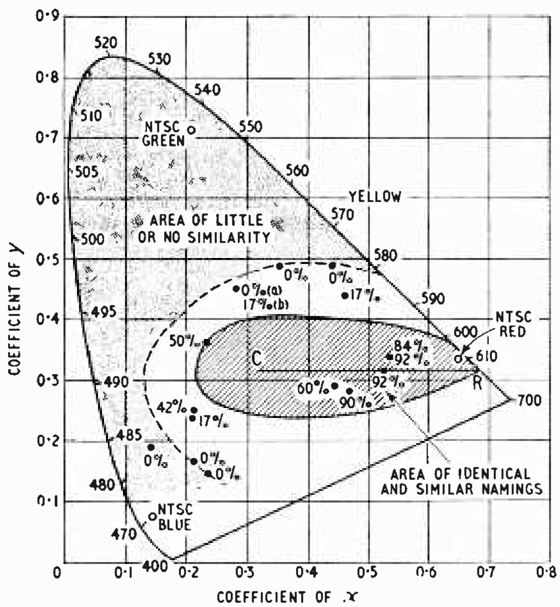
# Subjective Colour Tests

## MEASUREMENTS ON A REDISCOVERED "TWO-COLOUR" SYSTEM

TELEVISION 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.*

*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.*




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,

*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.

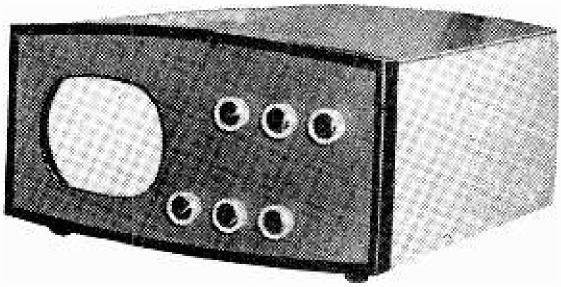
‡ For an explanation of the C.I.E. (Commission Internationale de l'Eclairage) chromaticity diagram and its $x$ and $y$ co-ordinates, see "Colour Fundamentals," by H. Henderson, *Wireless World*, August 1956.

## 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 oganized by Benger Laboratories, Ltd., and held at the London headquarters of the British Medical Association.



*Small television receiver seen at recent exhibition.*

# Electromechanical Analogies

By
" CATHODE RAY "

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

LAST 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. 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-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.

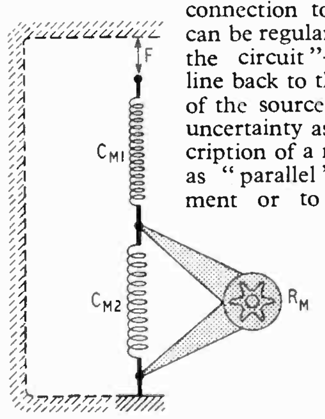



*Fig. 1. Mechanical "circuit", in which an alternating force F is applied to two springs, to one of which is connected a frictional damper.*

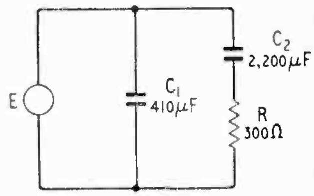



*Fig. 2. Direct electrical analogue of Fig. 1.*

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 2¼ 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.$^2$. 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/s² ("*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. $C_{M1}$ being (visually) in series with F and the combination of $C_{M2}$ and $R_M$, its analogue $C_1$ in Fig. 2 must be in parallel with them. And the analogues of the parallel pair $C_{M2}$ and $R_M$ 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 $C_{M2}$ and $R_M$, would appear in Fig. 2 as an inductance of 1 henry per kg. in the $C_2R$ 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 $C_2$ 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 $C_1$ would be several times greater than that of $C_2$ 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 being important) the impedance of $C_{M1}$ is relatively low, so it flexes most.

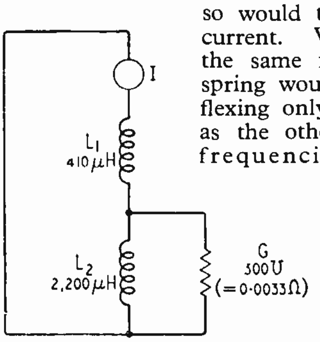



*Fig. 3. Inverse electrical analogue of Fig. 1 and dual of Fig. 2.*

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 expecially 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 2,200μF 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

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

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

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

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

and inversely

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

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

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

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 $C_2$ in Fig. 2 2.2μF, then from eqn. (4) $b/a = 1{,}000$, and if we make $b = 1/a$ we have $b^2 = 1/a^2 = 1{,}000$. 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 |

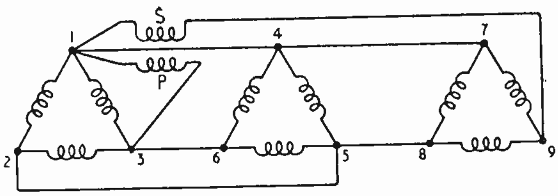



*Fig. 4. Use of an ideal 1:1 transformer (PS) to enable a circuit to be drawn without crossing wires. This brings such exceptional circuits within the scope of the rules for drawing dual circuits.*

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.)

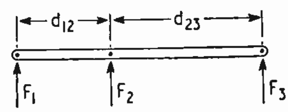
So far, then, all is well. The disdavantage is that when one comes to study the mechanical behaviour on a basis of familiarity with circuit behaviour, one's familiarity is found to be of the wrong kind. It may be hard at first to interpret the increase in voltage across $L_1$ with rise in frequency as 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

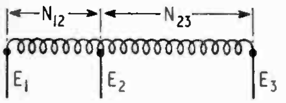



*Fig. 6. Electrical analogue of Fig. 6—an autotransformer.*

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 an 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:

$$F=B\,l\,I \quad \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

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):

$$E=B\,l\,V \quad \ldots\ldots\ldots\ldots\ldots (7)$$

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 " electro*static* " 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

$$F=\frac{E_0\,\epsilon\,AE}{d^2} \quad \ldots\ldots\ldots\ldots\ldots (8)$$

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

$$I=\frac{E_0\,\epsilon\,AV.}{d} \quad \ldots\ldots\ldots\ldots\ldots (9)$$

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 halycon 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 "Echophone." It was about 12 × 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 "Echophone," 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 × 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?).

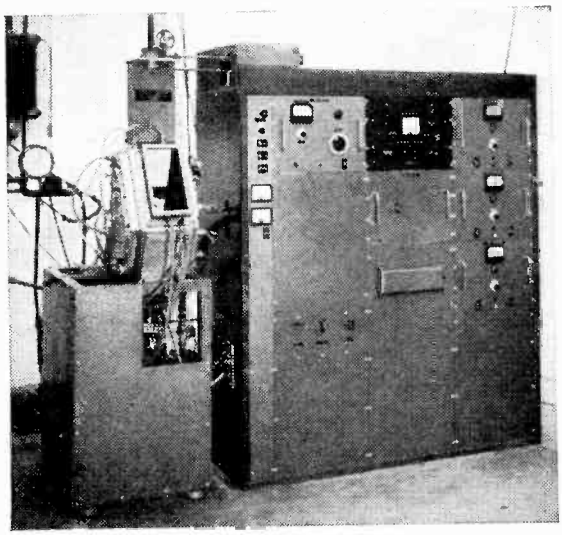
We were getting by with these Minute Marvels until the setmakers decided that too much of a good thing was not enough, and began their shrinking techniques upon TV receivers! Now, the average TV set, even some of our mail-order marvels, need quite a few more parts than a 4-transistor radio. Still, these 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!

** *Wireless World*, November 1957.



***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.*

# Loudspeaker Magnet Design

## With Special Reference to Capped Cylindrical Slugs of Alcomax III

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

THE 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, 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.

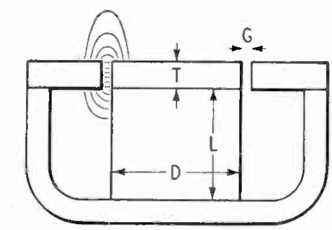



*Fig. 1 Dimensions and stray fields in the capped cylindrical-slug magnet design.*

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 diameter 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° 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° 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

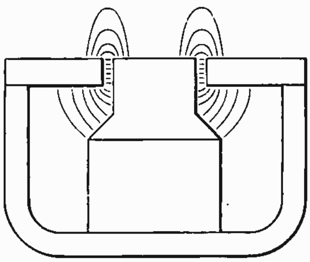


*Fig. 2 Skirted pole piece magnet construction showing stray fields.*

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

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

**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:—

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

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

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

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:—

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

**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 $wd/2\pi D$.

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., $T = wd/2\pi D$.

Hence $D = wd/2\pi T$ .. .. .. .. (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 | in | gauss | % |
| ½ | 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-columnar 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 3 Ω. The d.c. resistance of the voice coil may therefore be taken as 2.7 Ω.

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 2570 Ω per lb; since 2.7 Ω will weigh $2.7 \times 454/2570 = 0.48$ gm.

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

The overall diameter of 38 s.w.g. wire, enamelled, is $0.0067 \text{ in} = 0.01703 \text{ cm} = d$.

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

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

**Magnet.**—The values for B and H for semi-columnar 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 $2 \times 0.0067 + 0.003 + 2 \times 0.007 \text{ in} = 0.0304 \text{ in} = 0.0772$ cm.

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

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

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

$$\text{V} = \text{W} \times 28.4/7.35 = 3.86 \text{ W}$$

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

$$D^3 = 3.86\text{W} (3.83 \text{ T} + 1.034) \ldots \quad \ldots (10)$$

From equation (8) we have $T = 0.775/D$. Substituting this value of T in equation (10), we have:—

$$D^3 = 3.86\text{W} (2.97/D + 1.034)$$

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

$$D^4 - 3.99 \text{ WD} = 11.44 \text{ W} \quad \ldots \quad \ldots (11)$$

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

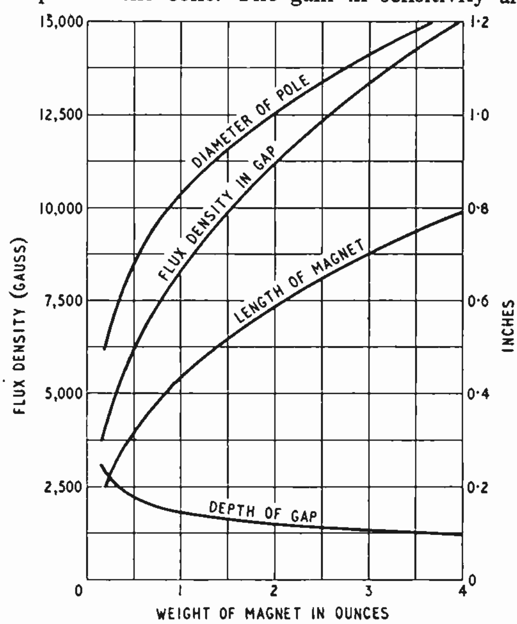



*Fig. 3 Magnet designs for small commercial loudspeakers showing diameter of pole, flux density in gap, length of magnet, and depth of gap in terms of weight of magnet.*

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 15 Ω. 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 10 Ω rather than 15 Ω less 10%. For this design we shall take 9 Ω.

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

A speaker to have a good low-frequency performance 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 ⅛in. above and below the gap. Thus the coil will not commence to leave the gap until the amplitude of movement exceeds ⅛in.

The gap depth may therefore be taken as ¼in or 0.625 cm less than the coil length. Thus

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

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

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

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

$$= \frac{6.98}{T+0.625} \qquad (13)$$

**Magnet.**—The voice coil wire diameter, $d$, $=0.0094$in. 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 $2\times0.0094+0.0045+2\times0.011$in $=0.045$in$=0.1143$ 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:—

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

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

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 ½ 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.

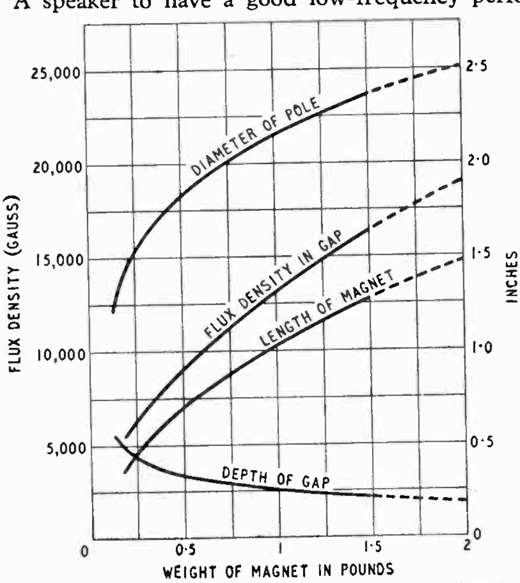



*Fig.4 Magnet designs for 12-in low-frequency loudspeakers showing diameter of pole, flux density in gap, length of magnet, and depth of gap in terms of weight of magnet.*

In considering these designs, it must be remembered that one requirement was that the voice coil must extend for ⅛-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 1½ lb therefore, it is considered that it would be better to increase the wire gauge and thus the length of wire for 9 Ω.

# 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.

THE 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

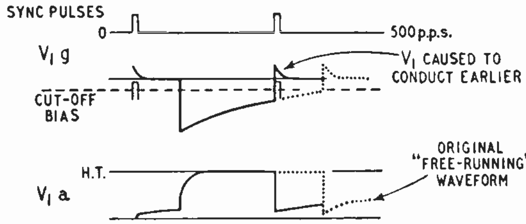



*Fig. 1.*

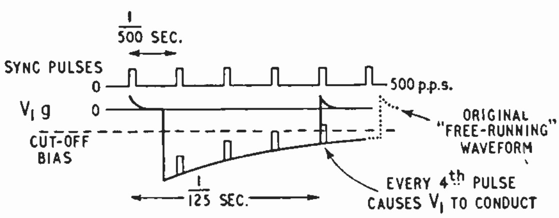



*Fig. 2.*

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 $n^{th}$ pulse. 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.

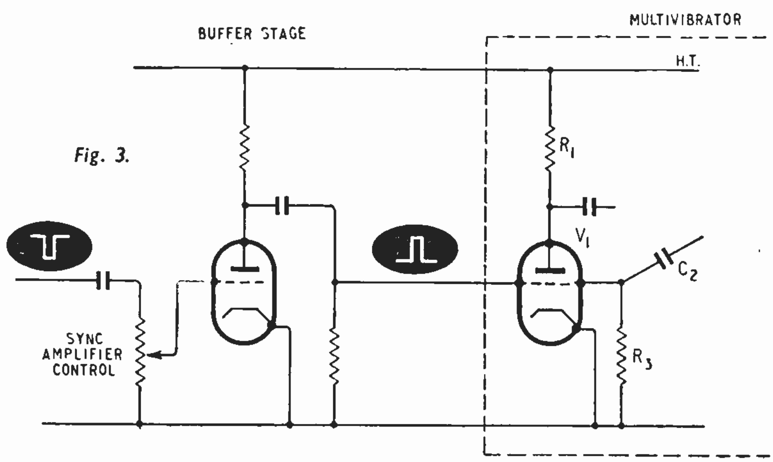
In the example shown, only the duration of the positive portion of the anode voltage waveform is affected by the triggering action. If the duration of both positive and negative portions of the waveform are to be controlled, it will be necessary for both valves to be triggered. A convenient method is 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. 3.*



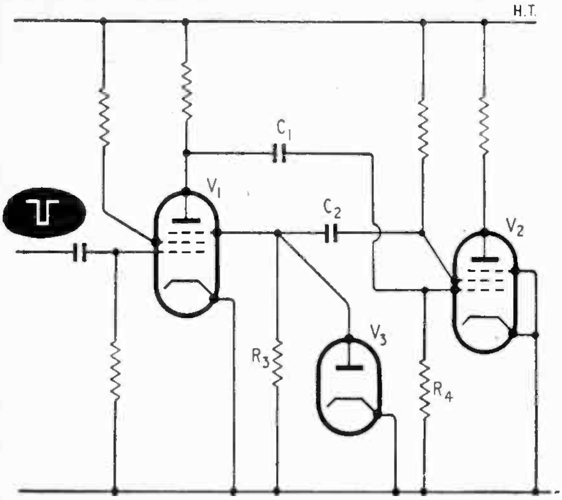



Fig. 4.

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 multivibrator. A squarer output waveform therefore

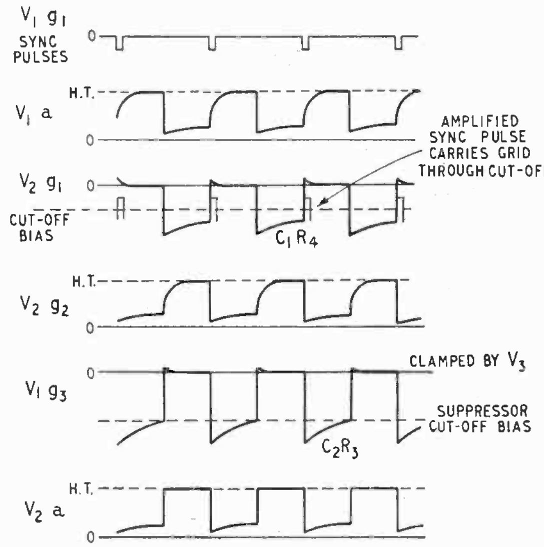



Fig. 5.

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 Rotasembler. 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 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.

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

The Rotasembler 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 16e).

**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, Alsterglacis 3, Hamburg 36, Germany).

**Interkama—International Congress and Exhibition for Measuring Techniques and Automation,** Dusseldorf .......... Oct. 19-26
(Nordwestdeutsche Ausstellungs-Gesellschaft m.b.H., Ehrenhof 4, Dusseldorf)

# 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 replacements 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 lininess 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 $8\frac{1}{2}$-feet from a 17-in screen, or $10\frac{1}{2}$-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 lininess.

## *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 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.

# UNBIASED

By FREE GRID

## *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 September, 1954. We must, at least, credit Mr. Bataimis with knowing his own language.

*"I was a bit surprised"*

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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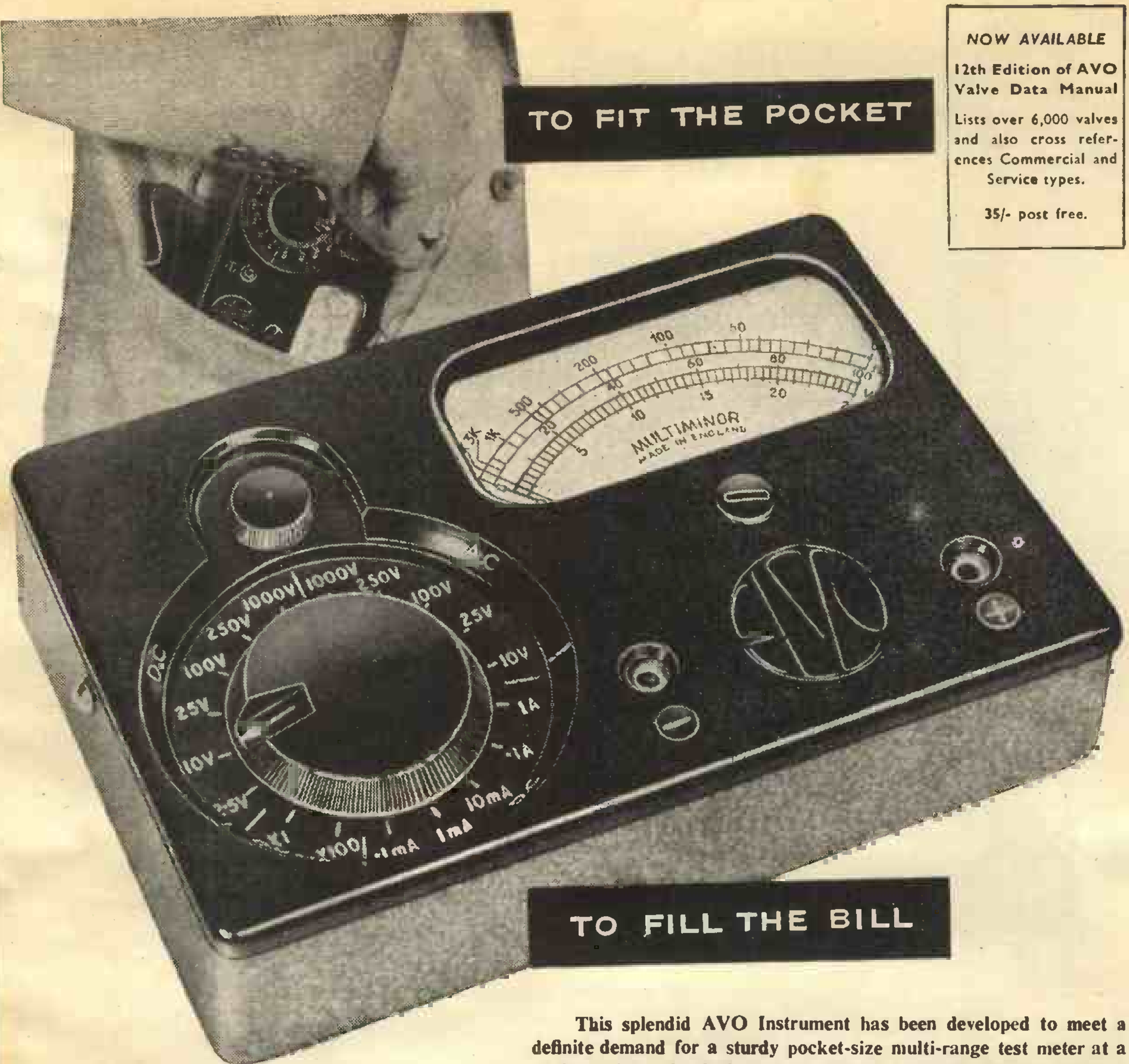


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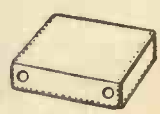

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| TYPE No. | OC 200 | OC 201 | OC 203 |
|---|---|---|---|
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| Maximum junction temperature (°C) | +150 | +150 | +150 |
| Abridged data (at Tamb 25°C) | | | |
| $v_{cb}$ (pk) max. (V) | —25 | —25 | —60 |
| $V_{cb}$ 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 |
| $r_{bb'}$ ($\Omega$) | 125 | 125 | 125 |

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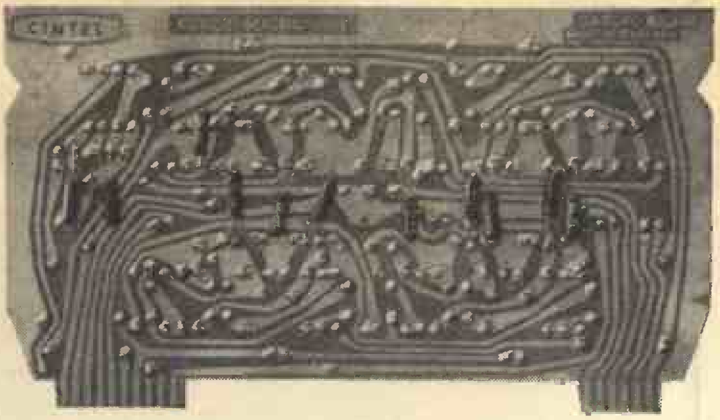

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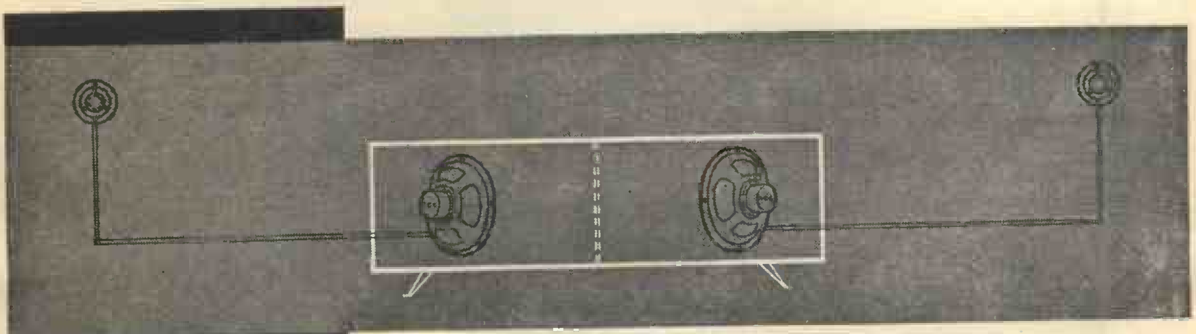

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Telephone: CANonbury 1234 (33 lines) Telegrams: Cossor, Norphone, London Cables: Cossor, London Codes: Bentley's Second

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
Cossor 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 μsec.
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 MΩ and 65 pF.

### Y2 AMPLIFIER
Identical with Y1 amplifier.

### SIGNAL DELAY
200 mμsec approximately. Not more than 10 mμsec differential between channels.

### PRE-AMPLIFIER (2)
Gain 10. 5 c/s to 200 kc/s (30% down).
Input Resistance: 3 MΩ.
One for A1 amplifier, the other for A2 or X amplifier.

### PROBES (OPTIONAL EXTRA)
Frequency-compensated "L" attenuator.
Input impedance: 6 MΩ and 15 pF.
Insertion loss: 10:1.

### TIME-BASE
Triggered.
Range: 0.03 μsec/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 μsec to 150 μsec. 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 ±3%.
Time measurement: by directly calibrated X shift control (±5%) and/or by 20 mμsec (±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 | 24¾ in. | (62.9 cm). |
| Weight | 80 lb. | (36.3 kg). |

### ACCESSORY
Camera Model 1428.

# 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. Code: Bentley's Second.

TAS/CI.12

No. 20

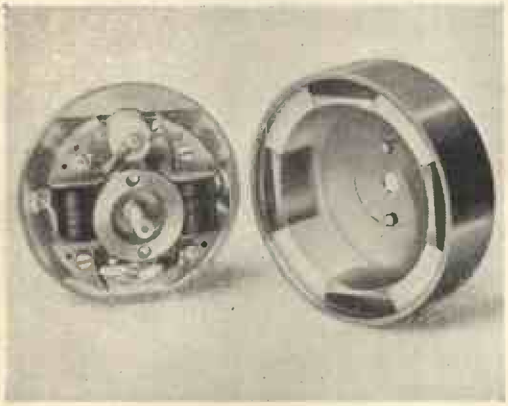
**Permanent Magnets** **Design Advisory Service**

# 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.

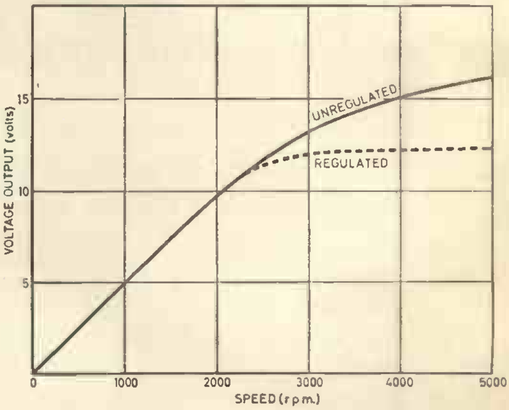


In this magneto the magnetic circuit is designed to have the highest practical efficiency. The rotor consists essentially of four 'Magnadur' 2 segments with mild steel pole pieces equally spaced inside a cup-shaped steel shell. The rotor/stator clearance is nominally 0.02″ and the 'Magnadur' magnets 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 2¼″. 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.

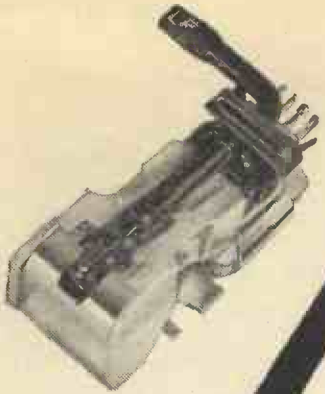
*If you wish to receive reprints of this advertisement and others in this series write to the address below.*

**Mullard**

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

MULLARD LIMITED, COMPONENT DIVISION, MULLARD HOUSE, TORRINGTON PLACE, W.C.1. LANgham 6633

MC283



# SONOTONE 8T

## TCL 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 ±1.5 dB*
- *Sensitivity, 200 mV at 1 kc/s on stereo*
- *Compliance 2.4 x $10^{-6}$ cm/dyn*
- *Separation, 20 dB between channels*
- *Tracking Weight 6 grams on record changers, 4 grams on transcriptor arms*
- *Inbuilt vertical rumble filter*
- *Completely compatable for 33⅓, 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.*

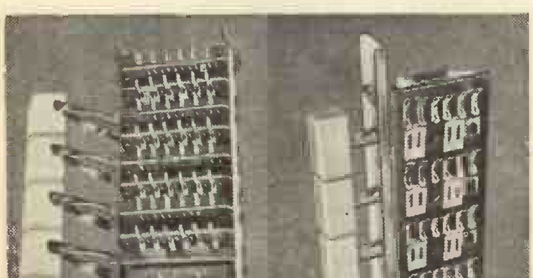
TCL

**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.

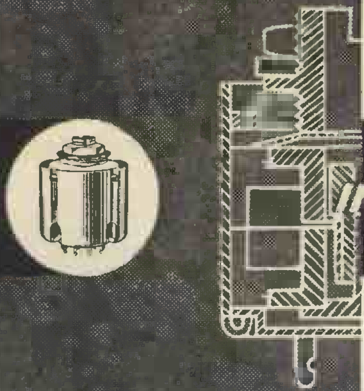
*✱ May we suggest that you talk to a Plessey Technical Representative about your switch requirements.*

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 ±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**

MULLARD LTD · COMPONENT DIVISION · MULLARD HOUSE · TORRINGTON PLACE · LONDON W.C.1

MC 280.


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 (8½in. x 6½in. x 13in.) 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 Chase Road Southgate London N.14

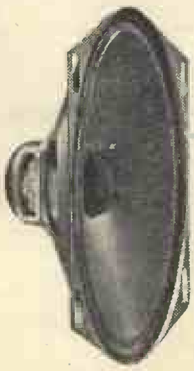
# New

# 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″×3″

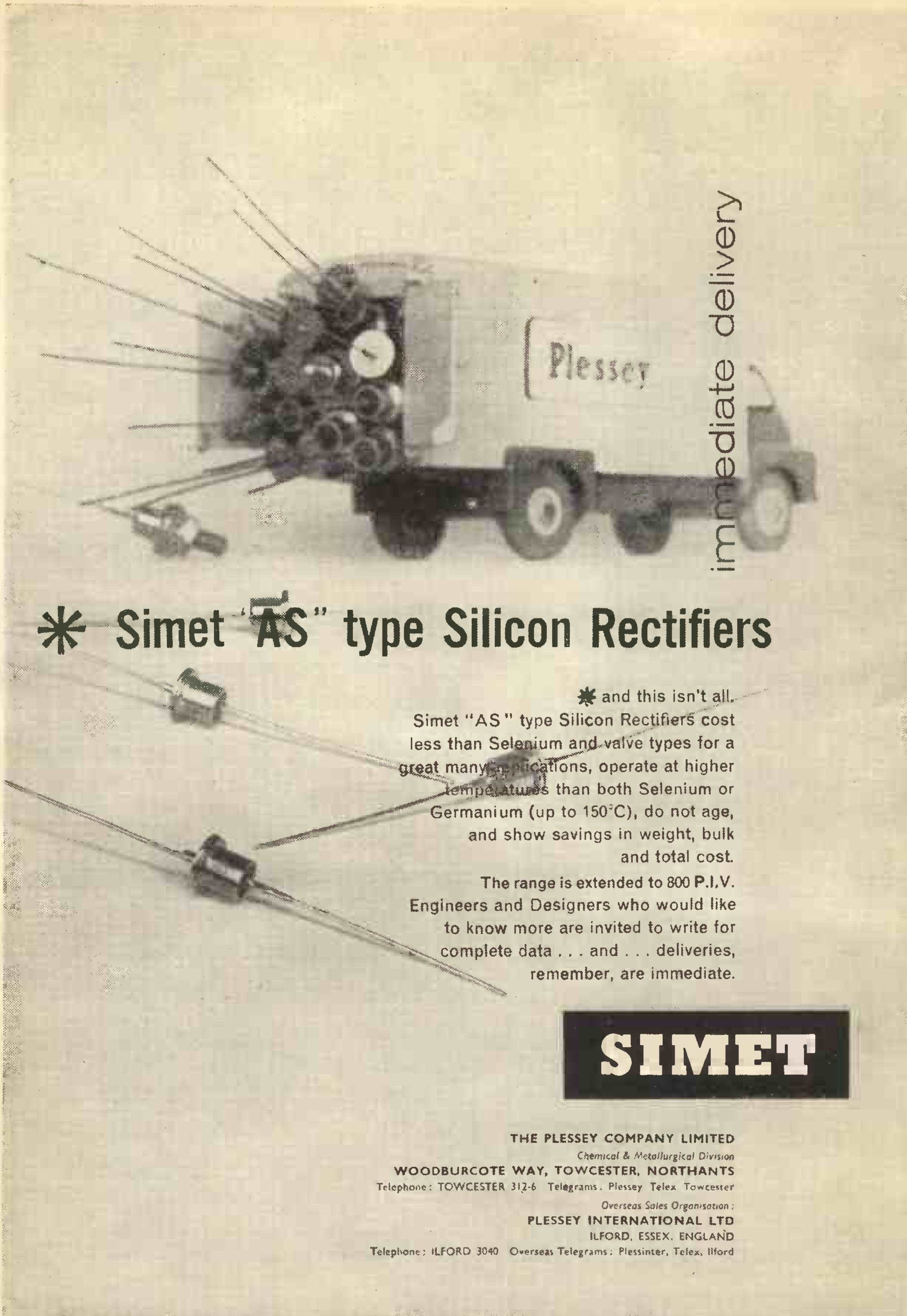


7″×4″

5″

**ELECTRO ACOUSTIC INDUSTRIES LTD., Stamford Works, Broad Lane, Tottenham, N.15**

*Tel: Tottenham 0505/9 (5 lines)*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immediate delivery
* 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.
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Engineers and Designers who would like to know more are invited to write for complete data . . . and . . . deliveries, remember, are immediate.
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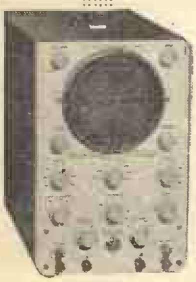
**So easy to build** — Heathkit DAYSTROM — **So easy to use**

# 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 k/c. (±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 100Ω to 5 megohms and power factor. 5-450 v. test voltages. Safety switch provided. **£7.19.6**

## TRANSISTOR PORTABLE KIT
### Model UXR-1

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. Prealigned 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/MONAURAL gram, 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 ........................ Price less valves £8/19/6 **£10.12.0**

## 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**

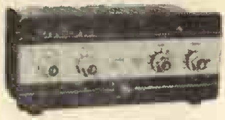
● Deferred Terms available on all orders above £10.

# DAYSTROM LTD.

DEPT. W.W.1, GLOUCESTER, ENGLAND

A member of the Daystrom Group. *MANUFACTURERS OF THE WORLD'S LARGEST-SELLING ELECTRONIC KIT-SETS*

**Technically** **Heathkit** DAYSTROM **excellent**



### 6 WATTS STEREO AMPLIFIER KIT Model S-33

A versatile high-quality self-contained STEREO/MONAURAL 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**

### MATCHED HI-FI STEREO KIT

| | | | |
|---|---|---|---|
| 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 |

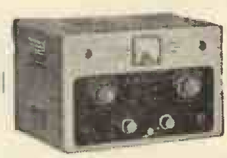
YOURS for £42/10/- if all ordered together or £8/8/- deposit and 9 monthly payments of £4/3/-. Pedestal speaker legs £2/14/- optional extra.

### 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.

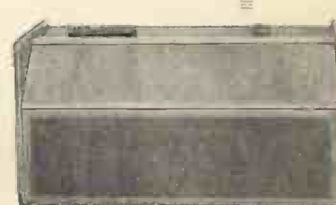
## GLOUCESTER

## a superbly designed stereo cabinet kit

OPEN

Specially developed to meet the varying needs of different homes. It will house Tape Deck and/or Record Player, F.M. Tuner and Stereo Amplifier. In addition for the convenience of those to whom space is an overriding consideration, it is possible to house speaker systems at each end. For this purpose a loudspeaker kit, comprising two 4in. plus 8in. speaker systems, balance unit, speaker grille, cutting template, padsaw and mounting details is also available. Neutral hardwoods have carefully been selected so that the finished product can be stained and polished to individual choice. There is storage space for records, tapes, etc., also for power amplifiers.

| | | | |
|---|---|---|---|
| Mk. I for Tape Deck or Record Player ......... | £15 | 18 | 6 |
| Mk. II for both T/D and R/P ..................... | £17 | 8 | 6 |



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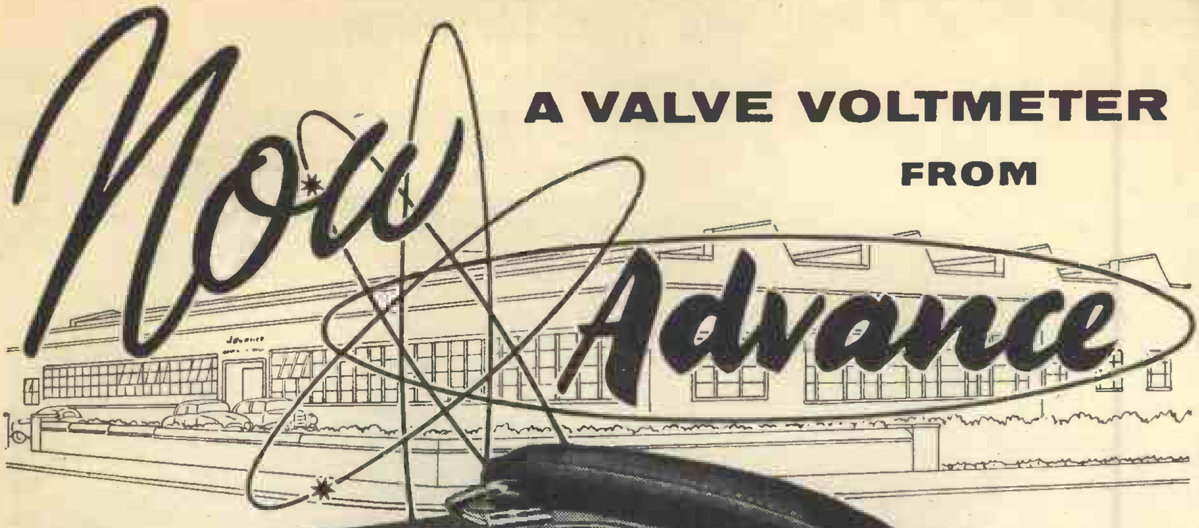
## DAYSTROM LTD.

**DEPT. W.W.1, GLOUCESTER, ENGLAND**

*A MEMBER OF THE DAYSTROM GROUP MANUFACTURERS OF*




# A VALVE VOLTMETER FROM


*With these*

***OUTSTANDING FEATURES***

**EXTREME SENSITIVITY**
accurate measurements are possible down to 100$\mu$V.

**WIDE VOLTAGE RANGES**
1mV. to 300 volts F.S.D.

**WIDE FREQUENCY RANGE**
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**

**INCORPORATES ITS OWN H.T. STABILIZER**

**SMALL COMPACT SIZE & ROBUST CONSTRUCTION**

*at this price . . .*

**£50** nett in U.K.

*(including very low capacity screened lead and probe)*

*with this backing . .*

Behind this, the most modern instrument in its sphere, is that specialist instrumentation skill and experience which has earned for all "Advance" products a reputation second to none throughout the industry. From our up-to-the-minute factory at Hainault comes this latest addition to the world-famous "Advance" range of instruments.

*Full Technical details in Leaflet W50*

Size $4\frac{3}{4}'' \times 7\frac{1}{2}'' \times 6\frac{3}{4}''$.
Weight 7lb.

THE **Advac**

**Advance** COMPONENTS LIMITED

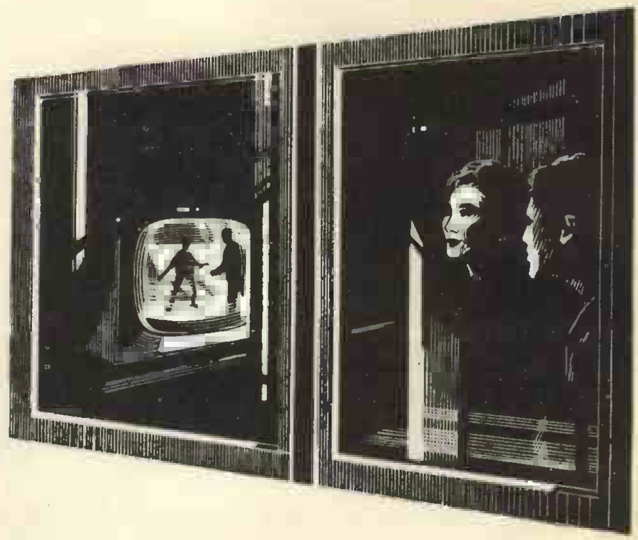
INSTRUMENTS DIVISION

ROEBUCK ROAD • HAINAULT • ILFORD • ESSEX TELEPHONE : HAINAULT 4444

GD 64

# 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.
Today that may sound like a daring prognosis—but tomorrow?



## Electron-Valves—
## A World's Wonder Has Become a Reality

Since the scientist K. F. Braun developed the cathode-ray valve 61 years have passed. That denotes six decades of technical progress since then and tremendous achievement in the field of electronic engineering.

The demand for electronic valves for television purposes has rapidly increased. Commercial activity with this important component grew to significant proportions in the world market.

Valve manufacturers of the German Democratic Republic are in a position to supply top-quality receiver valves, miniature valves, long life valves and others.

modern—
efficient—
dependable—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Agency for England: Messrs. Winter Trading Co. Ltd., 6, Harrow Road, London, W.2

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German Democratic Republic.

COUPON

Please forward your 294 page catalogue "Receiver Valves" free of charge. English, French, German Edition.**

**Please delete what does not apply.

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Address ............................................ Country ............................................

Remarks ............................................................................................

# A FURTHER IMPORTANT ANNOUNCEMENT

*by* AB *METAL PRODUCTS LTD*

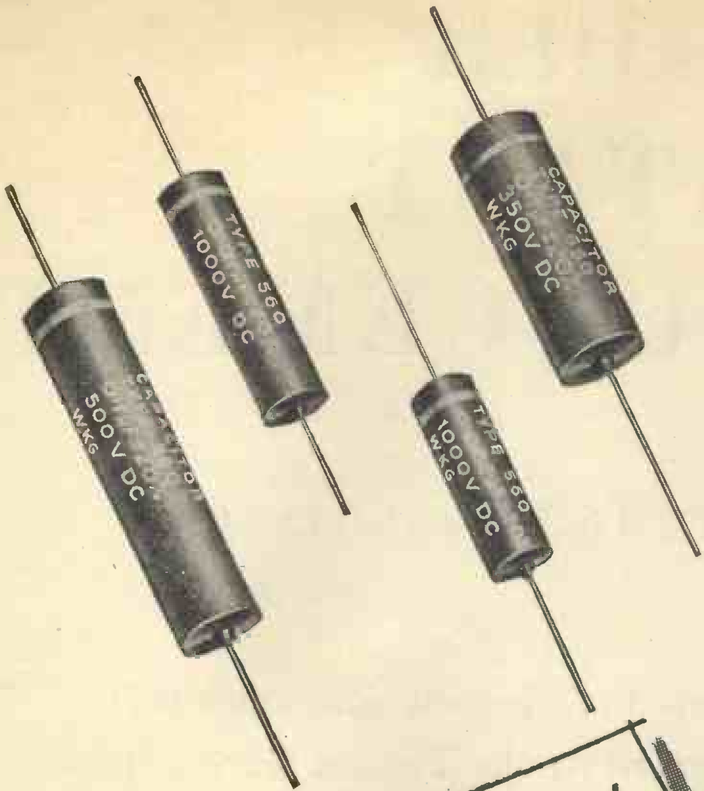
**A. B. Metal Products Ltd. proudly announce that they have been granted by the Trolex Corporation of Illinois, U.S.A., the sole manufacturing rights of the new "TROLEX" range of switches.**

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*

**AB METAL PRODUCTS LTD.,**
**Walkden House, Melton St., Euston Square, N.W.1.**
*Telephone EUSton 9226 (5 lines)*




- 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.
- Designed to meet the requirements of British Joint Service Standards RCS 131 and BS 2131 with humidity classification H.2.
- Solid construction eliminates internal movement, preventing damage by severe vibration.


## DUBILIER ENCAPSULATED PAPER DIELECTRIC TUBULAR CAPACITORS HAVING OUTSTANDING CHARACTERISTICS

The Dubiller Capacitor Type 560 is a new approach to capacitor requirements for all radio and electronic applications. It is constructed to meet long and arduous service conditions. The paper dielectric element is impregnated with a plastics material to produce a solid unit. The terminations are of great mechanical and electrical strength and the assembled element is sealed in an encapsulated mineral loaded epoxy resin so that there are no parts capable of movement, making the capacitor completely immune to shock and all normal atmospheric conditions.

Capacitance Tolerance; ±20% normal ±10% by selection. Power Factor; Less than 1% at 1,500 c/s. Insulation Resistance; Better than 20,000MΩ at normal temperature. Voltage Application; From −40° to +125°C for d.c. and from −40° to +70°C for a.c.

| CAPACITANCE μF | VOLTAGE RATINGS | | | DIMENSIONS | |
|---|---|---|---|---|---|
| | d.c. Wkg. at −40°C to +125°C | d.c. Test at 20°C | a.c. Wkg. r.m.s. at −40°C to +70°C and up to 60 c/s | Diameter +0.020" −0 | Length ±0.040" |
| 0.001 | 1,000 | 2,500 | 250 | 1/8 | 1 |
| 0.002 | 1,000 | 2,500 | 250 | 3/8 | 1 |
| 0.005 | 1,000 | 2,500 | 250 | 3/8 | 1 |
| 0.01 | 1,000 | 2,500 | 250 | 3/8 | 1 3/8 |
| 0.02 | 750 | 2,250 | 250 | 3/8 | 1 3/8 |
| 0.05 | 500 | 1,500 | 250 | [illegible] | 1 3/8 |
| 0.1 | 350 | 1,000 | 180 | 1/2 | 1 3/8 |
| 0.1 | 500 | 1,500 | 250 | 1/2 | 1 13/16 |

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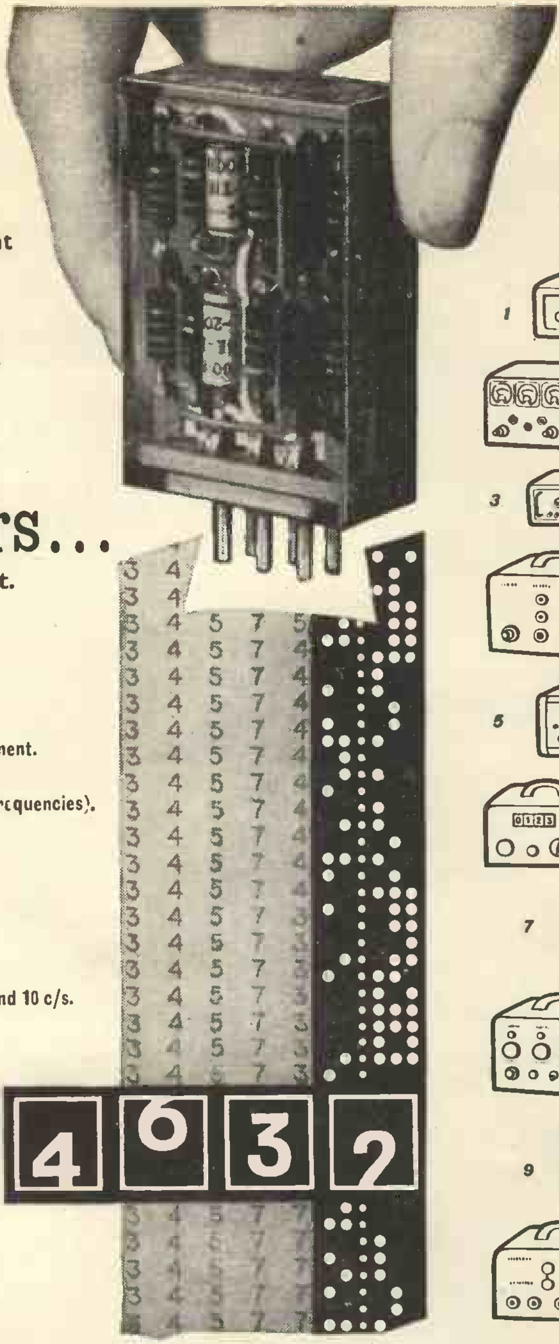


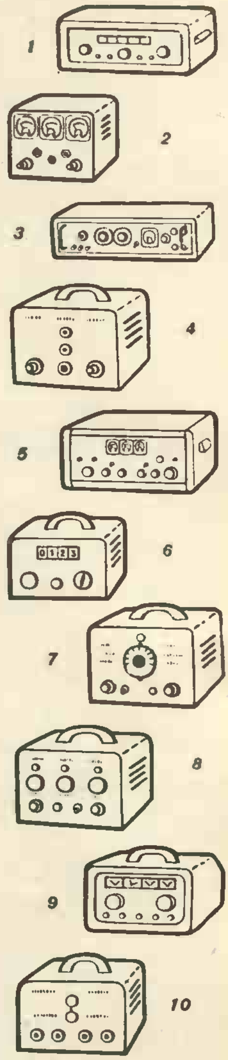

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*Some examples of 'specials' built from Venner plug-in stages are illustrated on the right.*

1 In-line readout frequency and time measuring equipment.
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4 Dual channel tuned amplifier.
5 Speedmeter with tape readout.
6 In-line readout t chometer.
7 So enoid valve timer.
8 3 digit batching counter.
9 Special purpose time measu-ing 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.

*If you are not familiar with our circuit blocks, please send for leaflet WW/104.*

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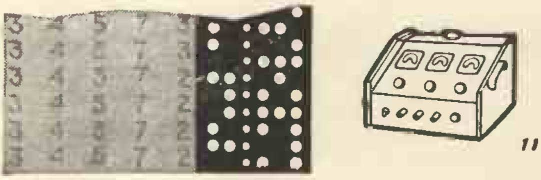

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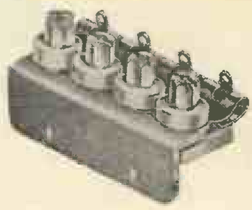
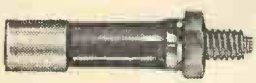


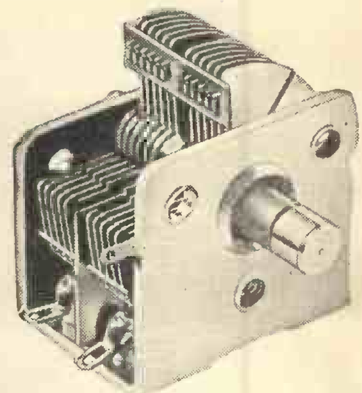
**S1204 Trimmer**

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.



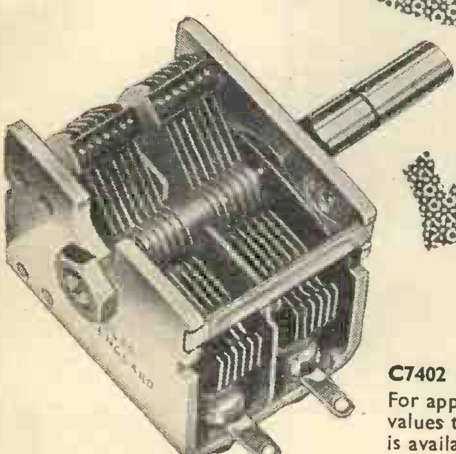
**S5511 Trimmer**

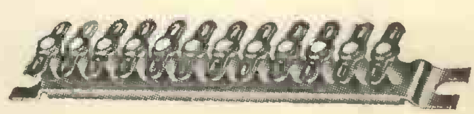
Screw type trimmer for chassis mounting. Capacity 1 pf to 10 pfs.



**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 each section or 153 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.

**TS6-12 Miniature Terminal Strips**

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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BY APPOINTMENT
TO H.R.H. DUKE OF EDINBURGH
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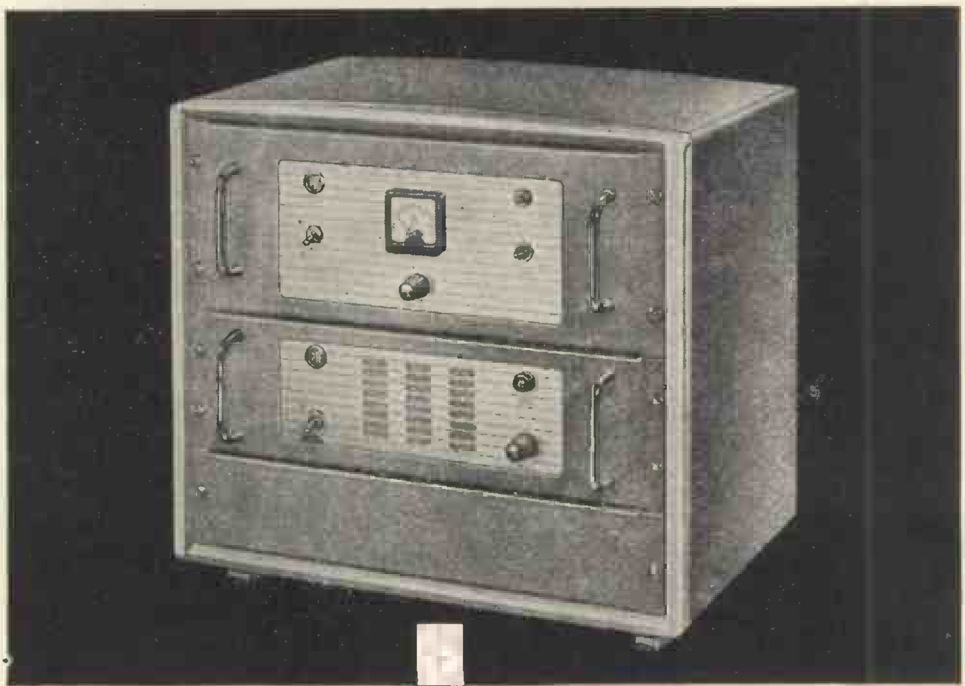
RADIO TELEPHONE EQUIPMENT
PYE TELECOMMUNICATIONS LTD.



## 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.

**PYE TELECOMMUNICATIONS LIMITED**

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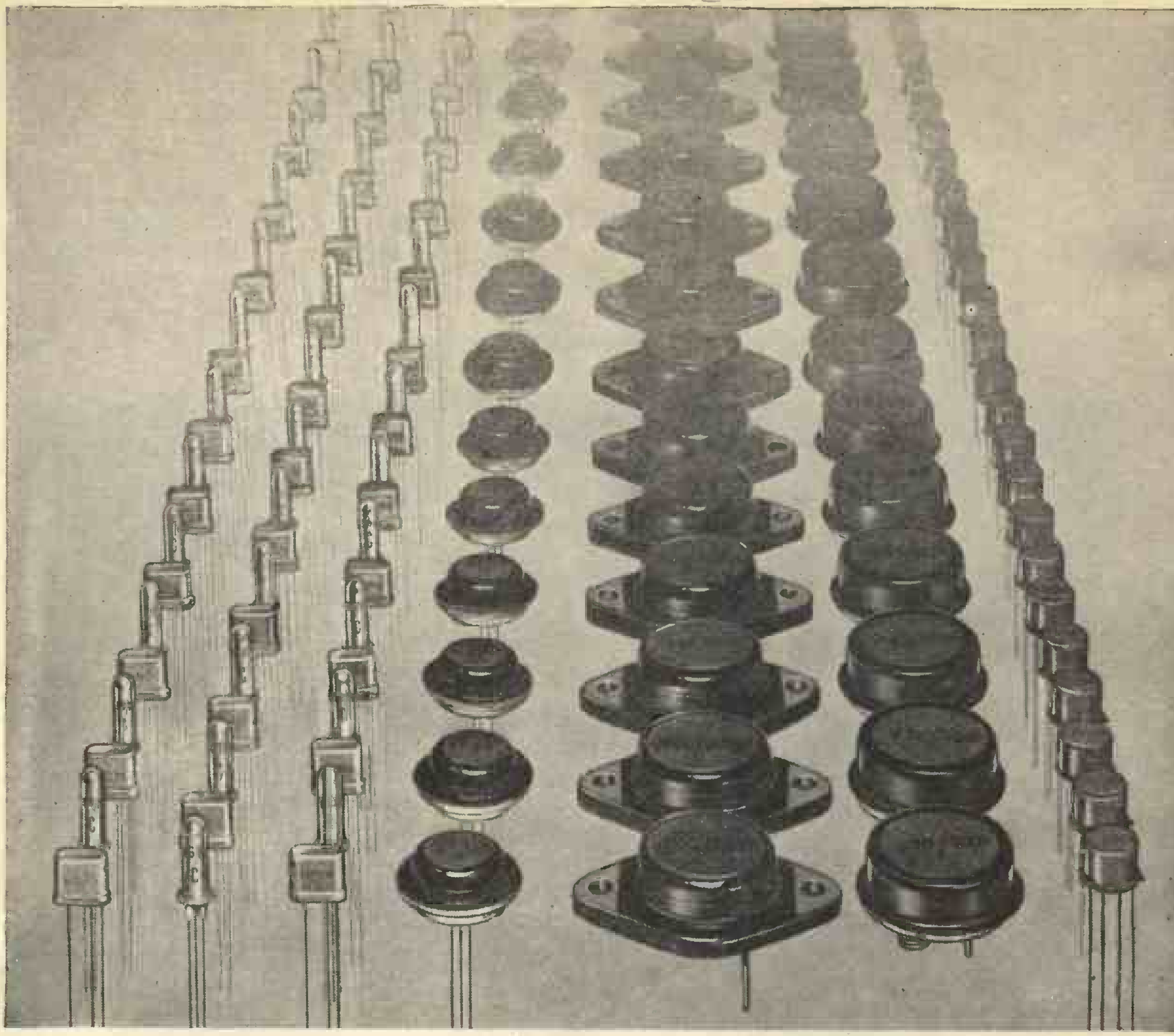

# The **Newmarket** range includes them all

| | | |
|---|---|---|
| Switching | V10/1S, V10/1SC<br>V10/2S, V10/2SC | Voltage ratings 10, 15 20V. Switching Rise times down to ·1 μs (V10/1S), ·2 μs (V10/2S)<br>Max. dissipation 125 mW; Peak current 500mA.<br>Rectangular or K1007/A1/D2 standard cylindrical style can. |
| R.F. | V6/2R, V6/2RC<br>V6/4R, V6/4RC<br>V6/8R, V6/8RC | Voltage ratings 6, 10, 15, 20, 25V.<br>Typ. frequency cut-offs 3, 5·5, 10 Mc/s.<br>Max. dissipation 125mW; Rectangular or K1007/A1/D2 standard cylindrical style can. |
| A.F. | V10/15A, V10/15AC<br>V10/30A, V10/30AC<br>V10/50A, V10/50AC | Voltage ratings 10, 15, 30V.<br>Typ. betas 20, 40, 75.<br>Max. dissipation 200mW; Rectangular or K1007/A1/D2 standard cylindrical style can. |
| I.P. (Intermediate Power) | V15/20IP<br>V30/20IP<br>V60/20IP | Voltage ratings 15, 30, 60V.<br>Typ. beta 40.<br>Max. dissipation 2W;<br>Max. current 2 Amp. |
| N.P. (Noodle Power) | V15/15NP<br>V15/30NP<br>V30/15NP<br>V30/30NP | Voltage ratings 15, 30V. Typ. betas 25, 40.<br>Max. dissipation 15W; Max. current 6 Amp.<br>Standard Diamond (JEDEC E2-42) Base.<br>Cold welded case. |
| P. (Power) | V15/10P, V30/10P, V60/10P<br>V15/20P, V30/20P, V60/20P<br>V15/30P, V30/30P, V60/30P | Voltage ratings 15, 30, 60V.<br>Typ. betas 18, 24, 40.<br>Max. dissipation 10W;<br>Max current 3 Amp. |
| VHF Drift | V15/20R | Voltage rating 15V. Typ. frequency cut-off 30 Mc/s. Max. dissipation 75mW,<br>Max. current 12mA. JEDEC TO-5 welded case. |

*If you have not received a copy of our booklet "Semi- conductor Device Data", ask us to send you one.*

NEWMARKET TRANSISTORS

**Newmarket Transistors Ltd**

Exning Road, Newmarket, Suffolk. Tel: Newmarket 3381/4. Cables: Semicon Newmarket

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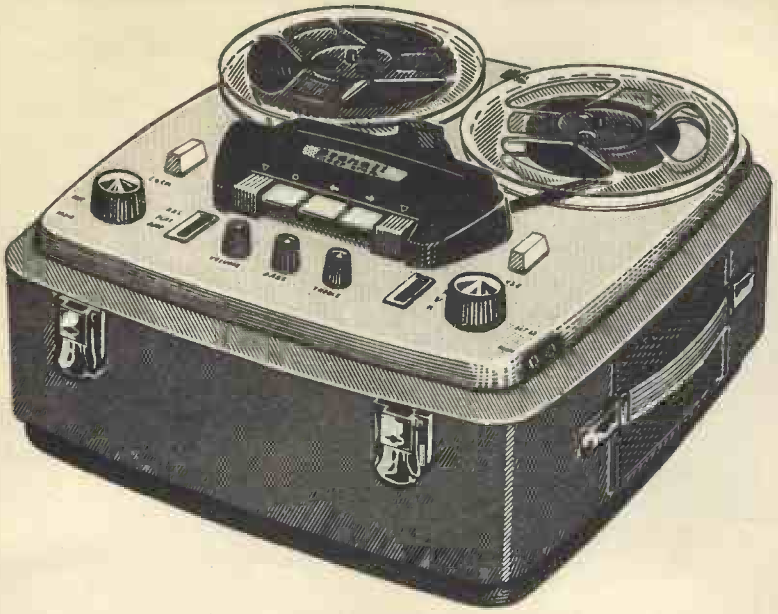
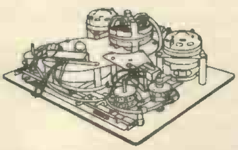


BRENELL 3 STAR 58 GNS.

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! Superb sound reproduction that the discerning ear of the connoisseur will find highly commendable and its versatility in application of immense advantage. Small wonder when you consider over 10 years of engineering development and production experience by Brenell—the sole manufacturers—are behind every machine produced. You'll be missing hi-fi at its finest if you fail to see and hear a Brenell in action before you make your choice.*

Three recording speeds $1\frac{7}{8}$, $3\frac{3}{4}$, $7\frac{1}{2}$ i.p.s. Frequency compensation at all speeds: Push button operation (interlocked): printed circuit amplifier: separate bass and treble controls: high quality speaker (8in. x 5in.): takes spools up to 7in.: pause control: digital rev. counter: contemporary style wooden cabinet for improved acoustic performance. Approved by the Council of Industrial Design. Price including 1200ft. tape, spool and quality microphone, **58 GNS.** 3 Star Stereo rec/playback model now available **89 GNS.** or with two microphones **95 GNS.**

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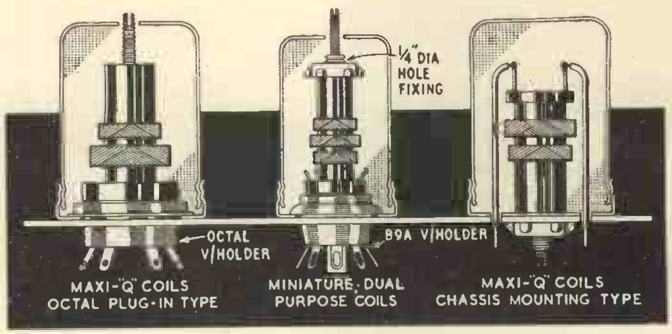


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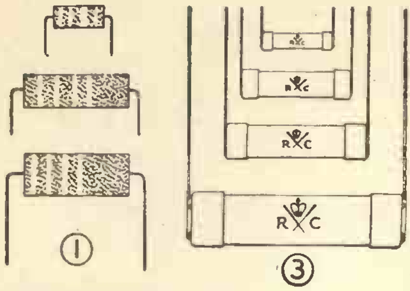


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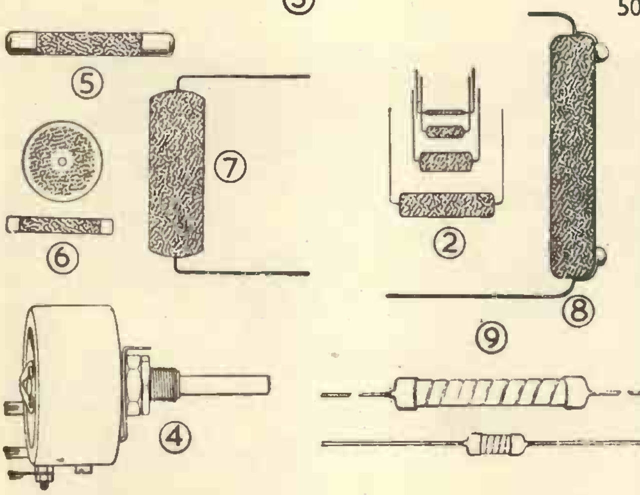


| CARBON | WATTS | OHMIC RANGE | TOLERANCES ± |
|---|---|---|---|
| 1. Solid | ¼ 1 & 2 | 10—10M | 5% & 10% |
| 2. Cracked | 1/30—20 | 1—500M | 5% & 10% |
| 3. *High Stability | 1/10—3 | 1—50M | 0.5% 1% 2% 5% |
| 4. Variable | ¼ | 5K—2M | — |
| 5. V. High Resistance | ¼—3 | 50M—$10^{13}$ | 5% & 10% |
| 6. V.H.F. (Rods & Discs) | 1/10—1 | 10—1K | 1% & 2% |
| WIREWOUND | | | |
| 4. Rheostats | 4—500 | 10—18K | — |
| 8. Vitreous | 3—500 | 1—150K | 1% 2% 5% |
| 7. Cemented | 1—15 | 1—25K | 5% & 10% |
| 9. Metal oxide | ¼—2 | 100—4.2M | 1% 2% 5% |

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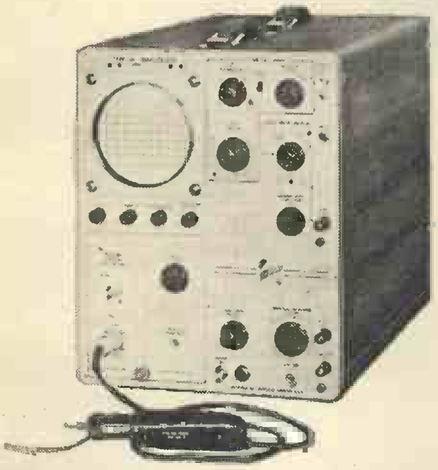

## 3.5 - millimicrosecond risetime.

### Type 581.

A new laboratory oscilloscope with many of the capabilities needed in the current rapid advancement of the electronic art. Its 3.5-m$\mu$ sec risetime, 0.1-v/cm sensitivity and 0.01-$\mu$sec/cm sweeptime are features for modern high-speed pulse applications. A new series of Tektronix plug-in preamplifiers promises outstanding signal-handling versatility for an oscilloscope with a vertical passband of dc to approximately 100 mc.

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### Type 585.

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.

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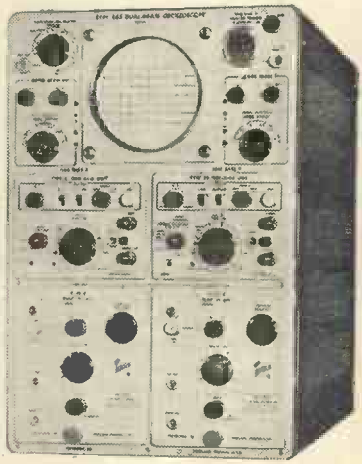
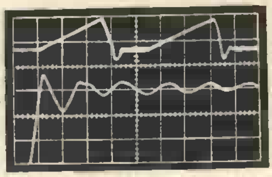
## *NEW* DC to 30 MC

## 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 type to facilitate instrument maintenance and the sweep speed is variable between 0.02 $\mu$sec/cm and 12 sec/cm. This new oscilloscope will accept the standard range of plug-in pre-amplifiers.



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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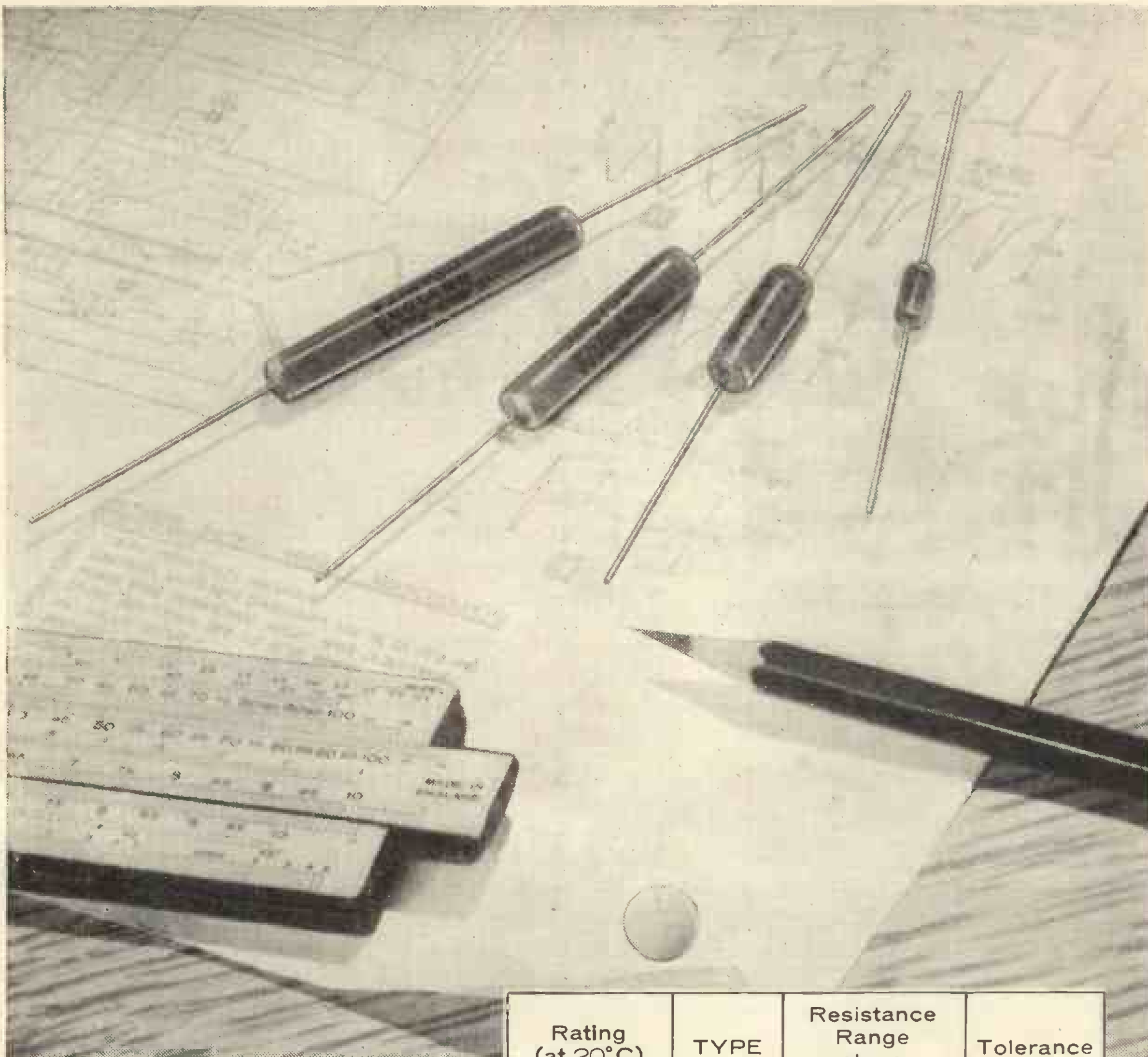
# PAINTON Miniature Vitreous Wirewound Resistors



| Rating (at 20°C) Watts | TYPE | Resistance Range ohms | | Tolerance |
|---|---|---|---|---|
| | | Min | Max | |
| 4 | MV1A | 1 | 9·9 | 10% |
| | | 10 | 6,800 | 5% |
| 7 | 301A | 2 | 68,000 | 5% |
| 10 | 302A | 4 | 140,000 | 5% |
| 5 | 306A | 1 | 33,000 | 5% |

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*The name ARMSTRONG is our registered trade mark.*

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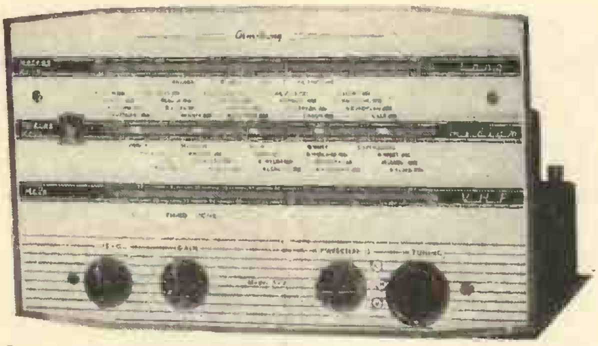

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**A gold plated relay contact hermetically sealed in inert gas for absolute reliability, high speed and low contact bounce.**

Actual size

| | |
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| maximum current... ... | 250 mA |
| maximum resistive load ... | 15 W |
| maximum closed resistance... | 50 mΩ |
| minimum open resistance... | $5 \times 10^{11}\Omega$ |

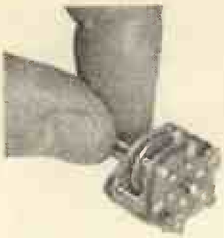
| | |
|---|---|
| nominal operate ampere turns | 120 AT |
| nominal release ampere turns | 60 AT |
| operate time less than ... | 2 mS |
| bounce time less than ... ... | 0.5 mS |
| release time less than ... | 0.5 mS |

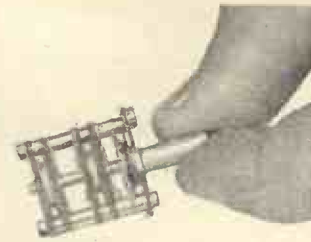
*our Technical Service Department is ready to provide further details of characteristics or application.*

**Hivac Limited**

STONEFIELD WAY - SOUTH RUISLIP - MIDDLESEX
*A member of the Automatic Telephone & Electric Group* *Ruislip 3366*

S.I.





Miniature

# ROTARY SWITCHES

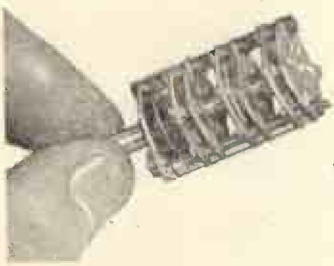
by

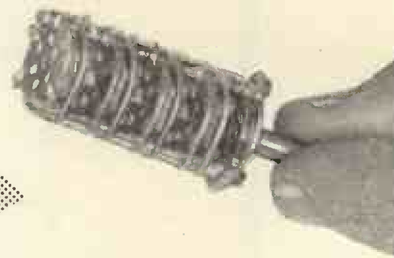
## ARDENTE

ARDENTE ACOUSTIC LABORATORIES LTD.

**8-12 MINERVA ROAD · LONDON · N.W.10**

*Phone: ELGAR 3923 (6 lines) Telegrams: HAILER, LONDON*





★ *full technical data upon request*

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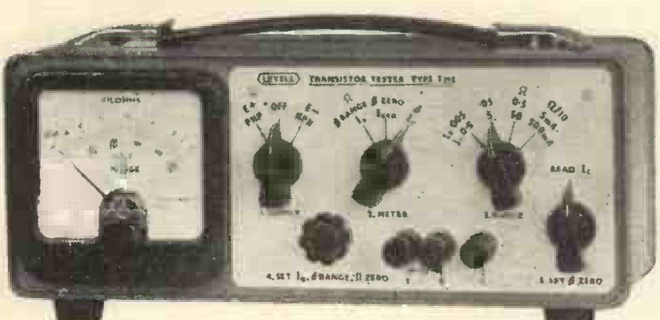
# LEVELL PORTABLE INSTRUMENTS



## TRANSISTOR TESTER

**TYPE TM5**

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.

Current Gain Ranges: 100, 250, 500.

Resistance Ranges: 0-50kΩ, 0-500kΩ.

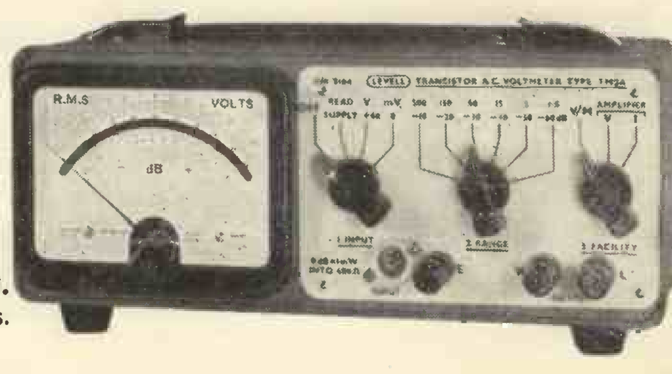
Price with batteries: **£17.0.0**

## A.C. MILLIVOLTMETER

**TYPE TM2A**

Measures 50$\mu$V to 500V on 12 ranges. Response $\pm$ 0.1dB from 30 c/s to 30 kc/s. High input impedance. Output for C.R.O. Gain up to 80 dB available with 2 V. output. Low noise level. Low microphony. No hum.

Price with batteries: **£36.0.0**




**LEVELL ELECTRONICS LTD.**
**10-12, St. Albans Road, Barnet, Herts.**
*Telephone: BARnet 5028*

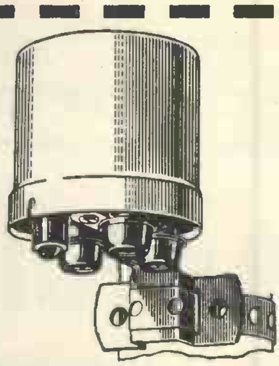
# NEW DIPLEXERS by ANTIFERENCE

INCORPORATING 'HIGH-Q' CIRCUITS EMPLOYING 'OPEN' COMPONENTS FOR MAXIMUM ATTENUATION OF UNWANTED SIGNALS WITH MINIMUM INSERTION LOSS.

## INDOOR MODEL

*Fully insulated cream polystyrene snap-on cover of attractive design. Easy cable connections.*

**Y5** *complete with standard coaxial plug (RECMF specification)* **10/6**



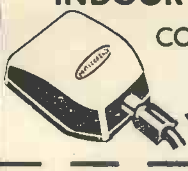
## OUTDOOR MODEL

*Fully weatherproofed by one-piece seamless canister and detachable waterproof universal grommets, complete with perforated strip for mast mounting, may also be mounted on to any flat surface. Easy cable connections.*

**Y6 . . . 12/6**

## OTHER ANTIFERENCE AERIAL ACCESSORIES

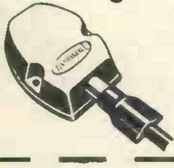
### INDOOR TRIPLEXER



COMPLETE WITH Coaxial plug

Y3 13/6

### Single COAXIAL OUTLET BOX



Complete with Coaxial plug

COB/1 4/6

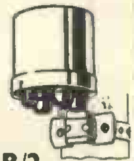
### Also NEW SPLITTER BOXES

enabling two RECEIVERS TO BE USED INDEPENDENTLY OF EACH OTHER

INDOOR MODEL

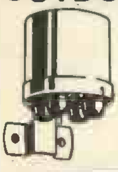
SB/1 6/6

OUTDOOR MODEL



SB/2 8/6

### OUTDOOR TRIPLEXER



Fully weatherproof mast or surface mounting.

Y4 17/6

### Coaxial PLUGS & SOCKETS

TVP/1

Efficient in use. Easy to fit.

BOTH 8d. EACH TVS/1

**ANTIFERENCE LIMITED**

AYLESBURY, BUCKS. *Tel. Aylesbury 2511 (6 lines)*

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DHB/7722

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Jason offer a number of constructional kit designs to meet requirements in modern test equipment and high-fidelity reproduction. The kits are readily available and embody excellent functional characteristics with clean layout, robust construction and satisfying appearance.

**JASON KITS REMAIN AS EVER THE FINEST IN THEIR CLASS. THEY ARE BRITISH DESIGNED TO HIGH TECHNICAL STANDARDS.**

*Valves extra except where stated.*

JSA/2

FMT/1

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**Oscilloscope OG.10**
Ideal for the service engineer and experimenter ........... £22 10 0

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Range 10 c/s to 100 Kc/s ... £14 5 0

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Covering 10 Kc/s to 250 mc/s £16 19 0

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**Valve Voltmeter EM10** ... £18 10 0

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F.M. Tuner—In chassis form £5 5 0
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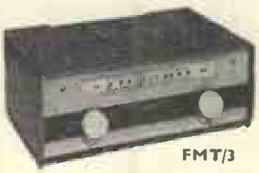
**FMT/3**
F.M. Tuner—Variable AFC, dual limiters................. £8 5 0

**Everest Transistor Portable**
7 transistors, R.F. stage, high quality speaker ............ £15 18 9
Six transistor model ......... £13 19 9

EM/10



FMT/3

**Demonstrations**
*of Jason kits and other Jason equipment daily in our showrooms. 8 p.m. Thursdays.*

*FULL DESCRIPTIVE LITERATURE SENT ON REQUEST.*

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**TYPE T75**
**Frequency Range: 85 to 1,000 megacycles.**

**TYPE T74.**
**Frequency Range: 20 to 250 megacycles.**

**Frequency calibration accuracy: .002% at 25° C. (or .01% between −20° C. to +70° C.).**

Crystal-controlled, portable heterodyne-type Frequency Meters used for Field testing and measurement of pulsed, modulated, or C.W.R.F. transmitters, receivers and signal-generators.

**Mains Operated Power Unit** available as optional extra and designed to fit into the battery compartment.

Reconditioned and calibration-checked B.C.221 Frequency Meters, range 125 Kc/s to 20 Mc/s, still available.

**Provisional specifications on a new wide-range, very high accuracy Frequency Meter and also an instrument covering the range 100 Kc/s to 1,000 Mc/s (higher under favourable conditions) available on request.**

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**Now available:
the complete range of
professional-quality**

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AUDIOTAPE, manufactured in the U.S.A. by Audio Devices, Inc., is known the world over for its flawless perfection of sound reproduction throughout the entire audio range, and its *consistent, uniform quality* from reel to reel and from one type to another. Available in eight different types, with a base material and reel footage to meet every recording requirement, AUDIOTAPE has only *one* standard of quality—the finest obtainable. This sterling performance reflects Audio Devices' more than 10 years of experience in magnetic tape manufacture, and more than two decades of practical experience in the sound recording art.

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*500 - 2000V A.C.*
*£26.0.0*

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*1 - 12V 1 amp.*
*£40.0.0*

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*10Ω - 10,000MΩ*
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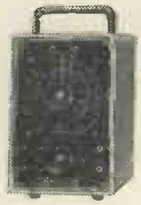
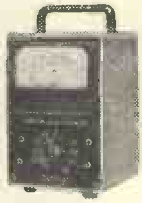
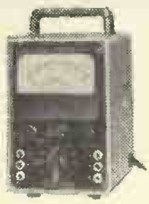


*R.C.C. Bridge*
*5 pf - μf 5Ω - 500MΩ*
*£30.0.0*



*Sensitive Valve Voltmeter*
*3mV - 300V.*
*40 c/s - 500 kc/s*
*£49.10.0*



*D.C. Valve Voltmeter*
*0.1 - 1000 volts*
*0.01 - 100μA*
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## *precision measuring equipment means accurate economic buying*

These six models are a selection from the wide range of NASHTON miniaturized electronic test instruments available for immediate delivery. Designed by Nash & Thompson to meet your everyday needs accurately, efficiently and economically, NASHTON units are compact, modern, streamlined, easy to read and operate. NASHTON give you what you need most — functional efficiency, not frills.

Others in the range include the A.C./D.C. Valve Voltmeter, Universal D.C. Meter, L.F. Quadrature Oscillator, 0.5 Amp. Stabilised D.C. Power Supply, Transistor Tester, Shorted Turn Detector, Digital Read-Out Meter, Preferred Value Resistance and Capacitance Boxes.

# Nash and Thompson LTD

HOOK RISE, TOLWORTH, SURBITION, SURREY Tel. ELMbridge 5252

# 3 reasons why it pays to

## cut your own disks from tape

- **Disks are permanent and cannot easily be erased or mutilated**
- **Disks can be played on any record player at any one of three speeds**
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A disk cutter is an indispensable item of equipment for the more thorough-going tape user. But it must be conveniently priced, easy to operate and economical to maintain.

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A disk cutter pays a handsome dividend within your organisation and, in goodwill, among those who receive your easy-to-handle disks.

**BLANK DISKS**

*Unmatched for quality and evenness of performance M.S.S. Blank Disks are available in three grades, covering every requirement. Full details and lists on application.*

*Send for details of MSS disk cutting accessories; amplifiers; hot stylus unit; swarf collector; mixer; control unit; microscope.*

# MSS DISK CUTTER AND BLANK DISKS

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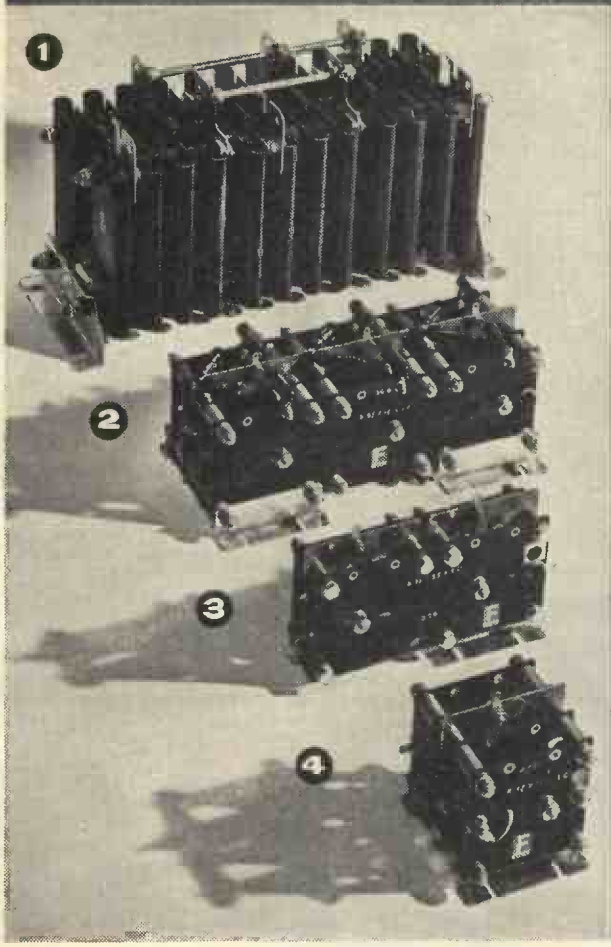
MSS RECORDING CO. LTD. COLNBROOK, BUCKS. TEL. COLNBROOK 2431
SHOWROOM & STUDIO 21 BLOOMSBURY STREET LONDON W.C.1

# FERRANTI

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## High Power Rectifier Stacks

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   Ratings up to 84/168 amps and 300/150 volts DC
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   Ratings up to 22/44 amps and 300/150 volts DC
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   Ratings up to 16 amps and 200 volts DC
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   Ratings up to 16 amps and 200 volts DC
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**APPLICATIONS**

Ferranti high power silicon rectifiers have many applications in the aircraft, electronic, electrical, chemical, marine and general engineering industries including aircraft and marine power supplies, radar systems, computers, chemical processing, welding and electroplating.

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- 110 VOLT ITEMS AVAILABLE

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| Philips EL3527 | 39 gns. | $87 |
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| Lenco GL58/R, Stereo P.U. | £29 3 10 | $62 |
| Garrard 301 | £22 7 3 | $54 |
| Garrard 4HF/Stereo P.U. | £19 17 7 | $41 |
| Garrard TA/Mk. II | £9 15 8 | $22 |
| Connoisseur Motor | £28 6 3 | $57 |
| Philips P.U. | 19 gns. | $41 |
| Golding 600 | £11 13 6 | $24 |
| Goldring 580 | £5 16 9 | $12 |
| Goldring 700 | £9 14 9 | $21 |
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*JASON KITS AS ADVERTISED IN THIS ISSUE*

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| Leak Point One Pre-Amp. | £21 0 0 | $60 |
| Avantic SPA II | £29 8 0 | $84 |
| Pamphonic 3001 | £35 0 0 | $100 |
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| Pilot SHF.15 | 32 gns. | $96 |
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| Quad FM Tuner | 29 gns. | $60 |
| Chapman AM/FM | £29 8 0 | $60 |
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| Ortofon Arm | £14 0 11 | $37 |
| Decca | £22 0 0 | $45 |
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★ RELIABLE ★ LOW COST

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*LIGHT, SPEEDY DRILLS*

A real asset in Aircraft, Electrical, Television, Radio and other light industries. Both models weigh less than 1¼lb. Best Power/Weight and power/air ratios. Locked-in motor. Capacity 1/16"—¼".

**SILENT, REVERSIBLE SCREWDRIVER & NUTRUNNER**

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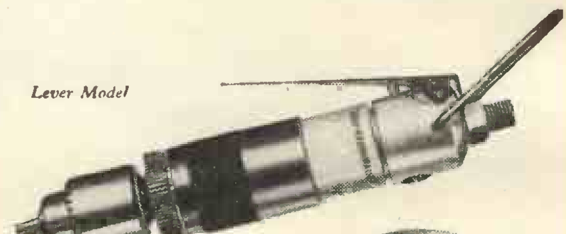
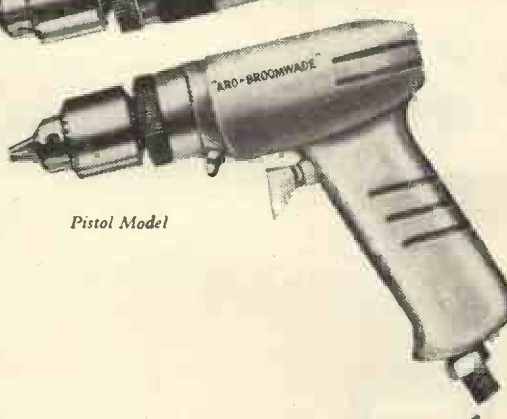
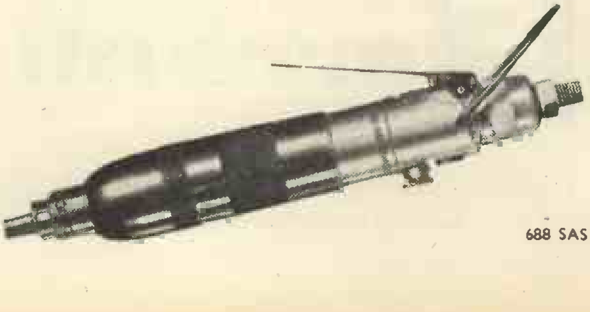
*Lever Model*



*Pistol Model*



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*Telephone:* High Wycombe 1630 (10 lines). *Telegrams:* Broom, High Wycombe (Telex)

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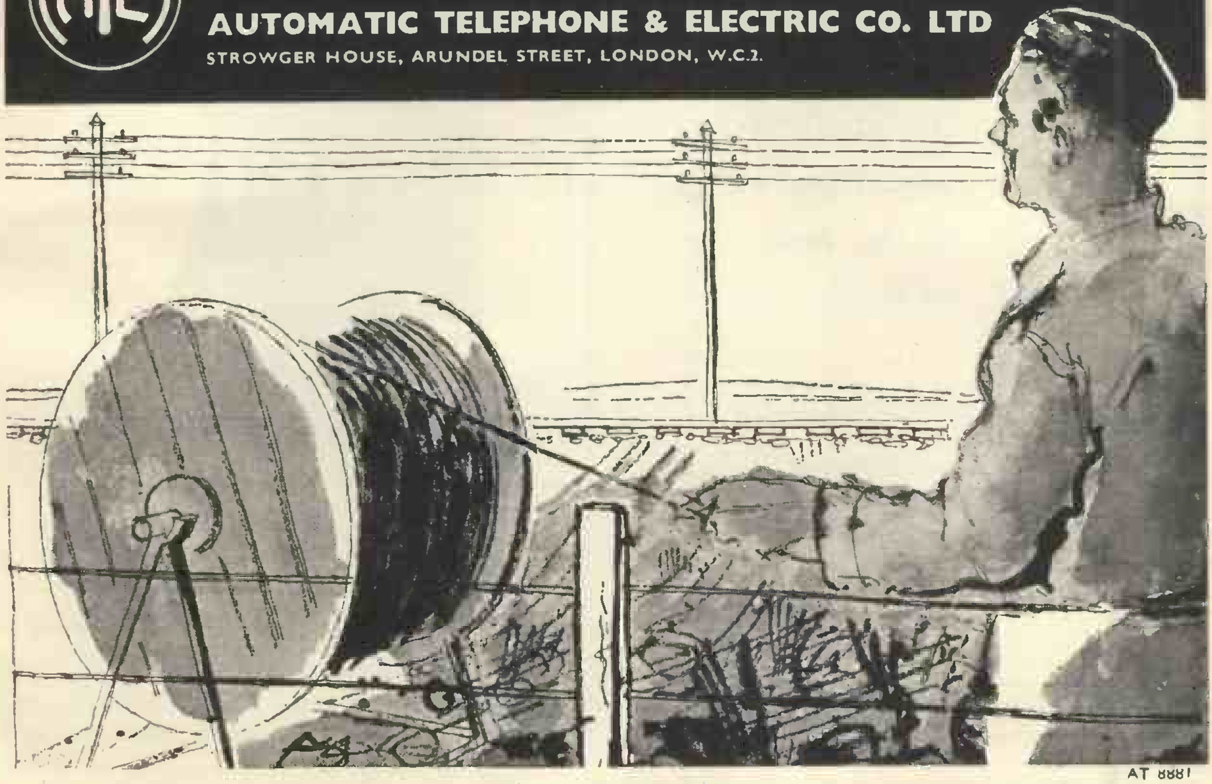

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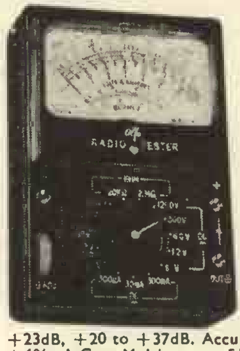


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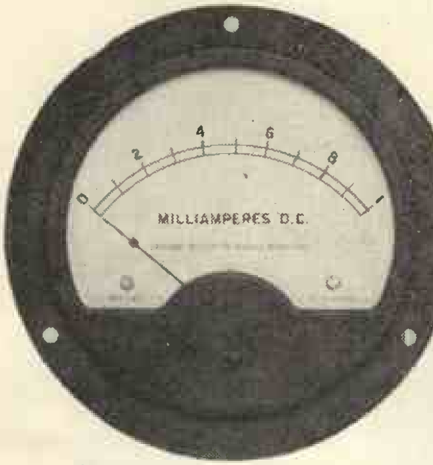


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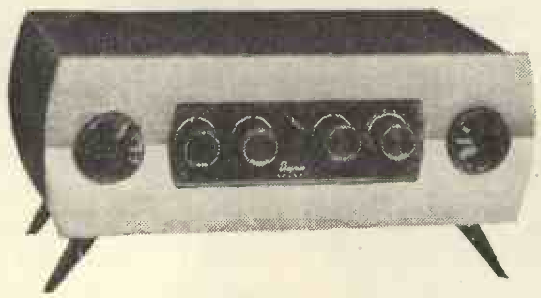

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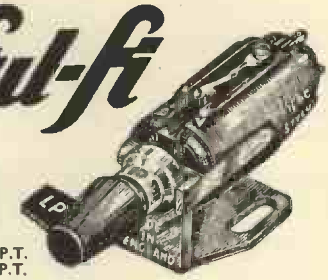


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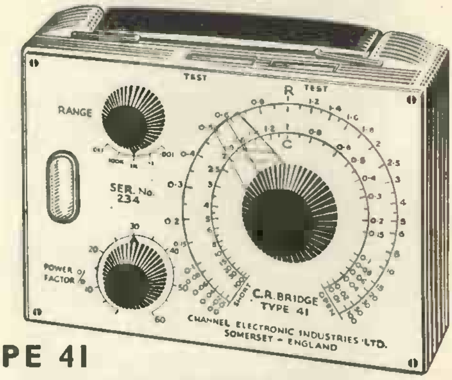


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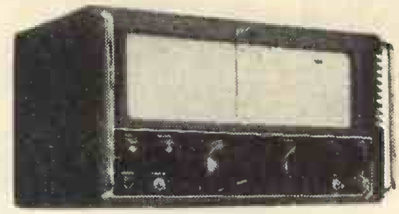

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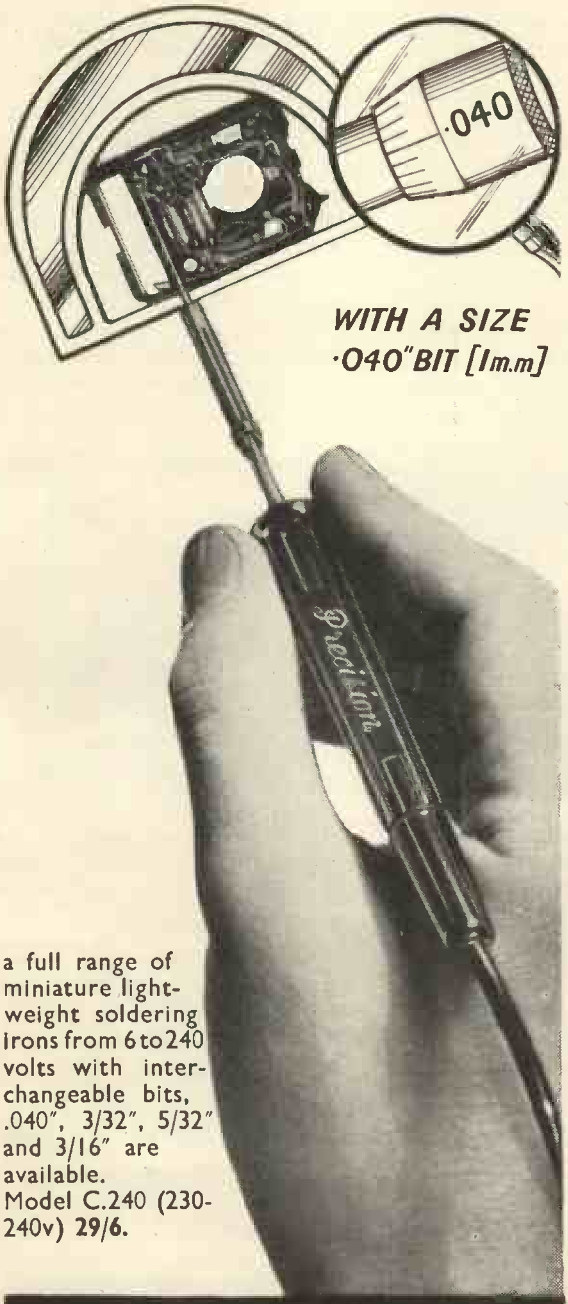


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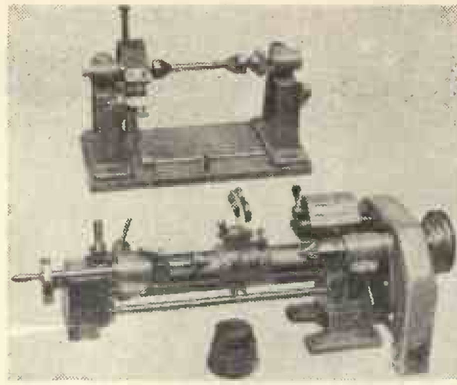

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# Avantic

# AUDIO AMPLIFIER STANDARD

*Suitable for use as:*

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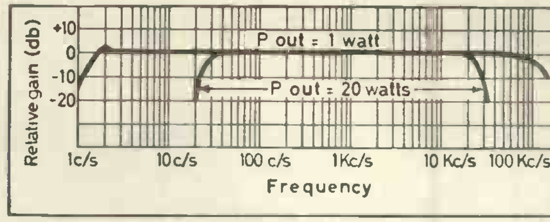
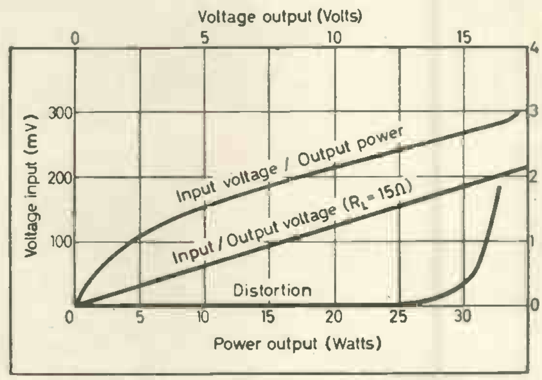
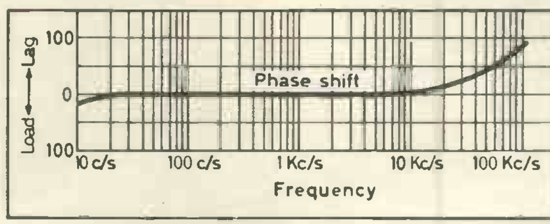
- *Test amplifier for microphones, pick-ups, loudspeakers, pre-amplifiers, tape decks etc.*
- *Recording amplifier.*
- *Broadcast Transmitter Modulator.*




The Avantic DL7-35, originally designed as a high fidelity amplifier, has proved to be of such advanced design that it has remained unsurpassed. During the three years it has been manufactured the high performance laid down in the design has been consistently maintained. It can now be regarded as a Laboratory Standard of the utmost reliability.

AVANTIC DL7-35 POWER AMPLIFIER

Harmonic Distortion:
$<0.05\%$ at 20 watts sine wave output.

Intermodulation Distortion:
0.7% at 20 watts
1.0% at 29 watts
fm=40 c/s. fc=10 kc/s. fm/fc=4

Hum and Noise:
—85dB relative to 20 watts output with 10kΩ source resistance.

Load Impedance:
4Ω, 8Ω, 16Ω switch selected with automatic feedback compensation.

Damping Factor:
50

Rise Time:
5μ secs.

Power Inputs:
105, 117, 125, 210, 233, 251 V. a.c.
40—60 c/s.

Volume Control.
Fused input.
H.T. fuse.
Distributed Load Push-Pull Output Stage.
High stability resistors in input stage.
Power outlets of 6.3V. at 2.5A. a.c.
440V. at 30mA. d.c.

Price: 30 gns.

✻ *Suitable pre-amplifiers available to increase sensitivity to 3mV.*

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Wireless World

ELECTRONICS, RADIO, TELEVISION

## JANUARY 1960



VOLUME 66 NO. 1

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FORTY-NINTH YEAR OF PUBLICATION



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# FRAME GRID VALVES FOR TELEVISION

## 4

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.

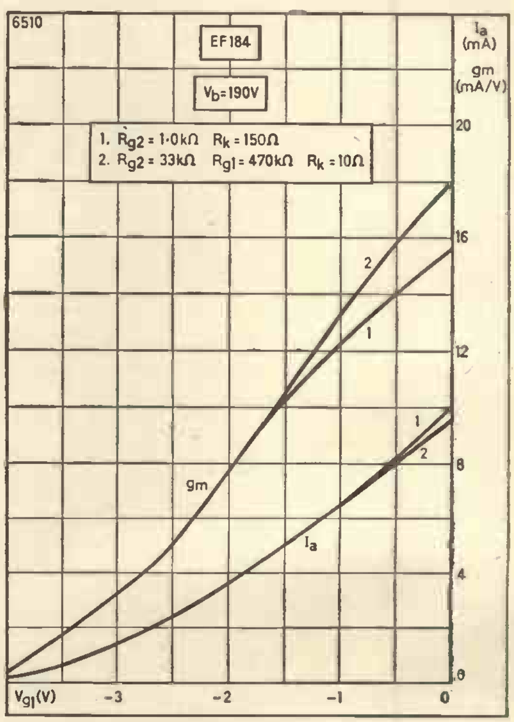
The EF184, in common with the other types in the Mullard frame grid range, has about twice the slope of its conventional counterpart. Under comparable conditions, the conventional EF80 has a slope of 7·4mA/V, as against 15·5mA/V for the EF184. This doubling of the slope provides a substantially improved gain per stage, of the order of 2 or 2½ times.


EF184

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 10Ω. 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.

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MVM 428

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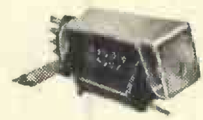


**ACOStereo Type 73**
Turn-over cartridge for stereo, LP and standard records.

**Acos Changer Dust Bug**
Fits most arms. Increases stylus life up to six times. Protects your records.

**Acos Styli**
x500 tested, diamond and sapphire, for all Acos and many other makes of cartridge.

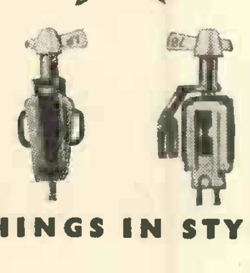
# Calypso Facto

Rhythms Latin or Caribbean, songs from Rio or Port of Spain—lively in the living room. Kingston (Jamaica) in Kingston (on Thames) with ACOStereo sound.

ACOStereo Type 71 converts many popular arms to stereo and costs only 52s. 10d. *including diamond stylus.* ACOStereo Type 73 universal cartridge is fitted in many leading players. Both give superb stereo reproduction at a reasonable cost.

Kingston (J) in the sitting room?

ACOStereo in Kingston (on T)



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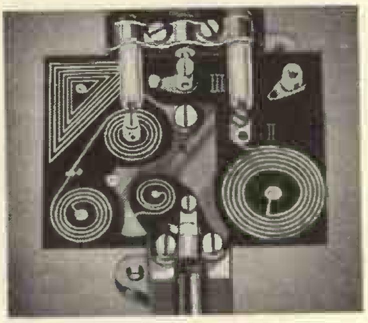
## "BELLING-LEE" NOTES

*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 cladded 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.

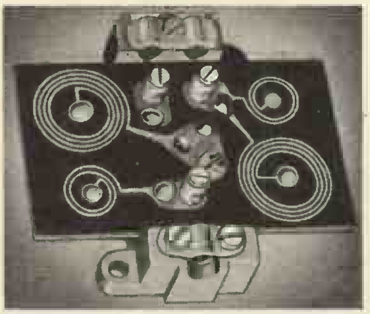
In some boards considered by us to be unsuitable, the copper is so thinly deposited that it is only useful as a key to solder, and the whole board must be dipped to ensure a satisfactory result. With the board we use the adhesion of the cladding is so good that we can, with safety and confidence, solder 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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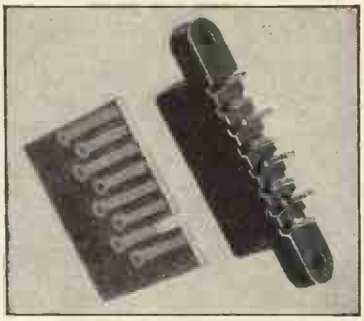
**Great Cambridge Rd., Enfield, Middx.**
***Written 12th November, 1959***

## "BELLING-LEE"
## PRINTED CIRCUIT CONNECTORS & GUIDES



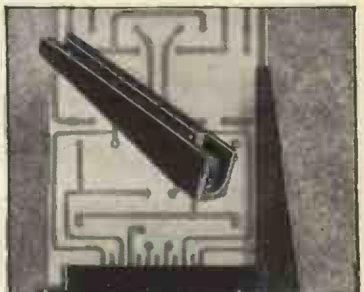
**L.1355/Au or Ag.** 8-pole, 0.1″ Module
**L.1369/Au or Ag.** 8-pole, 0.15″ Module
**L.1370/Au or Ag.** 12-pole, 0.15″ Module
**L.1372/Au. or Ag.** 18-pole, 0.15″ Module
**L.1380. Guide for printed circuit panels**

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. $\pm$ 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.



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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.

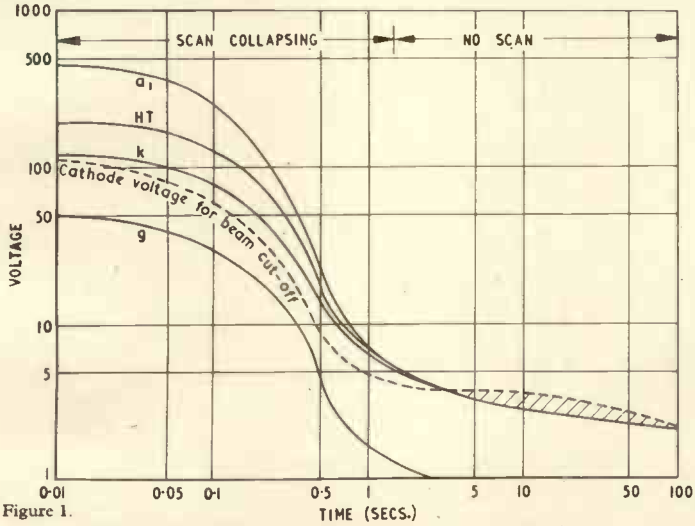


Figure 1.

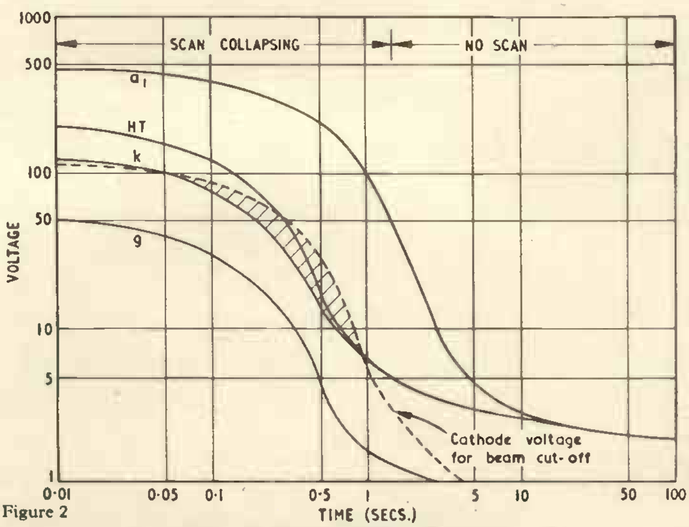


Figure 2

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 " Metrosil ". In this case, the E.H.T. voltage falls sufficiently rapidly for no more than a defocused moving spot to be briefly seen.

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## 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.**

### MAXIMUM DESIGN CENTRE RATINGS

| | | Heptode | Triode |
|---|---|---|---|
| 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) (volts) .. .. .. | $V_{g2+g4(max)}$ | 250 | — |
| Screen Voltage ($I_a$ = 7.6 mA) (volts) .. .. .. | $V_{g2+g4(max)}$ | 125 | — |
| Heater to Cathode Voltage (volts rms) .. .. | $V_{h\text{-}k(max)\,rms}$ | 100 | |
| Mean Cathode Current (mA) | $I_{k(av)max}$ | 12.5 | 6.5 |

### INTER-ELECTRODE CAPACITANCES (pF)

| | | Heptode | Triode |
|---|---|---|---|
| Anode to Earth .. .. | $c_{a\text{-}E}$ | 7.9 | 2.1 |
| Anode to Grid 1 .. | $c_{a\text{-}g1}$ | <0.006 | 1.0 |
| Grid 1 to Earth .. .. | $c_{g1\text{-}E}$ | 4.8 | 2.6 |
| Grid 3 to Earth .. .. | $c_{g3\text{-}E}$ | 6.0 | — |

Inter-electrode capacitances measured in fully shielded socket.

### CHARACTERISTICS

| | | Heptode | Triode |
|---|---|---|---|
| Anode Voltage (volts) .. | $V_a$ | 170 | 100 |
| Screen Voltage (volts) .. | $V_{g2+g4}$ | 102 | — |
| Grid No. 3 to Cathode Voltage (volts) .. .. | $V_{g3\text{-}k}$ | 0 | — |
| Grid No. 1 to Cathode Voltage (volts) .. .. | $V_{g1\text{-}k}$ | -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 |

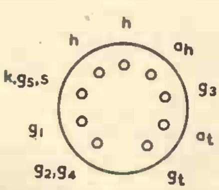
### TYPICAL OPERATION AS AM FREQUENCY CHANGER

| | | |
|---|---|---|
| ***Heptode*** | | |
| Supply Voltage (volts) .. .. .. | $V_b$ | 170 |
| Anode Voltage (volts) .. .. .. | $V_a$ | 170 |
| Screen Resistance (kΩ) .. .. .. | $R_{g2+g4}$ | 10 |
| Heptode Grid No. 3 and Triode Grid Resistance (kΩ) .. .. | $R_{g3+gt}$ | 47 |
| Screen Voltage (initial) (volts) .. .. | $V_{g2}$ | 102 |
| Grid 1 to Cathode Voltage (volts) .. | $V_{g1\text{-}k}$ | -2.2 |
| Heterodyne Peak Voltage (volts).. .. | $V_{het(pk)}$ | 12 |
| Conversion Conductance (μA/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 (μA) .. .. | $I_{g3+gt}$ | 200 |
| Grid 1 to Cathode Voltage for $g_c$ reduction 100 : 1 (volts) .. .. | | -24 |
| Valve Anode Resistance ($\delta v_a/\delta i_a$) (MΩ) .. | $r_a$ | 0.9 |
| Equivalent Grid Noise Resistance (kΩ).. | $R_{eq}$ | 70 |
| ***Triode*** | | |
| Anode Voltage (volts) .. .. .. | $V_{a(t)}$ | 103 |
| Anode Current (average) (mA) .. .. | $I_{a(t)}av$ | 4.5 |

### MAXIMUM DIMENSIONS (mm)

| | |
|---|---|
| Overall Length .. .. .. .. .. .. | 67.5 |
| Seated Height .. .. .. .. .. .. | 60.5 |
| Diameter .. .. .. .. .. .. .. | 22.2 |

Base: B9A (Noval)

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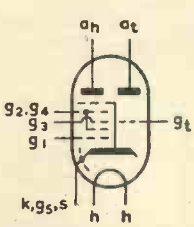
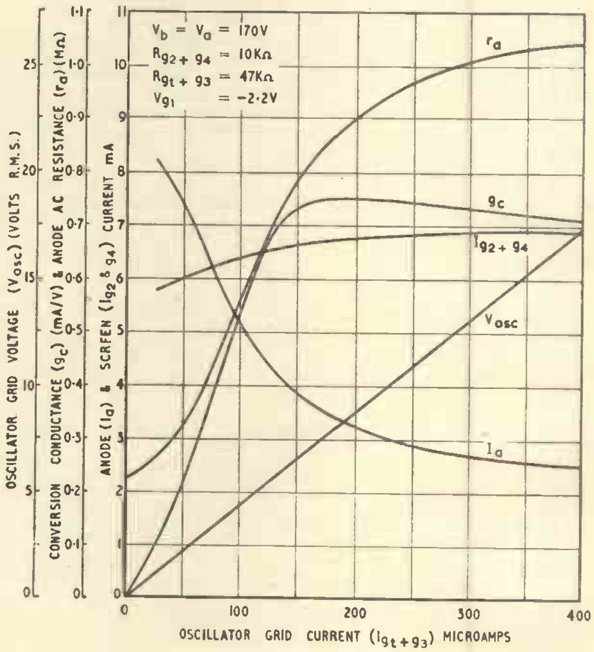
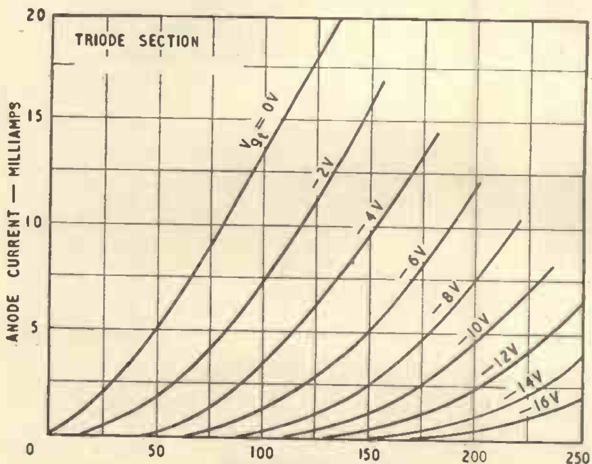



Preliminary characteristic curves of Ediswan Mazda Valve Type 10C14



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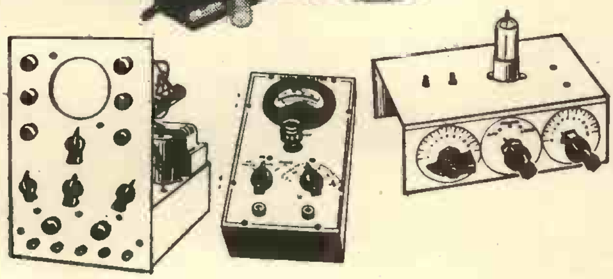

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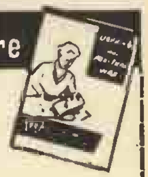

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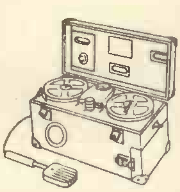
A new transportable model for making "studio" quality recordings in all conditions on outside location. Compactly housed in one rexine-covered wooden case, it is equally suitable to the needs of the recording engineer and the research worker. Features include —

- Twin Channels. The recorder forms a complete twin-channel machine with separate record and replay amplifiers. This allows a fresh programme to be set up and monitored while an earlier recording is still being replayed.
- Easy Servicing. Special attention has been given to servicing needs. Any of the chassis units can be easily removed in under two minutes. Plug in amplifier being employed.
- Vu Meter. Indicates levels for Bias, Line in, Record Level, Line Out and Erase—as selected by a five position switch.
- Tape Speeds. Twin track 15, $7\frac{1}{2}$ and $3\frac{3}{4}$/ips.
- Frequency Response.
  $3\frac{3}{4}$/ips within $\pm 2$ dB from 50 c/s to 6 kc/s
  $7\frac{1}{2}$/ips within $\pm 2$ dB from 50 c/s to 10 kc/s
  15/ips within $\pm 2$ dB from 50 c/s to 15 kc/s
- Recording Characteristics. Conform to CCIR Recommendations.
- Distortion. Less than 2% harmonic at peak recording level.

# EMI Tape Recorders

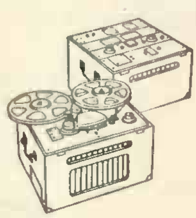
*Built for professionals – by professionals*

EMI professional recording equipment is world-famous for setting the highest possible standards of fidelity in sound recording. Designed to the most exacting specifications, recorders like these are in everyday use by the BBC and ITV, leading recording companies and industrial and scientific research teams— striking proof of supreme accuracy, reliability and versatility.



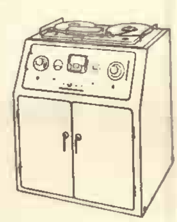
**L2/TA**

A transistorized version of the model L2 already in use throughout the world for "on-the-spot" recordings.



**TR90**

A highly versatile instrument, available in four versions to meet varying recording requirements—rack mounted, console, transportable, and trolley. There is also a stereophonic version.



**BTR2/AM**

The famous studio model for use wherever the highest recording standards are vital. Special unit construction provides great flexibility in application.

**EMI**

*For further information on any of these EMI recorders, telephone or write to:*

EMI SALES & SERVICE LTD (Recording & Relay Equipment Division)
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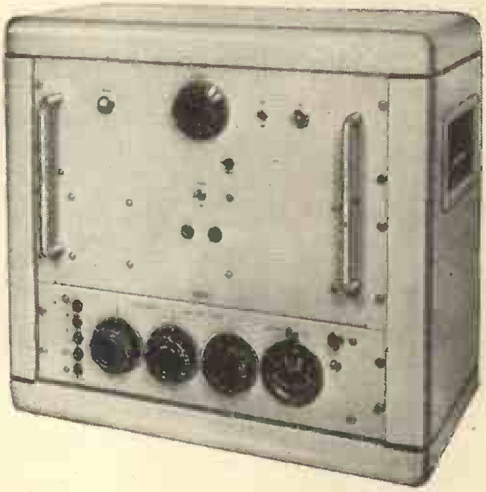
ES/P/18


# Vortexion quality equipment

## 120/200 WATT AMPLIFIER



## TAPE RECORDERS

The W.V.A. tape recorder now has provision for Stereo plug in heads to enable this recorder to replay Stereo. The regular models are retained with additions and improvements. Our high standard which has made these recorders famous has been maintained, resulting in their being chosen for the foremost musical centre in this country.

## 30/50 WATT AMPLIFIER

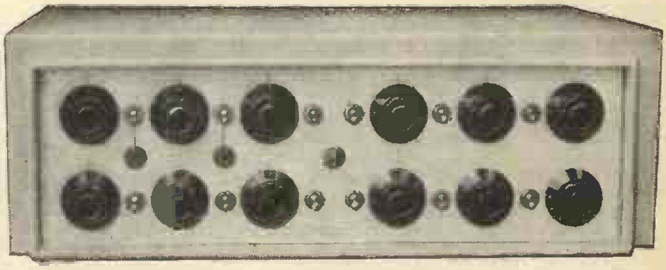
Gives 30 watts continuous signal and 50 watts peak Audio. With voice coil feedback distortion is under 0.1% and when arranged for tertiary feedback and 100 volt line it is under 0.15%. The hum and noise is better than—85 dB referred to 30 watt.

It is available in our standard steel case with Baxendale tone controls and up to 4 mixed inputs, which may be balanced line 30 ohm microphones or equalised P.U.s to choice.

Will deliver 120 watts continuous signal and over 200 watts peak Audio. It is completely stable with any type of load and may be used to drive motors or other devices to over 120 watts at frequencies from 20,000 down to 30 cps in standard form or other frequencies to order. The distortion is less than 0.2% and the noise level —95 dB. A floating series parallel output is provided for 100-120 V. or 200-250 V. and this cool running amplifier occupies 12¼ inches of standard rack space by 11 inches deep. Weight 60lb.

## 12-CHANNEL ELECTRONIC MIXER

This is similar to the 4-channel, but is fitted with 12 hermetically sealed controls, 12 balanced line microphone transformers potted in mu-metal boxes, and a mains transformer also potted in mu-metal. All components which can affect noise are tested and selected before insertion. It is supplied in standard steel case or 7in. rack panel.



*Full details and prices of the above on request*

**VORTEXION LIMITED, 257-263 The Broadway, Wimbledon, London, S.W.19**

Telephones: LIBerty 2814 and 6242-3 Telegrams: "Vortexion. Wimble, London."


For versatility in camera channels

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The E.M.I. Camera Channel Type 203 is unique in possessing the following features :

* Designed to operate with 4½ inch Image Orthicon pick up tubes with the facility of rapid interchange to 3 inch Image Orthicon or C.P.S. Emitron pick up tubes if required.

* Five position turret including one special position providing facilities for : easy withdrawal of pick up tube through turret without opening camera sides ; and mounting of diascope or non standard type of lens.

## E.M.I.'s new 203

* Will accommodate TTH Studio Varotal or Zoomar Zoom lens without modification.

* Operation on any one of the following systems by simple change of plug connectors :
*625 lines to CCIR/OIR Standards*
*525 lines to IRE/EIA Specifications*
*405 lines to BBC TV80 Specification*

* Extensive use of plug-in printed wiring units provides very good accessibility, and ease of maintenance.

* Special quality valves and high stability circuits eliminate need for adjustment over long periods of operation.

* Remote control of lens apertures by easily detachable servo mechanism.

* Optional preset filter wheel, electronic Image Orbiting and hour meter.

*For full technical details, or for a demonstration, get in touch with us.*

**EMI**

EE53

# Amplifiers that are acclaimed throughout the world

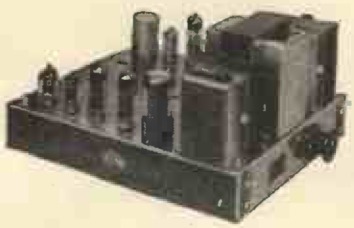
J. C. GILBERT, F.R.S.A., Assoc. I.E.E., M.Brit. I.R.E., F.T.S.

*The "Point One Stereo" pre-amplifier is designed so that it can be used with any Leak monaural power amplifier or a combination of any two Leak monaural power amplifiers additionally to its more normal use with the "Stereo 20" or "Stereo 50."*

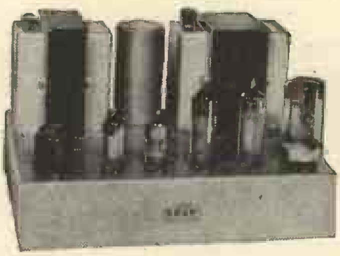
"The 'Point One Stereo' pre-amplifier is probably the most comprehensive unit in existence covering every refinement for stereo tape, disc and radio plus monaural amplification for any form of input signal . . . it is difficult to think of any additional requirement that one would ever wish. The equipment performs with the high performance always associated with the tradition of Leak equipment. It is a fine example of design and construction, and the pre-amplifier can be used with any other Leak main amplifiers. How the pre-amplifier can be sold for as little as £21 can be answered only by Harold Leak. . . . Summing up, therefore, one can highly recommend the Leak stereo system for use with any current monaural or stereo input whether it be from pickup, tape, radio or microphone."

*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.*

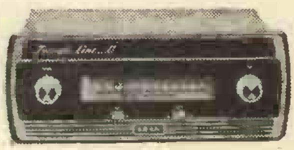

**£21:0:0** . . . . . *a price made possible only by world-wide sales*



**STEREO 20 amplifier 29 GNS**



**TL/12 PLUS amplifier 18 GNS**



**Trough-Line F.M. Tuner** *(self-powered)* **£25.0.0 plus £8.15.0 tax**

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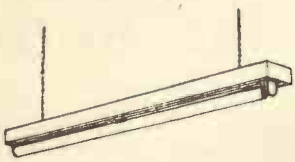
## INDUCTOR FLUORESCENTS



These represent today's best value in lighting. All models are complete with polyester-filled chokes (so far as we know not available in any other low-priced fittings) all are made from heavy gauge sheet steel, stove enamelled white, use all canister-type plug-in starters, and all are fitted with interference suppressors. Guaranteed for two years:

Inductor 80 for 5ft. 80-watt lamp 39/6+5/- carr. and ins.

Inductor 40 for 4ft. 40-watt lamp 32/6+4/6 carr. and ins.

The Three-Forty: for 3ft. 40-watt lamp 31/6 +3/6 carr. and ins.

Inductor 20 for 2ft. 20-watt lamp 29/6+3/6 carr. and ins.

Circle Light for 40-watt circular lamp 49/6 +3/- carr. and ins.

Note: Prices do not include tube but these are the latest bi-pin type easily obtainable from your local electrical shop or if you wish direct from us.

**Special Offers:**

Inductor 40 complete with tube ready to work 39/6+5/6 carr. and ins.

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## Miniature Microphone

American made. Dynamic type. Real bargain at 2/6, plus 6d. postage.

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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.

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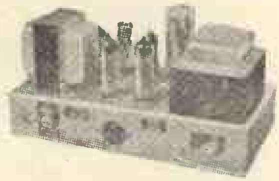
Particularly useful for controlling photoflood lamps which have only a short life at full brilliance. This toggle switch has three positions: the first position puts two lamps in series at half brilliance for setting up, the second position is off and the third position full brilliance for the operation shots. Also useful for controlling night lights, heaters, etc., etc. Price 3/9 each. Post 9d. Circuit diagram included.


## 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 feed-back all combined to give a truly linear output. Uses all-glass miniature valves, including two EL84s in push-pull. Price £12/12/-, or £1 down and 26 weekly payments of 10/-.

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- Simple but clever signal tracer
- Versatile power pack costing only 10/-
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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 diacon 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, 0-500 mA. Resistance: 0-1M and 0-10K. All at 10,000 ohms per volts—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.

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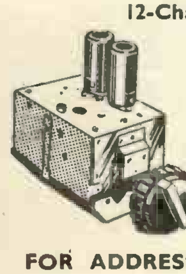
Car Battery Charger—ready-made high output battery charger in stove enamelled sheet steel louvred case. New, complete and ready to work. Rated at 12 v. 4 amps. and variable rate selector for trickle charging, also a meter to show charging rate. Suitable for 230/250 A.C. mains. Special snip price of 55/-, 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 motifed, two-tone cabinet as illustrated, tuning dial, two gang tuning condenser, combined bakelite chassis/printed circuit and easy-to-follow circuit. Costing value 57/6—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.

FOR ADDRESSES SEE OPPOSITE PAGE

## SPECIAL THIS MONTH

**Battery Charger Rectifier**—selenium 12-15 v., 5 amp., 12/6.

**Blank Metal Chassis**—all 2½in. deep from 18 gauge aluminium. Sizes: 6in. × 2in., 4/6; 7½in. × 5in., 6/-; 13½in. × 9in., 10in. × 7½in., 7/-; 11½in. × 7½in., 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 muffs, 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**

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| 0-500 microamp | 2in. flush | 17/6 |
| 250-0-250 microamp | 2½in. surface | 27/6 |
| 750 microamp | 2½in. surface | 17/6 |
| 5-0-5 microamp | 2½in. flush | 17/6 |
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| 0-100 milliamp | 2½in. flush | 15/- |
| 0-300 milliamp | 2½in. flush | 15/- |
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**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 6-ft. leads for 2/-.

**Metal Rectifier**, 60/80 mA. 250/300 v., 4/6.

**Filament Transformer**, 6.3 v., 1½ amps. 6/6

**.3 Amp Dropper**—tappings marked 200/220/250, 3/6.

**Output Transformer**—standard pentode—4/6, multi ratio, 6/6.

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**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/-.

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**Tag Panels.** Ideal for constructors, experimental circuits, etc., 3 of each of 12 different types, 5/-, post 1/6.

**Slydlok 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 Dubilier 2/6 doz.

**50 Assorted Resistors.** Well mixed and useful values ¼ and ½ watt, 5/- for 50.

Ditto, but 1 watt, 6/6 for 50.

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**Metal Rectifier.** 250 v. 60-80 milliamps., ideal for mains set or instrument or to replace that expensive valve, 5/6.

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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: 11¾in. wide, 1¾in. deep, 2½in. high, depth 2½in.

Mains model with stereo cartridge, £7/17/6.

Or with monaural cartridge, £6/18/6, post and ins. 3/6.

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| SB078 | 10 Mc/s min. | 7 to 20 | 10/- ea. |
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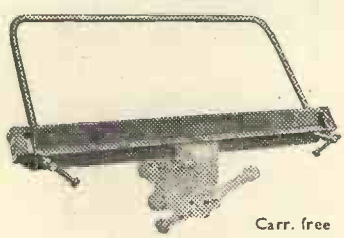

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*With Bevelled Former Bars*

**No. 1.** Capacity 18 gauge mild steel x 36in. wide ............... £7 10 0
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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.
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**FERRANTI $7\frac{1}{2}$-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%.

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- Can also be used as a variable transformer.
- **Unused.** Complete with spares and instruction book.

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for playing 45/45 records. Miniature ceramic type with replaceable diamond stylus. Constant velocity output approximately 20mV from each channel. Frequency range 20 to 16,000 cycles. Channel separation 20/25 dbs.

**(Complete as illus.)** ....£12/19/10
**Head only**................ £7/19/11
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### STEREOPHONIC AMPLIFIER AND PRE-AMPLIFIER

Twin channel amplifier and pre-amplifier for reproducing monaural and stereophonic sound from disc, radio and compensated tape.
Ultra linear push/pull output giving 7.5 watts peak from each channel.

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**Pre-amp. £16 . 10 . 0**

### BRAND NEW 2 SPEED STEREO TRANSCRIPTION MOTOR

Operates at 33⅓ and 45 r.p.m. Full 12in. turntable.

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Operates at 33⅓, 45 and 78 r.p.m. Non-ferrous turntable. Built-in large stroboscope with internal light source. Precision ground and lapped spindles. Adjustable nylon graphite bearings. Synchronous motor.

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| U.S.A. & | Decca Stereo pick-up with arm type ffss | $46.35 (£16. 9.6) | PACKED |
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R.C.S.C. Style RWV4-L

**FULLY R.C.S.C. TYPE APPROVED, 10Ω to 22KΩ, our RWV4-L style resistors conform to Inter-Services Spec. RCS 111.**

**Other styles available. R.C.S.C. type approval applied for.**

| RCSC Style | CGS Style | Rating in watts: Service | Rating in watts: Commercial | Range |
|---|---|---|---|---|
| RWV4-J | VPF4 | 3 | 4 | 5Ω to 8KΩ |
| RWV4-K | VPF10 | 4.5 | 10 | 5Ω to 68KΩ |
| RWV4-L | VPF14 | 6 | 14 | 10Ω to 100KΩ |

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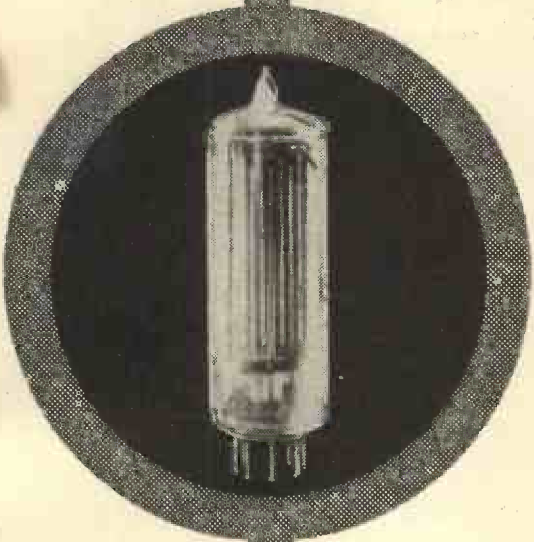

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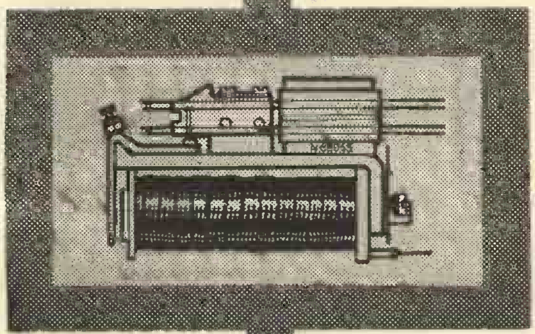

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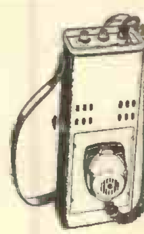

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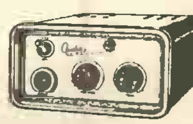

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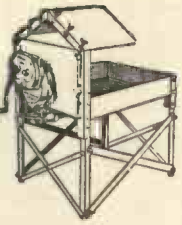

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Ten position speed selector for balancing bridge over each of three ranges 600 to 5,000, 1,200 to 10,000 and 2,400 to 20,000 r.p.m. Final balancing done at increased sensitivity by push-button control. Quick mounting provision for two indicators and generators with two sets of quick fitting interconnecting leads, spare flexible drives, spare brushes, bulbs, etc., in rear compartment. Smart grey enamel bench unit with sloping panel, overall size 19in. high × 15in. deep × 16in. wide, plus 11in. extension platform for generators. **£20** carriage paid

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American panel mounting "Radio Altitude" meter with modern (coil round magnet) movement giving beautifully steady deflection to reading on large dial boldly marked 1 to 4 with sub-divisions in tenths. Supplied with suppressed zero which requires 6.5 mA. for full scale deflection (0 = 1.5 mA.) but pointer is easily re-set to zero by moving conventional hair spring adjuster behind dial, when 5 mA. gives f.s.d. Rear housing incorporates on/off switch (operated by rotating small knob on front face) and 5-pin plug, two pins direct to meter and two to switch. Not new. 12/6, *post free.*

## TEST GEAR

**I-30-A SIGNAL GENERATOR 100-156 Mc/s**

Modern, portable, battery operated, 5 valve Signal Generator with alternative crystal or master oscillator, either optionally modulated by 1,000 c/s Hartley oscillator. Large directly calibrated dial with precision slow motion drive. Five step and variable attenuator. Supplied with matching black crackle carrying case for 6 and 135 volt batteries with 10ft. supply cable, and metal cased 1 mA. test meter for checking crystal resonance, etc. Brand new. £2/17/6 *plus 7/6 packing and carriage.*

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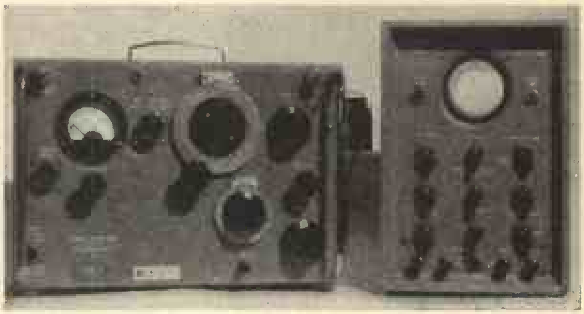

## SIGNAL GENERATOR 52A

As illustrated, mains operated 7 valve precision generator covering 5 to 50 Mc/s in 4 turret-tuned accurately calibrated bands with RF voltage set and monitored by 50 microamp meter in valve voltmeter circuit. Optional CW or internal modulation at 400 c/s to 30%, or variable depth external amplitude or pulse modulation down to 1 microsecond as required. 1 microvolt to 100 mV output through 5 step and microvolt calibrated vernier attentuator (accuracy ± 3 db) into 70 or 100 ohm dummy antenna on 3 foot cable.

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Four valve crystal controlled hetrodyne frequency meter covering 100 kc/s to 20 Mc/s in 8 switched bands with variable RF oscillator zero beat against crystal to give an audio output into high or low impedance phones. Designed to work as a signal generator with CW or modulated output through variable attenuator and incorporating also a second crystal oscillator that can be switched in to convert the unit to a fixed spot-frequency receiver or transmitter at the wavelength of any spare crystal between 100 kc/s and 20 Mc/s.

Precision two speed dial, calibrated book with crystal check points in lid of neat metal case. Designed for 2v. and 40-60V supply.

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A.C. input 100-260volts 45-65c/s D.C. output 24 volts 10amps. at max. ambient temperature of 131°F. but guaranteed max. output of 20 amps. All components are rated by manufacturers at this current. The charger is fitted with 20 amp. fuses on the D.C. output, 10 amp. fuses on the A.C. input. 2½in. 0-20 M.C. D.C. ammeter. On/off full charge/trickle charge switch. Heavy duty output terminals and mains neon indicator lamp. Behind control panel are mounted full charge ballast and trickle charge resistances.

These units are designed to charge all 24 volt lead-acid battery combinations. That is two 12 volt or four 6 volt batteries in series at a 20 amp. max. rate. Can also be used for trickle charging 24 volt batteries at 125. 350 and 700 m.a.: are ideal for the electronic industry, research laboratories, schools etc., as a general purpose L.T. supply unit.

Supplied brand new at a fraction of maker's price. Size: 2ft. x 1ft. 3¼in. x 2ft 8in Weight: 141lbs.

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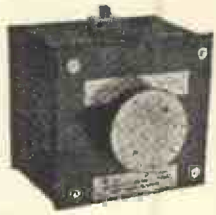

**ADMIRALTY HEAVY DUTY D.P.C.O.** 15 amp. Knife switches. Metal shrouded. New, 7/6. P.P. 2/6.

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# CLYNE RADIO LTD.

THE COMPONENT SPECIALISTS

"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 study before purchase at 1/6 post free.

**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.

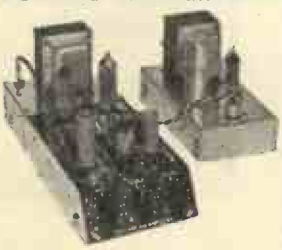
## NEW LOOK ECONOMY FOUR

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 Coils. 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.

## 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. and 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.

## SUPER MAGNETIC RECORDING TAPE SPECIAL!!!

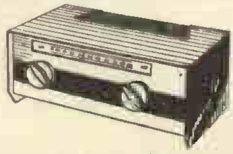
First delivery Famous American Ferrodynamics Acetate Base High Quality Recording Tape. An enthusiast's "must." Brand new (NOT SUB-STANDARD), 7in. 1,200ft. on plastic spool, 25/-; 7in. 1,800ft. on plastic spool, 35/-. Post free.

## 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 1½in. 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.

## THE NEW JASON FM TUNER

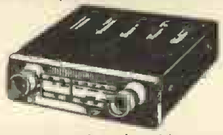
The latest addition to the impressive **JASON** range, and like all **JASON** equipment, can be depended upon for QUALITY, RELIABILITY and PERFORMANCE.



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. and p. Instruction booklet with itemised price list, full description dimensions, etc., available separately at 3/6 post free.

If not stated, please add postage on orders under £1. Cash with order or C.O.D. (charges extra).

*Our Advantageous H.P. and Credit Sale Terms are available on any single item over £5. Your enquiries invited.*

# CLYNE RADIO LTD.

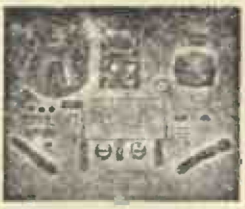
162, HOLLOWAY ROAD, LONDON, N.7. NORth 6295/6/7.
18, TOTTENHAM COURT ROAD, W.1. MUSeum 5929/0095.
(50 yards only from Tottenham Court Road Tube)

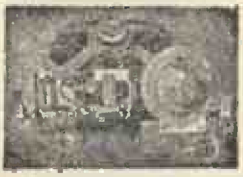
Open: Tottenham Court Rd.: 9 a.m. to 6 p.m. Mon. to Fri., Sat. 1 p.m.
Holloway Road: 9 a.m. to 6 p.m. daily. Thurs. 1 p.m., Sat. 5.30 p.m.

All post orders and correspondence to
162 HOLLOWAY ROAD, LONDON, N.7.

## 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 feed-back 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/-).**



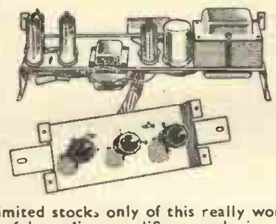


**COSSOR VHF/FM RECEIVER KIT 701K.** A first-class receiver of the latest type for the reception of B.B.C. VHF/FM programmes, and suitable for use on A.C. or D.C. mains supply, supplied in kit form, in manufacturer's original presentation carton, comprising: printed circuit (with all connections clearly 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 TRANSCRIPTOR.** 3 motors, 3-speed: 1⅞, 3¾, 7½ 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 chrome 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: 13½in. × 8½in. × 7¾in. 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**

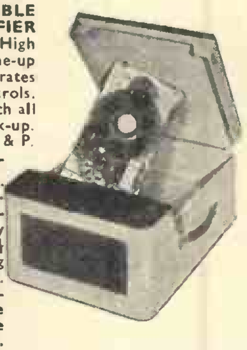


Limited stocks only of this really wonderful quality amplifier employing 4 valves: 2–EL84, ECC83, EZ80. Separate Bass and Treble Controls mounted with Volume Control upon loose panel with flying leads. Excellent quality components employed throughout. Overall dimensions: (Main chassis) 12¾in. × 4in. × 5in. high. Control panel: 6in. × 2¾in. 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.

### EXTRA SPECIAL OFFER!!

A small three-valve **PORTABLE RECORD-PLAYER AMPLIFIER** mounted on baffle 12 × 7in., with High Flux 6½in. 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 × 13¾ × 8½in. 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.**



### A QUALITY RECORDER FOR 39 GNS.

| | |
|---|---|
| Collaro Mark IV Tape Transcriptor Deck | £17 19 6 |
| Special amplifier | £14 14 0 |
| 8 × 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 |
| **TOTAL** | **£42 13 6** |

**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. × 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).

### 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.

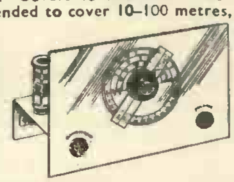
**E.M.I. 4-SPEED STEREO SINGLE RECORD UNIT.** Complete with Stereo Head and Sapphire Styli. Brand New and Fully G'teed. **ONLY £6/19/6** plus 3/6 P. & P. whilst stocks last.

### SPEAKER BARGAINS

Goodmans 8in. × 2¾in., 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.

### 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.

**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 × 3½ × 8½in. Only 59/6 plus 2/6 P. & P.

**SPECIAL CELESTION** 8 × 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.

NOTE. Supplied post free if all above items purchased together.

## CLYNE RADIO LTD.

**162 Holloway Road, London, N.7**
**and**
**18 Tottenham Court Road, London, W.1**

SEE OVER FOR MORE **BARGAINS** →

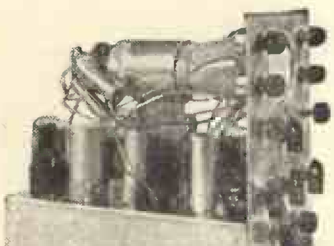
## JASON TEST EQUIPMENT

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 11½in. × 6½in. × 5½in. 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 2¾in. Cathode Ray Tube and 4 valves: 2/ECF80, 1/EF91, 1/EZ35, 6X5. 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. × 3½in.) 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. × 6½in. × 6¾in. 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.

**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 3¾in × 7in. × 1¾in. 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 3½in. × 5in. × 1¼in. overall. Supplied complete with instructions and test prods. ONLY £5/19/6 plus 2/6 P. & P.

### —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**
TS8 ........ 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.
OC/72 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 2½in. Flush Round, 65/-; 100 microamps 2½in. Flush Round Moving Coil at 45/-; 500 microamps 2in. Flush Round Moving Coil at 18/6; 1 mA. 2in. Flush Square Moving Coil "Elliott" 1954 man., 25/-; 50 mA. 2in. Flush Square Moving Coil 8/6; 1 mA. 2½in. Flush Round 35/-. Send stamp for complete list. We shall be pleased to quote for special meters to your own specification.

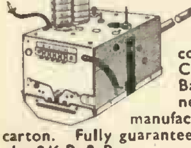
**AERIAL TUNING UNIT ZA0841.** This well made ex-W.D. unit contains a host of useful components including: 1 mA. 2in. flush round M/C meter, 1 mA. Westinghouse full-wave meter rectifier, 5-pole 5-way heavy-duty silver plated wavechange switch, 3in. dia. silver plated rotary tuning Indicator, 350 pF. tuning condenser with insulated coupler and 3½in. calibrated dial (0–180 deg.) etc., etc. Contained in strong metal carrying case 9in × 9in. × 8in. 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. × 14in. × 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.

# ★ 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.

**DLR5 BALANCED ARMATURE HEADPHONES.** Complete with headband and leads, 7/6 pair, plus 1/6 P. & P.

**HIGH IMPEDANCE LIGHTWEIGHT 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.

**CLYNE RADIO LTD.**
162 Holloway Road, London, N.7
and
18 Tottenham Court Road, London, W.1.

ALSO SEE PAGES 128 & 129

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 1-200ft. 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 .................. **£41.0.0**
H.P. Terms: Deposit £8/4/- and 12 months of £3/0/2.

MODEL CR3/T. Incorporates the very popular 3-speed COLLARO Mk. IV "TRANSCRIPTOR" Deck, which has both upper and lower tape tracks .................. **£49.10.0**
H.P. Terms: Deposit £9/18/- and 12 months of £3/12/7.

MODEL TR3/Mk. VI. Incorporates the New TRUVOX Mk. VI TWIN TRACK 2-speed Tape Deck .................. **£49.10.0**
H.P. Terms: Deposit £9/18/- and 12 months of £3/12/7.

## ! ! 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 4HF 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.) PRICE **£14.5.0**
HIRE PURCHASE: Deposit £2 and 12 months at £1/0/9. Incorporates the latest MULLARD PERMEABILITY TUNING HEART and the corresponding MULLARD VALVE LINE UP comprising ECC85, 2 type EF85s (or EF89s), EM84, Tuning Indicator, plus 2 type O.A. 79s Germanium Diodes. A really first-class Tuner very attractively presented and comparable to many offered at much higher prices. Power consumption is only 1.5 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, Preamplifiers, 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. 2½ amps. The design incorporates Reliant 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 7¾ × 4¾ × 6in. high.

## ! ! RADIOGRAM CHASSIS ! !

ARMSTRONG MODEL A F 208 .................. **£23.2.0**
Complete AM/FM chassis producing 5 watts. Separate Bass and Treble controls.
ARMSTRONG "STEREO TWELVE" .................. **£37.16.0**
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
ARMSTRONG "JUBILEE" .................. **£29.8.0**
An AM/FM chassis with nine valves and with push-pull output stage providing 6 watts.
ARMSTRONG AM/FM "STEREO 44" .................. **£28.7.0**
Provision is made for Stereo and Monaural playback from pick-up or tape. Outputs provided for Stereo or Monaural tape recording.

## RADIO TUNING UNITS

The JASON "MERCURY" Switched F.M. TUNER.
PRICE ASSEMBLED AND TESTED .................. **£13.10.0**
Complete Kit of Parts £9/19/6.
DULCI Model FMT/2 .................. **£19.17.6**
A complete self-powered FM Tuner incorporating automatic frequency control.
ARMSTRONG "S.T.3." AM/FM Tuning Units .................. **£27.6.0**
A self-powered high fidelity tuner covering full VHF. medium and long wavebands with automatic frequency control on VHF.
DULCI "H4/T" AM/FM Tuning Units .................. **£23.15.8**
A 4-waveband self-powered high fidelity tuner covering the VHF/FM transmissions plus the long, medium and short wavebands.
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 GOODMANS-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.F.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 .. **£17.10.0**

LOUDSPEAKER ENCLOSURES—TWEETER UNITS—CROSSOVER UNITS *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 Rexine—WE ALSO SUPPLY SEPARATELY:—

(*a*) The 2-stage (plus Rectifier) AMPLIFIER £4 2 6
(*b*) The PORTABLE CARRYING CASE £3 17 6
(*c*) 12in. P.M. SPEAKER ...... 18 9

(Carriage and insurance 4/- extra)

**STERN RADIO LTD.** 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 BRENELL 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**

## STERN'S MULLARD TYPE "C" TAPE PRE-AMPLIFIER—ERASE UNIT

**INCORPORATING THE NEW FERROXCUBE POT CORE PUSH-PULL OSCILLATOR and 3 SPEED TREBLE EQUALISATION by means of the latest FERROXCUBE 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.

DEPT. W 109 FLEET ST., LONDON, E.C.4
Telephone: FLEET STREET 5812/3/4

## 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 **£30.15.0**
(£1 extra if we are required to wire up Deck Banks)
(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**
H.P. Terms: Deposit £7/18/-, 12 months of £2/17/11.
(g) COMPLETE KIT to build the HF/TR3 AMPLIFIER with the BRENELL 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 BRENELL Mk. V Decks are also available.

## THE MODEL HF/TR3 TAPE AMPLIFIER

Incorporating
***3-SPEED TREBLE EQUALISATION by means of the latest FERROXCUBE POT CORE INDUCTOR.***

PRICE for COMPLETE KIT OF PARTS **£12/15/-**
FULLY ASSEMBLED AND TESTED **£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 6 x 6in.—Truvox—Collaro—or Brenell—please specify which. Send S.A.E. for leaflet or 2/6 for Assembly Manual.

**PLEASE ENCLOSE S.A.E. WITH ALL CORRESPONDENCE**

# 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 4¾ × 3¼ × 3½in.
**LASKY'S PRICE 35/-** Post 2/6.

## NEW YEAR RECORDER SCOOP!

### "MAESTROVOX MAJESTIC"
**ALMOST HALF-PRICE!**

Brand new and unused. Brief specification:—Collaro Tape Transcriptor, twin track, instantly reversible. Incorporates 4 heads (two for each track). 3-speed—3¾, 7½ and 15 i.p.s. Takes 7in. spools. Mixing facilities for recording and playback. Magic eye recording level indicator. Record monitoring and feed to amplifier. Extension l.s. socket. Handsomely designed cabinet, 18in. × 15½in. × 9in.

LIST 65 GNS. **LASKY'S PRICE 35 GNS.**

Including Tape and Take-up Spool. Mike extra.
Carr. and Insur. 21/-.

## 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 soiled 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 5¾in. 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 | 5¾in. | 7in. | 8¼in. |

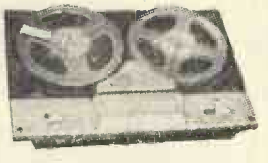
7in. Metal Spools, 1/9 each.
Post extra.

## 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 7½in. × 10in., maximum height 5in., gold hammer finish. Separate Pre-Amplifier in polished wood case, walnut veneered, with smart maple and gold escutcheon, size 10½in. × 3½in. × 4in. Brand new and unused.

## TAPE DECK OFFERS!



Latest B.S.R. "MONARDECK," SINGLE-SPEED TAPE DECK, 3¾ i.p.s., takes 5¾in. spools. Simple controls.
**LASKY'S PRICE £9.19.6**
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**

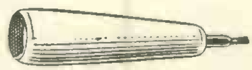
Latest COLLARO STUDIO TAPE TRANSCRIPTOR. 3 motors 3-speed, 1⅞, 3¾, 7½ i.p.s. takes 7in. spools. Push button controls.
**LASKY'S PRICE £15.15.0**
Tape extra. Carr. & Insur., 12/6

**COLLARO TAPE TRANSCRIPTOR**, Mk. IV, fitted with digital counter. Limited quantity. LIST £25.
**LASKY'S PRICE £17.19.6**
Carr. & Insur 21/-.

## 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.

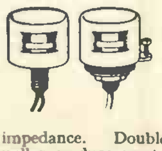
### MICROPHONE BARGAINS



**ACOS CRYSTAL STICK MIKE**, type MIC.39/1, complete with cable. Listed at £5/5/-.
**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/PLAYBACK, high impedance. Double wound and will reproduce up to 12,000 c.p.s. at 7½ i.p.s. Azimuth adjustments. Output 5 millivolts at 1 Kc. at 7½ i.p.s. ERASE, low impedance.
**LASKY'S PRICE 39/6** Per pair Post 1/3
Worth double. Please specify upper or lower track.

**LASKY'S RADIO FOR COURTEOUS SERVICE & TECHNICAL ADVICE**

# LASKY'S RADIO

## 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 7¾ x 3½in. max. height 4¼in. Controls mounted separately. **LASKY'S PRICE** complete with knobs. Post 3/6. **55/-**

MATCHED PAIR FOR STEREO .................... **5 Gns.** Post 5/-

**2-WATT GRAM AMPLIFIER,** uses UCL83, contact cooled rectifier. **LASKY'S PRICE** Post 2/6. **35/-**

### "LINEAR" AMPLIFIERS

"DIATONIC" 10-14 watt **12 Gns.**
"CONCHORD" 30 watt **15 Gns.**
L45 4-5 watt Amplifier **£5/19/6**
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 22/6.

Also available built ready for use. Price according to transformers used.

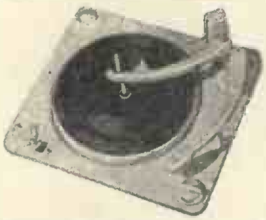
### BUILD THE 3-3 AMPLIFIER

Complete kit of parts with 3 Mullard valves EL84, EF86 and EZ81, £6/19/6. Post free. All components available separately.

## BARGAINS IN 4-SPEED MIXER AUTO-CHANGERS

**B.S.R.** 4-spd. mixer Auto-Changer type UA8, 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.



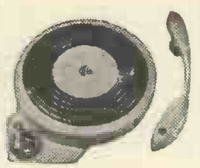
**COLLARO.** Incorporating auto and manual control. Complete with Studio crystal p.u. and sapphire stylus. LIST £13/17/-. **LASKY'S PRICE** Post 3/6. **£7.19.6**

### B.S.R. Latest Type UA12

4-spd. Wired for STEREO, complete with stereo cartridge. Post 5/-. **£8.19.6**
UA12 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 styli.

MOTOR only .................... 55/-
PICK-UP only ................. 27/6

**SPECIAL OFFER**

Motor and Pick-up together **75/-** Post free.

**COLLARO 4/564 or GARRARD 4SP** 4-spd. single player, auto. stop, T.O. crystal, Post 5/- **£6.9.6.**

### 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** Post 1/-. **29/6**

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** Post free. **18/-**

### CONVERT YOUR ALL-DRY PORTABLE RADIO TO MAINS 200–250 v.

with the **COSSOR BATTERY ELIMINATOR.** Two separate units identical in size to the B126 and AD35 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** Post 1/6 **37/6**

### 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. Post free. **25/10**

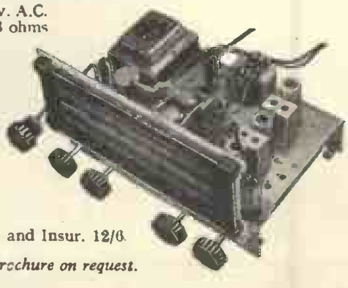
EARPHONES. High imp., **14/6.** Low imp., **7/6.** Post 1/6.

### 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** Carr. and Ins., 12/6. **20 GNS** Available on H.P. terms.

### 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 7¾in. front to back 8¾in. Limited number only.

LISTED AT 22 GNS.

**LASKY'S PRICE**

**£16.19.6** Carr. and Insur. 12/6.

*Available on H.P. terms. Brochure on request.*

## *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.

**SPEAKERS**
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.*

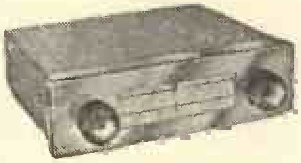
SEE OVERLEAF FOR MORE NEWS FROM LASKY'S RADIO

# LASKY'S RADIO

## LASKY'S HIGHLY EFFICIENT EASY-TO-BUILD SETS : TUNERS : AMPLIFIERS

| *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 3⅞in. × 3½in. | £5.12.6 Post 3/6 |
| **4-TRANSISTOR AUDIO AMPLIFIER,** Mk. II, 200/250 milliwatts, with 2 OC72 and 2 yellow/green. Size: 5¼ × 2 × 1½in. | £3.19.6 Post 3/6 |
| **?-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, 8¼ × 4½ × 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 6⅞in. × 3⅞in. × 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.

### 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 T12/54.
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 Ersin 5-core "Savbit" 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-milliamp METER RECTIFIERS.** Special offer of limited number at only **8/6** Post 9d.

### SPEAKER COVERINGS

Large stocks of "Tygan" and "Someweave." Any size piece cut. Sample and prices post free.

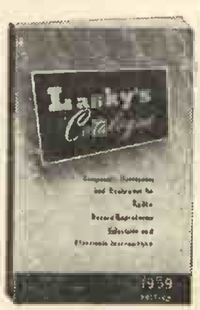
### NOW AVAILABLE PER RETURN

### THE FINEST COMPONENTS CATALOGUE

produced for the " ham " or service man. **OVER 100 PAGES, SIZE 8½in. × 5½in. WITH HUNDREDS OF UP-TO-DATE ILLUSTRATIONS.**

Price **2/-** Post 6d.

Our latest "BARGAIN BULLETIN" free with each copy.




### MULTI TEST METER BARGAIN

*Limited number only.*

*SEND TODAY*

AN/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, 3⅞ × 3⅞ × 1½in. deep. LIST 9 GNS.
**LASKY'S PRICE £5.19.6** Post 3/6. Leads 3/9 extra

### ALL TYPES OF CHASSIS

Leading makes, including ARMSTRONG, DULCI, EMPRESS, etc.,
A.M. chassis (L.,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

| 3½in. | 4in. | 5in. | 6½in. | 8in. |
|---|---|---|---|---|
| 17/6 | 19/6 | 14/6 | 16/- | 16/6 |

ELLIPTICAL

| 7×4 | 9×6 | 10×2½ | 10×6 | 10×7 |
|---|---|---|---|---|
| 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. (Double spot—yellow and green). **7/6**
3 for 20/-; 6 for 37/6 post free.
**R.F. P.N.P.** Junction Type suitable for medium and low freq. oscillators, freq. changers and I.F. amplifiers (1.5 to 8 Mc/s.) **15/-**
(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; TS4, 14/-; TP1 and TP2, 20/-; TJ1, TJ2, TJ3, 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
PADdington 3271/2

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

# 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 mega-cycles. It is extremely well designed and incorporates such desirable features of construction as potted " C " core trans-formers and paper smoothing capacitors for complete reliability. No electrolytic condensors are used.

| | |
|---|---|
| TIME BASE | 2 cps. to 750 Kcs. |
| Y PLATE AMPS. | 5 Mc/s. bandwidth (3 dB). |
| CAL. MARKERS | $1\mu$ sec. and $10\mu$ sec. |
| SIZE & WEIGHT | 13in. × 10in. × 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: $1\mu$H to 100H; C: $1\mu\mu$F to $100\mu$F. 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

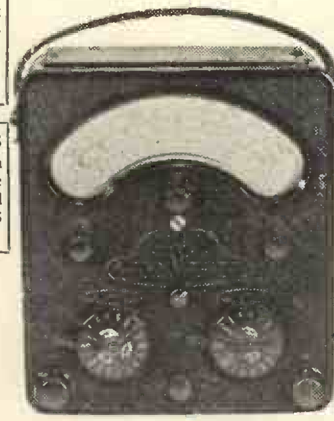
Volts 0 to 30, 150, 600 A.C./D.C. with additional 0-3 v. D.C. and 0-15 v. A.C. ranges; milliamps 0 to 7.5, 30, 150 and 750 D.C.; ohms 0-25K. Accuracy BSS 1st grade. 500 ohms per volt. With leads, prods, battery and instructions. In velvet lined 4×7×3in. case. Brand new condition, perfect working order 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 m/A. | 75 m/A. |
| 300 mV. | 15 V. | 30 m/A. | 150 m/A. |
| 1.5 V. | 75 V. | 150 m/A. | 750 m/A. |
| 3 V. | 150 V. | 300 m/A. | 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. | Resistance |
| 750 V. | | | 0-1000 ohms. |
| 1.5 KV | | | 0-10 K ohms. |

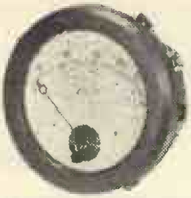
Thoroughly overhauled. Complete with batteries and instructions. An extremely robust meter at a very reasonable price.

### 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.

## CHARLES BRITAIN (RADIO) LTD.

**FERRANTI VOLTMETERS 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.



**CRYSTAL CALIBRATOR No. 10** A crystal controlled heterodyne wavemeter 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 7×7½×4in. 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'5ER (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 5½×4½×6½in. 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 9½×8½×6½in. 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, 7×7½×10½in. high. Wt. 50 lb. **BRAND NEW.** £3/10/-, 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 4×3½×2½in. 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 3½×3¾×3¾in. 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. 4¾×4½×5½in. high. Wt. 12 lb. Potted. Tag ends. RCA BRAND NEW. Boxed. 29/6, 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 crackled steel cabinet, size 10½×11½×6in. Fitted with rubber feet and 6ft. lead. Ideal for extension speaker, CR100, etc. In original cartons. BRAND NEW. 45/-. 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 | | 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 | 3½in. | 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 | 3½in. | Flush Circ. Scale 0-50/0-1,000 v. .................... | 62/6 |
| 100 Microamp. | D.C. M/C | 2½in. | Flush Square ........... | 42/6 |
| 1 Milliamp. | D.C. M/C | 3½in. | Flush Circular ........... | 50/- |
| 1 Milliamp. | D.C. M/C | 3½in. | Flush Squ. Scaled 0-250v. .. | 69/6 |
| 200 Milliamp. | D.C. M/C | 2½in. | 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 mA. 8/6, 5 mA. 8/6. STC 2 mA. 5/6.

**MINIATURE 373 IF STRIPS.** For FM tuner described in "Practical Wireless." Complete with 3 of EF91, 2 of EF92 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. VISCONOL CONDENSERS.** 8 mFd. 800 v. D.C. wkg. at 71 deg. C. CP152V. Size 3×1¾×5in. 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 coilsets 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 VOLTMETERS 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 10×10×9 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, Loctal, B7G, and Acorn types. Portable, in wooden carrying case 15½×8×5½in. 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.

**R1155 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., 12/6, post 3/6. 1Ω 12 A., 8/6.
**ZENITH ADJUSTABLE** 25Ω 4 A., 8/6. Post 2/6.
**PRECISION RESISTORS.** 1 Megohm 1% 1 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.
24 v. Input 230 v. A.C. 50 c/s. 100 watts output. In grey metal case. BRAND NEW. 92/6. Carr. 7/6.

**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

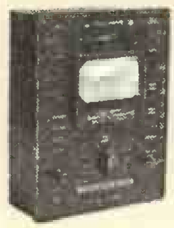
Phone: GERRARD 8204/9155
Cables: SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

## 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. | |
| 750 v. | | | 1,000Ω |
| 1,500 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 TELEPHONES 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 11.** 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 2,000/1,500/0/1,500/2,000 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. | 69/6 |
| 25 microamp. D.C. M/C. proj. rd. 2½in. | 59/6 |
| 50/0/50 microamp D.C. M/C., flush rd. 3½in. | 79/6 |
| 50 microamp. D.C. M/C. proj. rd. 2½in. | 49/6 |
| 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 sq. 2in. | 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 sq. 4in. | 69/6 |
| 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/I. flush rd. 2½in. | 25/- |
| 300 volt A.C. M/C. rect. flush rd. 2½in. | 25/- |
| 500 volt A.C. M/I. 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 VOLTMETERS.** 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 Q. 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 Q. 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 |
| 1,500 v. | | | |

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** | **RESIST'CE** |
| 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/-.

## R.S.C. HI-FI TAPE RECORDER KIT

**Build a high quality recorder in the £70 class for only** **29½** GNS. Carr. 17/6

OR DEPOSIT 3 GNS. and 12 monthly payments of 53/9. Cash price is settled in 3 months.

INCORPORATING THE LATEST MK. IV COLLARO TAPE TRANSCRIPTOR. THE LINEAR LT45 HIGH QUALITY TAPE AMPLIFIER. A HIGH FLUX 7 × 4in. LOUDSPEAKER, Reel of Best Quality TAPE. Spare Tape Spool, a Portable Cabinet, size approx. 18 × 13 × 9in., finished in veneered walnut or sapele, and connection diagram for wiring amplifier to transcriptor.

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.

## 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.

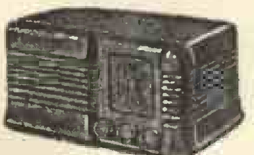
**VALVES!** Full range at really competitive prices. All guaranteed!

REPANCO CONSTRUCTIONAL ENVELOPES AND COMPONENTS ALWAYS IN STOCK

All parts for: One Transistor Receiver 25/-; Two Transistor Receiver 42/-; 3 Dee 3 Transistor Receiver £3/19/6; 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 Dee 9d., Mini 3 Pocket Portable 1/3, Mini 7 1/6, Major 7 1/6.

## THE SKY FOUR T.R.F. RECEIVER

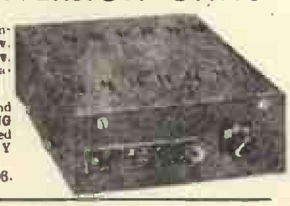


A design of a 3 valve 200-250 v. A.C. mains. L. and M. wave T.R.F. receiver with selenium rectifier. For inclusion in cabinet illustrated or walnut veneered type. It employs valves 6K7, SP61, 6F6 and is specially designed for simplicity in wiring. Sensitivity and quality are well up to standard. Point-to-Point 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.

## R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all dry battery eliminator. Size 5½ × 4½ × 2in. approx. Completely replaces batteries supply 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s is available. Suitble for all battery portable receivers requiring 1.4 v. and 90 v. This includes latest low consumption types Complete kit with diagram 39/9 or ready for use 46/9.

Type BM2. Size 8 × 5½ × 2½in. Supplies 120 v. 90 v. and 60 v., 40 mA. and 2 v. 0.4 a. to 1 amp., fully smoothed. THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND H.T 2 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 3¾in. per sec.
★ Negative Feedback Tone Compensation.
★ Excellent Frequency Response.
★ Takes 5¾in. Tape Reel.
★ Fast rewind.
★ Magic Eye Recording Level Indicator.

Complete with Reel of best quality Tape, Spare Spool, and Microphone. **19** GNS. Carr. 10/6

H.P. TERMS, DEPOSIT 2 Gns. and 12 monthly payments of 33/6.

★ Twin Track.
★ Automatic Erasing.
★ High Sensitivity.
★ High Flux 7 × 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/-)

39-1 Stick type

**39/6** (Listed 5 Gns.)

Limited number.

## R.S.C. TRANSFORMERS

FULLY GUARANTEED

INTERLEAVED AND IMPREGNATED

MAINS TRANSFORMERS

Primaries 200-230-250 v. 50 c/s.

FULLY SHROUDED UPRIGHT MOUNTING

| | |
|---|---|
| 250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a. | 17/6 |
| 250-0-250 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. 130 mA., 6.3 v. 4 a., c.t., 6.3 v. 1 a. suitable for Mullard 510 Amplifier | 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 |

TOP SHROUDED DROP-THROUGH TYPE

| | |
|---|---|
| 260-0-260 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 |
| 250-0-250 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 |

ELIMINATOR TRANSFORMERS

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 |

FILAMENT TRANSFORMERS

Primaries 200-250 v. 50 c/s.

| | | | |
|---|---|---|---|
| 6.3 v. 1.5 a. | 5/9 | 12 v. 1 a. | 7/9 |
| 6.3 v. 2 a. | 7/6 | 6.3 v. 3 a. | 8/11 |
| 0-4-6.3 v. 2 a. | 7/9 | 6.3 v. 6 a. | 17/6 |

OUTPUT TRANSFORMERS

| | |
|---|---|
| Midget Battery Pentode 66 : 1 for 384. 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 6V6 to 3 ohms | 8/9 |
| Push-pull 8 watts EL84s to 15 ohms | 8/9 |
| Push-pull 10-12 watts 6V6 to 3 Ω or 15 Ω | 16/9 |
| Push-pull 10-12 watts to match 6V6 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 510 | 27/9 |
| Push-pull 15-18 watts, sectionally wound, 6L6, KT66, etc., or 3 or 15 ohms | 23/9 |
| Push-pull 20 watt high-quality sectionally wound, 6L6, KT66, etc. to 3 or 15 Ω | 47/9 |

SMOOTHING CHOKES

| | | | |
|---|---|---|---|
| 250 mA., 5 H., 100 Ω | 11/9 | 80 mA., 10 H., 350 Ω | 5/6 |
| 150 mA. 7-10H. 250 Ω | 11/9 | 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 |

## EXTENSION SPEAKERS

Limited number in handsome walnut veneered cabinets. 2-3 ohms speech coils, 6½in. 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. 5in. 850ft. reels 22/6. 7in. 1,700ft. reels 35/-. Less than wholesale price.

### SUPERHET RADIO FEEDER UNIT

Design of a high quality Radio Tuner Unit (specially 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 Gram position. 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 45 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 UA8, 4 speed. T/O Pick-up with sapphire stylus £7/19/6. Carr. 4/6.

Collaro AC4/564 4-speed single players with hi-fi turnover crystal pick-up head £6/12/6. Carr. 4/6.

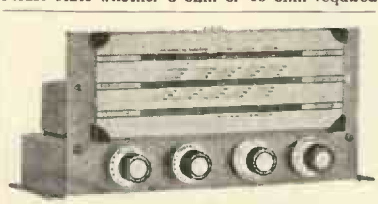
## R.S.C. A12 STEREO AMPLIFIER KIT

**£3-19-6** Carr. and packing 7/6.

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.

### 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 RC/120H. Limited number of £9/19/6 (approx. half price). Carr. 5/6. Brand new.

## 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 **13½** 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, ECC83, 807, 807, GZ34. Tone Control Pre-Amp. stages 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., 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 18/9 extra.

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 ± 3 D.B. 30-20,000 c/cs. Tone Controls ± 12 D.B. at 50 c/cs. ± 12 D.B. to — 6 D.B. at 12,000 c/cs., hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue hammer. Overall size 12 × 9 × 9in. 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, GARRISON 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 LI/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.p.s. Output for 2/3 ohm speaker. Three miniature Mullard valves. Size only 6 × 5 × 5½in. 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.

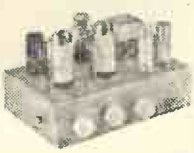
**L63 MINIATURE 3 WATT GRAM AMPLIFIER**

For 200-250 v. 50 c.p.s. A.C. mains. Overall size only 6¼ × 4¼ × 2½in. 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. H.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 £4/15/- 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 2½in. Perdio 21/9. 5in. Goodmans 17/9. 7 × 4in. R.A. Elliptical 19/9. 6½in. Rola 19/9. 8in. Rola 19/9. 8in. Goodmans 21/9. 8 × 6in. Elac with high flux magnet 25/9. 10in. R.A. 28/9. 10 × 6in. Elliptical Goodmans 29/9. 12in. R.A. 29/11. 12in. R.A. 3 or 15 ohms. 10 watts. 12,000 lines, 59/6.

**TWEETERS.** 4in. 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.** Cartoned latest model. For 200-250 v. A.C. mains. £7/19/6. Carr. 4/6.

**ACOS** Crystal Microphone Inserts. Brand new. Only 5/11 ea. Ex. Equip. 4/11 ea.

**ACOS HGP59 Hi-Fi Crystal Cartridges.** (Turnover type, with sapphire stylus.) Standard replacement for Garrard and Collaro. Only 19/9. B.S.R. Ful-fi 19/9. Garrard GC2 19/9.

**COSSOR V.H.F. F.M. RADIO RECEIVER KITS** Brand New Boxed with valves, printed circuit and 10 × 6in. Speaker. For 200-250 v. A.C. mains. Pre-aligned I.F.Ts. Normal price 15 Gns. Our price £8/19/6.

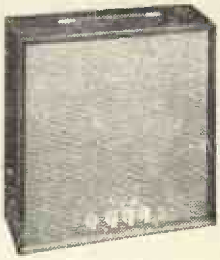
# HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

**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 5 valves, ECC83, ECC83, EL84, EL84, 5Y3. High Quality sectionally wound output transformer specially designed for Ultra Linear operation and reliable small condensers of current manufacture. **INDIVIDUAL CONTROLS FOR BASS AND TREBLE** "Lift" and "Cut." Frequency response ± 3 D.B. 30-30,000 c/cs. Six negative feedback loops. Hum level 60 D.B. down. **ONLY 23 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 12-9-7in. For A.C. mains 200-250 v. 60 c/cs. Output for 3 and 15 ohms speakers. Kit is complete to last nut. 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 louvred metal cover with 2 carrying handles can be supplied fo 18/9. **TERMS ON ASSEMBLED UNITS. DEPOSIT 18/9,** and 12 monthly payments o 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



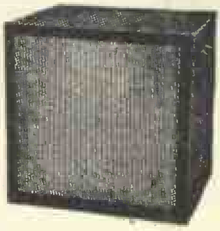
**JUNIOR 5 WATT** High Quality Output. Separate Bass and Treble "cut" and "boost" controls. Sensitivity 15 mv. High Flux 8in. l/speaker. Input sockets for Radio/Tape or Gram Pick-up and Mike/Instrument Pick-up. Handsome strongly made cabinet (size approx 14 × 14 × 7in.). Finished in satin walnut and fitted carrying handle. **£8/19/6** Carr. 7/6. Or Deposit £1 and nine monthly payments £1. 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 12in. P.M. for Bass notes and a 7 × 4in. elliptical for Treble. Cabinet is well made and finished satin walnut. Size approx. 18 × 18 × 8in. 15 Gns. Plus 10/- carr. H.P. TERMS. DEPOSIT 26/9 and 12 monthly payments 26/9. Both models for 200-250 v. A.C. mains.

**STAAR GALAXY 4-SPEED MIXER AUTO-CHANGERS** Brand New, cartoned. Turnover sapphire styli. Many exclusive features. Unique design motor 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. Rexine covered. Wide selection of attractive designs and colour combinations. PRICES FROM **15/9**



**12in. 10 WATT HIGH QUALITY LOUDSPEAKER IN POLISHED WALNUT FINISHED CABINET**

Gauss 12,000 lines. Speech coil 3 ohms or 15 ohms. Only £4/19/6. Carr. 5/-. Terms: Deposit 11/- and 9 monthly payments of 11/-. 12in. 20 WATT 15,000 line l/speakers 15 ohms, in Cabinet finished as above. Size 18 × 18 × 8in. £7/19/6 or Deposit 13/10 and 12 monthly payments 13/10.

**PORTABLE CABINETS.** Attractive design. Two-tone rexine covered. Will take Collaro, B.S.R., Garrard or Staar Auto-Changer, amplifier and 7in. × 4in. or 5in. speaker. Slightly soiled. Only 49/6.

**ACOS HIGH FIDELITY PICK-UPS.** GP54 with HGP59/52 Cartridge. Turnover sapphire Styli. cream finish. Limited number at approx. half price. Only 29/11.

## SPECIAL OFFER

Above cabinet Staar Changer, Gram amplifier, and 5in. or 8in. × 4in. speaker £9/19/6. Carr. 10/-. Or with Collaro Conquest changer in lieu of Staar, 12 Gns. Carr. 10/-.

## PLESSEY DUAL CONCENTRIC 12in. P.M. SPEAKERS

(15 ohms), consisting of a high quality 12in. 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 £5/17/6. Or Deposit 10/6 and 12 monthly payments of 10/6.

# 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.**

# R.S.C. MANCHESTER BRADFORD and LEEDS (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. £6/15/-. 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 | | H.T. Types H.W. | |
|---|---|---|---|
| 2/6 v. ½ 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 | 250 v. 80 mA. | 6/11 |
| 6/12 v. 5 a. | 14/6 | 250 v. 75 mA. | 8/11 |
| 6/12 v. 6 a. | 15/6 | 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, 12/6. Audio type 6/9. Power type Goltop V15/10P 2 watts 17/9. OC71, 10/-, OC72 17/-, XB102 10/-, XB104 10/-, XA101 OC44 22/6.

**VIBRATORS.** Oak and Wearite, synchronous 7-pin, 2 v. 7/9, 6 v. 8/3, 12 v. 4-pin non-synchronous 7/9.

**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 c/s 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. 60 mA., 6.3 v. 2 a. ........ 11/9
265-0-265 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
0-24-26-28 v. 15 amps. A.C. conservative Govt. rating (marked with D.C. rating after rectification) 69/9. Carr. 15/-.
0-10-20-25 v. 24 a. (Govt. rating) 79/6. Carr. 15/-.
AUTO 500 watts, 0-215-220-225-230-235-240 v. 29/9. Carr. 7/6. 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 c.p.s.; 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,
Parmeko 8/9; 100 mA., 5 H., 100 ohms 3/11; 150 mA., 10 H., 50 ohms 9/9; 80 mA., 20 H., 900 ohms 5/9; 120 mA., 12 H., 100 ohms 8/9; 50 mA., 55 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 × 10 × 8½in. high. IDEAL FOR BATTERY CHARGER OR INSTRUMENT CASE, COVER COULD BE USED FOR AMPLIFIER. Only 9/9, 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, fuse-holders, 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 c/s.
0-9-15 v. 1½ a. ...... 12/9
0-9-15 v. 2½ a. ...... 15/9
0-9-15 v. 3 a. ...... 16/9
0-9-15 v. 5 a. ...... 19/9
0-9-15 v. 6 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. 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

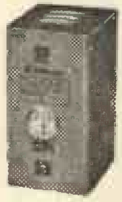
0-1.5 amp., 0-3 amp., 0-4 amp., 0-7 amp., 0-25 amp., 0-60 amp 8/9

### 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 49/9 Carr. 3/9.
As above, but for 3 amp. charging. Only 59/6. Carr. 3/9

All for A.C. Mains 200-250 v. 50 s/c
Guaranteed 12 months

### ASSEMBLED 6v. or 12 v. 4 amps.



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. **69/9** 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.

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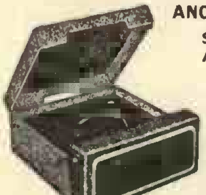


### ANOTHER SNIP OFFER

**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/-.

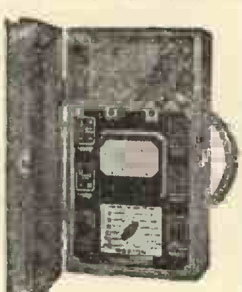
### BUILD THIS YOURSELF

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

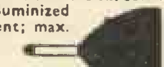


**BRAND NEW IN WOODEN CASE**

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. milliamps:* 10, 50, 250 IM/A 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.

# Electronics (FLEET ST) Ltd

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152/3 FLEET ST., LONDON, E.C.4
*Telephone : FLE 2833*
Business hours: weekdays 9-6. Saturdays 9-1.

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# HI-FI Centre

## COME AND HEAR THE LEADING MAKES IN AMPLIFIERS, TUNERS AND SPEAKER SYSTEMS

**AMPLIFIERS, STEREO AND MONAURAL, BY:**
VERDIK, QUAD, ARMSTRONG, LEAK, ROGERS, W.B., DULCI, etc.

**V.H.F. TUNERS BY:**
ARMSTRONG, T.S.L., LEAK, DULCI, QUAD, ROGERS, etc.

**HI-FI SPEAKERS BY:**
GOODMAN, W.B., PLESSEY, T.S.L., WHARFEDALE, G.E.C., LORENZ, etc.

## 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 7½in. **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:** 12¾ x 6½ x 3¾in. **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:** 12¾ x 6½ x 3¾in. 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. crossoevr 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/cs., 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 18¾in., width 11¾in., 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 deisgn variable reluctance pick-up. Cartridge completely protected from dust, damp and mechanical shock. Embodies an 8-pole balanced design providing the adavntages 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 Transcriptor 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 3¾, 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 m/volts 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 5¾ 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.

**ELECTRONICS (FLEET ST.) LTD. 152/3 FLEET STREET, LONDON, E.C.4**

# 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 × 12 × 10in. deep. Ins. Carr. 8/6.

**Cash price 89/6.**

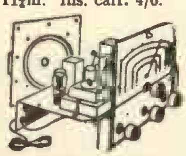
## HOME * RADIO 5/1

**(plus carr. and ins.) initial payment and 19 weekly payments of 3/11.**

**Cash price 79/6.**

AC/DC Universal mains 5-valve octal superhet, 3 waveband receiver can be adapted to gram p.u. In attractive wooden cabinet. 9½ × 18½ × 11½in. Ins. carr. 4/6.

## * SUPER CHASSIS 5/1



**(plus carr. and ins.) initial payment and 19 weekly payments of 3/11.**

**Cash price 79/6.**

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 × 7 × 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 × 5 × 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 × 4½ × 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**
Brand new. 200 ohms. 10K, and 20K. P. & P. 9d. **2/9**

**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.

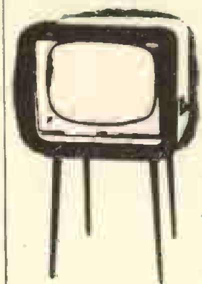
**SCANNING COILS 15/9**
Wide angle 90 deg. 38 mm. Low impedance. P. & P. 1/3.

**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.

## 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. 2¾ × 1½in. P. & P. 1/9.

**OUTPUT TRANSFORMER AND SMOOTHING CHOKE COMBINED 4/9**
2¾ × 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 m.A. 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 6V6 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 4¾ × 2in. dia. Base 4 × 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.

## MODERN 17" T.V. CHASSIS COMPLETE AND WORKING 24 GNS. 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.**

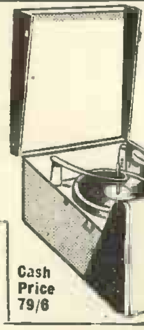
**DUKE**

# FROM OUR EXCITING RANGE OF RECORD PLAYER CABINETS:—

## T.W.1 5/1

**Initial payment. Balance over 19 weeks at 3/11.**

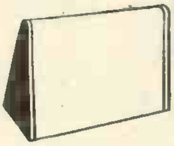
Size 15⅜ × 19⅞ × 10⅜in. Takes B.S.R. U.A.8 4 speed autochanger. Twin speakers. 3 control amplifier. Carr. and ins. 4/6.

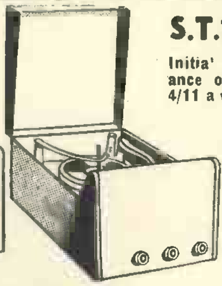


Cash Price 79/6

## THE NEW CONTINENTAL TYPE RECORD PLAYER CABINETS

in gay two-tone colours





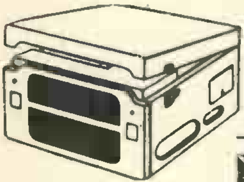
Cash price 99/6

## S.T.1 6/1

**Initia' payment. Balance over 19 weeks at 4/11 a week.**

Continental style cabinet including extra clip on speaker cabinet. 15⅜ × 10⅜ × 24⅞in. 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 13⅜in. × 15in. × 8½in. deep. Detachable lid with compartment for spare tape. Covered in green washable plastic material. P. & P. 4/6.

## P.L.10 3/1

**Initial payment. Balance over 19 weeks at 1/11 per week.**

Size 14⅜ × 12½ × 6in. Takes B.S.R. T.U.9. 4 speed record player unit. 8 × 3in. elliptical speaker, single control amplifier. Carr. & Ins. 4/6.

Cash price 39/6.

**When goods are bought on our interest-free credit terms, the cost of carriage and insurance must be sent with the initial payment.**

## R.P.2 4/7

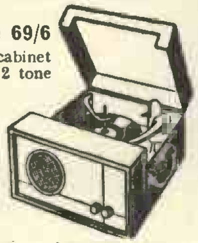
A beautifully styled cabinet. Made by a famous manufacturer. In polka dot cloth with clipped lid and carrying handle. Size 16 × 14½ × 8½in. deep. Will take B.S.R. Monarch 4 speed autochanger and 7 × 4in. elliptical speaker and most of the modern portable amplifiers. Carr. and Ins. 4/6.

Cash Price 69/6 Initial payment and 19 weekly payments of 3/5.

## R.P.3 Cash price 69/6

A delightful looking cabinet 14⅜ × 17⅞ × 8⅜in. 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 × 17 × 8in. deep. Takes a B.S.R. Monarch 4 speed autochanger; 7 × 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.

# 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 × 2¼ × 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 × 2¼ × 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 × 2¼ × 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 × 5¼ × 9⅞in. 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 £7/19/6.**

**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 £6/19/6.

**U.A.12. LATEST B.S.R. MONARCH 4-SPEED MIXER**

**9/7** Initial payment and 19 weekly payments of 8/5. Cash price £8/9/6.

**COLLARO CONQUEST 4-SPEED AUTOCHANGER**

**8/1** Initial payment and 19 weekly payments of 6/11. Cash price £6/19/6.

**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.

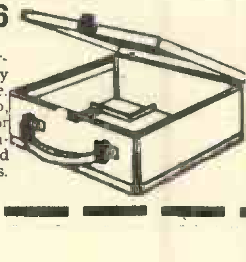
## IDEAL FOR STEREOPHONIC SOUND

8in. P.M. Speakers 8/9. With O.P. trans. fitted 10/-. Post 2/6.

7 × 4in. Elliptical speakers, 19/6.

9½ × 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. 2/6.

**& 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**

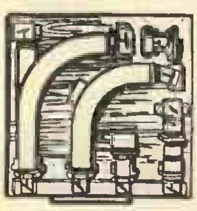
| | |
|---|---|
| Max. A.C. In. 125 v. D.C. Out. 80 mA. | 4/– |
| Max. A.C. In. 250 v. D.C. Out. 50 mA. | 7/– |
| Max. A.C. In. 250 v. D.C. Out. 85 mA. | 8/6 |
| **Television Type** | |
| Max. A.C. In. 250 v. D.C. Out. 300 mA. | 18/6 |
| **Full-Wave Bridge Connected** | |
| Max. A.C. In. 250 v. D.C. 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.

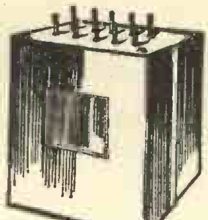
**W. W. RHEOSTAT.** New. 3.5K, 25 watts. Price 7/6. P. & P. 1/6.

**W. W. RHEOSTAT.** New. 5K, 25 watts. Price 7/6. P. & P. 1/6.

**SLIDER RESISTANCE,** 44 ohm, 1½ amp. Price 18/6. P. & P. 2/-.

**EX P.O. MAGNETIC COUNTER** 3 ohms type for 4½/6 volt D.C. operation. Price 6/6 each. P. & P. 1/-.

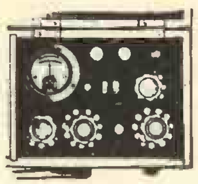
**AS ABOVE** 500 ohm for 24/36 volt D.C operation. Price 6/6 each. P. & P. 1/-.



**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.

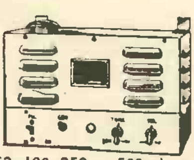


**WHEATSTONE BRIDGE UNIT.** 4 stud switches 0–10, 0–100 ohms, galvanometer centre zero, F.S.D. 2.5 mA. In oak carrying case 16 × 7½ × 6in., 40/- each. P. & P. 3/6.

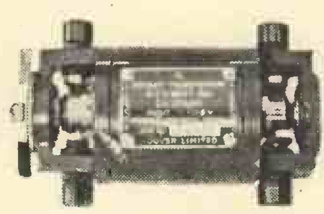
**EVERSHED AND VIGNOLES.** Circuit testing Ohms Meter, pattern "S" complete with testing prods, inst. book etc. Two ranges: 0–3 and 0–30ohms. Brand new, guaranteed perfect, as illus. Offered at fraction of maker's price. £4/17/6 each. P. & P. 2/6.

**BRIDGE MEGGER,** Evershed and Vignoles Series II, 250 volt. Condition as new, guaranteed perfect. Price £22. Carriage paid. Leather case available 20/- extra.

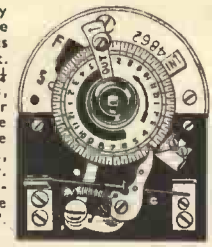
**TRIPLE RANGE VOLTMETER.** 0–5 25–250 v. D.C. M/C 3½in. meter 3in. scale, mounted in bakelite carrying case 7½in. × 4½in. × 3in. complete with handle and test leads. 27/6 each. P. & P. 2/–.



**12 v. D.C. AMPLIFIER,** as new, for operation on 12 v. car battery, 10 watts undistorted output, with 6L6 valves in push-pull. Mike/Gram input, tapped output 7½, 15, 62, 100, 250 or 500 ohms. £12/10/- each. Carr. 15/–.



**MIDGET ROTARY TRANSFORMERS.** 2¼in. dia. × 4½in. 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, ¼ 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 tapped 200/250 volt. Output multi-tapped from 3 to 30 volts at 2 ampere. Price 19/6. P. & P. 2/–.

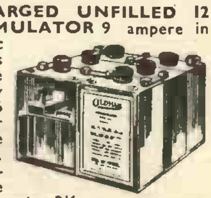
**JACK PLUGS,** cylindrical, bakelite, screw on covers, red or black as required, two contacts. Price 2/– each post free. Dozen lots 20/- post free. Three contacts same price.

**MERCURY SWITCH,** 10 amp. contacts, Single pole, New. Price 3/6. P. & P. 6d.

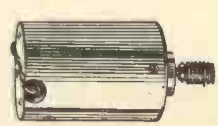
**METERS GUARANTEED PERFECT**

| | |
|---|---|
| **Charging Types** | |
| 2½ amp. D.C. M.I. 2in. fl. rnd. | 7/6 |
| 5 amp. D.C. M.I. 2½in. fl. rnd. | 11/6 |
| 7½ amp. D.C. M.I. 3½in. proj. rnd. | 12/6 |
| 9 amp. D.C. Hot Wire W.R. 2½in. fl. rnd. | 6/6 |
| **Voltmeters** | |
| 12 v. D.C. M.C. 2½in. 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. 2½in. | 10/6 |
| 250 v. A.C. rectified moving coil linear scale 3½in. fl. rnd. | 35/– |
| 300 v. A.C. M.I. 2½in. fl. rnd. | 22/– |
| 400 v. A.C. M.I. 4½in. fl. rnd. | 35/– |
| **Milliammeters** | |
| 2 mA. M.C. 2½in. fl. rnd. | 14/6 |
| 5 mA. M.C. 2in. round | 12/6 |
| 10 mA. M.C. 3½in. fl. rnd. | 30/– |
| 30 mA. M.C. 2½in. fl. rnd. | 9/6 |
| 200 mA. M.C. 2½in. fl. rnd. | 9/6 |
| 500 mA. M.C. 2½in. fl. rnd. | 9/6 |
| **Microamp** | |
| 50 microamp. scaled 0-100, M.C. 2½in. rnd. fl. | 42/6 |
| 200 microA. M.C. 2½in. rnd. fl. (calibrated 0–50) | 29/6 |
| 50 microA. 2½in. square, sidefitting 3 scales | 35/– |
| 500 microA. M.C. 2in. rnd. | 16/6 |

*Postage on all meters 1/- each.*



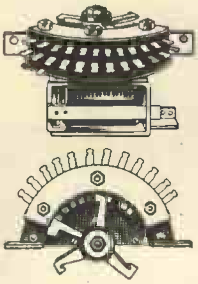
**NEW UNCHARGED UNFILLED 12 VOLT ACCUMULATOR** 9 ampere in unspillable plastic cases. Comprises 6×2 v. separate cells connected by terminal strips. 6 × 5½ × 4½in. over terminals. Price 19/-, plus P. & P. 2/9. Wooden carrying case for same with lid and strap price 3/6.



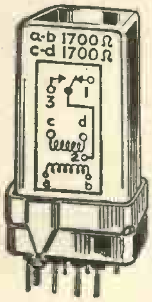
**MINIATURE P.M. MOTOR.** 12/24 volt, reversible. 1½in. dia. New. Price 9/6 each. P. & P. 1/–.

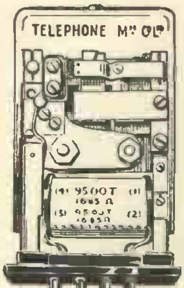
**AIRCRAFT CINE CAMERA G45B Mk. III** Fully modified, fitted with f/3.5 triple anastigmatic lens, takes 25ft. of 16 mm. film, fitted with 24 v. motor. 16 exposures per sec. Brand new, original packing, £4/10/- each. P. & P. paid.

# SERVICE TRADING COMPANY →



**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.



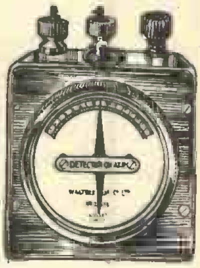

**SIEMENS H.S. RELAY.** Very latest type, sealed. H96E. 1,700 ohms plus 1,700 ohms, single C.O. contacts. Brand new with fixing clip. In maker's cartons. Price 16/6 each, plus 1/- P. & P.

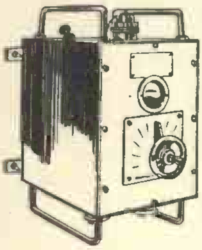
**NEW CARPENTER'S TYPE POLARISED RELAYS.** 2 x 9,500 turns at 1,685 ohms. Price 22/6 each. P. & P. 1/-.

**BRAND NEW SOUND POWER OPERATED EX ADMIRALTY HEAD AND BREAST SETS.** Two such sets connected up will provide perfect intercomm., no batteries required. Will operate up to ½ 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.

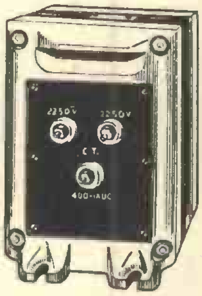
**NEW GALVANOMETERS** Solid brass, 3in. dial, in polished wooden case. 70 degree scale, 35 mA either side. 100 ohm coil. Price 12/6 each. P. & P. 1/6.



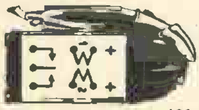


**L.T. TRANSFORMER.** Input 230 V. Output 50 V. 50 amp. Adjustable by regulator switch on primary. Steel case with mains switch Will take 100% overload. Weight 150 lb. Wound at 800 amps. per sq. inch. Brand new. Price £15. Carr. £1.

**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 13in. x 9in. x 6½in. Price £6/10/- each plus carr. 10/-.



**MINIATURE MOVING COIL DIFFERENTIAL RELAY.** Two coils 350 ohms each. Operating current minimum 140 microamp, 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 1¼ x ⅞ x ⅞in. Price 22/6 each.



**HIGH SPEED RELAY.** Siemens, two bobbins, 1,000 ohms each. New, 10/6 each. P. & P. 1/-.

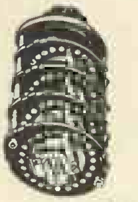
**SOLENOID OPERATED MAGNETIC RELAY.** Type S. 5CW/3942 with 4 make, 4 break 25 Amp. contact D.C. coil resistance 160 ohms, 24 v. operation. Housed in metal screening can 2⅜in. x 1in. x 1⅞in. Brand new. 7/6 each. P. & P. 6d.

**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 2½ 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/-.



**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.

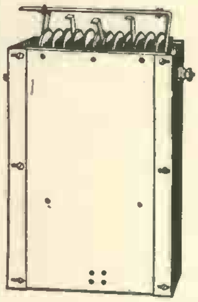
**20 WAY STRIP** containing standard Post Office telephone Jack Sockets, overall size 11 x 3¼ x ⅛in. New. Price 15/- each. P. & P. 1/6.
**10 WAY STRIP** standard Post Office telephone Jack Sockets, spacing allowing Igranic Jack Plugs. New. Price 10/-. P. & P. 1/6.

**LATEST MOST MODERN TYPE OF EX W.D. MINIATURE HEADPHONES** As illustrated. Brand new, low impedance. Price 10/6 plus P. & P. 1/6.

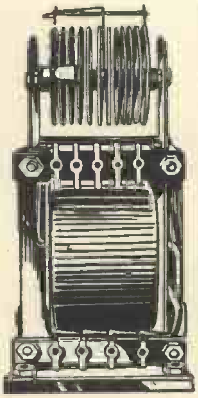
**NEW MOVING COIL HEADSETS.** Complete with Tannoy carbon hand microphone, with plug suitable for No. 19 set. Price 12/6 each, plus P. & P. 2/-.

**AUTO TRANSFORMERS.** Step up, step down, 110-200-220-240 v. Fully shrouded. New. 300 watt type £2/2/- 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/-.



**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 11½in. x 8in. x 4¾in. Price 45/-. P. & P. 3/3.



**TWELVE PLATE 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 manufacturers' 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:* *(Early Closing Thursday)*
**47-49 High Street, Kingston-on-Thames**
*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 3¼
★ 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.

**TRANSISTOR "8"**
**STILL AVAILABLE AT £10-19-6**

**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 3¼ x 2¼in. All parts with Power transistor, less speaker. 52/6. P.P. 2/-. 5in. 18/6; 7 x 4, 20/-; 6½in., 18/6.

---

## MAJOR—2
(Two-transistor Pocket Radio)

★ 4-stage reflex
★ Medium wave; tuneable
★ 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 ¾in.
★ Includes personal ear-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 2¼ x 1¼ x 1in. P.P. 1/-

## R.F., I.F. GENERATOR
★ Size 2¼ x 1¼ 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 5¾ x 3¼ x 1½in. A unit for use with Major 2 and 3 or any earpiece 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, 1¾in. 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!**

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## "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.

**5, HARROW ROAD, PADDINGTON, W.2**
(AT JUNCTION OF EDGWARE ROAD AND HARROW ROAD)
**PAD 1008/9**

SHOP HOURS: 9 a.m. to 6 p.m. MON. to SAT. THURS. 1 p.m.

## 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 ±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

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| EF91 | 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/- | STV/280/40 | 15/- |
| VS70 | 6/- | QS105/45 | 10/- | STV/280/80 | 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.**

## A.C., D.C., R.F. METERS

| | | | |
|---|---|---|---|
| 0–15 v. | 2½in. | M.I. (AC) F.R. | 8/6 |
| 0–20 v. | 2in. | M.C. (DC) F.S. | 7/6 |
| 0–40 v. | 2in. | M.C. (DC) F.S. | 7/6 |
| 0–150 v. | 2½in. | M.C. (DC) F.R. | 12/6 |
| 0–200 v. | 2½in. | M.C. (DC) F.R. | 12/6 |
| 0–300 v. | 2½in. | M.I. (AC) F.R. | 10/- |
| 0–600 v. | 2½in. | M.C. (DC) F.R. | 12/6 |
| 0–300 v | 5in. | M.I. (AC) P. | 50/- |
| 0–1½ kv. | 2½in | M.C. (DC) P. | 15/- |
| 0–2½ kv. | 2½in. | M.C. (DC) P. | 15/- |
| 0–500 UA | 2½in. | M.C. (DC) F.R. | 15/- |
| 0–500 UA | 3½in. | M.C. (DC) F.R. | 59/6 |
| 0–400 UA | 3½in. | M.C. (DC) F.R. | 59/6 |
| 0–1 mA | 2½in. | M.C. (DC) F.R. | 22/6 |
| 2½–0–2½ mA | 2½in. | M.C. (DC) F.R. | 12/6 |
| 0–30 mA. | 2in. | M.C. (DC) P. | 7/6 |
| 0–50 mA. | 2in. | M.C. (DC) F.S. | 7/6 |
| 0–10 mA | 2½in. | M.C. (DC) F.S. | 10/- |
| 0–100 mA. | 2in. | M.C. (DC) F.S. | 10/- |
| 0–150 mA | 2in. | M.C. (DC) F.S. | 7/6 |
| 0–500 mA | 2½in. | M.C. (DC) F.R. | 12/6 |
| 0–750 mA | 2in. | T.C. (RF) P. | 6/- |
| 0–500 mA. | 2in. | T.C. (RF) P. | 6/- |
| 0–1 amp. | 2in. | T.C. (RF) P. | 6/- |
| 0–3 amp. | 2in. | T.C. (RF) F.S | 6/- |
| 0–12 amp. | 2½in. | T.C. (RF) P. | 10/- |
| 0–20 amp. | 2in. | M.C. (DC) P. | 7/6 |
| 0–30 amp. | 2in. | M.C. (DC) F.S. | 7/6 |
| 5–0–5 amp. | 2½in. | M.C. (DC) P. | 10/- |
| 0–10 amp. | 4in. | M.C. (DC) P. | 25/- |

FREE COMPLETE LIST ON REQUEST

## V.H.F. TRANS/RECEIVER TYPE TR1920

★ 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-way Control unit | 382 | 6/- | — | 9d. |

All the above are in absolute new condition. Full circuits available 1/9 post free.

## CATHODE-RAY TUBES

| | | |
|---|---|---|
| 2AP1 | 2in. | 25/- |
| VCR139A | 2¾in. | 35/- |
| 3BP1 | 3in. | 30/- |
| 3FP7 | 3in. | 12/6 |
| 3AP1 | 2¾in. | 30/- |
| Mullard DG7/5 | 2¾in. | 45/- |
| 5FP7 | 5in. | 20/- |
| VCR517C | 6in. | 30/- |
| VCR97 | 6in. | 40/- |
| Screens for VCR97 | | 7/6 |

P.P. 2/- any type.

*FREE LIST and Data on request.*

## 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.

## 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.

## 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.

## R.C.A. SPEAKER

8in. 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/-.

## 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/-.

## 182A INDICATOR UNIT

COMPLETE. INCLUDES VCR97 with Mu-metal screen; 3—EF50; 4—SP61; 5U4G; POTS; TRANSFORMERS, etc. **67/6** P.P. 5/-.

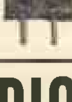
## AVO-MINOR

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/-

## QUARTZ CRYSTALS


FROM **5/-** EACH
From 6 Kc/s–17 Mc/s. FT243, FT241, 10XJ and B7G.
All types for all purposes.
*Send for free list.*



## SURPLUS EQUIPMENT

New Free List of Units, Meters, Generators and Equipment, including Vibrators, Radar Units, RX/TX etc.

# HENRY'S RADIO LTD.

**5, HARROW ROAD, PADDINGTON, W.2**
(AT JUNCTION OF EDGWARE RD. AND HARROW RD.) PAD 1008/9

# C.R.T. ISOLATION TRANSFORMERS

For Cathode Ray Tubes having Heater/Cathode short-circuit and for C.R. 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. Optional boost 25%, 50% 75%. **16/6** each

Type B. Mains input. Low capacity. Multi Output 2, 4, 6.3, 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., ¼ w., 4d.; ½ w., 4d.; 1 w., 6d.; 1½ w., 8d.; 2 w., 1/-. HIGH STABILITY. ½ w., 1%, 2/-. Preferred values 100Ω to 10 meg. Ditto 5%, 9d., 100Ω to 5 meg.

WIRE-WOUND RESISTORS 25 ohms—10,000 ohms: 5 watt 1/3; 10 watt 1/6; 15 watt 2/-.
15,000 ohms—50,000 ohms 5 w., 1/9; 10 w. 2/3

WIRE-WOUND POTS. 3 w. Pre-set Min. T.V. type Knurled Slotted knob. All values 25 ohms to 25K., 3/- ea., 30 K., 50 K., 4/-. Ditto, ¼ w. Carbon Track 30 K. to 2 Meg., 3/-.

WIREWOUND POTS. 4 w. Standard size Pots, long Spindle High Grade. All values 100 ohms to 50 K., 6/6; 100 K., 7/6. W/W EXT. SPEAKER CONTROL 10Ω, 3/-.

O/P TRANSFORMERS. Heavy Duty 50 mA., 4/6. Multi-ratio push-pull, 7/6. Miniature 3V4, etc., 4/6. Hygrade Push-pull 10 watts, 15/6. MULLARD "510" 6k or 8k 30/-. L.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, 80 mA., 6.3 v. 3.5 a. tapped 4 v. 4 a. Rectifier 6.3 v. 1 a., tapped, 5 v. or 4 v. 2 a. Ditto 350-0-350 | 22/6 |
| MINIATURE 220 v. 20 mA., 6.3 v. 1 a. | 10/6 |
| MIDGET, 250 v. 45 mA., 6.3 v. 2 a. | 15/6 |
| 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. 1½ a., 7/6. 3 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, ¼in., 8d.; ⅜in., 10d. 0.3in. FORMERS 5937 or 8 and Cans TV1 or 2, ⅞in. sq. × 2½in. or ⅝in. sq. × 1½in., 2/- with cores.
SLOW 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/-.
MAINS DROPPERS. 3×1½in. Three Adj. Sliders, .3 amp. 750 ohms, 4/3. .2 amp., 1,000 ohms, 4/3.
LINE 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 ⅞×1⅛in.
ACOS CRYSTAL DESK MIKE. Bargain. 35/-.

MIKE TRANSF. 50:1, 3/9 ea.; 100:1 Potted, 10/6.
LOUDSPEAKERS P.M. 3 OHM. 5in., Rola, 17/6. 6in. × 4in. Rola, 18/-. 7in. × 4in. R.A., 21/-. 10in. × 6in. Rola, 27/6. 8in. Plessey, 19/6. 6½in. Rola, 18/6. 8in. Rola, 21/-. 10in. R.A., 30/-.
HI-FI TWEETERS, 4in., 25/-. 12in. Plessey, 30/-. 12in. Baker 15 wt. 3 ohm and 15 ohm models, 105/-. 12in. Baker foam suspension 15 w. 15 ohm, £8. 12in. 15 ohm Plessey 10 wt., 45/-.

**I.F. TRANSFORMERS 7/6 pair**
465 kc/s. slug tuning miniature can 2¼×1×1in. High Q and good bandwidth. By Pye Radio. Data sheet supplied.
Wearite M800 I.F. Miniature 465 kc/s., 12/6 pair.
Wearite 550 I.F. Standard 465 kc/s., 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 spout, 4/3 tin.
TWIN GANG CONDENSERS. 365 pf. Miniature, 1½in. × 1½in. × 1⅛in., 10/-. .0005 Standard with trimmers, 9/-; less trimmers, 8/-. Midget, 7/6; Single 50 pf., 2/6; 100 pf., 150 pf., 7/-. Solid dielectric 100, 300, 500 pf., 3/6.
VALVE HOLDERS. Pa. int. Oct., 4d. EF50. EA50, 6d. B12A, CRT, 1/3. Eng. and Amer. 4, 5, 6, 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, EF50, B7G, B9A, Oct., 1/-; B7G, B9A Cans 9d.
SPEAKER FRET. Gold Cloth 17in. × 25in., 5/-. 25in. × 35in., 10/-. Tygan 54in. wide, 10/- ft. 27in. wide, 5/- ft. Samples, S.A.E.

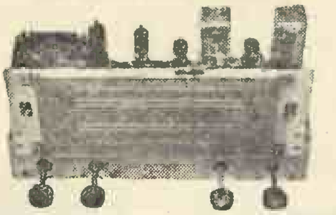
WAVECHANGE SWITCHES.

| | |
|---|---|
| 2 p. 2-way, 3 p. 2-way, short spindle | 2/6 |
| 5 p. 4-way, 2 wafer, 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 wafer, 8/6; 2 wafer, 12/6; 3 wafer 16/-; 4 wafer 19/6; 5 wafer 23/-; 6 wafer 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, 25, 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/-**
R.F. XA104 frequency changer up to 4 Mc/s. **18/-**
XA103 IF amp. up to 2 Mc/s. **15/-**
Goltop Power V15/10P, up to 10W with heat sink, 20/-.

## 1960 RADIOGRAM CHASSIS



THREE WAVEBANDS
S.W. 16 m.—50 m.
M.W. 200 m.—550 m.
L.W. 800 m.—2,000 m.

FIVE VALVES
LATEST MULLARD
ECH81, EF89, EBC81, 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 13½in. × 5½in. × 2¼in. Glass Dial Size 10 × 4½in. 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 5 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. 108-87 Mc/s. Med. 190-550 m. Long 1000-1900 m. Gram input. Ready for use. A.C. Mains 200/250 v. Isolated chassis. Output point 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 ★

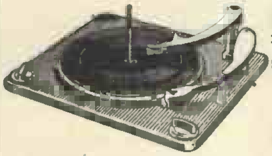
Brand new and fully guaranteed 12 months.

**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 COLLARO AUTOCHANGER

**£7.19.6**



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 6½in. speaker for above 79/6
3 valve amplifier and 6½in. speaker for above 95/-
Wired and tested ready for use.

## ★ GARRARD 4-SPEED SINGLE RECORD PLAYER ★

**AUDIO PERFECTION** POST FREE

MODEL TA MK II £8/10
MODEL 4 HF £18
Stereo Heads £2 extra

## BATTERY-MAINS POWER PACK

Same size as batteries B126 and AD35, 90 v. H.T., 1½ 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 I 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/- D.P. Sw. 4/9
Linear or Log Tracks.

**80 ohm Cable Coaxial**
Semi-air spaced, ¼in. dia
Ideal Band III 6d. yd
Losses cut 50%
Post 1d. per yard.
**FRINGE QUALITY**
AIRSPACED .... 1/- yd.

COAXIAL PLUGS .... 1/-  LEAD SOCKETS .... 2/-
PANEL SOCKETS .... 1/-  OUTLET BOXES .... 4/6
BALANCED TWIN FEEDER per yd. 6d., 80Ω or 300Ω
TWIN SCREENED BALANCED FEEDER 1/6 yd., 80 ohm.

ALUMINIUM CHASSIS. 18 s.w.g. Plain, undrilled with 4 sides, riveted corners and lattice fixing holes, with 2½in. sides, 7 × 4in., 4/6; 9 × 7in., 5/9; 11 × 7in., 6/9; 13 × 9in., 8/6; 14 × 11in., 10/6; 15 × 14in., 12/6 and 18 × 3in., 16/6.

BLACK CRACKLE PAINT. Air drying, 3/- tin.
P.V.C. CONN. WIRE, 8 colours, single or stranded, 2d. yd.
NEON MAINS TESTER SCREWDRIVERS, 5/-.
CORED SOLDER RADIOGRADE, 4d. yd., ½lb., 2/6.
PAXOLIN 1/15in. 8in. × 10in., 1/6. 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 5¾in. 1,200ft. 28/-. 3in. 225ft. 7/6.
"INSTANT" Bulk 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 COOLED 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/-.
COILS. Wearite "P" type, 3/- each. Osmor Midget "Q" type adj. dust core from 4/- each. All ranges.
TELETRON. L. and M. T.R.F. with reaction, 3/6.
FERRITE ROD AERIALS. M.W., 8/9; M. & L., 12/6.
T.R.F. COILS. A/HF, 7/- pair. H.F. CHOKES, 2/6.

JASON F.M. 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. Tubular 500 v. .001 to .01 mfd., 9d.; .05 .1, 1/-; .25, 1/6; .5 1/9; .1/350 v., 9d.; 1/1,000 v., 1/9; 0.1 mfd., 2,000 v., 3/6; .001 mfd. 2,000 v., 1/9.
CERAMIC CONDS. 500 v., .3 pf. to .01 mfd., 9d.
SILVER MICA CONDENSERS. 10%. 5 pf. to 500 pf., 1/-; 600 pf. to 3,000 pf., 1/3.
CLOSE TOLERANCE (±1 pf.) 1.5 pf. to 47 pf., 1/6. DITTO 1% 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., 1/6. 600 pf., 750 f., 1/9. Phillips, 1/- ea.

**NEW ELECTROLYTICS. FAMOUS MAKES**

| TUBULAR | | TUBULAR | | CAN TYPES | |
|---|---|---|---|---|---|
| 1/350 v. | 2/- | 64/350 v. | 5/6 | 8/500 v. | 3/- |
| 2/450 v. | 2/3 | 100/25 v. | 2/- | 16/500 v. | 4/- |
| 4/450 v. | 2/3 | 250/25 v. | 1/- | 32/350 v. | 4/- |
| 8/450 v. | 2/3 | 500/12 v. | 3/- | 100/270 v. | 5/6 |
| 8/500 v. | 2/9 | 8+8/450 v. | 4/6 | 2,500/3 v. | 4/- |
| 16/450 v. | 3/6 | 8+8/500 v. | 5/- | 6,000/6 v. | 5/- |
| 16/500 v. | 4/- | 8+16/450 v. | 5/- | 8+16/500 v. | 7/- |
| 32/450 v. | 5/6 | 8+16/500 v. | 5/6 | 32+32/450 v. | 6/6 |
| 25/25 v. | 1/9 | 16+16/450 v. | 5/6 | 50+50/350 v. | 7/- |
| 50/25 v. | 2/- | 16+16/500 v. | 5/- | 64+120/350 v. | 11/6 |
| 50/50 v. | 2/- | 32+32/350 v. | 4/6 | 100+200/275 v. | 12/6 |

FULL WAVE BRIDGE/SELENIUM RECTIFIERS. 2, 6 or 12 v. 1½ amp., 8/9; 2 a., 11/3; 4 a., 17/6; 6 a., 22/6.
CHARGER TRANSFORMERS. Tapped input 200/250 v for charging at 2, 6 or 12 v. 1½ a., 15/6; 2 a., 17/6; 4 a., 22/6. Charger circuit free. AMPMETRES, 4 a. and 5 a., 14/6.

**VALVES** NEW and boxed — 90-day guarantee

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1R5 | 8/6 | 6L6G | 10/6 | EA50 | 1/6 | EY51 | 12/6 |
| 1S5 | 8/6 | 6N7M | 7/6 | EABC80 | 10/6 | EZ81 | 8/6 |
| 1T4 | 8/6 | 6Q7G | 10/6 | EB91 | 6/6 | HABC80 | 12/6 |
| 2X2 | 2/6 | 6SA7M | 10/6 | EBC33 | 8/6 | HVR2A | 7/6 |
| 3S4 | 8/6 | 6SJ7M | 10/6 | EBC41 | 10/6 | MU14 | 10/6 |
| 3V4 | 8/6 | 6SN7 | 8/6 | EBF80 | 10/6 | P61 | 6/6 |
| 5U4 | 8/6 | 6V6G | 7/6 | ECC84 | 12/6 | PCC84 | 12/6 |
| 5Y3 | 8/6 | 6X4 | 7/6 | ECF80 | 11/6 | PCF80 | 11/6 |
| 5Z4 | 10/6 | 6X5 | 7/6 | ECH42 | 10/6 | PCF82 | 11/6 |
| 6AM6 | 8/6 | 12A6 | 8/6 | ECL80 | 12/6 | PCL82 | 11/6 |
| 6BE6 | 7/6 | 12AT7 | 10/6 | ECL82 | 12/6 | PEN25 | 6/6 |
| 6BH6 | 10/6 | 12AU7 | 9/6 | EF39 | 7/6 | PL82 | 10/6 |
| 6BW6 | 10/6 | 12AX7 | 9/6 | EF41 | 10/6 | PY80 | 8/6 |
| 6D6 | 7/6 | 12BA6 | 9/6 | EF50 | 5/6 | PY81 | 10/6 |
| 6F6G | 7/6 | 12BE6 | 9/6 | EF80 | 10/6 | PY82 | 8/6 |
| 6H6GT | 3/6 | 12K7 | 8/6 | EF86 | 14/6 | SP61 | 5/6 |
| 6J5M | 6/6 | 12Q7 | 8/6 | EF92 | 5/6 | UBC41 | 10/6 |
| 6J6 | 7/6 | 35L6 | 9/6 | EL32 | 5/6 | UCH42 | 10/6 |
| 6J7G | 8/6 | 35Z4 | 9/6 | EL41 | 10/6 | UF41 | 10/6 |
| 6K6GT | 6/6 | 80 | 10/6 | EL84 | 10/6 | UL41 | 10/6 |
| 6K7G | 5/6 | 807 | 6/6 | EZ40 | 8/6 | UY41 | 8/6 |
| 6K8G | 8/6 | 954 | 1/6 | EZ80 | 8/6 | U22 | 10/6 |

# RADIO COMPONENT SPECIALISTS

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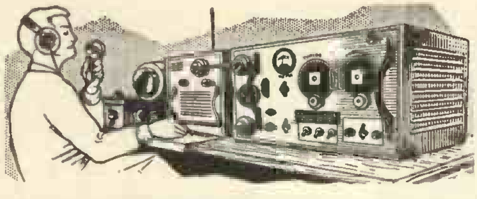
**337 WHITEHORSE RD., WEST CROYDON**

POSTAL SERVICE 1/-, OVER £2 FREE. C.O.D. 1/6 (EXPORT C.W.O. POST EXTRA.) Wed. 1 p.m.  THO. 1665. Buses 133 or 68



## 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.

SET ONLY **65/-** Carr. 10/-

**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/-.**

### POCKET MULTI-METER

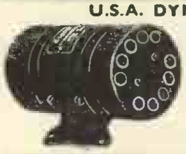
2,500 o.p.v. Multi range. 6/30/120/300/1,200 v. A.C., ditto D.C. 0-1k., 0-1 meg-ohm; 400 micro-A., 12 M.A., 300 M.A.; —00 to +64-DB, 5 ranges 3×4¼×1¼in. Large clear dial. Leads supplied. (List price £6/19/6.) OUR PRICE £4/7/6. P. & P. 2/6.

### T.C.S. RECEIVER

1.5 to 12 Mc/s. 7-valve superhet, built like a dream. 12SK7-RF, 12SA7 Mixer, 12A6 Oscillator, 12Q7 Detector, AVC - BFO - 1st AF, 12SK7-I.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/-.

### U.S.A. DYNAMOTORS



Manufactured by EICOR (as illus.). Input 12 v., output 400 v. at 180 ma. Size 7×4×4¼in. Brand new 45/-. **D.M.34.** 12 v. in. with 220 v. out. at 80 mA. ONLY 35/-, P. & P. 3/6 on each.

### F.M. TRANS/RECEIVERS BC620

Frequency range 20-27.9 Mc/s. Crystal controlled, operating on any two of 80 different channels in 100 Kc/s. steps. Average range 5-10 miles. Contains 14 valves, filament plate, alignment meter, volume control, mike and 'phone inputs. 6 and 12 volt supply unit and dry battery case. **Complete Station only £8/10/-.** Carr. 20/-. U.S.A. hand set 20/- extra.

# 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.

### 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 inserts.

### D.C. DYNAMOTORS

Eicor Model, 12 volts in, 400 v. output at 180 M.A. Hoover Model 12, volts in, 490 v. output at 65 M.A. U.S.A. D.M.34, 12 volts in, 220 v. output at 80 M.A. Delco Model, 12 and 24 v. in, 265 v. output at 120 M.A. and 540 v. at 26 M.A.

### ACCUMULATORS

2 volt 16 A.H. Unspillable Model. Oldham, Exide, etc.

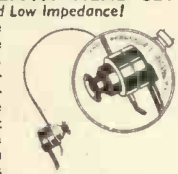
**All equipment ex-stock and fully guaranteed.**

**BRAND NEW VARIABLE TRANSFORMERS.** Input 230 volts. Output 0-240 volts, 5 amps. Brand new, only £8. Carr. 12/6.

**MINE DETECTOR No. 3.** Complete equipment comprising 2 search heads, amplifier, headset, control box, haversack. Operates from standard batteries. Will detect all ferrous and non-ferrous metals. Fully portable and sensitive. New in original transit case, 65/-. Carr. 15/-.

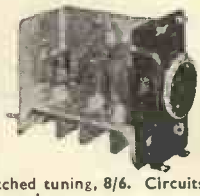
### AMERICAN LIGHTWEIGHT HEAD SET

*They're High and Low Impedance!*



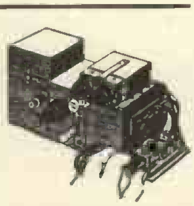
These H.S.30 phones are the smallest used by the U.S Air Force. 250Ω imp. using soft rubber miniature ear moulds for maximum music and voice reproduction of the finest quality. Supplied free is a small transformer unit with cord and plug which steps impedance up to 4,000Ω. ONLY 15/-. P. & P. 2/6.

### 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.

### INSTANT VALVE FILAMENT TESTER MODEL VT-41

**Pocket-size battery operated GIVES INSTANT CHECK OF:**

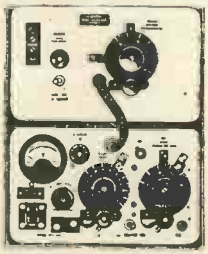
- All Radio Valves.*
- All T.V. Valves.*
- All T.V. Radio Fuses.
- Circuit Continuity.
- All Pilot Lamps.
- Has built-in miniature 7- and 9-pin valve straighteners and battery test.

* International Octal, B.8, B.9, B7 Battery and Mains types.

Beautifully styled—precision made. complete. Fully guaranteed. ONLY **30/-** Supplied P. & P. 2/6.

**NEW 1960 ILLUSTRATED CATALOGUE 1/3**

# PORTABLE TRANSMITTER RECEIVER No. 18



**Entirely self-contained 6-valve Transmitter Receiver for voice and C.W. Frequency: 6-9 Mc/s. (50-33 metres). The Transmitter signal is generated by a master oscillator circuit followed by a power amplifier. The aerial is auto-coupled to the power amplifier by aerial taps to a parallel tuned output circuit. The Receiver is a 4-valve superhet, comprising signal frequency amplifier, frequency changer, IF amplifier, 2nd det.-A.V.C.-A.F. Stage. Selectivity: The resonance curve of the IF amplifier has a width of 7 Kc/s. with an average cut-off of 5db/kc/s. Full netting facilities, circuit set for full modulation, operated by standard dry batteries, range approximately 10 miles. Incorporates Test Meter for aerial loading, H.T. & L.T. readings. Supplied Brand New complete with Power Microphone, Headphones, Morse Key, Aerials, Webbing and full instruction book all for only 80/-, carriage 10/-.**

**18 Set as above less attachments 60/-, carriage 10/-.**

**80/-** carriage 10/-.

**Relda Radio Ltd.**

*Callers:* **87 TOTTENHAM COURT ROAD, LONDON, W.1**

*Mail orders:* **(DEPT. W.) 32a COPTIC ST., LONDON, W.C.1.** MUS. 9607

***WOT! You don't own a Relda catalogue! It's terrific and fully illus. Only 1/3***

## 25,000 OHMS PER VOLT TESTMETER

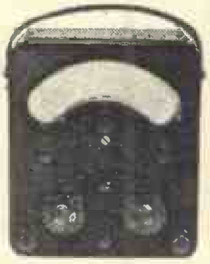
Made by TRIPLETT of America. Size 7¾ x 6¼ x 6¼in., and incorporates a unique tilting bakelite container size 5¾ x 3¼in., which has two meters, a 25,000 ohms per Volt moving coil for D.C. measurements, and a first grade moving iron for A.C. Reads Resistance up to 40 Megohms, A.C. & D.C. Volts to 1,000, D.C. Current to 250 mA., and also has 0-50 Microamps range. Facilities for measuring Condenser Capacity, etc., and Audio Output. Completely portable, with protective face cover. Complete with leads, batteries, and instructions. Fully re-conditioned. ONLY £10/10/- (post. etc., 3/6).

## UNIVERSAL AVOMETER 34 RANGE MODEL D

Ex-Air Ministry, but thoroughly re-conditioned and checked. Supplied with internal batteries and instructions. Covers ranges as follows:

| 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. | |
| 300 v. | 1,500 v. | 30 amp. | Resistance |
| 750 v. | | | 1,000 Ω |
| 1,500 v. | | | 10,000 Ω |

ONLY £8/19/6 (Postage, etc., 3/6).



CANADIAN MOVING COIL PHONES. Low-resistance, fitted noise excluding chamois ear muffs, and leather covered head-band. Lead terminates to jack plug. BRAND NEW. ONLY 19/6 (Post 1/6).

## 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 24in. x 13in. x 17in. Complete, ready to switch on, thoroughly tested and checked before despatch. IN NEW CONDITION. ONLY £13/10/- (carriage 20/-).

## CRYSTAL CALIBRATOR No. 10

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 CV286 (Neon Stabiliser), and Instruction Book. Size 7in. x 7¼in. x 4in., 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 mills. Size 5¼ x 3¼in. 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 6in. 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 8½in. x 8½in. x 5½in. Recently made for the Air Ministry, by Everett Edgcumbe, and in perfect order. Brand New and Unused. ONLY £7/10/-. 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).

## HETERODYNE FREQUENCY METERS TYPE LM14

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 8½in. x 8in. x 8½in. Full information on request.

## 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 £7/19/6.

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 8in. P.M. Speaker £6/10/-. DEDUCT 10/- IF PURCHASING RECEIVER AND POWER PACK TOGETHER.

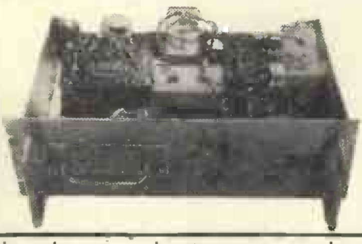
Send S.A.E. for illustrated leaflet, or 1/3 for 14-page booklet which gives technical information, circuits, etc., and is supplied free with each receiver. Add carriage 10/6 for Receiver, 5/- for Power Unit.

## AR88 LF RECEIVERS

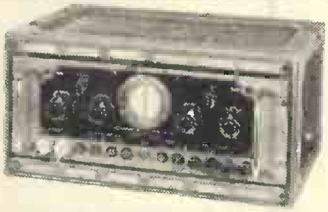
Reconditioned as new, and in perfect order. Frequency coverage 75-140 kc/s and 1.2-30 Mc/s. ONLY £50 (carriage 25/-).

## POWER UNITS TYPE 234

Primary 200/250 v. 50 cycles. Outputs of 250 v. 100 mA., and 6.3 v. 4 amps. Fitted double smoothing. For normal rack mounting (or bench use) having grey front panel size 19in. x 7in. BRAND NEW. ONLY 59/6 (carriage, etc., 7/6).



RCA 8in. P.M. SPEAKER, in heavy black crackled metal case, designed for use with AR 88 Receiver, or any set with 3 Ohms Output. BRAND NEW IN MAKERS CARTONS. ONLY 45/- (Post 3/6).



## OSCILLOSCOPE No. 11

Made by A. C. Cossor. 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 2½in. tube type ACR10. Grey and black engraved front panel, size 19in. x 7in. For standard rack use if required, depth of unit being 12in. In steel transit case as illustrated. Complete with leads and suggested modification data. BRAND NEW. ONLY £12/10/- (carriage 15/-).

"Q FIVER" COMMAND RECEIVER.

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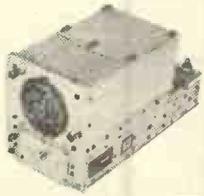

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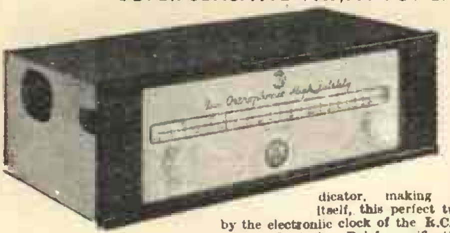

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| VP133 | 15/- |
| VR22 (PM2A) | 3/- |
| VP23 | 6/6 |
| VP41 | 8/6 |
| VR105/30 | 8/- |
| VR116 | 4/- |
| VR150/30 | 7/6 |
| VU120A | 3/6 |
| VU39 (MU12/14) | 8/9 |
| VU111 | 2/6 |
| W76 | 7/6 |

| | |
|---|---|
| W77 | 8/6 |
| W729 | 10/6 |
| Y63 | 9/- |
| Z309 | 7/6 |
| Z359 | 7/6 |
| 1A3 | 3/6 |
| 1A7GT | 12/6 |
| 1C2 | 11/6 |
| 1C5GT | 12/6 |
| 1D5 | 12/6 |
| 1D6 | 12/6 |
| 1H5GT | 9/6 |
| 1L4 | 6/6 |
| 1LD5 | 3/6 |
| 1N5 | 10/6 |
| 1R5 | 7/6 |
| 1S4 | 10/6 |
| 1S5 | 6/6 |
| 1T4 | 6/- |
| 2C26 | 1/6 |
| 2P | 26/6 |
| 2X2 | 4/6 |
| 3A4 | 7/- |
| 3A8GT | 6/- |
| 3D6 | 5/- |
| 3Q4 | 8/- |
| 3Q5GT | 9/6 |
| 3S4 | 7/6 |
| 3V4 | 8/6 |
| 4D1 | 3/- |
| 5R4GY | 9/6 |
| 5U4G | 6/6 |
| 5V4 | 11/6 |
| 5Y3G | 8/- |
| 5Y3GT | 5/- |
| 5Z4G | 9/- |
| 6A7 | 10/- |
| 6A8G | 9/- |
| 6AC7 | 6/6 |
| 6AG5 | 5/6 |
| 6AK5 | 6/6 |
| 6AL5 | 5/6 |
| 6AM5 | 12/6 |
| 6AM6 | 5/- |
| 6AQ5 | 7/6 |
| 6AT6 | 8/6 |
| 6AU6 | 10/6 |
| 6B8G | 4/- |
| 6BA6 | 7/6 |
| 6BE6 | 8/- |
| 6BG6G | 23/3 |

| | |
|---|---|
| 6BH6 | 9/- |
| 6BJ6 | 9/- |
| 6BR7 | 12/6 |
| 6BW6 | 9/- |
| 6BW7 | 8/6 |
| 6C4 | 5/- |
| 6C5GT | 6/6 |
| 6C6 | 5/- |
| 6C9 | 17/3 |
| 6C31 | 7/6 |
| 6CD6G | 29/10 |
| 6D6 | 5/- |
| 6CH6 | 10/6 |
| 6F6G | 7/6 |
| 6F6M | 7/6 |
| 6F1 | 14/- |
| 6F13 | 14/- |
| 6F14 | 26/6 |
| 6F15 | 14/- |
| 6F18 | 15/3 |
| 6F23 | 18/7 |
| 6F33 | 7/6 |
| 6H6 | 2/6 |
| 6H6GT | 2/6 |
| 6J5GT | 5/- |
| 6J5M | 6/6 |
| 6J6 | 6/- |
| 6J7G | 6/6 |
| 6J7M | 9/- |
| 6K7G | 4/- |
| 6K7M | 6/9 |
| 6K8G | 7/6 |
| 6K6GT | 7/- |
| 6K7GT | 5/9 |
| 6K8GT | 10/- |
| 6K25 | 19/11 |
| 6L6G | 8/- |
| 6L6M | 7/6 |
| 6L7G | 7/6 |
| 6L1 | 23/3 |
| 6L18 | 11/6 |
| 6L19 | 23/3 |
| 6LD20 | 15/11 |
| 6M1 | 17/3 |
| 6N7GT | 7/6 |
| 6P1 | 19/3 |
| 6P26 | 19/11 |
| 6P28 | 26/6 |
| 6Q7G | 7/6 |
| 6Q7GT | 9/6 |
| 6SA7GT | 8/- |

| | |
|---|---|
| 6SG7 | 7/6 |
| 6SH7 | 6/- |
| 6SJ7 | 8/6 |
| 6SK7 | 6/- |
| 6SL7GT | 8/- |
| 6SN7GT | 7/6 |
| 6SQ7 | 9/3 |
| 6U4GT | 12/- |
| 6U5/6G5 | 17/3 |
| 6U5G | 8/6 |
| 6U7G | 8/6 |
| 6V6G | 6/- |
| 6V6GT | 7/9 |
| 6X4 | 7/6 |
| 6X5G | 7/- |
| 6X5GT | 7/- |
| 6/30L2 | 12/6 |
| 7B6 | 10/6 |
| 7B7 | 8/6 |
| 7B8 | 6/- |
| 7C5 | 8/- |
| 7C6 | 8/- |
| 7D6 | 13/6 |
| 7H7 | 9/- |
| 7Q7 | 9/- |
| 7S7 | 9/6 |
| 7Y4 | 8/6 |
| 8D2 | 2/9 |
| 9D2 | 3/6 |
| 10C1 | 17/3 |
| 10C2 | 17/6 |
| 10D2 | 12/- |
| 10F1 | 15/- |
| 10F3 | 23/3 |
| 10F9 | 15/3 |
| 10F18 | 15/3 |
| 10L1 | 15/11 |
| 10LD11 | 15/11 |
| 10M2 | 23/3 |
| 10P13 | 17/6 |
| 10P14 | 19/3 |
| 12A6 | 6/6 |
| 12AT6 | 10/6 |
| 12AT7 | 7/6 |
| 12AU6 | 8/- |
| 12AU7 | 8/- |
| 12AX7 | 8/- |
| 12BA6 | 9/- |
| 12BE6 | 9/- |
| 12C8 | 9/- |
| 12E1 | 35/- |

| | |
|---|---|
| 12H6 | 3/6 |
| 12J5GT | 3/- |
| 12J7GT | 10/6 |
| 12K7GT | 7/6 |
| 12K8GT | 13/6 |
| 12Q7GT | 7/6 |
| 12SG7 | 7/6 |
| 12SH7 | 6/- |
| 12SJ7 | 6/- |
| 12SK7 | 6/- |
| 12SL7 | 8/- |
| 12SN7GT | 15/- |
| 12SQ7 | 8/6 |
| 14S7 | 17/- |
| 15D2 | 7/9 |
| 19AQ5 | 9/9 |
| 19BG6G | 23/3 |
| 20D1 | 15/3 |
| 20F2 | 26/6 |
| 20L1 | 26/6 |
| 20P1 | 26/6 |
| 20P3 | 23/3 |
| 20P5 | 23/3 |
| 25A6G | 10/6 |
| 25L6GT | 10/- |
| 25Z4 | 9/6 |
| 25Z5 | 8/- |
| 25Z6 | 10/- |
| 27SU | 19/11 |
| 30C1 | 10/6 |
| 30F5 | 10/6 |
| 30FL1 | 10/6 |
| 30L1 | 19/11 |
| 30L15 | 23/3 |
| 30P4 | 15/- |
| 30P12 | 12/6 |
| 30P16 | 9/6 |
| 30PL1 | 12/6 |
| 30PL13 | 21/11 |
| 35L6GT | 10/- |
| 25Y5 | 9/9 |
| 35W4 | 7/6 |
| 35Z4GT | 8/- |
| 42 | 8/- |
| 35Z3 | 16/7 |
| 35Z5GT | 9/- |
| 50C5 | 11/6 |
| 50CD6G | 29/10 |
| 50L6GT | 8/6 |
| 75 | 11/6 |
| 77 | 7/6 |

| | |
|---|---|
| 80 | 8/6 |
| 142BT | 3/6 |
| 185BT | 33/2 |
| 210DDT | 4/6 |
| 210VPT | 3/6 |
| 83 | 10/- |
| 301 | 10/6 |
| 302 | 10/6 |
| 304 | 10/6 |
| 305 | 10/6 |
| 306 | 10/6 |
| 807 | 6/6 |
| 954 | 2/- |
| 955 | 4/- |
| 956 | 3/6 |
| 5763 | 9/- |
| 9004 | 5/6 |
| 9006 | 5/6 |

**DIODES**

| | |
|---|---|
| OA70 | 4/- |
| OA79 | 4/- |
| OA81 | 4/- |
| CG6E | 4/- |
| CG12E | 4/- |

**TRANSISTORS**

| | |
|---|---|
| OC45 | 23/- |
| OC66 | 25/- |
| OC70 | 14/- |
| OC71 | 14/- |
| OC72 | 17/- |
| XB102 | 10/- |
| XB104 | 10/- |

Our New 1960 Catalogue is now ready, please send 1/- in stamps to cover cost.

Trade Catalogue also available, apply on Business Letter Heading.

## LOUDSPEAKER UNITS

All Brand New, Note the Special Prices. All Permanent Magnet, 3 ohms Impedance.

| | |
|---|---|
| 2½in. square Celestion | 18/6 |
| 3in. Square Celestion | 18/6 |
| 3½in. Square Elac | 19/6 |
| 5in. Round, Goodman, Celestion and Plessey | 16/6 |
| 6½in. Round Celestion | 17/6 |
| 10in. Round Elac and Celestion | 22/6 |
| 12in. Round Plessey | 32/6 |
| 6in. x 4in. Plessey | 19/6 |
| 7in. x 4in. Plessey & Goodman | 19/6 |
| 8in. x 5in. Allen (Golden) | 25/6 |
| 10in. x 6in. Goodman & Celestion | 25/6 |
| Special Offer: 8in. Golden Eight, 15 ohms Speech coil | 42/6 |

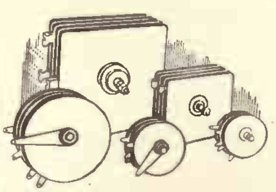
## MAINS TRANSFORMERS 3-WAY MOUNTING TYPE

MT1 Primary 200/250 v., Secondaries 250-0-250 v. 80 mA. 0-6.3 v. 4 A. 0-4 v. 2 A., both tapped at 4 v., 21/9 each.

MT2 Primary 200/250 v., Secondaries 350-0-350 v. 80 mA. 0-6.3 v. 4 A. 0-5 v. 2 A., both tapped at 4 v., 21/9 each.

MT3 Primary 200/250 v., Secondary 30 v. 2 A. Taps at 3 v. 4 v., 6 v., 8 v., 9 v., 10 v., 15 v., 20 v., 24 v., 21/9 each.

Postage and Packing please add 2/- per transformer.



## RECTIFIERS FOR BATTERY CHARGERS

| | |
|---|---|
| 12 v. 1 amp. | 4/3 |
| 12 v. 2 amp. | 7/- |
| 12 v. 3 amp. | 10/- |
| 12 v. 4 amp. | 12/- |
| 12 v. 5 amp. | 14/6 |

## RECORD PLAYER UNITS

BSR Monarch Model UA8, 4 speed, 10 record capacity, Ful-Fi turnover crystal cartridge, £6/19/6.

Collaro Conquest, fully mixing changer on 7in., 10in. and 12in. records, fitted with Studio 'O' Crystal Cartridge, £7/19/6.

Garrard RC120/D/11, 4 speed automatic unit, manual control to enable records to be played singly, £8/17/6.

Collaro AC4/564, 4 speed single player, with automatic stop, fitted Studio 'O' Crystal Cartridge, £6/19/6.

Pifco All-in-One Radiometer, for all practical testing, 32/6.

Tyana Soldering Irons, 40 watt, 16/9 each.

## ACOS MICROPHONES

Acos Mic 39-1. Crystal Stick Microphone for use as a hand, desk or floor stand unit for high quality recording, broadcasting and public address work. LIST PRICE £5/5/-. OUR PRICE 39/6.

With stand, 47/6. With Floor Stand adaptor, 52/6. Postage 1/6.

MIC 40, as supplied with most modern tape recorders, listed at 35/-. OUR PRICE 25/-. With folding rest and 8ft. lead, 40/-. 6,000 c.p.s.

Headphones, Low Resistance, 120 ohms. 7/6 pair.

Headphones, High Resistance, 4000 ohms 13/6 pair.

## CABY UNIVERSAL TEST METERS

Pocket size multi-range test meters of excellent quality 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.

## TELEVISION BAND III CONVERTERS

INVICTOR Model 245. Self contained own power unit. Bands 6 to 10. Listed £9/19/6. OUR PRICE £3/19/6.

INVICTOR 13 Channel Adaptor, for Models 118, 119, 120. Listed £7/19/6. OUR PRICE 49/6.

WOLSEY TC165 Aerial Converter. Listed £9/19/6. OUR PRICE £3/19/6.

## CATALOGUE

Our 1960 catalogue is now available, please send 1/- in stamps for your copy. Trade Catalogues also available, please attach your Business Letter Heading.

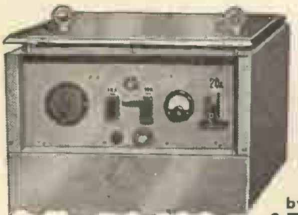
**ALPHA RADIO SUPPLY CO.**

**103 LEEDS TERRACE WINTOUN STREET LEEDS 7**

TERMS: Cash with order or C.O.D. Postage and Packing charges extra, as follows: Orders value 10/- add 1/-; 20/- add 1/6; 40/- add 2/-; £5 add 3/- unless otherwise stated. Minimum C.O.D. fee and postage 3/-.
For full terms of business see inside cover of our catalogue.
Personal shoppers 9 a.m. to 5 p.m. Mon. to Friday. Saturday 10 a.m. to 1 p.m.

**BENEFIT FROM WHOLESALE BUYING! GET EQUIPMENT THAT'S IN TIP-TOP CONDITION. GET IT FROM IRONGATE — ENGLAND'S LEADING EQUIPMENT WHOLESALERS**

## HEAVY DUTY
## 20 AMP. L.T. SUPPLY UNIT



by **S.T.C.**

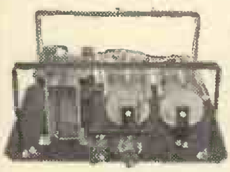
*Normal cost over £100*

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 × 24 × 32in. high.
In attractive Grey Cabinet.

ex-Warehouse **£22-10-0**

*(Circ. diags. and instru. 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 CONVERTORS.** 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 tappings. 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. Ref. 5C/4098)
*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

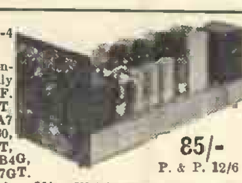
Kits comprise—6 2¼in. dia. Tubular Steel Sections of 6ft. length, top-section and base, Pickets, Guys and Fittings. **YOU** can purchase this normally expensive **MAST** for a fraction of its cost. Please add £1 for (returnable) wooden carrying case. The **MAST** is particularly suitable to take aerials for Tx., Rx., F.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. × 2¼in., 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 1in. 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 R.D.F. Valve: 1-6SN7GT, 4-6SK7GT, 1-6SA7GT, 1-VR105-30, 1-5U4G, 1-6H6-GT, 1-6SL7GT, 3-6B4G, 2-879/2-2, 1-6SJ7GT.

**85/-** P. & P. 12/6

Chassis size 20 × 9 × 11in. Weight 26lb. Brand new. *Components value (transformers, condensers, switchgear, etc.) far exceeds this remarkable low price. Buy now. Only 150 sets available.*

## 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. × 7½in. × 4in. A miniature B.C.221 in every respect. A must for every laboratory, etc. ONLY £4/19/6. P. & P. 2/6.

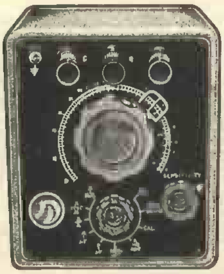
**BRIDGE MEGGERS**

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 10mfd. 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 Bros 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 kV/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, side 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 TANNOY 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 ¼, 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 × 6½ × 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 ¾in. (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/-. |

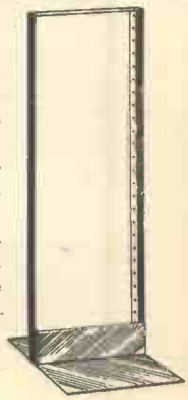
**RE-ENTRANT LOUD HAILERS**
(Ex-Govt.)
Heavy duty 20 watts all-metal 15 ohms. Diameter 15in., length 15in. (approx) good condition. £6/10/-. Carr. 10/-. Ditto. Brand new, £8. Carr. 10/-.

**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, 35-16,000 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/-.



# D.C. OSCILLOSCOPE

## A.C. MAINS 200-250 VOLTS

### SIMPLIFIED SERVICING PROBLEMS WHEN USING THE 'TESTGEAR' SCOPE

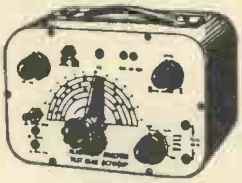
### 3in. D.C. OSCILLOSCOPE

Engineered to precision standards, this high-grade instrument is made available at the lowest possible price, incorporating the essential features usually associated with luxury instruments. This "SCOPE" will appeal particularly to Service Engineers and Amateurs. A high gain, extremely stable differential Y-Amplifier (30 mV/C.M.). Provides ample sensitivity with A.C. or D.C. inputs. Especially suitable for measurement of transistor operating conditions where maintenance of D.C. levels is of paramount importance. Push-pull X amplifier; Fly-back suppression; Internal Time-base Scan Waveform available for external use; pulse/output available for checking T.V. Line O/P Transformers, etc.; Provision for external X I/P and CRT. Brightness Modulation. Size 10in. high, 6¾in. wide, 9in. deep. Wgt. 11½lb. £15/15/- plus P. & P. 7/6, or 30/- deposit, plus P. & P. 7/6 and 12 monthly payments of 26/6.

FULL 12 MONTHS' GUARANTEE INCLUDING VALVES AND TUBE

# ALIGNMENT ANALYSER TYPE MC12

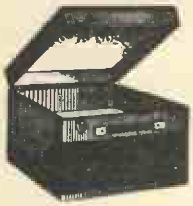
A.C. MAINS, 200/250 volts. Provides:—"WOBBULATOR" (SWEPT FREQUENCY) OPERATION, for FM/TV alignment linear frequency sweep up to 12 Mc/s. From 400 Kc/s.—80 Mc/s. CAPACITANCE MEASUREMENT. Two ranges provided 0—60 pf and 0—120 pf. SPECIAL FACILITY enables true resonant frequency of any tuned cct. I.F. transformer, etc., to be rapidly determined. Cash price £6/19/6 and 5/- P. & P. H.P. terms, 25/- deposit and 5/- P. & P. and 6 monthly payments of 21/6.



# B.S.R. MONARCH UA8 with FUL-FI HEAD

4-speed plays 10 records 12in., 10in. or 7in. at 16, 33, 45 or 78 r.p.m. Intermixes 7in., 10in. and 12in. records of the same speed. Has manual play position; colour brown. Dimensions: 12½in. × 10¾in. Space required above baseboard 4¾in., below baseboard 2½in. Fitted with Ful-Fi turnover crystal head. £6/19/6. Plus 5/- P. & P.

STEREO HEAD £7/19/6 Plus 5/- P. & P.



# PLAYER CABINET

Finished in 2-tone leatherette, will take B.S.R. UA, with room for amplifier and 7in. × 4in. speaker. Overall size 15½in. × 13½in. × 9½in.

Similar to the above in POLISHED WALNUT, will take Collaro.

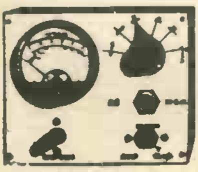
**39/6** Plus 5/- P. & P.

# CHANNEL TUNER

Will tune to all Band I and Band III stations. BRAND NEW by famous manufacturer. Complete with P.C.C. 84 and P.C.F. 80 valves (in series). I.F. 16-19 or 33-38. Also can be modified as an aerial convertor (instructions supplied). Complete with knobs. Plus 3/6 P. & P. **22/6**

HEATER TRANSFORMER to suit the above, 200-250 v., 6/- Plus 1/6 P. & P.

# AC/DC POCKET MULTI-METER KIT



Comprising 2in. moving coil meter, scale calibrated in A.C./D.C. volts, ohms and milliamps. Voltage range A.C./D.C. 0-50, 0-100, 0-250, 0-500. Milliamps. 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.

**19/6** Plus P. & P. 1/6. Built and tested 7/6 extra.

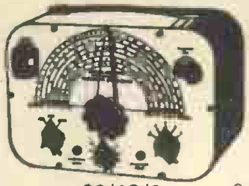
Point-to-point wiring diagram 1/- free with kit.

# MAINS TRANSFORMERS

All with tapped primaries 200-250 volts.

0-160, 180, 200 v., 60 ma., 6.3 v. 2 amps., 10/6. 320-0-320 v. 75 ma., 6.3 v., 2.5 amp., 5 v., 2 amp., 10/6. 280-0-280, 80 ma., 6.3 v., 2 amp., 6.3 v., 1 amp., 10/6. Postage and packing on the above 3/-.

# SIGNAL GENERATOR

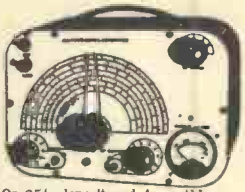


Covering 100 Kc/s-100 Mc/s. on fundamentals and 100 Mc/s to 200 Mc/s. on harmonics. Metal case 10in. × 6¾in. × 5½in., grey hammer finish. Incorporating three miniature valves and Metal Rectifier. A.C. Mains 200/250 v. Internal Modulation of 400 c.p.s. to a depth of 30%. Modulated or unmodulated R.F., output continuously variable 100 millivolts C.W. and mod. switch, variable A.F. output. Incorporating magic-eye as output indicator. Accuracy plus or minus 2%.

**£6/19/6** Or 25/- deposit and 6 monthly payments of 21/6 Post & Packing 5/- extra.

# SIGNAL GENERATOR

Coverage 120 Kc/s—230 Kc/s., 300 Kc/s.—900 Kc/s., 900 Kc/s.—2.75 Kc/s., 2.75 Mc/s.—8.5 Mc/s., 8 Mc/s.—28 Mc/s., 16 Mc/s.—56 M/cs., 24 Mc/s.—84 Mc/s. Metal case 10in. × 6½in. × 4½in. Size of scale 6½in. × 3½in. 2 valves and rectifier A.C. mains 230-250 c. Internal modulation of 400 c.p.s. to a depth of 30 per cent. modulated or unmodulated R.F., Output continuously variable 100 millivolts C.W. and mod-switch variable A.F. output and moving coil output meter. Grey hammer finish case and white panel. Accuracy plus or minus 2%. **£4/19/6**



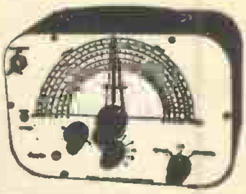
Or 25/- deposit and 4 monthly payments 21/6. P. & P. 5 - extra.

# SIGNAL & PATTERN GENERATOR

**£6/19/6** P. & P. 5/-

Or 25/- deposit. P. & P. 5/- and 6 monthly payments of 21/6.

Coverage 7.6 Mc/s.-210 Mc/s. in five bands, all on fundamentals, slow motion tuning audio output. 8 vertical and horizontal bars, logging scale. In grey hammer finished case with carrying handle. Accuracy ±1% A.C. mains 200-250 v.



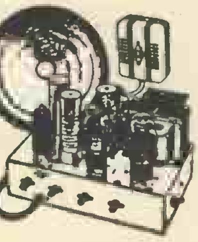
# F.M. TUNER UNIT

Permeability tuned by famous German Manufacturer. Coverage 88—100 Mc s. Complete with ECC85. Size 4in. × 2in. × 2in.

**25/-** Plus P. & P. 1/6 Circuit diagram free with unit. **1/-**

10.7 Mc s. I.F. and Discriminator Coil 2/6 pair.

# 8 WATT PUSH-PULL AMPLIFIER



COMPLETE WITH CRYSTAL MIKE AND 8in. LOUDSPEAKER

A.C. mains 200/250 v. Size 10½in. × 6½in. × 2½in. Incorporating 6 valves, H.F. pen., 2 triodes, 2 output pens, and rectifier. For use with all makes and types of pick-up and mike. Negative feed-back. Two inputs, mike and gram., and controls for same. Separate controls for Bass and Treble lift. Response flat from 40 cycles to 15 Kc/s, ±2 db; 4 db down at 20 Kc/s. Output 8 watts at 5%, total distortion. Noise level 40 db down, all hum. Output transformer tapped for 3 and 15 ohm speech coils. For use with Std. or L.P. records, musical instruments such as Guitars, etc.

**£4.19.6** Plus P. & P. 7/6

Or £1 deposit, plus P. & P. 7/6 and 4 monthly payments of 23/-.

# LINE E.H.T. TRANSFORMER

With built-in line and width control and winding for EY51. 14 KV. Scan coil, 90° deflection, on ferrite yokes. Frame O.P. transformer 500 pf. 18 KV. smoothing condenser. Can be used for 14in., 17in. or 21in. tubes. Complete with circuit diagram.

**29/6** Plus 4/- P. & P.

Focus Magnet suitable for the above (state tube). 10/- Plus 2/6 P. & P.
17in. PERSPEX MASK 8/6 Plus 2/6 P. & P.

# 2-TRANSISTOR POCKET RADIO

Plus Germanium diode, fully tuneable over medium and long waves. Size 3¼in. × 4in. × 1¼in. Complete set of components including case, 2 transistors and earpiece (less batteries). Point to point wiring diagram 1/6. (Free with kit.)

**19/6** Plus P. & P. 1/6.

# PUSH-PULL OUTPUT STAGE

Inclusive of transistors with input and output transformers to match 3 ohm speech coil, suitable for use with the above kit. Complete kit of parts including transistors. Point to point wiring diagram 1/6. (Free with kit.)

**19/6** Plus P. & P. 1/6.

# RADIO AND T.V. COMPONENTS (ACTON) LTD.

23, ACTON HIGH STREET, LONDON, W.3

*GOODS NOT DESPATCHED OUTSIDE U.K. ALL ENQUIRIES S.A.E.*
*TERMS OF BUSINESS C.W.O.*

# VALVES

**Brand new, individually checked and guaranteed**

| Valve | Price |
|---|---|
| AC/DD | 2/6 |
| AC/P | 4/6 |
| AC/P1 | 2/6 |
| AC5PENDD | 4/- |
| AC6/PEN | 5/- |
| AC/SP3 | 4/6 |
| AL60 | 6/- |
| AR6 | 2/6 |
| AR8 | 5/- |
| ARDD5 | 2/- |
| ARP3 | 3/- |
| ARP4 | 3/6 |
| ARP12 | 2/9 |
| ARP21 | 5/6 |
| ARP24 | 3/6 |
| ARP34 | 4/6 |
| ATP4 | 2/9 |
| ATP7 | 5/6 |
| AU1 | 5/- |
| AU4 | 5/- |
| AW3 | 4/- |
| BL63 | 6/- |
| BT45 | 40/- |
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| D41 | 3/3 |
| D42 | 4/- |
| D77 | 4/3 |
| DA30 | 12/6 |
| DD41 | 4/6 |
| DET5 | 15/- |
| DET18 | 30/- |
| DET19 | 2/6 |
| DET20 | 2/6 |
| DH76 | 4/9 |
| E1323 | 25/- |
| EA50 | 1/6 |
| EAC91 | 4/6 |
| EB34 | 1/6 |
| EBC33 | 6/- |
| EC52 | 3/- |
| EC54 | 3/6 |
| ECC32 | 4/- |
| ECC81 | 6/6 |
| ECC82 | 6/9 |
| ECC83 | 7/- |
| ECC84 | 7/9 |
| ECC91 | 4/- |
| ECL80 | 9/6 |
| EF22 | 7/3 |
| EF32 | 5/- |
| EF36 | 3/6 |
| EF39 | 4/6 |
| EF50 | 2/6 |
| EF52 | 5/- |
| EF54 | 3/6 |
| EF55 | 6/- |
| EF70 | 4/- |
| EF80 | 6/9 |
| EF85 | 6/10 |
| EF89 | 8/9 |
| EF91 | 4/10 |
| EF92 | 5/- |
| EL32 | 3/9 |
| EL35 | 9/- |
| EL84 | 8/3 |
| EL91 | 7/6 |
| EM4 | 4/- |
| EY91 | 3/6 |
| EZ40 | 7/- |
| EZ80 | 7/6 |
| FW4/500 | 6/6 |
| H30 | 5/- |
| H63 | 3/6 |
| HP4101 | 6/- |
| KBC32 | 5/- |
| KF35 | 5/- |
| KT2 | 4/- |
| KT31 | 8/- |
| KT33C | 7/- |
| KT44 | 9/- |
| KT241 | 9/- |
| KTW63 | 6/6 |
| L30 | 4/- |
| MH4 | 3/6 |
| ML4 | 4/- |
| ML6 | 6/- |
| MS/PEN | 6/- |
| MS/PENB | 6/- |
| MS/PEN/T | 6/- |
| N34 | 8/- |
| NR15A | 3/- |
| NT37 (4033A) | 10/- |
| OD3 | 5/- |
| OZ4 | 5/- |
| OZ4A | 5/- |
| P61 | 2/6 |
| PCC84 | 8/- |
| PCC85 | 8/- |
| PEN25 | 4/6 |
| PEN46 | 5/6 |
| PEN65 | 6/6 |
| PEN141 | 4/- |
| PEN220A | 3/- |
| PEN1340 | 6/- |
| PENDD/1360 | 9/6 |
| PL81 | 11/- |
| PL82 | 8/- |
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| PM4DX | 3/- |
| PT25H | 7/6 |
| PY82 | 8/- |
| QP21 | 6/- |
| QP25 | 5/3 |
| QS75/20 | 6/9 |
| QS95/10 | 6/9 |
| QS108/45 | 6/9 |
| QS150/15 | 6/9 |
| R10 | 12/6 |
| REL21 | 25/- |
| RG1-240A | 17/6 |
| RG3-250 | 17/6 |
| RG4-1250 | 9/- |
| RK34 | 2/6 |
| RL37 | 3/6 |
| SP2 | 4/- |
| SP4B | 7/6 |
| SP13C | 4/6 |
| SP41 | 2/6 |
| SP61 | 2/6 |
| SP210 | 4/- |
| SU2150A | 4/9 |
| T41 | 19/- |
| TP25 | 15/- |
| TT11 | 3/- |
| U18 | 6/- |
| U19 | 7/- |
| U27 | 8/- |
| UL84 | 8/6 |
| UL85 | 7/- |
| UU4 | 4/6 |
| V2D33B | 8/- |
| VP23 | 3/6 |
| VR78 | 4/- |
| VR99 | 8/- |
| VR105/30 | 7/6 |
| VR150/30 | 7/3 |
| VS110 | 4/- |
| VT25 | 8/6 |
| VU111 | 3/- |
| VU120 | 3/3 |
| VU133A | 3/- |
| W31 | 7/- |
| W42 | 7/- |
| Y63 | 5/- |
| Y66 | 8/- |
| Z31 | 6/- |
| 1A3 | 3/6 |
| 1A5GT | 5/- |
| 1C5GT | 7/6 |
| 1D8GT | 6/- |
| 1E7GT | 7/6 |
| 1L4 | 3/9 |
| 1LDS | 3/6 |
| 1R5 | 6/9 |
| 1S5 | 6/- |
| 1T4 | 4/- |
| 2A3 | 8/- |
| 2A6 | 7/- |
| 2C34 | 2/6 |
| 2D4A | 4/- |
| 2X2 | 4/- |
| 3A4 | 6/- |
| 3B24 | 3/- |
| 3E29 (829B) | 60/- |
| 3Q5GT | 9/- |
| 4A1 | 4/6 |
| 4D1 | 2/6 |
| 5U4G | 5/- |
| 5V4 | 7/- |
| 5Y3GT | 6/9 |
| 5Z3 | 8/6 |
| 5Z4G | 8/- |
| 6A6 | 5/- |
| 6AB7 | 5/- |
| 6AC7 | 4/3 |
| 6AG5 | 4/6 |
| 6AG7 | 8/- |
| 6AJ7 | 4/3 |
| 6AK6 | 7/6 |
| 6AK7 | 8/- |
| 6AM5 | 5/- |
| 6AM6 | 6/3 |
| 6B4G | 4/6 |
| 6B8 | 5/6 |
| 6B8G | 2/6 |
| 6C4 | 4/- |
| 6C5 | 6/- |
| 6C6G | 4/6 |
| 6C8G | 5/- |
| 6F5G | 5/6 |
| 6F6 | 7/- |
| 6F8G | 6/6 |
| 6F12 | 4/6 |
| 6G6G | 3/- |
| 6H6M | 2/- |
| 6H6GT | 1/9 |
| 6J5 | 3/6 |
| 6J6 | 4/3 |
| 6K6GT | 6/6 |
| 6K7G | 2/3 |
| 6K7GT | 5/3 |
| 6K8G | 6/6 |
| 6L5G | 6/- |
| 6L6 | 9/- |
| 6L6G | 6/6 |
| 6L34 | 4/6 |
| 6N7GT | 7/- |
| 6Q7G | 6/3 |
| 6R7G | 7/6 |
| 6SA7 | 6/- |
| 6SC7G | 5/6 |
| 6SC7GT | 6/- |
| 6SG7 | 5/- |
| 6SH7 | 5/- |
| 6SJ7 | 6/9 |
| 6SJ7G | 6/6 |
| 6SK7 | 5/6 |
| 6SL7GT | 6/9 |
| 6SN7GT | 4/6 |
| 6SQ7 | 6/6 |
| 6SR7 | 6/6 |
| 6SS7 | 5/- |
| 6V6G | 5/6 |
| 6V6GT | 6/- |
| 6X5GT | 6/6 |
| 8D2 | 2/6 |
| 9D2 | 3/- |
| 12A6 | 5/- |
| 12AH7 | 7/- |
| 12AT7 | 6/6 |
| 12AU7 | 6/9 |
| 12AX7 | 7/- |
| 12C8 | 7/6 |
| 12E1 | 22/6 |
| 12H6 | 2/- |
| 12JSGT | 3/6 |
| 12SC7 | 4/6 |
| 12SG7 | 6/6 |
| 12SH7 | 4/9 |
| 12SJ7 | 6/- |
| 12SK7 | 5/- |
| 12SL7 | 7/- |
| 12SR7 | 6/- |
| 15D2 | 6/- |
| 15E | 8/- |
| 15R | 7/6 |
| 30 | 5/- |
| 35T | 30/- |
| 35Z4GT | 7/- |
| 39/44 | 6/- |
| 53A | 3/- |
| 58 | 6/- |
| 59 | 6/- |
| 71A | 4/6 |
| 77 | 6/- |
| 80 | 6/3 |
| 82 | 8/- |
| 83 | 9/6 |
| 83V | 12/- |
| 84 | 12/6 |
| 89 | 6/- |
| 210LF | 3/- |
| 210VPT | 2/6 |
| 217C | 17/6 |
| 220VSG | 3/- |
| 446A | 14/- |
| 446B | 14/- |
| 705A | 17/6 |
| 715B | 97/6 |
| 717A | 8/6 |
| 801 | 6/- |
| 803 | 22/6 |
| 805 | 30/- |
| 807 AMER | 5/3 |
| 807BR | 3/9 |
| 808 | 8/- |
| 813 | 70/- |
| 815 | 80/- |
| 816 | 30/- |
| 829A | 30/- |
| 833A | £14 |
| 843 | 7/6 |
| 866A | 10/- |
| 872A | 35/- |
| 930 | 8/- |
| 954 | 2/- |
| 956 | 2/- |
| 1619 | 5/- |
| 1625 | 6/- |
| 1626 | 4/6 |
| 1629 | 4/6 |
| 4242A | 6/- |
| 7193 | 1/9 |
| 7475 | 5/- |
| 8010AR | 22/6 |
| 8013A | 10/- |
| 8020 | 6/- |
| 9001 | 5/- |
| 9003 | 5/6 |
| 9004 | 4/- |
| 9006 | 4/- |

**Cathode Ray Tubes:**

| Tube | Price |
|---|---|
| 3BP1 | 25/- |
| 5BP1 | 35/- |
| 5CP1 | 42/6 |
| 5FP7 | 45/- |
| PG7/5 | 15/- |
| VCR517 | 10/- |
| VCRX258 (with scanning coil) | 45/- |

**Special Valves:**

| Valve | Price |
|---|---|
| 2J31 | 45/- |
| 3A/1481 | 45/- |
| 3J/170/E | £35 |
| 3J192/E | £37/10 |
| 723AB | 52/6 |
| 726A | 27/6 |
| ACT25 | 40/- |
| CV691 | 60/- |
| KR3 | 45/- |
| VX7110 | 15/- |
| WL417A | 15/- |

*AND MANY OTHERS IN STOCK including Cathode Ray Tubes and Special Valves.*

All U.K. orders below 10/- P. & P. 1/-; over 10/-, 1/6; orders over £2 P. & P. free. C.O.D. 2/- extra. Overseas postage extra at cost.

**BRAND NEW ORIGINAL SPARE PARTS FOR AR88 RECEIVERS.**

**TUNING MECHANISM.** (Gear). £2/10/- post free.

Please write your other requirements.

**TRANSCEIVERS** 68T 3-5 mc/s. together with aerial rods, microphones, H.R. headphones, Key in full working order. £6/15/-. P. & P. 5/-.

**FAMOUS U.S.A. FIELD TELEPHONES** in canvas or leather case, type EE8 £9 per pair post free.

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**HRO MAINS** power pack, input 115/250 v. A.C. Output 250 v. 75 mA. and 6.3 v. 3.5 amps. £3, inc. carr.

**VARIOMETERS** for W/S No. 19. Fully tested and working 12/6. P. & P. 2/6.

**BLOCK CONDENSERS.** 0.1 mfd. 12,000 v. D.C. test 12/-. 0.0044 mfd. 20,000 v. D.C. test 8/-. 0.5 mfd. 8,000 v. D.C. test 8/-. 7.5 mfd. 400 v. D.C. test 3/-.

**ELECTROLYTIC CAN TYPE.** 250 mfd., 12 v. D.C. VKG 2/6. 150 mfd., 25 v. D.C. VKG 2/6. 8 + 8 mfd. (Block), 450 v. D.C. VKG 3/6.

**FILAMENT TRANSFORMERS.** Primary 0-190-210-230-250 v., 50 c/s. Sec. 1. 2.5 v. C.T. at 10 amps. 2. 2.5 v. CT at 10 amps. 3. 10.5 v. CT at 11 amps., 4,000 v. insulation. Price £2/19/-. P. & P. 5/-. Primary 0-190-210-230-250 v. 50 c/s. Sec. 1. 10 v. CT at 4.5 amps. 2. 10 v. CT at 4.5 amps., 4,000 v. insulation. £1/16/-. P. & P. 5/-. Primary 230 v. 50/60 c/s. 67 v/amps. Sec. 1. 6.3 v. 1-6 amps. 2. 6.3 v. CT 3 amps. 3 6.3 v. CT 3 amps. 4. 6.3 v. CT 3 amps. £1/12/-. P. & P. 5/-.

**Signal Generator Type TS.14/AP.** 3,200-3,370 Mc/s. Fully guaranteed, £85.

**Low Resistance Headphones**, brand new, type CLR, 5/-; Balanced Armature, 7/6. P. & P. 1/-.

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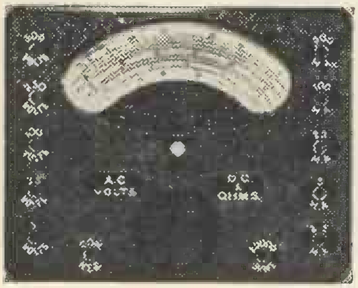
**TRANSFORMERS.** Relay supply. Primary 230 v. Sec. 0-27/29/31 v. at 0.5 amps., 15/-. P. & P. 5/-.



**AVOMINORS** in leather case with leads. Fully tested and guaranteed, with batteries. AC/DC volt range to 500 v., £3/19/6; as above, but to 1,000 v., £4/19/6. P. & P. 2/6 either.

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**COMPLETE SET OF STRONG AERIAL RODS** (American). Screw-in type MP49, 50, 51, 52, 53, total length 15ft. 10in., top diameter 0.615in., bottom diameter 0.185in. together with matched aerial base. MP37 with ceramic insulator, ideal for car or roof insulation, £2/10/-, post free.

**TELESCOPIC AERIAL MASTS.** 7 sections, total 11 yards. Immediate erection £4/10/- each or £8 per pair. Post free.

**LIGHT HEADGEAR ASSEMBLY.** Ideal for mobile use. Headphone 600 ohms, carbon microphone. 18/-. P. & P. 3/-.

**AR88D and I.F. Receivers**, completely overhauled and tuned, £60 and £57/10/- respectively. Completely rebuilt with P.V.C. wiring £85.

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**REALISTIC SOUND—**
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GUARANTEED 3 YEARS
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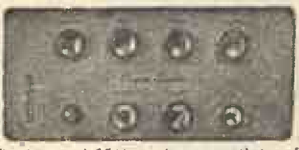
6W: Per Channel Distortion 0.15% Freq. 30-30K c.p.s. Hum and Noise — 80dB. Output Imp. 3Ω, 8Ω, and 15Ω.



**CONTROL UNIT**

Inputs: Gram (3mV.) Radio Tape (100mV.) Hum and Noise —70dB. Also suitable for use with two B.P.I.

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| BUILT | £15 15 0 | BUILT | £16 0 0 |
| KIT | £12 12 0 | KIT | £13 13 0 |

**MODEL B.P.I. 10-12 WATT AMPLIFIER**
Freq. 30-30K c.p.s. Distortion 0.1%. Hum and Noise —80dB. Output Imp. 3Ω, 15Ω.
BUILT £14 5 0
KIT £12 5 0

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Inputs: Gram (3mV.) Mic. (1.5 mV.) Radio and Tape (100mV.). Hum and Noise —70dB. Switched Filter.
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KIT £7 17 6

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Bass and Treble Controls. Spare Power: 250V. 40mA. 6.3V. 2A. O.I. 3Ω, 15Ω.
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KIT £7 10 0

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Distortion 0.15%. Inputs Gram. Radio, Tape, Spare Power 250V. 40mA. 6.3V. 2A. O.I. 3/8/15Ω.
BUILT £15 15 0
KIT £12 10 0

Full details and stage-by-stage building instructions 2/8 each, post free (" Bantam " 1/8) or free with each unit.

**H. L. SMITH & CO. LTD.** 287-289 EDGWARE RD., LONDON, W.2. Telephone: PAD 5891-7595

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**MONITOR 56,** comprising **Indicator 248** and **Power Unit 675.** Valves VCR138a, 3/EF50, 2/ECC33, 5/EF55, EF37A, 6V6, 3/EA50 and 2/5U4G, VU120A. Two units each 12×9×18in., black finish. **Panel controls:** Brill., Focus, T.B. Expansion, " Y " shift, " X " shift (two). T.B. 10/20k secs., A.C./D.C. switch, " Y " amp. multiplier/divider. Sig. input, trig., and Y2 input. Voltmeter centre-zero, 5/20/100. " X, Y and G " on " jumpers " at rear. 230 v. A.C. input, with 18-way cable and mains cable. Cathode probe unit extra, 17/6, £8 10s. (Rail 20/-). **VALVES:** CV2160 (ESU77), 50 kV., 150 watts, G.E.S. Base, 25/-. **RELAYS** (Contactors), two heavy-make contacts; 12 v. or 24 v. either 3/6. Bendix **MN26C,** new, 70/-; **RA-10DB,** 90/- (Rail 10/-). **INDICATORS,** type 277, with 1in. C.R.T., 4/VR91, 2/VR92, 37/6 (p.p. 3/6). Type 101, with VCR530 (6½in. Blue, magnetic. Octal base), and 2/EB91, 2/EF91, 2/R10, new cond., 30/- (Post 3/6). Type 1, with VCRX263, 2/EF52, 5/6J6, 1/6V6, 1/EY51, 2/EB91, 3/EF91; RF EHT Generator and 28 kc/s. xtal, 45/- (Rail 7/6). Type 97 with VCR517, 10 valves, 30/- (Rail 7/6). **HEADPHONES,** CLR, 7/6. CR100 Noise limiter assemblies, with valve 3/6. **NEW M.C. METERS,** 3½in. round flush, 50µA., 70/-; 100µA., 65/-; 1 mA., 55/-; 2 mA. (rectified), 45/-. 2½in., 1 mA., 22/6; 2in. 100 mA., 200 mA., 300 mA., each 8/6. 2½in. 20 v. A.C., 8/6; 2in. 40v., 8/6; 300 v. A.C. 2½in. 15/-. **VIBRATORS,** Mallory G634C 12 v. 4-pin, 7/6; 6 v. 5-pin reversible, 7/6. **R1155B,** good condition, tested, with handbook, £7/10/- (Rail 10/-). **SCR522** Modulation or Driver Trans., either 7/6. **MORSE TRAINER SET** with buzzer and key wired for 4½ v. battery, 8/6. **DRIVES:** slow-motion Admiralty 200 : 1 ratio, scaled 0-100, 5/6. **R1155 S.M.** " N " type, new, 10/6. **VIBRAPAK,** 6 v. D.C. to 250 v. 60 mA., smoothed, cased, 22/6. 12 v. to 250 v. 60 mA., 21/- (p.p. 3/6). **DYNAMOTORS** (post 3/6); 12 v. to 250 v. 60 mA. and 6.3 v. 2.5 A., 11/6; 6 v. to 250 v. 60 mA., 11/6. Potentiometers, miniature wirewound, 6Ω, 100Ω, 600Ω, 1k or 2k, each 1/-. **CHOKES.** LF 10H 200 mA., 8/6; Potted 10H 100 mA., 7/6; " C " 5H 400 mA., 10/6. **RELAYS,** 12/24 v. coil; 4 make, 4 break contacts (10 amp. rated) by Magnetic Devices, 7/6. **SWITCHES,** toggle U.S.A., DPDT, 1/6. **R.F.27,** good cond., 18/- (p.p. 3/6). **METAL RECTIFIERS,** 240 v. 100 mA., 4/-; 240 v. 30 mA., 3/6; 600 v. 30 mA., 5/6; 240 v. 80 mA., 5/6; 1,000 v. 30 mA., 7/6. **Mic inserts,** G.P.O. carbon, 2/6, bal. armature type, 2/6. **VALVE-HOLDERS,** U.S.A., Octal, doz. 4/-. **ACCUMULATORS,** 2 v. 4AH 2¼×1⅞×3¼in., 7/6. **POWER UNIT:** Input 115/250v. Outputs DC 330v. 80mA (plus!); 6.3v. twice AC. 5Z4G rec. Potted trans. & choke, new, 30/- (post 3/6). **C.R. TUBES,** new, VCR138a or VCR139a, each 30/-. **VALVES:**—VR91, CV138, CV140, CV136, CV1798, 6N7M, VR105. EF55, 6E5, VT61, VR54, 6C4, 20/- per dozen.

LIST AND ENQUIRIES: S.A.E. please. Terms, C.W.O. **Postage extra.** Immediate despatch.

*Callers and Post:* **W. A. BENSON (WW), 136 Rathbone Road, Liverpool, 15.** *SEF* 6853
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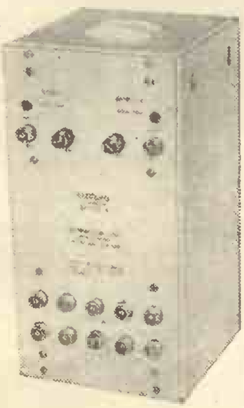
AMPLIFIERS FOR

Radford

# V-H-F



**MODEL VH2. Band I & III DISTRIBUTION AMPLIFIER**

The unit comprises two amplifiers (one for each band) with independent pre-set gain controls, fed to a combiner unit, the output of which is attenuated at all sockets except one. At this socket the full gain of the amplifiers is available for feeding a distribution system. One or all attenuated sockets may be used without affecting other outputs.

**SPECIFICATION.**

GAIN: Plus 15dB each channel at MAX. output socket. 3dB each channel attenuated outputs loaded to 80 ohms. BANDWIDTH: ±2dB each channel. INPUT: 80 ohms, co-axial socket. Separate each channel. OUTPUTS: 9 attenuated sockets; 1 full gain. POWER OUTPUT: Each channel .2 v into 80 ohms without cross modulation of vision/sound carriers. ISOLATION: Better than 22dB between sockets. MAINS INPUT: Tapped transformer 200/240V A.C. **PRICE: 12 gns.**

*When ordering please state which channels required.*
*Leaflet on full range of V.H.F. Amplifiers together with details for the design of distribution systems available upon request.*

**RADFORD ELECTRONICS LTD.**
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## BC 221 HETERODYNE FREQUENCY METERS

**125 kc/s to 20 mc/s**

Complete with all valves, crystal, headset, and instruction book, but less calibration charts. 100% condition.

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## ELECTRONIC COMPUTERS

The outstanding success of Ferranti Computers not only in Britain but overseas is reflected in the Company's requirements for:—

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who should possess sound electronic knowledge based on a Higher National Certificate or on **good experience in the technical branches of the Services.**

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of at least H.N.C. status and preferably possessing knowledge of computing circuitry and techniques. Previous experience in development would be an advantage.

These vacancies offer:

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**TELECOMMUNICATIONS**
**of CAMBRIDGE**
**have some attractive vacancies**
**for**
**SENIOR and JUNIOR**
**ELECTRONICS ENGINEERS**
**for work on**
**ELECTRONIC SWITCHING**

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Preference will be given to those experienced in any of the above techniques, particularly Transistor Circuit Design.

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## Canadian General Electric Co. Ltd.

**Requires**
**ELECTRONIC ENGINEERS**
**for**
Canada's Largest Tube & Semi-Conductor Manufacturer

**1—VALVE DEVELOPMENT ENGINEER**

For design and development of both entertainment and reliable receiving tubes.

Good knowledge of fundamentals and sufficient originality to create new designs and to make improvements to those existing.

Application knowledge advantageous.

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For field and laboratory application work dealing with circuitry as applied to receiving and small power tubes at broadcast, V.H.F. and U.H.F. frequencies in radio, television and communication equipments.

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## For the best of the world's laboratory standards and measuring equipment and specialised components

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# AVELEY ELECTRIC LIMITED

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P.3978

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To lead a team engaged on character recognition using transistor, pulse and digital techniques.

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A sound understanding of valve or transistor circuits, initiative and qualifications ranging from O.N.C. to honours degree standard.

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A keen interest in electronics and preferably substantial practical experience.

*Please apply in confidence to the Chief Engineer,*

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The General Electric Company's Telecommunication Group in Coventry is expanding its activities in connection with digital computers. This expansion has created vacancies for:

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**BRADFORD INSTITUTE OF TECHNOLOGY**
Principal: E. G. Edwards, Ph.D., B.Sc., F.R.I.C.

Applications are invited for the post of
**TECHNICIAN in the
ELECTRICAL ENGINEERING LABORATORIES**

The principal duties of the person appointed will be the maintenance and repair of apparatus, setting up of laboratory experiments and lecture demonstrations and the testing of instruments. A knowledge of electronics would be an advantage.

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Salary Scale, £465 to £650 per annum, with efficiency bars at £525 and £590. Commencing salary according to qualifications and experience.

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*Clerk to the Governors.*

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Experience in one or more of the following:—
(1) Maintenance of radio communication receivers.
(2) Sub-assembly lay out, wiring and testing of radio type chassis.
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(4) Fault finding in and maintenance of electronic apparatus.
(5) Maintenance of teleprinter or Cypher machines and associated telegraph equipment

Basic Pay £9/9/8 per week plus merit pay, assessed at interview and based on ability and experience as under:—
ORDINARY RATE 10/- to 32/-
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Opportunities for permanent and pensionable posts. Five-day week, good working conditions, single accommodation available.

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Cheltenham, Glos.

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**RADIO OPERATORS**
Write giving details of Education, Qualifications and Experience to:—
*PERSONNEL OFFICER,*
**(3/R), G.C.H.Q., (FOREIGN OFFICE),
53, Clarence Street, Cheltenham.**

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**VORTEXION TAPE RECORDERS**
P.A. Equipment. Personal Recordings etc.
Tape to Tape/Disc. Service
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INVITE APPLICATIONS FOR THESE POSTS**

### ASSISTANT TO SERVICE MANAGER
A sound technical and practical knowledge of broadcast receiver engineering and maintenance is required, together with administrative ability. Car radio experience desirable but not essential to person of right calibre.

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Experience of car radio application and maintenance desirable but not absolutely essential. This progressive appointment is in the Service Department.

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with a sound theoretical knowledge and good practical experience.

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capable of formulating test specifications and procedures for a variety of equipment and directing the work of a group of test engineers, required for new works producing television and radio transmission equipment.

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competent in the use of electronic measuring instruments for varied and interesting work comprising, TEST, ALIGNMENT, CALIBRATION & MAINTENANCE.

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Leading manufacturers in the western London area have the following vacancies:

(i) **ASSISTANT CHIEF DRAUGHTSMAN**
Salary range up to £1,500 p.a.

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Salary range up to £1,100 p.a.

Scope and prospects in these positions are exceptional.

(i) Initiative and enterprise in liaising with manufacturing unit; supplies; supervision and checking.

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Good conditions. Pensions and life assurance scheme.

Saturday interviews arranged if desired.

Please write brief details of experience, age, salary desired, to

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## TELEVISION ENGINEERS!!

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Write or call: **J. & F. STONE LTD., Edgware Road, The Hyde, Hendon, London, N.W.9.**
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(iii) **T.V. DRAUGHTSMEN**
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Interviews will be arranged (Saturdays if required) for engineers with experience and/or academic qualifications.

**THERE ARE GOOD OPPORTUNITIES TO JOIN FIRST-RATE TEAM OF RESEARCH AND DEVELOPMENT ENGINEERS AND FOR ADVANCEMENT FOR MEN WITH ORIGINAL IDEAS AND INITIATIVE**

FREE LIFE ASSURANCE AND CONTRIBUTORY PENSIONS SCHEME. FIRST-CLASS EQUIPMENT AND FACILITIES

ALL APPLICATIONS IN THE STRICTEST CONFIDENCE TO:
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Box. No. 6024 c/o "Wireless World."

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MEN AND WOMEN under 21 with G.C.E. "A" level passes in Mathematics and Physics and "O" level passes in English Language and two other subjects are invited to apply for Short Service Commissions of 5 to 8 years in the

# Technical Branch of the Royal Air Force

Selected candidates will be required to undergo officer training, on completion of which they will carry out one year's technical training. There are opportunities for a permanent career when further technical instruction will be given. Write for details now to: AIR MINISTRY (M.9) (W.D.568), ADASTRAL HOUSE, LONDON, WC1.

There are also openings for University Graduates and holders of Higher National Diplomas, Higher National Certificates, etc. for Short Service and Permanent Commissions. Full details from above address.

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# CENTRAL ELECTRICITY GENERATING BOARD

### *Research and Development Department*

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## ELECTRONIC ENGINEERS or PHYSICISTS

are required in the Electronics and Instruments Section for research into **radio and inductive interference.**

The work involves a study of the fundamental aspects of interference from high voltage plant and its effect on telecommunications circuits, and radio and television reception. A sound knowledge of radio wave propagation theory, aerial and receiver design is essential, particularly in the frequency range up to 1,000 Mc/s.

Applicants must have a University Degree or H.N.C.

**Salaries on scales within one of the following ranges according to duties and responsibilities: £1,195-£1,775 p.a. or, up to £1,300 p.a.**

**Applications, stating age, qualifications, experience, present position and salary, to the Personnel Officer, 24/30, Holborn, London, E.C.1, by 15th January. Envelopes should be marked "Confidential Ref. WW/469."**

## METEOROLOGICAL RADIO SONDE TRANSMITTERS

Frequency Range approx. 400 mc/s. Transmitter consists of modulator Valve 5875 and RF valve 5794. Operation from a dry battery 110 v., 6.6 v. and 1.4 v. Dimensions—complete with aerial—2½in. dia. × 8in. long. Weight, less batteries, 7 oz. R.F. output is pulse modulated with an audio frequency dependent on the value of resistor used in the 5875 circuit.
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High Speed Sealed Relay. General Electric type CR2791, SPDT, 2,000 ohms coil; operating current 4 to 5 mA.; will operate satisfactorily on 6 volts.
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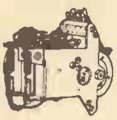
Type 1013-24, SPST, 205 ohms, 24 volts 2/9 p.p. 1/-
Miniature Relay, SPST, 300 ohms, 6 volts 4/- p.p. 1/-
12 volts, SPST, 70 ohms.......... 1/- p.p. 9d.



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(part of SCR-522 Transmitter-Receiver)

4 Crystal controlled channel, 100-156 Mc/s. (3.0-1.93 metres). Valves 9003 R.F. stage; 9003 Mixer; Three I.F. stages 12SG7; Det./AVC/Audio 12C8; Second Audio 12J5GT; Oscillator 12AH7GT, Harmonic Generator 9002; Harmonic Amplifier 9003; Audio Squelch—other section of 12AH-7GT. High and Low Impedance output.
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(part of SCR-522 Radio Set)

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Frequency Range: 5.5 to 52 mc/s. Output 1 microvolt to 100 mV. Output Impedance: 70 and 100 ohms. Internal modulation. Provision for External Modulation. Power supplies: 230 v. 50 c/s, or 80 v. 1,000 c/s.

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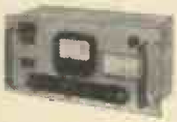

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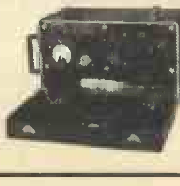

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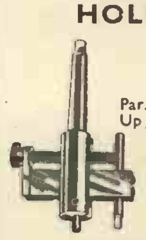

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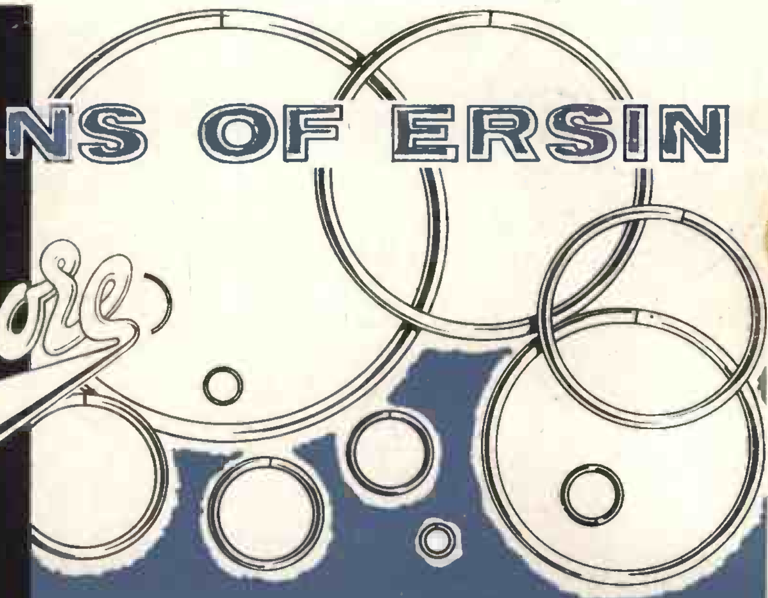

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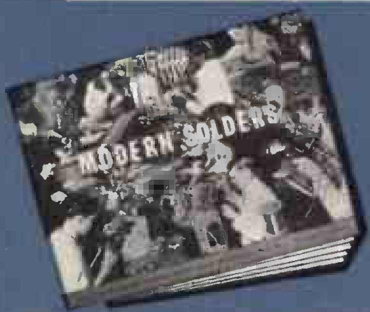


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