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NOVEMBER 1959

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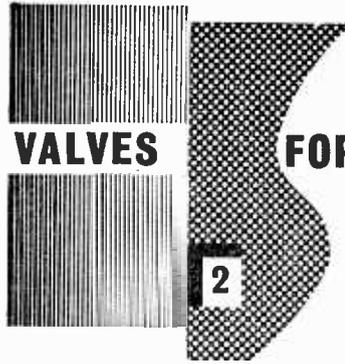
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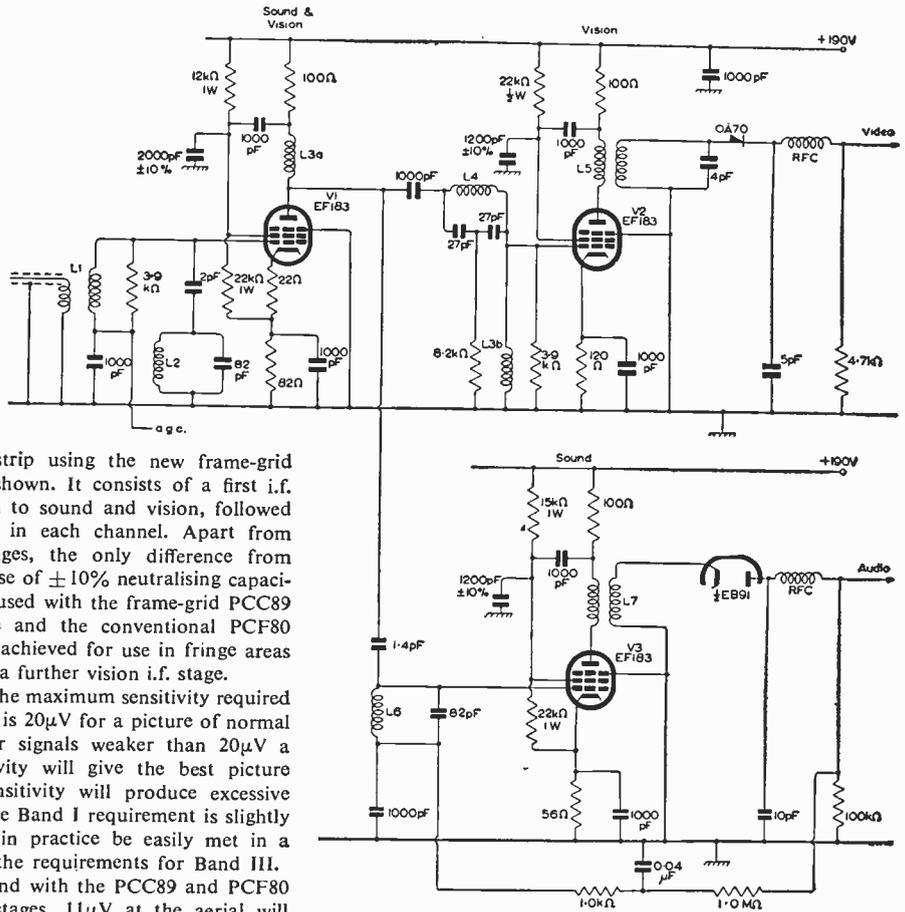
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FRAME GRID VALVES FOR TELEVISION

The first advertisement in this series discussed the frame grid valve in general terms, and outlined the advantages which it brings in the tuner and i.f. stages of a television receiver. We shall now look at the i.f. stages in more detail, with particular reference to the needs of fringe areas.



A circuit for an i.f. strip using the new frame-grid variable-mu EF183 is shown. It consists of a first i.f. stage which is common to sound and vision, followed by a second i.f. stage in each channel. Apart from component value changes, the only difference from normal practice is the use of $\pm 10\%$ neutralising capacitors. When the strip is used with the frame-grid PCC89 in a cascode r.f. stage and the conventional PCF80 mixer, adequate gain is achieved for use in fringe areas without the addition of a further vision i.f. stage.

For Band III reception the maximum sensitivity required of a fringe area receiver is $20\mu\text{V}$ for a picture of normal contrast level. Even for signals weaker than $20\mu\text{V}$ a receiver of this sensitivity will give the best picture possible. (A higher sensitivity will produce excessive noise on the screen.) The Band I requirement is slightly less stringent and will in practice be easily met in a receiver which satisfies the requirements for Band III. With the strip shown, and with the PCC89 and PCF80 in the r.f. and mixer stages, $11\mu\text{V}$ at the aerial will provide 2.0V of video. A typical receiver with a conventional valve line-up (PCC84, PCF80, EF85 first i.f., EF80 sound i.f., EF80 vision i.f.) requires $63\mu\text{V}$. Thus the conventional receiver fails to cover the required signal range for fringe areas, and it would need another i.f. stage. The frame-grid receiver, on the other hand, covers the range and has an adequate margin for production tolerances.

It will be noticed that the conventional PCF80 has been retained in the mixer stage. If the frame-grid PCF86 is substituted, then the second i.f. stages can be modified

to take the conventional EF80, with the EF183 retained in the first i.f. stage. With this new line-up, a 2.0V video output is obtained with $9\mu\text{V}$ on Band III and $5\mu\text{V}$ on Band I.

The circuit shown provides adequate a.g.c. on sound, and approximately 80dB vision gain control without serious cross-modulation. Comparable performance is obtained with the PCF86 variant. Both versions are notably superior to conventional line-ups.

National Science

SCIENCE is a method, a habit of thought which is practised not only spontaneously and individually for its own sake, as a rewarding personal activity, but collectively and deliberately as a means to an end in solving efficiently the problems of technology and economics. Pure science is at the same time infra- and supra-national in the sense that original thought is the work of individuals who have an affinity of interest with other workers in the same field regardless of race or creed. Applied science, on the other hand, has a military and market value and is consequently, and quite properly, a subject of political interest.

Under the pressures of expediency and in circumstances where the well-being of the community as a whole is involved the Government has voted money and accepted responsibility for scientific work of all kinds, from agriculture to atomic energy and from roads to radio. While some of this work is necessarily secret, much that should be more widely known is lost to view because it is considered either too esoteric or too dull to catch the popular fancy. At times like the present when satellites and moon rockets serve to make the man in the street conscious of the vast scale of scientific effort throughout the world it is natural that he should want to know what we in this country are doing to keep pace with the march of events.

Although questions of detail can be put to the Ministers responsible for the separate departments, it is not always easy to find where the responsibility lies because the labyrinth of Government Science is so complex that many of its byways are obscure, even to those with some knowledge of its main structure. The feeling is widespread that not enough is known about the deployment of national resources and effort in the scientific sphere, and this was no doubt partly the reason for the inclusion in the Conservative Party's election manifesto of a promise to appoint a Minister for Science responsible to the Cabinet for the overall promotion of scientific and technological development.

Wisely, we think, the new Government has resisted pressures to form a whole new Ministry of Science. This would have proved altogether too unwieldy and would have involved wholesale shifting of responsibilities, general disruption, and diversion of effort from the main business of research and development. The Government's

policy is to leave the various Departments to get on with their work, but to provide greater facility for the removal of possible antagonisms and to increase co-operation where this would be beneficial.

It is unfortunate, but inevitable, that there must always be a conflict of interest as far as the claims of civil and military science are concerned. In our own field this shows itself in the arguments over the allocation of radio frequencies. Whereas the claims of broadcasting and civil communications must be justified in the greatest detail, those of the fighting services are safe from public criticism behind the wall of "security." As we have said before, these conflicts can be resolved only by a minister of Cabinet rank who can be entrusted with the full facts on either side. In this respect the powers of the Minister for Science will be similar to those which he held as the Lord President of the Council. We hope that they will be exercised and that some means may be found of allaying suspicions that the military are hoarding wavebands as they sometimes do land.

The main functions of the Minister for Science will be to listen sympathetically and to talk persuasively, to release tensions and to reassure, and, if any real malfunction is diagnosed, to recommend treatment. The choice of Lord Hailsham for this post is, we think, a good one. Although not a qualified scientist he has already shown himself, as Lord President of the Council, to be *en rapport* with the scientific world. He will continue to have first call on the services of the Advisory Council on Scientific Policy and he will maintain contacts with the Royal Society, the Universities, the Ministry of Education and the Research Councils. Already he has said that one of his first tasks will be to forge closer links between Government research stations and the Universities in the belief that both stand to gain in prestige and effectiveness by more intimate association.

Not since the Restoration have the portents for British science been more favourable, and in Lord Hailsham this country has found the man to match the hour. His long political experience, his forthright approach, his interest in science and scientists and his ability to command and hold public attention qualify him not only to do those things which ought to be done, but also to let it be seen that they are being done.

Travelling-Wave Valves

Mechanisms of Interaction Processes between Electrons and Fields

By C. H. DIX*, B.Sc., A.M.I.E.E.

THE object of this article is to describe in a rather more mechanistic way than is usual the interaction processes in the two principal types of travelling-wave valves. By a travelling-wave valve is meant a valve in which two essential features are present:—

(1) The valve contains a guiding slow-wave structure which propagates an electromagnetic wave over the frequency range considered at a speed slower than in free space.

(2) There is a continuous interaction between the fields due to this wave and an electron beam.

There is then a convenient and important division which can be made.

(a) "*O*" Type Valves. These are valves in which the interaction takes place in a region in which there are no d.c. electric fields. In these the electrons are injected at a velocity higher than that of the propagating wave, and cause it to grow by giving up kinetic energy. Focusing of the electron beam is usually maintained by a magnetic field parallel to the electron beam. The best known valve of this type is the helix-type travelling-wave tube, but as will be seen there are many others.

(b) "*M*" Type Valves. These are valves in which there exist in the region of interaction electric and magnetic fields perpendicular to each other and to the direction of propagation. In these valves the velocity of the electrons in the direction of propagation remains constant, and the electrons can be thought of as providing a pivot for the interchange of potential energy between the d.c. and r.f. fields. Here, undoubtedly the most familiar example is the magnetron.

The nomenclature of "*O*" and "*M*" types is due to R. Warneche and his colleagues of the Cie. Generale de Telegraphie Sans Fil in Paris, who were prominent early workers in this field, and used the names "Carcinotron *O*" and "Carcinotron *M*" for the two corresponding types of backward-wave oscillator.

"*O*" Type Valves.—In this division the well-known helix-type travelling-wave tube, due to R. Kompfner and J. R. Pierce, provides an easily understood introduction. The action of this can be described in the following way. Consider the r.f. fields due to a wave propagating along a helix.

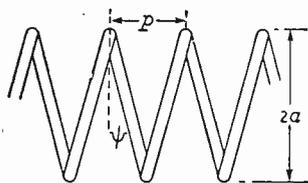


Fig. 1. Helix dimensions.

If the helix is wound so that there are (say) four turns per wavelength, so that approximately $2\pi a \sec \psi = \lambda_0/4$ where $\lambda_0 =$ free space wavelength (see Fig. 1), then the instantaneous r.f. electric fields produced in it

will be as shown in Fig. 2. These fields also, of course, extend outside the helix, but we shall only be concerned here with the fields within it

Roughly speaking, a wave propagates along a helix as though it were travelling at the velocity of light along the wire of the helix. The velocity of axial propagation is therefore approximately $v = c \sin \psi$, where $c =$ velocity of light.

Let us now consider a beam of electrons injected at just the velocity of this wave. If we imagine ourselves to be travelling with the electrons and the

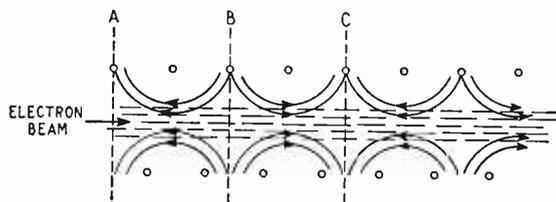


Fig. 2. R.F. fields inside helix.

wave, we see that a given electron will experience a constant force due to the r.f. fields. Referring again to Fig. 2, it can be seen that electrons in the region AB will be accelerated towards B, while electrons in the region BC will be decelerated towards B. As the beam and wave move together along the tube, therefore, the electrons in the whole moving region AC will gradually collect in a small bunch at B, and this process will continue until the space-charge forces of repulsion of the electrons for each other intervene. (This repulsion gives rise to a saturation in the output power).

Considering now average velocities over the region in which this has been taking place, the electrons in the region AB have been accelerated by the r.f. field. They have, therefore, absorbed energy from the r.f. field, causing it to decay. Similarly, electrons in the region BC have been decelerated by the r.f. field, and have given up the same amount of energy to it. Thus there is no resultant gain of energy by the r.f. field.

Looking at the beam, two additional properties have been added to it. These are a velocity modulation of the electrons, i.e. a periodic change in electron velocities along the tube, and a density modulation, or bunching of electrons.

Suppose now that the beam is injected at a velocity slightly higher than that of the wave, bunching will still occur, but since the electrons now start with a slight excess velocity, as the bunches start to form, they drift forward relative to the moving wave. Hence the bunches start to form not at B,

* G.E.C. Research Laboratories.

the point of zero r.f. field, as in the first case, but a little in advance of it, in the region BC, and hence are in a retarding r.f. field. We now have more electrons in the retarding r.f. field region than in the accelerating region. These electrons continue to be retarded by the r.f. field so that there is a resultant gain of energy by this field, thus causing it to grow. The most forward electrons may pass right through this region, having given up only a little energy, and be rapidly accelerated through the next accelerating r.f. field region into the next bunch, when they again give up not only the energy gained in the brief acceleration, but also more of their initial energy. As the fields grow, they are more able to influence the electrons and hence to grow faster, and this can be recognized as typical of an exponential process. The wave then continues to grow as it travels along the helix, until saturation effects occur. The form of the gain curves is shown in Fig. 3, where output power is plotted against input power on logarithmic scales.

This process of bunching of electrons, i.e. ensuring that there are more electrons at places where the r.f. fields are such as to retard them and to gain energy, and less where the r.f. fields are such as to accelerate them and lose energy, is an extremely important and fundamental one, and forms the basis of all amplification by electron tubes.

This is an attempt at a physical description of the interaction in an "O" type travelling-wave tube. It is clear that the energy that appears on the r.f. circuit has come from slowing down the electron beam, i.e. decreasing the kinetic energy of the beam.

The essentials of an "O" type tube would therefore appear to be:—

(1) An electron gun, to form a parallel beam and inject this into the circuit at an appropriate velocity.

(2) A slow-wave circuit, such as a helix, with coupling to a wave-guide or coaxial line input or output circuit at each end.

(3) A collector to receive the beam after it has passed through the circuit.

In addition, two other components are necessary:—

(4) Some means of preventing the beam from spreading out due to space-charge repulsion as it passes along the tube. A uniform magnetic field parallel to the beam is most frequently employed for this.

(5) An attenuator. The necessity for this is seen when it is realized that the bandwidth of the interaction process given by a helix is over an octave. If any reflection occurs at the output end of the tube, the reflected wave will be propagated back along the

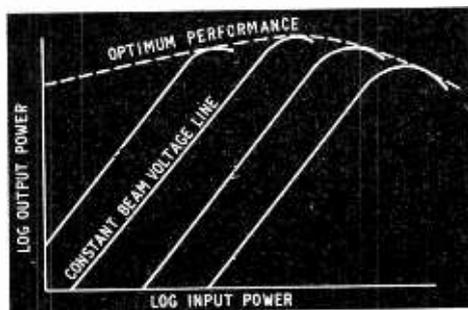


Fig. 3. Gain characteristics of helix type tubes.

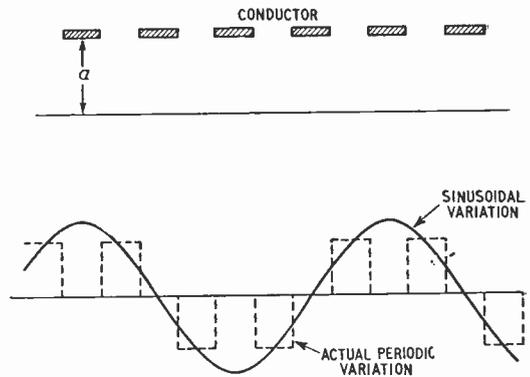


Fig. 4. R.F. fields in a periodic circuit.

helix; if it is then partially reflected at the input end, the reflected part will again be amplified. It can be seen that if the voltage reflection coefficients at the ends are ρ_1 and ρ_2 and the voltage attenuation of the circuit is α , then oscillation will occur if $G\rho_1\rho_2/\alpha^2$ is greater than 1 where G is the forward electronic tube voltage gain. Typically we require G/α to be of the order of 50, hence $\rho_1\rho_2/\alpha$ must be less than 0.02 over the whole bandwidth, a requirement very difficult to meet for small values of α . We therefore arrange to have an attenuating region at least equal to the overall gain, so that, for example, to obtain an overall gain of 30 dB the attenuation might be 35 dB, and the forward electronic gain of the tube 65 dB. Even if total reflection occurs, the combined forward and return cold attenuation is now 70 dB, and the tube will therefore be stable. The attenuation is not usually distributed along the entire circuit, but is concentrated in a relatively short region near the middle of the tube, since if it is placed too near the input, in the region before the growing wave is predominant, it gives an excessive loss, while if it is placed near the output, it leads to a severe reduction in saturated maximum power.

Although a helix has a very great bandwidth it is difficult, especially at high frequencies, to obtain a high thermal dissipation with it. This arises from the fact that if, for a given circuit, we plot gain per unit length against γa ($\approx \beta_0 a$) where $\gamma^2 = \beta_0^2 + k^2$, $\beta_0 = \omega/v_0$, $k = \omega/c$, $\omega = 2\pi \times$ frequency, $v_0 =$ velocity of wave on the circuit, a is the helix radius and c the velocity of light, we find that the gain per unit length has a maximum for most practicable circuits which occurs between $\gamma a = 1.4$ and $\gamma a = 2$. Thus γa must be maintained between these limits. Now $\gamma a \approx \omega a/v_0 \approx \omega a/u_0$ where u_0 is the beam velocity. Moreover, as will be shown, there is a maximum value of voltage or beam velocity u_0 which can be used before oscillations interfere. Hence as the frequency, or ω , is increased, it is necessary to reduce the helix diameter to maintain γa within the required limits. For high powers, therefore, other circuits are used, which permit operation at higher voltages than can be utilised with a helix.

Space-harmonics.—In all our analysis we make the assumption that axial r.f. electric fields vary as $\exp [j(\omega t - \beta z)]$ i.e. the z variation along the tube is sinusoidal. If, however, we consider a practical circuit, it is seen that this cannot be the case, since at $r = a$ the axial field must be zero along the conducting boundaries. Thus, instead of varying as

shown by the full line in Fig. 4, the axial field will in fact vary as shown by the dotted line. The total field, therefore, can be considered as consisting of the fundamental component, our original sine variation, plus a series of fields due to waves having the same frequency, but travelling at different velocities. These are known as space-harmonics and it will be shown later that $\beta_n = \beta_o + 2\pi n/p$ where n is a positive or negative integer and p the pitch of the circuit. The complete field is then described by

$$E = \sum_{n=-\infty}^{n=\infty} E_n(r, \theta) e^{j(\omega t - \beta_o z)} e^{-j \frac{2\pi n}{p} z}$$

The important thing to note here is that, since n may be positive or negative, both positive and negative space-harmonic velocities are involved, i.e. although the group velocity of a wave is in the forward direction, some of its space harmonics have phase-velocities in the opposite direction. Now we saw when describing helix interaction that the beam and the wave have similar velocities, and interaction then occurs between the beam and what we now recognize as the fundamental component of the wave. If, however, we had injected the beam with the velocity of the n th space harmonic, we should find that the interaction could be quite well described by assuming that it only interacted with that space-harmonic. If we consider field shapes due to periodic boundaries, it can be seen that the spatial distribution of the space-harmonic fields may be quite different from that of the fundamental, and that, in general, higher order fields decay more rapidly as we go away from the circuit.

To consider on a more physical basis how interaction occurs between electrons and space-harmonic fields, consider a circuit which has, at the edge of the beam, periodic conducting regions and gaps. Considering Fig. 5, the condition for forward interaction we have obtained is that the electron should go from A to B in about the same time as it takes the wave to go the same distance, i.e. $n = 0$ so that $\beta_n = \beta_o = \omega/u_o$, where $u_o =$ electron velocity.

However, if while the electron is in the field-free region between A and B, the field at B reverses $2n$ times, the electron, on arriving at B will be unaware of this, and will still interact with the field that it

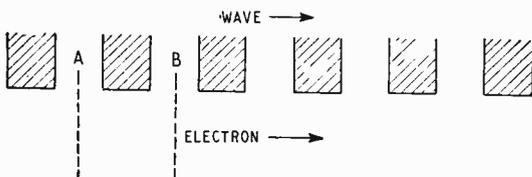


Fig. 5. Space-harmonic interaction.

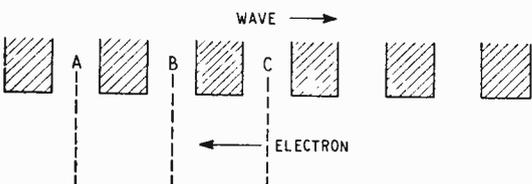


Fig. 6. Backward-wave interaction.

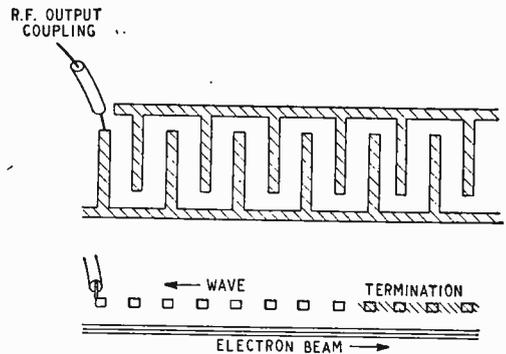


Fig. 7. Interdigital line backward-wave oscillator.

finds at B, since this is just the same field that it met in the synchronous case. If originally the transit time was t_o , the transit time will now be $t_o + nT$ where $T =$ period of r.f., i.e.

$$t_n = t_o + \frac{2\pi n}{\omega}$$

The velocity will therefore be

$$u_n = \frac{p}{t_o + \frac{2\pi n}{\omega}} \quad (p = \text{pitch of circuit})$$

$$= \frac{p}{\frac{p}{u_o} + \frac{2\pi n}{\omega}}$$

Hence β_n , which $= \frac{\omega}{u_n} = \frac{\omega}{p} \left(\frac{p}{u_o} + \frac{2\pi n}{\omega} \right)$

$$\text{i.e. } \beta_n = \beta_o + \frac{2\pi n}{p}$$

This describes interaction between the n th forward space-harmonic, and would lead to broadband amplification somewhat as in the case of the fundamental.

Backward-wave Interaction.—Let us now consider interaction between a beam and a wave travelling in the opposite direction. Using still a similar circuit conception, but considering an electron now moving in the opposite direction as in Fig. 6, we see that as before, if the electron moves at a velocity such that it sees a similar field at each gap, interaction will take place. There is here, however, an important difference, since the wave has its group velocity in a direction opposite to that of the beam. Electrons crossing the gap B cause the wave amplitude at B to increase. This increase propagates to C where a still further increase occurs, and thus we have a wave increasing in the opposite direction to that of the beam velocity. Since the amplified wave interacts with the beam, which then increases the wave further back along the circuit, if the beam current is large enough and the interacting length long enough, oscillation will occur, being initiated by r.f. noise in the beam which is always present at all frequencies. Moreover, this oscillation will occur at a frequency which will depend on the beam velocity, i.e. on the beam voltage, thus giving a voltage-tuned oscillator. Such a device is called a backward-wave oscillator (B.W.O.), and consists therefore of a circuit propagating a wave having a phase velocity in the opposite direction to its group velocity, coupled to an external circuit at the beam

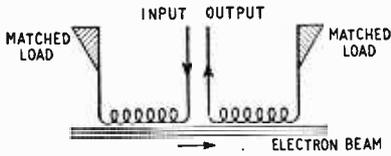


Fig. 8. Cascade backward-wave amplifier.

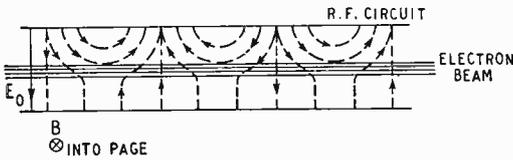


Fig. 9. Crossed-field interaction.

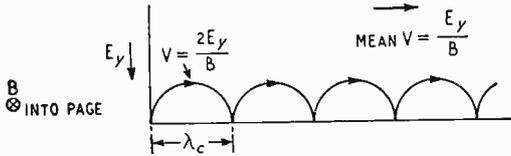


Fig. 10. Electron motion in crossed fields.

injection end, and terminated in a matched load at the other end. The most frequently employed circuit is the interdigital line used in conjunction with a strip beam as in Fig. 7. The helix also can be used as a backward-wave oscillator circuit, but usually the oscillation frequency is much higher than the frequency which the helix would be used to amplify. As the velocity of the helix beam is increased, however, these two frequencies approach each other, and at a velocity corresponding to a beam voltage of about 10kV they become equal. Any high-power amplifier would operate at a beam current far in excess of the start-oscillation current, hence such a valve would turn out to be a backward wave oscillator. This seriously limits the maximum powers which can be obtained from helix-type amplifiers.

If the beam current is insufficiently large, or the circuit too short, oscillation will not occur. An input coupling can be added to the other end of the circuit and we obtain instead amplification over a narrow frequency band, whose centre frequency is again determined by the beam voltage. This thus gives a selective voltage-tuned amplifier. Clearly the gain that can be obtained without oscillation will be limited. It may however be increased by the use of successive circuits, in a cascade backward-wave amplifier, depicted in Fig. 8.

A single circuit B.W. amplifier may run at say 0.9 of the oscillation starting current. This can give a useful gain, but with a very limited bandwidth. If the current is reduced, the bandwidth may be improved at the expense of gain. Using two circuits, it is possible to obtain satisfactory gain at about 0.8 of the starting current, hence giving an improved bandwidth, e.g. 10 dB with a few tens of Mc/s at S-band (around 3,000 Mc/s).

Crossed-field Valves ("M"-type) with Linear Injection.—In the O-type valves, the efficiency is limited by the fact that only kinetic energy can be extracted from the electrons and that the process of efficient bunching is limited by the increase of space-charge repulsion. These limitations are avoided in crossed-field valves, in which potential energy is

interchanged, and in which the r.f. bunching is formed by displacement of the beam without causing an increase in space-charge density.

In the simplest type of crossed-field valve, as shown in Fig. 9, there is an r.f. slow-wave circuit and a linear (parallel) electron beam is injected into the interaction region from a separate electron gun. Over the entire beam, and over the entire region of interaction, there is a static electric field E_0 between the r.f. circuit and another conductor, and a static magnetic field B at right angles to both the electric field and the direction of motion. Strip beams are usually employed, since it is convenient to use an interacting region of rectangular cross-section. The r.f. electric fields produced by the circuit are then of the form shown by the dotted lines in Fig. 9.

As is well known, an electron starting from rest under the action of crossed electric and magnetic fields follows a cycloidal path as shown in Fig. 10 in which the period of each cycloid is $2\pi/\eta B = 2\pi/\omega_c$ (where $\eta = e/m$ and B is the magnetic field) and in which the mean velocity $V = E_0/B$ where E_0 is the electric field. The distance covered in each cycloid due to the r.f. field E_{\sim} is therefore

$$\lambda_c = \frac{E_{\sim}}{B} \cdot \frac{2\pi}{\omega_c}$$

Comparing this with the r.f. wavelength λ_g , $\lambda_g = V \frac{2\pi}{\omega}$

$$\text{i.e. } \lambda_g = \frac{E_0}{B} \cdot \frac{2\pi}{\omega}$$

They are in the ratio

$$\frac{\lambda_c}{\lambda_g} = \frac{E_{\sim}}{E_0} \cdot \frac{\omega}{\omega_c}$$

In a typical device, ω_c is of the same order as ω , but the r.f. field E_{\sim} is many times smaller than the d.c. field E_0 . The resultant electron motion is therefore at right angles to the total electric field, in a series of small cycloids.

To see how the gain mechanism occurs, consider again motion in crossed continuous fields (Fig. 10). Electrons move with a mean velocity E_y/B in cycloidal paths in a direction normal to both E_y and B . No mean work is done by the E field over any complete number of cycles, since the total electron displac-

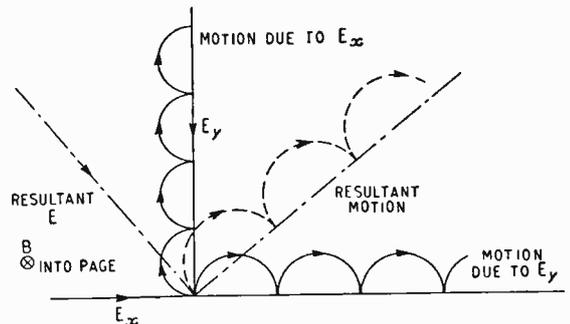


Fig. 11. Electron motion in combined crossed fields.

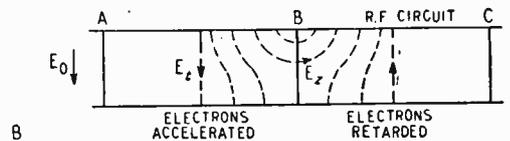


Fig. 12. Bunching mechanism in crossed-field valves.

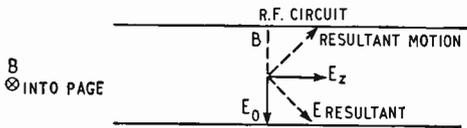


Fig. 13. Effect of axial fields in crossed-field valves.

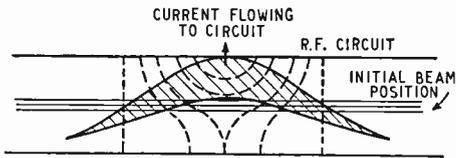


Fig. 14. Displacement of beam in crossed-field interaction.

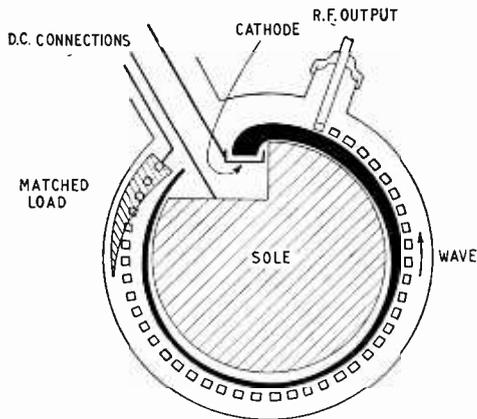


Fig. 15. Crossed-field backward-wave oscillator.

ment in the direction of the field is zero. Consider now the addition of another field component E_x , (see Fig. 11). This by itself will produce net motion in the y direction, at a mean velocity E_y/B . These motions will of course add vectorially to produce net motion at right angles to the total field $\vec{E}_x + \vec{E}_y$ and the resultant motion will be as shown in Fig. 11.

The electron has, however, fallen through the additional potential $E_y \cdot y$ and hence an additional amount of work $e E_y \cdot y$ has been done on it by E_y . It has also moved a distance x against the force $e E_x$, and has therefore given an amount of energy $e E_x \cdot x$ to the field E_x .

If both E_y and E_x are components of the same steady field E , then $x/y = E_y/E_x$. Hence the total energy interchange is $e(E_y \cdot y - E_x \cdot x) = 0$, as we should expect.

If, however, E_y and E_x are supplied by different sources, energy is absorbed from one and given up to the other, and the electron acts as a sort of pivot to allow the interchange to take place.

Let us now return to the situation in a crossed-field valve. The r.f. field can everywhere be resolved into transverse and axial components E_t and E_z and in addition we have the steady transverse field E_0 (Fig. 12).

The mean axial electron velocity is always $E/B = (E_0 + E_z)/B$. Therefore in the region AB, the electron velocities are increased, while in the region BC, where E_t is in the opposite direction to E_0 , they are reduced. All the electrons in this whole

moving region AC will thus gradually move towards the plane B, i.e., r.f. bunching will occur.

Now consider the axial r.f. field component E_z (Fig. 13). The mean electron axial velocity $u_0 = E_0/B$ is changed in both magnitude and direction to $u = (\vec{E}_0 + \vec{E}_z)/B$. The electrons again absorb energy from one component of the total field, E_0 , and give it up to the other, E_z , and this process continues until the electrons finally arrive at the r.f. circuit, as shown in Fig. 14.

Summarising, the electrons are formed into bunches axially by the transverse r.f. field components, and at the same time displaced transversely by the axial field components. The beam therefore becomes displaced, as in Fig. 14.

Crossed-field Backward-wave Oscillator.—This valve is the best known of linear-injection (parallel-beam) crossed-field valves. Like its O-type counterpart it has a beam which interacts with a wave having a phase velocity in the opposite direction to its group velocity, and is therefore a voltage-tuned oscillator. The usual arrangement is as shown in Fig. 15. The curving of the axis is done to minimize the weight of the magnet.

Space-charge Amplification—Diocotron Effect. Even if no r.f. circuit is present, amplification can occur in an electron beam under the action of crossed fields. To see how this occurs, we observe first that a thin sheet of electrons is unstable. If we consider a layer of electrons, all repelling each other, as in Fig. 16, initially the electron at A is in equilibrium due to the forces on it from the other electrons. If, however, it is displaced to A', these forces no longer balance, and it will be accelerated away from the sheet.

Now consider a thin sheet beam in crossed E and H fields, slightly perturbed by some r.f. disturbance. Its initial position is shown dotted in Fig. 17 and it is perturbed to the position shown by the full lines. The space-charge forces at the points A and B will be as shown by the full arrows, and because of the action of the crossed fields, the resultant motions will be as shown by the dotted arrows. There will therefore be an increase in charge density between A and B.

Next, consider a beam in which an r.f. disturbance to the charge density has arisen, as shown in Fig. 18. Due to the increased charge density at C, there will

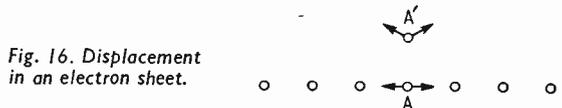


Fig. 16. Displacement in an electron sheet.

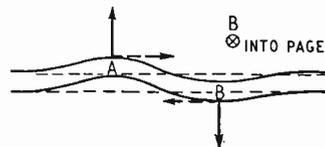
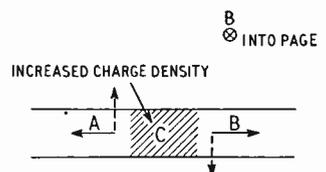


Fig. 17. Effect of r.f. disturbance on a sheet beam in crossed fields.

Fig. 18. Effect of charge perturbation in a sheet beam in crossed fields.

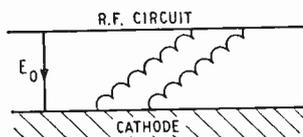


be forces as shown by the full arrows acting on the electrons at A and B, and this will result as previously in motion as shown by the dotted arrows, giving the situation shown in Fig. 17.

Thus it is seen that any displacement perturbation will cause a charge perturbation, which will then increase the displacement perturbation still further, thus leading to a growing wave. Now perturbations are always present at all frequencies in the form of noise, and hence a crossed-field amplifier always acts as a noise amplifier, even without a slow-wave circuit. This limits its maximum useful r.f. gain, and crossed-field devices are principally used as high-power oscillators, or high-power low-gain output amplifiers.

Continuous-injection Crossed-field Valves.—Perhaps the most severe limitation of linear-injection (parallel-beam) valves is the difficulty of designing electron guns with large cathode areas. The maximum current and therefore the maximum r.f. power obtainable is thus limited. However, it is possible to have the cathode at one side of the entire length of the interaction space, supplying electrons as fast as they are removed by the r.f. circuit, as in Fig. 19.

This is, of course, done in the magnetron, which we now recognize as a crossed-field travelling-wave oscillator. Since the circuit is now re-entrant the magnetron will oscillate whether the interaction is



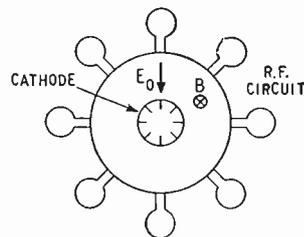
Left: Fig. 19. Continuous-injection cathode.

Below: Fig. 20. Magnetron.

with a forward or a backward wave.

There are also other types of travelling-wave microwave valves, but the "O" and "M" types cover the great majority of the valves now in use.

In the past, travelling-wave valves have found their main applications in radar and communication systems, and perhaps this will continue to be so, but increasing use is now being made of the much more refined performance offered by modern designs. Microwave television and telephone links, tropospheric scatter systems, aircraft navigation and approach systems, missile guidance and control systems and road traffic speed control are but a few of the increasing number of fields of application of such valves.



Commercial Literature

High-Vacuum Equipment including rotary and diffusion pumps, equipment which protects against power supply failures and leaks, solderless couplings, Pirani gauges and Geisler discharge tube pressure indicators. Booklet available from N.G.N. Electrical, Accrington, Lancs.

Regulated Power Supplies giving d.c. outputs from 200V to 400V with 6.3-V a.c. outputs from separate transformers (to avoid effects of d.c. load variations). Stability is 0.02% for $\pm 10\%$ mains change; ripple less than 1mV. Details of the range and prices in a leaflet from Brandenburg, 139 Sanderstead Road, South Croydon, Surrey.

Resistors, fixed and variable; a catalogue giving very complete details of the whole range, and including rotary switches, resistive coated strips, resistive "pills" and ignition suppressors. A price list is included. From Morganite Resistors, Bede Trading Estate, Jarrow, Co. Durham.

Time Calibrator, an electronic instrument producing a crystal-controlled train of marker pulses at intervals of 0.5, 1, 5, 10, 50, 100, 500 and 1,000 microseconds, for checking timebase generators, pulse lengths, etc. Specification on a leaflet from Cawkell Research and Electronics, Scotts Road, Southall, Middlesex.

Storage Oscilloscope using a 5-inch Memotron tube with "infinite persistence" to avoid the need for photographic recording. Writing speed is better than 8 μ sec/cm. Trace erasure, by push-button or automatic means, takes less than 0.2sec. Two identical Y channels have a sensitivity of 10mV/cm to 30V/cm and a bandwidth of 0-1Mc/s. Technical details on a leaflet from The Solartron Electronic Group, Thames Ditton, Surrey.

Transistor Portable Superhet for m.w. and l.w., a design using six Edison Mazda transistors and a germanium diode, delivering an output of over 200mW, with a mean sensitivity of 90 μ V/m for 5mW output. A ferrite rod aerial is used, and the total weight, excluding cabinet, is 3 $\frac{1}{2}$ lb. Described in a 20-page Application Report from Siemens Edison Swan, Radio Division, 155 Charing Cross Road, London, W.C.2.

Waveform Sampling Unit called the Nanoscope is an attachment for oscilloscopes which allows fast repetitive waveforms of a few millimicroseconds duration to be displayed on an ordinary c.r.o. with a bandwidth not exceeding 50kc/s. Principle was described in the March, 1959, issue

(p. 131). Described in a leaflet from Lion Electronic Developments, Hanworth Trading Estate, Hampton Road, Feltham, Middlesex.

Epoxy Resin Adhesives, a useful booklet showing how to use Araldite for joining various materials. A table lists the materials and indicates which type of Araldite to use and whether any preliminary treatment is required. Another chart gives the properties of the various resins in the range. From CIBA (A.R.L.), Duxford, Cambridge.

Moisture Meters, based on a capacitor detecting element with a hygroscopic dielectric and capable of indicating 1 part in 10⁶ of water vapour in dry air or gas. Response time: 1 second. Illustrated leaflet giving details of a large range of instruments from Shaw Moisture Meters, 31 Market Street, Bradford, Yorks.

Independent-Sideband Transmitter, designed for simplicity of operation and operation in operation. Any one of four spot frequencies in the range 2-20Mc/s can be selected readily by an unskilled operator. Output is 250 or 350 watts (peak envelope power) into 50 Ω unbalanced coaxial feeder. Technical summary on a leaflet from Marconi's Wireless Telegraph Company, Chelmsford, Essex.

Portable Audiometer for pure tone threshold measurement by air and bone conduction, with a range of 125-8,000c/s. A filtered white noise masking generator provides seven separate noise bands for each test tone used, and each noise band has a width of $\pm 5\%$ of the tone frequency. Described in a folder from Amplivox, Beresford Avenue, Wembley, Middlesex.

Precision Helical Potentiometers, three-turn and ten-turn types, with maximum values between 40k Ω and 500k Ω . They have positive end stops and can be supplied with various bearings and mountings. Linearity is $\pm 0.3\%$ and resistance tolerance 3%. Leaflets from General Controls, 13/15 Bowlers Croft, Honeywood Road, Basildon, Essex.

Hall-Effect Devices, mainly probes for detecting and measuring magnetic fields, but also including modulators and multipliers. An informative catalogue, including a section on the principles and construction of the devices, from Siemens and Halske (Germany), through the U.K. distributors, R. H. Cole (Overseas), 2 Caxton Street, London, S.W.1. Also a leaflet on **Semiconductor Photoelectric Devices** of high sensitivity to light.

Words, Words, Words

By P. P. ECKERSLEY, M.I.E.E., F.I.R.E.

Polonius: What do you read, my Lord?

Hamlet: Words, words, words.

"FORCE, Energy, Power, whatever you like to call it"—thus a practical man explaining a practical invention. There seemed to be a considerable scope for making a choice, but the need for a knowledge of fundamentals in doing so.

Those who might smile tolerantly at the practical man's naiveté, do they always use the right word in the right place? I doubt it and it is my purpose to call attention to some of the solecisms of common usage—and, likely as not, when pointing the sins of others, I shall commit like ones myself. I hope so; the subject needs ventilating.

The accusation of pedantry coming from those whose work depends upon accuracy of concept and execution has a hollow sound. The excuse for abuse that "you know what I mean" neglects those, new to some aspect of technology, who do not.

And now for some examples. Circumstances have lately determined that I should become familiar with electro-mechanical relays. A newcomer, I was surprised to find a general use of the term contact pressure instead of contact force. "Fifty million so and so's can't be wrong!" The point is that normally they are; in this case although "everybody uses it" everybody is wrong. Need I add that pressure is determined by area—and that the area of a contact can vary by thousands of times?

I recently attended a lecture on d.c. amplifiers and listened, with growing astonishment, to an exposition which associated—indeed stressed—the characteristic of "bandwidth" in relation to "d.c." So soon as the cognoscenti had contributed to the discussion I sprang to my feet, asking to be put out of my misery—I said that I had hitherto associated zero frequency with direct current now it seemed that a d.c. amplifier was also an a.c. amplifier—why?

"I suppose," said the lecturer, "that you would expect zero bandwidth." Falling into the trap I said "Yes" and rebuked myself for so doing. An amplifier with zero bandwidth would, of course, never respond to any change of input; I did, however, ask why it was necessary to provide any wider frequency response than would ensure a reasonable build-up time.

The answer, which perhaps many readers know, is that a so-called d.c. amplifier is designed to amplify pulses, i.e. waves in which the rate of change of amplitude over a considerable time period may be zero, but also very rapid over short ones. Why cannot we use the term "d.c.-a.c. amplifier" to describe a device which has to amplify both d.c. and a.c.?

It would be quite possible that anyone discussing the performance of "d.c. amplifiers" would have said that they had to amplify "square waves." Here

is another inaccuracy, a better term would be "rectangular waves."

An affectionate recollection is an old friend (B.A.Cantab.) talking about "Ohm's Law for Alternating Current." To my inquisition "Tell me, what is this Law, what's its nature—indeed its virtue?" the simple reply was "You know, $I = E / \sqrt{R^2 + X^2}$." We now learn that in fact Ohm never postulated a law and that if he had it would not have been one. We are, I think, more concerned here with the interpretation of the word "law" than any question of confusion between impedance and resistance. The O.E.D. defines a "natural law" as a "correct statement of invariable sequence between specified conditions and specified phenomenon" and gives examples such as "the laws of motion, three propositions formulated by Newton"—I cannot help adding that forty or more years ago I (Certificate of Technology, Manchester) always referred to "Ohm's Law for alternating current." "If age could do and youth but knew."

Overworking the Bel

The Bel is very elegant, but, like the third person singular, it wants watching. If, basing our calculations on voltage or (less likely) on current ratios, we say that an amplifier has a gain of so and so many dB and if we know the input and output resistance no one can cavil. If however the input resistance is that of the grid to ground resistance of a valve when worked in class A connection there can be some indefiniteness about "dB gain." In my submission the right way to define the input resistance of an amplifier, when the grid to ground circuit is not shunted by a resistor of known value (and therefore is very large or, as some say "infinite") is to say that it is equal to the internal resistance of the source which generates the input voltage. We then postulate an optimum input power matching, even though it may not exist, only in this way have we any right to speak of power gain. The gain, using input volts to represent power, as is too often wrongly done, will seem to be 6dB greater than the real power gain with the postulated matching at the input.

All this may seem pedantic—it probably is—but so-called pedantry is the only recourse when terms are defined accurately and used carelessly.

A much-respected author of a textbook on radio furnishes us with a glaring example of this carelessness when he publishes a graph showing the gain in current (by cancelling inductive by capacitive reactance) on a scale of decibels. If the gain had been expressed in nepers, a unit which is, by definition, based on a ratio of currents, no one could object.

There does seem to be a modern tendency to enlarge the scope of the decibel: what we seem to lack is an offspring of the neper, with a base of 10 rather than e , when we should be able to express gains on a logarithmic scale but in terms of voltage

and current without the confusion that power too often introduces.

Great fun may be had with detection and demodulation. My authority (B.S.I. 204:1943) deprecates either "Demodulator" or "Rectifier" for "Detector"—the latter, says the Glossary, is "a device, having non-linear conducting characteristics, used for detection."

I should have thought that there is, in fact, a distinction between a detector and a demodulator. While the detector has "non-linear conducting characteristics" the demodulator essentially has not; it involves a modulator in association with an oscillator (or at any rate demands a source of oscillations) to make it function. The process of disentangling information from the carrier which bears it can be consummated either by a detector or by a re-modulation of the carrier (by a so-called demodulator) and agreeable as it is to deprecate confusion between the processes it is surely right to make a distinction between them when each has the same end product.

The term modulator is defined by B.S.I., not very bravely, as "a device for producing modulation" and modulation is defined, very generally, as "the process by which the amplitude, frequency or phase of a carrier wave is modified in accordance with the characteristics of a signal." The significant word here is "signal," meaning, one supposes, the electrical equivalent of some intelligence that is required to be transmitted or, as some say, "modulated on" to a carrier. On the other hand, there is a usage, in line transmission, which embraces the term "group modulation." The process of group modulation adds or subtracts a constant frequency to or from the several carriers of a group of channels of communication, it is therefore basically a method for frequency changing and yet it is characterised as modulation. We know that modulation does in fact produce a change of frequency and so it is possible to look upon carrier transmission as, at the sender (not transmitter), a means to add a constant carrier frequency to the audio frequencies representing the intelligence and, at the receiver, means to subtract it (by detection or demodulation).

Thus transmission involves frequency changing and frequency changing involves modulation! It is also a pet hobby of mine to demonstrate that the action of a detector can be simulated by modulating the carrier by a rectangular wave of unit amplitude.

The only serious criticism relevant to this aspect of terminology is the use of the term group modulation instead of group frequency-changing or something of the sort.

Rearguard Losses

I greatly admire the efforts of those who serve the B.S.I.; they are the standard bearers of a regiment fighting a rearguard action in defence of logical terminology against the ponderous army of lazies who prefer abusage and cite usage as their support.

"Habit," said Wellington, "is ten times nature." The lazy lie back on their comfortable cushions. "I've always called it that and I don't care if it is illogical; you know what I mean."

There is no need to despair. For instance, 50 years ago we called the receptacle for an electric charge a capacity or, worse, a condenser; now, except in proper names remembering the past, all but the belligerently conservative call it a capacitor. The

same goes for resistor and inductor. I have yet to hear of the "impedor"; rearguards inevitably suffer their losses.

A friend and colleague, who like myself is sometimes described as pompous when it comes to terminology, seldom misses an opportunity to favour "transconductance" rather than the accepted "mutual conductance." What, he asks, is mutual about it? On the other hand B.S.I. defines "mutual conductance" as "the control-grid to anode transconductance" . . . leaving this writer a little puzzled. Would my friend define transconductance as the control-grid to anode mutual conductance? I must ask him.

Another jihad (jihad I am now instructed) which he eloquently fights is against the term space-factor as applied to windings of insulated conductors. "Copper factor," says my friend, "it points the term with far more precision." I have remarked that we do happen to wind insulated resistance wire on bobbins. Perhaps "conductor factor" or "metal factor" would therefore be more to my friend's point.

Do you, gentle reader, plot a graph or a curve? I think you ought to plot a graph otherwise a straight line becomes a curve! Many refer to an oscillograph when it is not making a graph and an oscilloscope when, plotting a graph, the trace may be invisible.

Ionic Wanderers

I must say I defend the term valve, most of all when it is "hard." Of course the word valve has many meanings, for instance it is "one of the halves or sections of a dehiscent pod, pericarp or capsule (1760)," but in a less esoteric category, it is "that which controls the flow of vapours or liquids" so why not that which controls the flow of electricity? Tube! Pooh!

But I doubt "thermionic," certainly the cathode is hot but does it emit ions or if it does are these what are chiefly present? I was taught to believe that while "ion" is "neut. part. of *eimi*, to go," it also has an association with a wanderer. An Ionian was a "member of part of the Hellenic race which occupied Attica, Western Asia Minor, etc." I sense movement of tribes as inquisitive wandering rather than purposive going. So if ions are wanderers and surely electrons, rushing down a potential gradient cannot be classified as such; their movements, once escaped from a space charge, are purposeful; even their bunching is controlled, few are in a condition to wander.

My purpose has been to cite a few examples where usage is either cruel to logic or murders it. There are many more examples, for instance binaural (I always listen to my loudspeaker with both ears), shot noise (it is an effect not a noise), resistance coupling (not so good for a.c. amplification without an associated capacitor), volume control (when used instead of gain control), potentiometer (which measures nothing), mixer (which sounds culinary but is too often a synonym for a frequency changer) the term constant (when coefficient is usual) envelope (when bulb is less pompous) frequency distortion (how do you distort a frequency?) electronic relay (the term relay belongs to electro-mechanics, the similarity to, for instance, a thyatron is too remote)—and so on and so forth.

I ask for short terms which read as directly as possible on to the concept, or the devices which they

describe. Most of my examples have been concerned with devices; it will be perhaps of some interest to examine some terms of a less concrete, more abstract nature.

With the Editor's consent I will live dangerously and dare to consider the term "wireless". I must condemn its general use (and therefore range myself for once with a majority) but welcome its continuance when forming part of a proper name. Contrary to the implications of the dictum that "a rose by any other name would smell as sweet" I believe the world would lose a very proper name if "wireless" were divorced from it. The same sentiment attaches to the name of a famous company. Names are in a different category from technical terms, they have ancestry, they are property, they preserve tradition and therefore support history.

Picture Broadcasting

A certain dubiety about using the word television to define picture broadcasting arises from an anticipation of a semantic embarrassment (a truly "precious" sentence!). What name shall we give to it when we can see as well as hear through the telephone? Telegraph, telephone, television—these are names describing a logical evolution of line and radio communication. We do not however describe sound broadcasting as "telephone": why is picture broadcasting called "television"? It would be a quixotic task to attempt to do away with the term television (and its degradation to "the Telly") and I doubt if it will concern me personally when, many years hence, one subscriber to the telephone service may see another when speaking to him (notably her) but, always seeking logical terminology, I am concerned with another defiance of it.

How I dislike the compressions, but I can be sure that the utilitarians will justify their uglies. A product now has "manufacturability," a picture "viewability" (why not fightability or boxability for the man with a fast right hand?) Mocking laughter would doubtless be the only comment on a suggestion that a product was "susceptible to manufacture," that a picture had some particular quality which the lazy writer hides under an ugly compendium word which might just as well be "good" for all it says. For an example of a different nature the hideous plural of spectrum as spectrums is not only a barbarism but offends the modern compulsion to shorten—it has two more letters in it than spectra. But what's the good of being an angry old man? Perhaps jargon is a necessity to those whose minds are crammed full of facts.

I propose now to discuss the art and practice of writing, meaning putting thoughts into sentences which are both clear and concise.

I say (with fear of contradiction) that it is the poet who reaches the heart of the matter more surely than any philosopher, ideologue, or man of science ever does or did. It would be altogether unfair to my thesis to interpret it as denying value to prose writers and thinkers who with their disparate styles and contrasting idioms have contributed so much. I still maintain that the penetration to the heart of the matter is more illuminatingly discovered, more concisely expressed when the poet speaks. In an attempt to lower technical eyebrows let me explain by example. Read Pope's Essay on Criticism, and take as an observation relevant to my text about accuracy

of expression that "a little learning is a dangerous thing"; *learning*, be it clear, not, as so often misquoted, knowledge. It is the little learning, badly digested and sickeningly regurgitated which offends. Again when the poet wrote that

"The strongest poison even known
Came from Caesar's laurel crown"

was not this the heart of the matter, concentrated into two lines of verse?

What saner outlook upon the evils and joys of drinking than Chesterton's.

"Good drink that is dishonoured by the
drunkards of the town"?

And in the admirable example in the lines which follow the dictum about the dangers of a little learning

"Drink deep, or taste not the Pierian spring.
There shallow draughts intoxicate the brain,
And drinking largely sobers us again."

It would be possible to multiply examples page by page but let a simple story suffice. A young man was taken to see Hamlet. Asked what he thought of it he replied, "Not much, it's full of quotations."

Only the "pale cast of thought," the evil of thinking divorced from sensibility can, and probably will, attempt to deny the truth of what I so confidently preach.

The false deduction from my argument that I want all technical writing done in verse would be as silly as it would be unfair. What I am driving at is to ask technical people to take an interest—a deeper interest unfortunately than some modern education permits—in the humanities, in literature, in poetry; because not only will they thereby find more numerous sources of enjoyment but also, when they write about their discoveries, inventions, or the more pedestrian accounts of laboratory experience, they will do it better and enjoy doing it more. The exemplar for any writer is the poet, for, in the final issue, he goes to the heart of the matter, he expresses himself concisely, and his compression gives his words a pungency which for ever preserves them.

I must say, in passing, that I mean by "poet" one whose works are or will be immortal and not one who, for fear that someone will discover the barrenness of his mind or heart, hides all meaning behind a thick shrubbery of words.

Faraday's "Researches"

There is, in the sense I am trying to express, a poetic quality behind for instance Faraday's "Experimental Researches in Electricity." Here is the proud humility of genius, simply and nobly expressed. I think students of science and technology should be made to commit paragraphs of it to mind and so to heart. Notably those Victorians who studied "natural philosophy" (which was the synonym for what we now call science) always wrote well; some wrote excellently; all of them had an education which embraced the arts; many of them could be described as cultured.

Without wanting even to seem to sneer I would wish that more of those who are growing up to be engineers, scientists, technicians (what you will) were given a better opportunity to study, understand and enjoy the humanities. For it is my conviction that not only would the style of technical writing be improved by more familiarity with the humanities;

but also the value of the work, about which reports might be written.

I sympathize with those who find difficulty in explaining their ideas and observations in writing. Many who excel in talking seem to be overcome by self-consciousness when it comes to the grim business of putting thoughts on paper. There are, of course, cases where a plethora of speech disguises a "little learning" and when writing reveals a vacuum, and other cases where the hand which holds the pen becomes either paralysed or overstimulated. Did I hear a whisper?

The first principle in writing technical reports is simplicity; the first sin, prancing. Simplicity says "the cat sat on the mat," prancing might say "a member of the feline species, classified among the small mammals, took up a recumbently characteristic position upon the fibrous and movable floor covering." A second principle is order, meaning the logical development of the story from its basic simplicities to its more complex aspects and so to a clearly expressed conclusion. For instance, signposting the way for a development report, I would suggest this order, namely, objective, methods of achieving the objective, difficulties encountered, the outcome, and so a conclusion.

I have used the word prancing to describe what is to me an altogether abhorrent style of writing. Rather than attempt precisely to define what I mean by the term I will give an almost perfect example of it. The writer is concerned with an explanation of why a thermistor does not produce amplitude distortion in alternating currents flowing through it; he writes:—

"Now the current arising from the application of an e.m.f. *if allowed to flow long enough* (the writer's italics) will cause a change (of) resistance and therefore voltage/current ratio. By a process of confused thought this change is often adduced as a reason for saying that the device is a non-linear resistor, but, in the interests of clarity, this error should be avoided."

Here is a pawky sentence, smarmed over with tautology, that ends up (by "a process of confused

thought") in arriving at a totally wrong conclusion. Maybe it's just forgivable to get all superior when you are right, it's damnable to prance publicly when you are all wrong.

It is, however, not so easy to explain the action of the thermistor simply, but a good exercise to try. In attempting the difficulty we might say that the resistance of a transistor varies markedly with its temperature and hence with the amplitude of a current flowing through it. However, the mass of material comprised by a thermistor is large enough to prevent its resistance from following rapid changes of current amplitude. Thus when the currents passed through a transistor are alternating the resistance of the device attains a mean value and therefore does not cause sensible waveform distortion; albeit a thermistor is properly classified as a non-linear resistor.

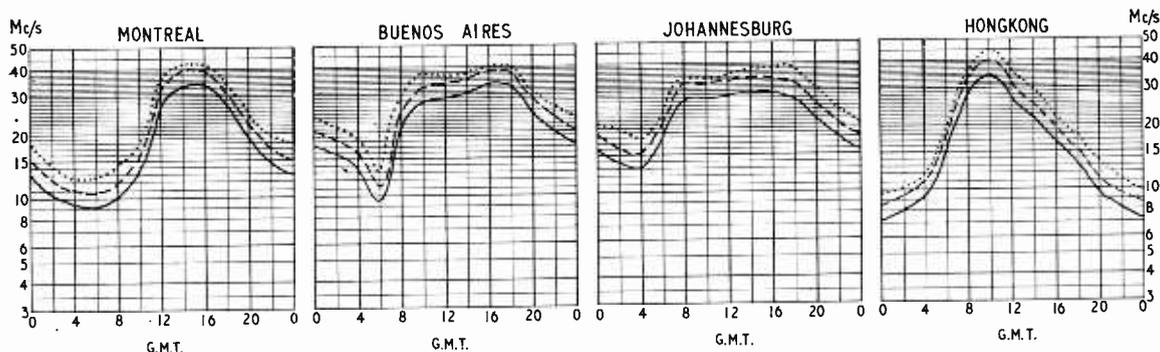
My objection to the original, apart from its sneer at those who "often adduce" a reason for saying what is in fact true, is that it combines tautology with pretentiousness; we do know the relationship between resistance and the voltage/current ratio and generally speaking there is no need to talk down to us.

But when all's said and done, writing, be it of *belle-lettres* or technical reports, is beset with difficulties. Someone described it as "chipping words out of one's breast bone"; the sharper the pen the more painful the process. It is the very fact of its difficulty which makes the practice of writing so fascinating, so worth while. Moreover, as many have discovered and many more will discover, the business of attempting to write a description of a technical process, a device, a discovery, or whatever often proves to the writer that he may not understand the subject he is forced to write about as clearly as he thought he did.

Coming to an end of this preaching and reading over what has been written leaves me with the usual dissatisfactions. If I have, here and there, given to any one reader the desire to do well what, without false modesty, I feel I do not do well enough, then perhaps a labour of love is not lost.

SHORT-WAVE CONDITIONS

Prediction for November



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 November.

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

- FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME
- PREDICTED MEDIAN STANDARD MAXIMUM USABLE FREQUENCY
- FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS

WORLD OF WIRELESS

Public Radio-Telephone Service

THIS country's first mobile radio-telephone service linking suitably equipped cars with the public telephone system was inaugurated by the new Postmaster General, Mr. Reginald Bevins, on October 28th. Initially the pilot scheme is limited to cars operating in the southern half of Lancashire, the Wirral and parts of north Cheshire. These areas are covered by two base stations, one at Liverpool and the other near the I.T.A. television station at Winter Hill, near Horwich.

The service is conducted on five channels around 160 Mc/s with a 50-kc/s separation. One channel is used for calling, for which a loudspeaker is fitted in the receiver. The conversations are conducted on one of the remaining four channels; the exchange operator advising the occupier of the vehicle to which he should switch, depending on the position of the car in relation to the two stations. Frequency modulation is used and the standards employed are those adopted for the v.h.f. maritime services—a maximum deviation of ± 15 kc/s, pre-emphasis and de-emphasis of 6dB per octave within the band 300-3,000c/s and frequency tolerances of ± 2 kc/s for the base station and ± 3 kc/s for the mobile station.

Transmitters and receivers for the base stations have been supplied by Pye, whose mobile equipment, Type PTC8205, has received Post Office approval for fitting into vehicles. The car installation costs £195, or it can be rented at 30s a week. The Post Office licence for the "Radiophone" service, as it is called, is £7 10s a quarter. A three-minute call costs 2s 6d.

Technical Training

IT has become the tradition for the new president of the Institution of Electrical Engineers to review in his inaugural address the sphere of industry with which he has been most closely associated. The new president, Sir Willis Jackson, who, to use his own words, "is identified with the preparation of young people for careers in electrical engineering," did not depart from this practice at his installation on October 9th, and took for his subject "The making of professional engineers." Having first reviewed the contribution made by schools, universities and colleges to the education of technologists, Sir Willis went on to discuss the shortage of industrial training facilities which has become "the Achilles' heel of our national plans for the further development of technological and technical education."

In the past comparatively few firms have "had the foresight to provide training facilities," but "responsibility for training the increasingly large national pool of technologists and, no less important, of technicians and craftsmen" cannot continue to be carried by these few firms. Sir Willis stressed once again that this problem could be solved only if the smaller and more specialized firms will collaborate in the organization of group schemes in which their limited individual resources are properly co-ordinated.

B.B.C. Annual Report

REFERENCE is again made in the annual report of the B.B.C.*—as it was last year—to "the very serious threat to television reception in Band I" which the continued expansion of forward-scatter services represents. The interference is particularly bad in areas served by stations operating in Channel 1. Guidance has been given by the B.B.C. to dealers on methods of reducing the effect of the interference which depends to some extent on the design of the receiver, and the attention of set manufacturers has been drawn to this point.

The 161-page report covers most aspects of the Corporation's work and administration. Here are some points:—

A total of 26,689 schools (about 71% of the country's total) were registered as listening to school broadcasts in the year under review.

The Corporation's income from licence fees increased by over £2M to £27,323,115 and its net revenue from publications rose to £1.14M.

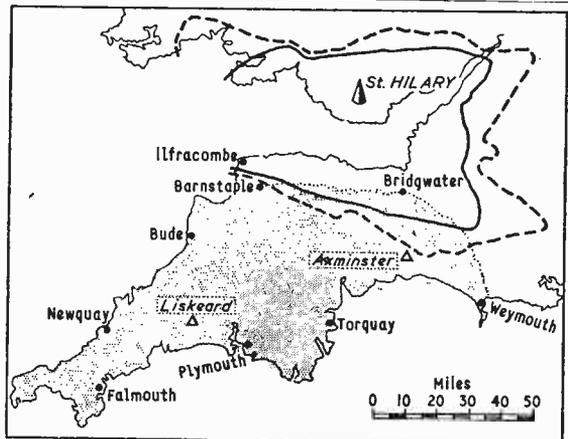
Of the £7.29M expenditure under "engineering" for the national sound and television services £4.62M was for television—an increase of £0.75M during the year.

Rental paid to the Post Office for lines exceeded £1M.

* "Annual Report and Accounts of the B.B.C. 1958-59" Cmnd. 834, H.M.S.O. 8s.

Broadcasting in Kenya

SINCE 1931 the broadcasting service in Kenya has been conducted by Cable and Wireless and its predecessor Imperial and International Communications. The 25-year charter held by Cable and Wire-



ESTIMATED SERVICE AREA of the two I.T.A. stations which will serve the south-west of England is shown (shaded) in relation to the primary and secondary service areas of the St. Hilary station. The two stations, one near Axminster and the other near Liskeard, will be operated jointly by one programme contractor. They are planned to be in service early in 1961.

less, which was extended for a further three years, expired on September 30th and the Kenya Broadcasting Service set up by the Kenya Government came into operation the following day. The director of broadcasting is C. P. Jubb and the chief engineer Graham Phillips, both seconded from the B.B.C.

Four new 10-kW transmitters at the main transmitting station at Langata, near Nairobi, have been supplied by Marconi's—two for operation in the m.f. band and two in the h.f. band. The service also uses a number of existing transmitters at Mombasa, Kisumu and Nyeri, which have been transferred from Cable and Wireless.

Test Card C.—Since our correspondent, K. Dice, wrote his letter (see page 507) referring to "Diallist's" recent plea for more test card transmissions, the B.B.C. and I.T.A. have announced a new schedule. This provides that at any time during the morning trade tests from 10.0 to 1.0 a Test Card C will be available from one or other of the two stations (B.B.C. or I.T.A.) serving an area.

I.T.A. Northern Ireland television transmitter at Black Mountain, outside Belfast, was brought into service on October 31st. It operates in channel 9 using horizontal polarization. The directional aerial on the 750-ft mast is nearly 1700ft above sea level and gives an e.r.p. of from 20 to 100kW according to direction. Ulster Television Ltd. are the programme contractors for the station which has been equipped by Marconi's.

E.I.B.A.—Among the donors listed in the annual report of the Electrical Industries Benevolent Association are the Radio Industries Club (London and Manchester), the B.B.C., British Radio Equipment Manufacturers' Association; British Radio Valve Manufacturers' Association; Electronic Engineering Association; Radio and Electronic Component Manufacturers' Federation and many firms in the radio and electronics industry. During the past twelve years the number of people helped by the Association has grown almost ten times and last year totalled 2,392.

University College of North Wales' Department of Electrical Engineering has taken over a new building in Bangor. The present head of the department, which was until last year known as the Dept. of Electrical Engineering, is Professor M. R. Gavin. Power engineering and hydro-electricity, as such, have largely disappeared from the course which is at present being taken by 70 students. The new building can accommodate 120 students.

Press Communications.—The Army Wireless Reserve Squadron, formed some years ago to recruit those interested in radio communication for part-time training as operators and technicians, has a new name. It is in future to be known as 404 Signal Squadron AER (Press Communications). Details of the training are obtainable from Capt. J. A. Bladon (G3FDU), 28 Jack Lane, Davenham, Northwich, Cheshire.

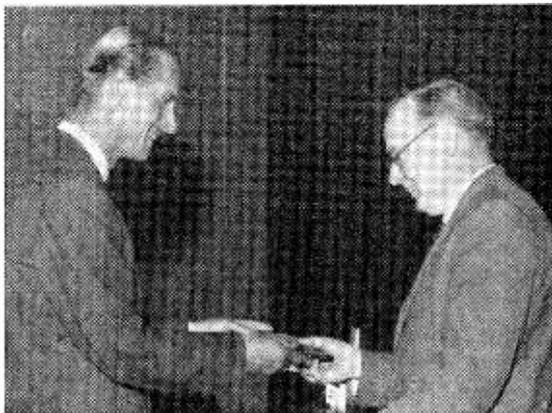
Receiving Licences.—Combined television and sound licences in the U.K. increased by 90,815 during September, bringing the total to 9,718,472. Sound-only licences totalled 5,199,421, including 405,732 for car radio.

Ekco Lightweight Radar.—The weight of the new E190 airborne search radar was incorrectly quoted in our review of the S.B.A.C. Exhibition, Farnborough (p. 431, October issue). The correct weight of this set is only 56 lb.

Mullard Films.—Three more Mullard films—"Modern magnetic materials," "The manufacture of junction transistors," and "The junction transistor in radio receivers"—have been added to the list of films available free from the Central Film Library of the Central Office of Information, Government Building, Bromyard Avenue, Acton, London, W.3.

Gold Medal of the Institute of Navigation for 1959 has been presented to J. E. Clegg, for the development in this country of the Doppler system of air navigation.

The Institute's citation records that "The originality, drive and foresight of Clegg has been the major factor in putting the Royal Air Force ahead in the installation of Doppler equipment in operational aircraft." Mr. Clegg, who was at one time at T.R.E. (now R.R.E.), went to Australia in 1952 to join the Weapons Research Establishment of the Australian Department of Supply, Salisbury, where he is now superintendent of the Trials Division.



H.R.H. The Duke of Edinburgh presenting the Institute of Navigation's gold medal to J. E. Clegg at the Institute's annual meeting on October 22nd.

Institute of Navigation.—Although the Institute records in its annual report for 1958/59 a continued small increase in membership bringing the total to 1,755, the Council appeals for a substantial increase so that it can "acquire the stability which its work demands." The honorary membership of the Institute has been granted to Sir Robert Watson-Watt, who was president in 1949/50. J. Wikkenhauser, chief development engineer of Kelvin and Hughes, is among the five members elected into Fellowship.

Microwave Radio Links.—A colloquium on microwave communication, arranged by the Hungarian Academy of Sciences and the Scientific Society on Telecommunication, opens in Budapest on November 10th for four days.

Australian Television.—On November 2nd, Queensland's first non-commercial television station—operated by the Australian Broadcasting Commission in Brisbane—was brought into service. The State now has three transmitters, two commercial stations having opened in Brisbane in the last few months. The estimated population within the station's service areas is about 700 000. Australia now has eleven television stations—eight commercial and three national.

Educational Wallchart.—The latest wallchart issued by the Mullard Educational Service is entitled "The Television Picture Tube." It illustrates the principle and construction of the cathode-ray tube and shows how the electron beam is formed, focused and deflected. The coloured chart, which measures 43in by 30in, is available to educational establishments free of charge from the Mullard Educational Service, Mullard House, Torrington Place, London, W.C.1.

International Study Groups.—The titles of two of the U.K. study groups listed in the note on the work of the C.C.I.R. on page 432 of our October issue were inadvertently transposed. The title of Study Group IV, of which Dr. R. L. Smith-Rose is chairman, is space vehicles, and that of Study Group V, of which Dr. J. A. Saxton is chairman, is groundwave and tropospheric propagation.

Personalities

Professor R. L. Russell, D.Sc., who has succeeded **Professor J. C. Prescott, D.Eng., M.I.E.E.**, in the Chair of Electrical Engineering at King's College, Newcastle upon Tyne, had been on the staff of the University of Bristol since 1946. For the past four years he has been reader in electrical engineering. In 1938 he graduated in mathematics at the University of Leeds, from which he received the degree of D.Sc. earlier this year. Soon after graduating he joined the Admiralty Degaussing Department and then for a few years was lecturer on radio, first at the Royal College of Science and Technology, Glasgow, and later at Robert Gordon's Technical College, Aberdeen. Immediately prior to going to Bristol in 1946 Dr. Russell was in the research department of B.T.H. at Rugby.

P. D. Canning, of the Plessey Company, has been appointed chairman of a new sub-committee (12-7) formed by the International Electrotechnical Commission (C.E.I.) to deal with climatic and durability testing of telecommunications equipment. He recently led the U.K. delegation to Ulm, in Western Germany, for similar sub-committees on electronic components, and also acted as secretary of sub-committee (40-5) on basic testing procedures for electronic components. The C.E.I., with its headquarters in Geneva, is affiliated to the International Organization for Standardization, its main object being to facilitate the co-ordination and unification of electrotechnical standards.



P. D. Canning.



R. C. McCormick.

R. C. McCormick, B.A., M.Sc., has joined Airtech Ltd., of Haddenham, Bucks, as chief electronics engineer. After graduating with first class honours in experimental physics from Dublin University in 1949, he was employed as assistant engineer in the Department of Posts and Telegraphs, Ireland. He later joined Mullard Research Laboratories to work in the line communications section. Immediately prior to joining Airtech Ltd., he was with Ultra's special products division as executive engineer.

Bernard R. Greenhead, who joined A.B.C. Television, the I.T.A. programme contractors, as technical controller in June, 1958, from Alpha Television Studios, Birmingham, has become general manager of Iris Productions Ltd., an A.B.C. associated company concerned with the production of TV programmes. He started his career as a research engineer in television and radar with E.M.I. Ltd. before the war. He joined the B.B.C. in 1950 and in 1956 went to Alpha Television Studios, Birmingham. Mr. Greenhead is a director of the London Video-Tape Recording Centre.

A. N. Christmas, superintendent of the Armament Research and Development Establishment of the Ministry of Supply at Fort Halstead, Kent, since 1954, has been appointed Director, Guided Weapons Research and Development (Techniques). Mr. Christmas, who received a first class honours degree in electrical engineering from London University in 1935, joined the Government service in 1937 as an assistant engineer with the G.P.O. In 1946 he went to the Royal Aircraft Establishment's Guided Weapons Department, to work on control systems for beam-riding missiles. In 1951 he was appointed to the British Joint Services Mission in Washington, U.S.A.

D. J. E. Ingram, M.A., D.Phil., reader in the Electronics Department of the University of Southampton since 1957, has been appointed Professor of Physics at the University College of North Staffordshire. Dr. Ingram, who is 32, was for three years demonstrator in the Clarendon Laboratory, Oxford, before joining the staff of the University of Southampton in 1952. He is author of the book "Spectroscopy at Radio and Microwave Frequencies" (Butterworth).

The appointment of the following three new directors to the board is announced by Ferranti Ltd.:—

E. Grundy, O.B.E., B.Sc.Tech.(Hons.), M.I.E.E., who is 53, joined the company's Instrument Department in 1921 and has been general manager of the Moston factory since 1949;

J. Prince, M.I.E.E., 56, who joined Ferranti's from Salford Electrical Instruments in 1926, was appointed chief engineer of the Meter Department in 1935 and has been manager of the department since 1939; and

O. M. Robson, M.A., M.I.E.E., 56, who after coming down from Cambridge joined Ferranti's in 1925, serving in Transformer Designs and since 1944 has been general sales manager.

M. L. Whelan, M.A., Ph.D.(Cantab.), of the Crystallographic Laboratory, Cavendish Laboratory, Cambridge, has been awarded a Royal Society Research Fellowship to carry out investigations of metals by transmission electron microscopy at the Department of Physics, Cavendish Laboratory.

R. Linton is appointed engineer-in-charge of the B.B.C.'s new television and v.h.f. sound transmitting station near Peterborough, which was brought into service on October 5th. He joined the B.B.C. in 1943 as a maintenance engineer at the short-wave transmitting station at Daventry, becoming an instructor in the Engineering Training Department in 1946. For the past eleven years he has served at a number of the Corporation's high-power transmitting stations including Holme Moss and Sutton Coldfield.

C. Glover, until recently sales manager of the United Insulator Division of the Telegraph Condenser Co., has been appointed general manager of the division. The new sales manager is **B. E. J. Honey**, who was with the R. H. Symonds Group of Companies for thirteen years.

J. E. Green has joined General Controls Ltd., of Basildon, Essex, as chief development engineer. He will be engaged on the development of the range of precision potentiometers to be manufactured in this country. They will be similar to those produced by the parent company in the U.S.A. Until recently Mr. Green was with Taylor Controls Ltd., of Walthamstow.

F. W. Newell, who joined the Marconi Marine Company as a sea-going radio officer in 1940 and for the past three years has been an inspector, has been appointed marine manager of the Brazilian associate company, Companhia Marconi Brasileira. He is now residing in Rio de Janeiro.

C. G. Hutchinson is appointed general sales manager of Data Recording Instrument Co. Ltd., an associate company of International Computers & Tabulators Ltd.

J. Reginald Bevins, M.P., the new Postmaster-General, entered Parliament in 1950 as member for Toxteth (Liverpool) which he still represents. For two years, 1951 to 1953, he was Parliamentary Private Secretary to Mr. Macmillan and was Parliamentary Secretary, Ministry of Housing and Local Government, in the last Government. He is 51. The new assistant P.M.G. is Miss Mervyn Pike, M.P., member for Melton.

R. J. Halsey, C.M.G., B.Sc.(Eng.), F.C.G.I., D.I.C., M.I.E.E., who, as announced in our last issue, has been appointed a director of Cable and Wireless Ltd., is well-known for his work on the planning and engineering of the first transatlantic telephone cable. He was made Director of Research in the Post Office last



R. J. Halsey

year, and will continue in this position. After five years' apprenticeship at Portsmouth Dockyard he won a Royal Scholarship to the City and Guilds College, London, and took an honours degree in engineering in London University in 1925. Two years later, at the age of 25, he entered the engineering department of the Post Office and was posted to the Research Station at Dollis Hill. In 1947 he became head of the line transmission division and in 1953 was appointed an assistant engineer-in-chief.

OUR AUTHORS

J. G. Spencer, author of the article describing the application of a new type of f.m. limiter and discriminator, joined the Research Department of the B.B.C. in 1946. Much of his work since then has been concerned with frequency modulation, commencing with the early laboratory and field tests which preceded the establishment of the v.h.f. service.

C. H. Dix, B.Sc., A.M.I.E.E., contributor of the article on travelling-wave tubes in this issue, has been on the staff of the G.E.C. Research Laboratories since 1951 and, for the past five years, leader of the travelling-wave tube group. He served for five years in the Royal Signals before going to London University, where he took B.Sc. general and special physics degrees in 1950 and 1951, gaining first-class honours in both.

D. E. O'N. Waddington, who describes a transistor stopwatch on page 521, came to this country from South Africa in 1957, since when he has been an electrical design engineer with Marconi Instruments. Two years before coming to this country he joined Marconi (South Africa), Ltd., at Baragwanath. He is 29.

J. Skinner, author of the article on page 509 describing a simplified method of transformer testing, is manager, electronics and transformer production, at Radford Electronics Ltd., of Bristol, where the system he describes is in use. He joined the company in 1955.

OBITUARY

Dr. Balthazar van der Pol, director of the International Radio Consultative Committee (C.C.I.R.) from its formation in 1948 until 1956, died on October 6th at the age of 70. Dr. van der Pol, who was born in Utrecht, spent three years in this country during the First World War studying under Fleming at London University and J. J. Thomson at Cambridge. From 1922 until his C.C.I.R. appointment he was director of research at Philips, Eindhoven, and for the last ten years of his service with Philips he was also Professor of Theoretical Electricity in the Technical University, Delft. In 1952 he was awarded the Valdemar Poulsen gold medal by the Danish Academy of Technical Sciences for his theoretical and practical work on the propagation of radio waves. In a tribute to his work on his retirement from the C.C.I.R., the *Journal of the International Telecommunication Union* emphasized that "as a man of science he could conceive of no frontiers . . . as an international official he systematically overlooked the nationality of the technical experts he had occasion to meet and treated them exclusively as scientists and engineers with whom ideas and information could be exchanged."

News from the Industry

Cossor.—The Marquess of Exeter, in his report as chairman of A. C. Cossor Ltd., said that the elimination of Cossor Radio and Television Ltd. as a subsidiary has had a marked effect on the accounts for the year ended last March. They show a group profit after taxation of £139,411 compared with a loss of £37,134 the previous year. He concluded: "We have cut out, not without cost, the main source of the unsatisfactory position of the group in recent times. The result has been a comparatively successful year."

Pye.—The report of the directors of Pye Ltd., and its subsidiaries records a trading profit for the year ended last March of £2,834,841 and a profit before taxation of £1,885,423. The consolidated profit of £945,128 after taxation is some £150,000 above the previous year's figure.

Gas Purification and Chemical Co., of which Grundig, Wolsey and A.B. Metal Products are among the subsidiaries, had a net group surplus during the past year of £505,336 before taxation. The year's surplus of £296,876 after deducting all charges has been set against the previous year's deficit of £469,392, which leaves a deficit of £172,516 to be recovered.

Radio and Television Trust Ltd., of which Airmec is the manufacturing subsidiary, announce a profit for the fifteen-months ended in June of £138,482 before taxation. This was about £34,000 up on the previous year's profit. As announced last month, the controlling interest in the company has been disposed of by Crompton Parkinson Ltd., and it has been acquired by D. D. Prens, of Truvox.

Hagan Controls Ltd. has been formed jointly by Plessey Ltd., who hold 90% of the shares, and Hagan Chemicals and Controls Inc. of Pittsburgh, Pa. The company which is operating from Ilford, Essex, has the manufacturing and selling rights in Great Britain and the Commonwealth (except Canada) for the entire range of Hagan automatic control equipment for the maintenance of physical conditions within given tolerances, and "Cybernetes" data processing equipment.

Plessey Products Directory lists all the products manufactured by the Plessey group of companies alphabetically and also under the division or associated company manufacturing them. The directory also gives the location of the various manufacturing units and laboratories.

Nash & Thompson Ltd. are now the exclusive selling agents in the U.K. and the Commonwealth for KOVO, the foreign trade corporation for the import and export of precision engineering products made in Czechoslovakia. Among the instruments that will be imported into the U.K. for the first time are the Polaroscope and Polarographs designed at Professor Heyrovsky's Research Institute in Prague. Other apparatus includes the Tesla B.S.242 intermediate electron microscope, telecommunication equipment, spectrophotometers and electrolytic analysis apparatus.

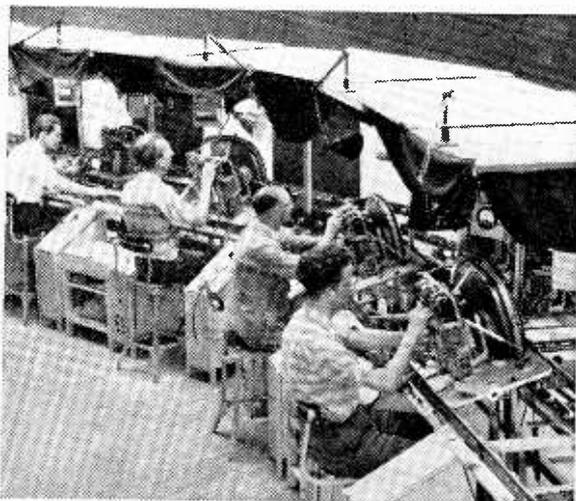
Beam-Echo International Ltd., with offices at 820 Greenwich Street, New York 14, has been formed by H. M. Rahmer, managing director and founder of Beam-Echo Ltd. Mr. Rahmer is vice-president of the American company, of which Michael Muckley, a Canadian, is president. New showrooms for demonstrating Beam-Echo equipment were recently opened in London at 8 Eccleston Street, S.W.1.

Irish magnetic recording tape, which is manufactured by ORRadio Industries Inc., of Opelika, Alabama, U.S.A., is now available in this country from Wilmex Ltd., who have been appointed sole concessionaires for the U.K. Their address is: 131 Sloane Street, London, S.W.1 (Tel.: Sloane 0621).

Gate Electronics Ltd. have moved from Hackney, London, to a new factory at Maylands Avenue, Hemel Hempstead, Herts. (Tel.: Boxmoor 6464.) They are manufacturers of the Gate telephone answering machine and television distribution amplifiers and produce a number of different types of tape recorder for various companies.

Hursant Electronics Ltd., of 13-14 The Mall, Ealing, London, W.5, has been formed by D. C. Adams and R. C. Lever, until recently, respectively, sales manager and chief engineer of Hivolt Ltd. The company is initially producing a range of sub-assemblies for building up a wide variety of high- and low-voltage supply units.

Hall Electric Ltd., exporters of receiving, transmitting and special valves, have moved to new premises at Haltron House, Anglers Lane, Kentish Town, London, N.W.5 (Tel.: Gulliver 8531). The new premises will enable them to increase their present stock of over 3,000 different types of valves.



TAILOR-MADE gravity conveyors constructed from Dexion slotted angle and "Glidewheel's" are being used on the television receiver assembly line at the Southend-on-Sea factory of E. K. Cole Ltd.

Levell Electronics Ltd., consulting and manufacturing electronic engineers, have moved from Edgware, Middlesex, to 10-12 St. Albans Road, Barnet, Herts. (Tel.: Barnet 5028).

EXPORT NEWS

Signal Generators.—A second contract for the supply of telecommunication measurement equipment has been placed with Marconi Instruments by the Canadian Department of Defence Production. The order is for 123 a.m. signal generators type TF 801D which will be used in the maintenance of ground-to-air v.h.f. multi-channel equipment of the Royal Canadian Air Force.

A 4MeV linear accelerator for X-ray treatment of deep-seated tumours is being built by Mullard Equipment Ltd., for the Cancer Institute Board of Victoria, Australia. Valued at £60,000 it will be installed at the Board's Peter MacCallum Clinic in Melbourne in the middle of next year. This will be the fourth medical linear accelerator to be built by the Company, and the first to be exported.

Radar Defence System.—Contracts for the design and supply of the electronic equipment valued at approximately £1.5M for Sweden's new air defence system, have been awarded to Marconi's. The system has been evolved by Marconi's in collaboration with the Swedish Air Force. Security forbids a detailed description but it is known that the heart of the system is a very high-speed computer which solves a large number of interception problems simultaneously.

Airborne search radar equipment has been ordered from Ekco for use in two de Havilland Comet 4B jet airliners of Olympic Airways of Greece.

Shock Mounts.—Cementation (Muffelite) Limited, manufacturers of anti-vibration and shock control equipment, have received a £5,000 order from Australia for the supply of Barrymount shock mounts for signals equipment fitted to military vehicles.

"**British Design,**" a display of nearly 500 U.K. products, being staged in Copenhagen from November 20th to 29th, includes some radio and sound reproducing equipment. Among the items to be shown are an amplifier and "Transhailer" by Pye, radio tuner units by Acoustical Manufacturing and Jason and a Cossor record player.

Aviation Transmitters.—A £55,000 contract for 37 transmitters for beacons and communication services at Yugoslavian airports, has been placed with Redifon.

CLUB NEWS

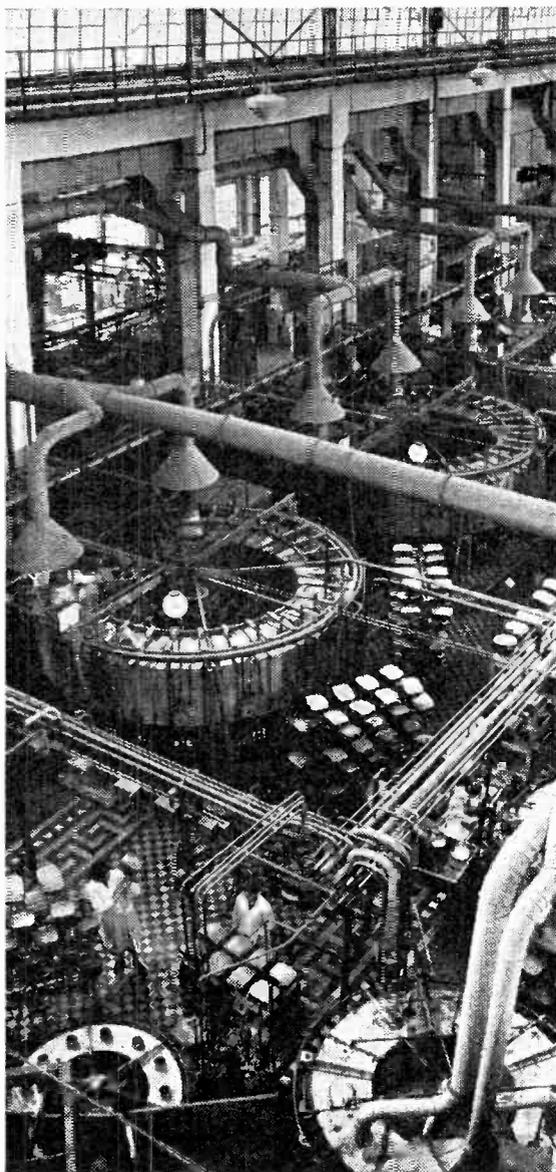
Bexleyheath.—The history, development and manufacturing techniques of the Avometer will be described by J. A. Thomas (Avo) at the meeting of the North Kent Radio Society on November 12th. A fortnight later A. O. Milne (G2MI) will deal with the work of the International Amateur Radio Union. Meetings are held at 8.0 at the Congregational Hall, Bexleyheath.

Reading.—A description and demonstration of modern oscilloscopes will be given to members of the Calcot Radio Society on November 19th by E. D. Taylor of Solartron. On December 10th S. Woodward will give a demonstration lecture comparing mono and stereo sound reproduction. Meetings are held at 7.45 at St. Birinus Church Hall, Calcot, Reading.

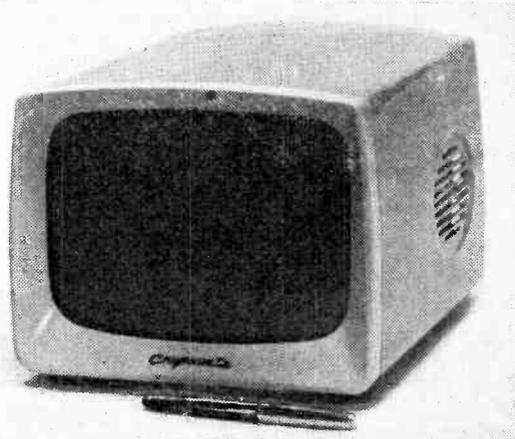
Wellingborough.—"Aspects of Tape Recorders" is the title of the talk to be given by G. B. Shaw at the November 19th meeting of the Wellingborough and District Radio and Television Society. Meetings are held each Thursday at 7.30 at the Silver Street Club Room.

RUSSIAN TV PRODUCTION

SOME RECENT FACTS AND FIGURES



Cathode-ray tube production in the U.S.S.R. is typified by this photograph taken in one of the factories of the Moscow Electric Lamp Works.



The transistor receiver "Sputnik-2" has a 10-inch screen and weighs about 14lb. (Courtesy Brit.I.R.E. Journal.)

TRANSISTOR television sets are planned for mass production in the U.S.S.R. in 1961-62. For this purpose a 17-inch model has been developed which can be powered from batteries or the a.c. mains. The picture above shows a 10-inch model with 30 transistors, the "Sputnik-2," which was developed last year. It has a resolution of 500 lines and a sensitivity of $100\mu\text{V}$, and is intended to run from a 12-volt car battery.

Speaking at the Brit.I.R.E.'s Cambridge convention on television engineering, B. A. Berlin, of the U.S.S.R. State Committee for Radio Electronics, gave further information about the present production of valve receivers. In January of this year, he said, about 3M sets were in use in the Soviet Union. It is expected that 1.2M will be produced in 1959 and that by 1965 the annual output will be 3.5M. In six years' time a total of 18M sets should be in operation.

Manufacturing processes and circuit units are standardized in order to keep prices down and simplify servicing, and the public has a choice of three main classes of receiver. The first class are 21-inch high-quality sets, the second (and most popular) are 17-inch models, while the third are small cheap sets with screen sizes up to 14 inches. There are different cabinet designs within each class, and all first- and second-class models have f.m. sound reception. Small quantities of projection and extra high-quality receivers are also being produced. The last-mentioned sets incorporate sound receivers, tape recorders and record players.

Wide use is made of automatic control and stabilization circuits, and present development aims at introducing a.f.c. for tuners. Picture tubes have 70° deflection angles at present, but a transition to 110° tubes is due to take place this year.

On the transmitting side, the smaller towns are being equipped with 5kW e.r.p. stations and the larger ones with 50kW e.r.p. stations. In 1961 Moscow will have a new transmitter with a power of 200kW e.r.p. and a giant aerial about 1,400ft high. Translator equipments are used for the smallest towns and villages. Colour television development continues, and about 40% of transmission equipment is intended for this purpose.

Dynamic Limiter

By J. G. SPENCER*

This receiver was designed primarily to show that a low-cost receiver can be produced with the type of a.m.-rejection characteristics usually associated with expensive equipment. The limiter and discriminator section (from V3 anode to V4 triode grid) is eminently suitable for inclusion in new or existing f.m. receivers, where it will offer better performance than even the best ratio detector whilst not requiring the addition of extra i.f. stages or a separate limiter valve.

phase discriminator; L_1C_1 is a parallel resonant circuit across which is connected a voltage limiting device. The presence of this limiter makes the shunt impedance across L_1C_1 very low but if L_1 is loosely coupled to L_2 , the coupling acts as an impedance inverter and the discriminator is effectively fed from a high impedance source. Thus, although limiting is carried out at the voltage level of the discriminator, the two functions are independent and the presence of the limiter imposes no restrictions on the design of the discriminator.

The limiting device could take any one of several forms; one possibility is a biased diode which conducts when the peak i.f. voltage across L_1 exceeds the bias threshold. The limiter used here is based on the dynamic-diode type.⁴ It employs a diode in series with a load consisting of a resistor and capacitor in parallel, the time constant of the combination being longer than the period of the lowest audible frequency. With this arrangement, amplitude changes having a period shorter than the time constant are suppressed by variation of the loading on the limiter tuned circuit. When the signal increases in amplitude the diode-load voltage cannot change, so the diode current increases very sharply, with a resultant increase in the loading. Conversely, when the signal decreases in amplitude the diode tends to cut off, thus reducing the loading. One disadvantage of this type of limiter is that it gives no protection against a slow amplitude change whose period is

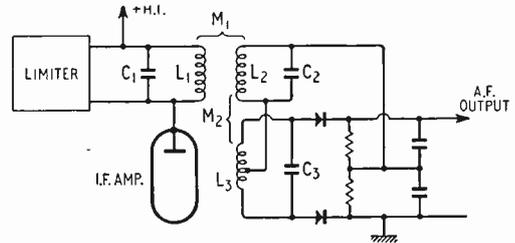


Fig. 2. Basic circuit of limiter and discriminator.

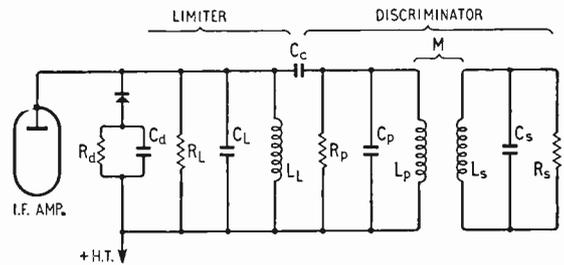


Fig. 3. Equivalent circuit of limiter and discriminator.

long compared with the diode-load time-constant; the load voltage follows the signal amplitude and the loading imposed by the diode circuit is constant.

This limitation has been overcome in the receiver described by using the voltage across the limiter-diode load for automatic gain control.

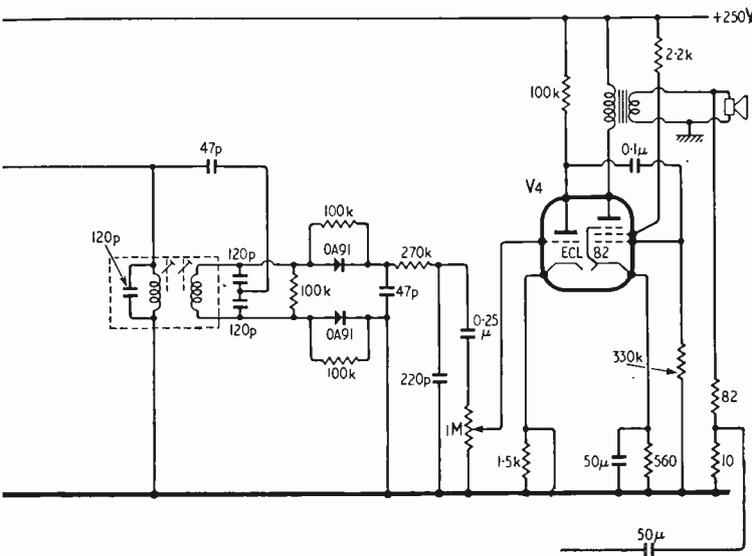
The practical design of the limiter can best be considered with reference to Fig. 3. The following symbols will be used; the remaining symbols given in Fig. 3. are self-explanatory.

$$Q_p = \frac{R_p}{\omega_o L_p} \quad k = \frac{M}{\sqrt{L_1 L_2}}$$

$$Q_s = \frac{R_s}{\omega_o L_s} \quad Q = \sqrt{Q_p Q_s}$$

where R_p = total shunt losses of discriminator primary, including diode loading; R_s = total shunt losses of discriminator secondary, including diode loading; R_L = total shunt losses of limiter tuned circuit, excluding loading due to limiter diode, and $\omega_o = 2\pi f_o$, where f_o is the intermediate frequency.

*B.B.C. Research Department.



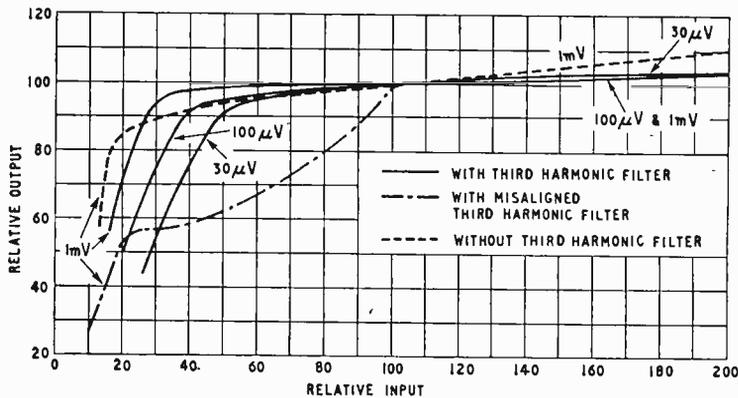


Fig. 4. Correct dynamic-limiter characteristics for various input levels and effect of mis-tuned harmonic filter (two-kneed curve) and absence of filter (dotted curve).

At the mid-band frequency the input impedance of the discriminator, i.e. the circuit to the right of C_c , is

$$R'_p = \frac{R_p}{1 + (kQ)^2}$$

The shunt impedance reflected into the limiter circuit at mid-band is therefore

$$R_o = \frac{X_c^2}{R'_p}$$

where $X_c = 1/\omega_0 C_c$. The resulting shunt impedance across which the limiter operates is

$$R'_L = \frac{R_L R_o}{R_L + R_o}$$

If we assume a rectification efficiency of 100% in the diode limiter, the effective shunt loading of the limiter circuit by the diode, with a constant amplitude input, is $R_d/2$. The ability of the limiter to cope with upwards modulation is virtually unlimited, but the maximum downwards modulation which can be dealt with is determined by the ratio between R'_L and $R_d/2$. In order to deal with a fractional depth of modulation m , we require that

$$R'_L \geq \frac{R_d}{2} \left(\frac{m}{1-m} \right)$$

If this condition is not fulfilled the limiter diode will cut off in the troughs of amplitude modulation and the input to the discriminator will not be stabilized over that part of the modulation cycle. It should be noted that when this occurs the discriminator diodes continue to function, in contrast to the ratio detector in which, if the maximum possible modulation depth is exceeded, the discriminator diodes are cut off over part of the modulation cycle.

Taking as typical values $R_d = 10 \text{ k}\Omega$, $R_L = 50 \text{ k}\Omega$, $R'_p = 2 \text{ k}\Omega$, $f_0 = 10.7 \text{ Mc/s}$, it follows that to achieve satisfactory amplitude modulation suppression for values of m up to 0.8, C_c is required to be 1.8 pF. The impedance reflected across the discriminator primary from the limiter circuit is X_c^2/R'_L , where R'_L is the effective dynamic impedance of the limiter and its load. Measurements indicate that R'_L is about 500 Ω , so that with the conditions specified $X_c^2/R'_L \approx 130 \text{ k}\Omega$. This is sufficiently high, compared with R'_p , to be negligible. As C_c is reduced, the downwards amplitude modulation depth which

can be dealt with is increased, but the discriminator slope is reduced; this parameter is therefore a compromise between overall gain and the depth of modulation that can be handled.

The limiter in the form shown in Fig. 3, with an OA86 crystal diode, gives an a.m. suppression ratio of some 30-35 dB; but if a parallel-tuned circuit, resonant at the frequency of the third harmonic of the i.f., is inserted in series with the limiter diode, a further increase in limiting efficiency is obtained. The action of this harmonic filter is to modify the shape of the current pulses through the diode in such a way that its effective dynamic impedance is reduced. The limiter circuit actually embodied

in the receiver differs from Fig. 3 in three respects:—

- (i) The third-harmonic filter is included.
- (ii) The limiter-circuit inductor is wound as a close-coupled transformer; this isolates the limiter from the h.t. line and permits the limiter load to be earthed, thus simplifying the provision of an a.g.c. voltage.
- (iii) A delay voltage is applied to the diode to improve the a.g.c. characteristic and hence the suppression of slow amplitude fluctuations.

Dynamic input/output curves of the limiter as embodied in the receiver, for input levels of 30 μV , 100 μV and 1 mV, are given in Fig. 4, together with the 1-mV curve of the basic limiter without the third-harmonic filter. All curves are normalized to the same operating point and the effective reduction of amplitude modulation by the limiter is shown by the ratio of the slope of the dynamic curve to that of the line passing through the origin and the operating point. These curves also demonstrate the reduced capacity to handle downwards modulation at low signal-input levels; this is due partly to the delay voltage applied to the limiter, and partly to the rise in the impedance of the diode at low currents.

Construction and Alignment of Limiter and Discriminator

Details of the construction of the coils in the limiter and discriminator circuits are given below. In all cases the cores used were Neosid Grade 900, Type 6 \times 1 \times 12.

Limiter Transformer: Neosid Type 5000A/6E former

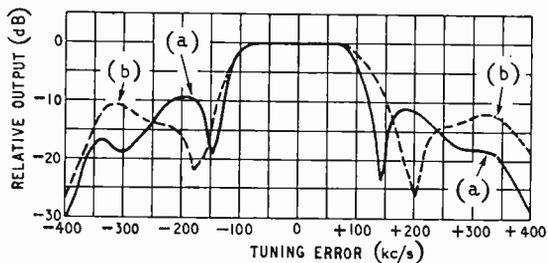


Fig. 5. Tuning characteristic with (a) narrow-band discriminator, (b) wide-band discriminator.

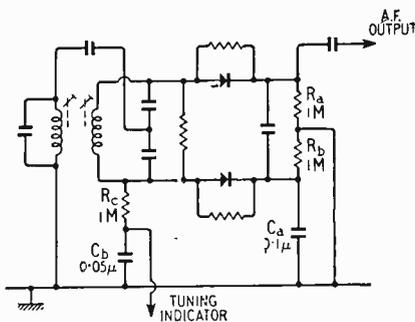


Fig. 6. Circuit modifications to obtain tuning indicator drive from discriminator.

(7.6 mm dia.). Two single-layer solenoids, each 50 turns 38 s.w.g. enamelled wire, close wound, one over the other and separated by one layer of cellulose tape. The external connections are arranged so that the low i.f. potential ends of the two windings are adjacent.

Third-harmonic Filter: Neosid Type 3500 former (7 mm dia.) 25 turns 38 s.w.g. enamelled wire, close wound.

Discriminator Transformer: Neosid Type 5000B/6E former (7.6 mm dia.) Primary: 15 turns 30 s.w.g. enamelled wire wound with 1/1 space ratio. Secondary: 20 turns 30 s.w.g. enamelled wire close wound. The space between adjacent ends of the primary and secondary windings is 6.5 mm.

Alignment of a limiter and discriminator of this type is most conveniently carried out in two stages. First, the third-harmonic filter is short-circuited and the limiter transformer tuned to the intermediate frequency by adjusting for the maximum d.c. voltage across the limiter load; the discriminator can then be aligned in the usual way. To give an oscilloscope display of the limiter input/output curve, the receiver is fed with a 100% amplitude-modulated signal and the Y input of the oscilloscope is connected through a suitable "isolating" resistor (minimum value, 100 kΩ) to one side of the discriminator transformer secondary, thus using one discriminator diode as an a.m. detector. The X input to the oscilloscope is obtained from the signal-generator modulating voltage. This will produce on the oscilloscope a limiter curve similar to those shown in Fig. 4. The short circuit is now removed from the third-harmonic filter and the final adjustment of the limiter-transformer tuning, harmonic-circuit tuning and limiter-to-discriminator coupling is made. The limiter transformer is tuned to obtain the maximum downwards limiting, the value attainable being determined by the limiter-to-discriminator coupling capacitance. The harmonic filter is tuned principally for maximum flatness of the top of the curve, that is, maximum a.m. suppression; but also to ensure maximum downward limiting. Thus it will be found that as the tuning inductance is increased from the optimum value the flat top of the dynamic curve begins to tilt, while if the inductance is reduced, the downward limiting threshold is raised. The adjustment is not unduly critical; a variation of some +20%–10% of inductance from the optimum could be tolerated in the prototype receiver without serious impairment of the limiter performance. Gross mis-tuning, however, causes a considerable deterioration, the effect of an increase

of inductance of 80% above the optimum value is shown in Fig. 4. Having set up the limiter, the discriminator tuning should be checked to complete the alignment.

Tuning the Receiver.—One difficulty in tuning an f.m. receiver is to distinguish between the side responses and the central response of the discriminator. If no tuning indicator is fitted it is essential, in order to avoid confusion, that these side responses are either sufficiently low in amplitude or are recognizable by their poor signal-to-noise ratio. Curve (a) of Fig. 5 gives the tuning characteristic of the receiver with an input signal of 1 mV, frequency modulated to ± 30 kc/s. If better suppression of the side responses is required, it may be obtained by increasing the discriminator bandwidth, and curve (b) shows the performance under the same input conditions with a discriminator having a peak separation of ± 200 kc/s. The use of the wider discriminator bandwidth entails a reduction of about 3 dB in adjacent-channel suppression and some loss of gain, but this may be thought justifiable for greater ease of tuning. A difficulty that remains, however, is that of obtaining the best tuning position within the central response.

A better approach to the problem of simplifying

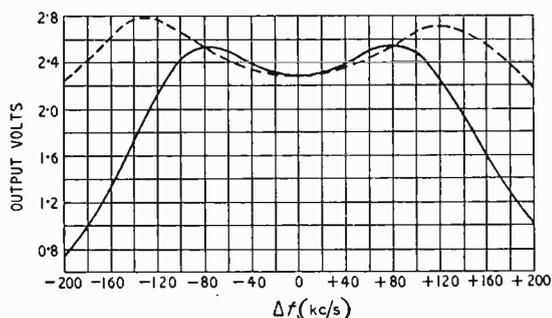


Fig. 7. Potential derived from discriminator to feed tuning indicator (solid line); 1mV constant input to receiver. Dotted line shows response of discriminator alone.

tuning is to provide some kind of indicating device, preferably one which shows the centre point of the discriminator response and is unaffected by the shape of the i.f. amplifier response.

With the normal phase-discriminator circuit the outputs of the two diodes are combined in such a way that a null-point indicator is required. It is possible, however, by making minor modifications to the circuit, to obtain a d.c. output from the discriminator which is suitable for operating a conventional "magic eye" tuning indicator. These modifications, shown in Fig. 6, involve the addition of three resistors, R_a , R_b , and R_c and two capacitors, C_a and C_b . The discriminator secondary circuit is now earthed to modulation frequencies by the capacitor C_a , but the d.c. earth is at the junction of R_a and R_b , with the result that a voltage equal to the mean of the rectified voltages across the two diode loads appears at the junction of R_c and C_b . The variation of this voltage with carrier frequency is shown in Fig. 7. The dip in the middle of the curve provides a precise indication of the centre of the discriminator response; because the discriminator is outside the a.g.c. loop,

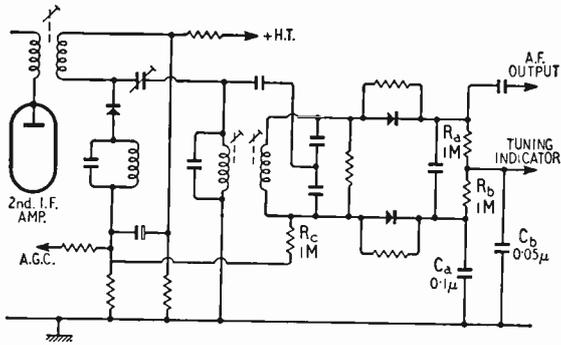


Fig. 8. Circuit modifications to obtain tuning-indicator drive from combination of a.g.c. and discriminator voltages.

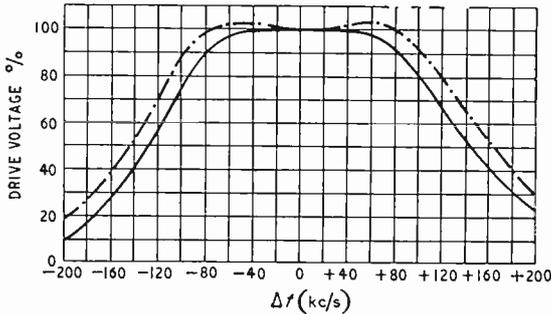


Fig. 9. Potential derived for tuning indicator from combined a.g.c. and discriminator action (solid line). The broken line represents a.g.c. voltage. Indicator drive voltage is relative to that at midband frequency.

while any variations in the i.f. amplifier response are compressed by the action of a.g.c., the accuracy of the indication is not greatly impaired by asymmetry of the i.f. response.

The disadvantage of this system is that it requires the user to adopt an unusual criterion in observing the tuning indicator. This can be overcome, at some sacrifice of accuracy, if the circuit is rearranged as shown in Fig. 8, with the lower end of the resistance R_c connected to the negative end of the limiter-diode load, and the tuning-indicator voltage obtained from the junction of R_a and R_b . With this arrangement the indicator is operated by the difference between the a.g.c. voltage and the discriminator mean voltage. The shape of the resultant curve is shown in Fig. 9; for comparison the curve of the a.g.c. voltage alone is also shown, normalized to the same amplitude at the tuning point.

Performance Tests

It should be noted that all ratios of signal to noise, hum or interference quoted were measured with a mean-square meter preceded by an aural-sensitivity weighting network based on the C.C.I.F. (1934) curve for broadcast-relay circuits.⁵ Unless otherwise

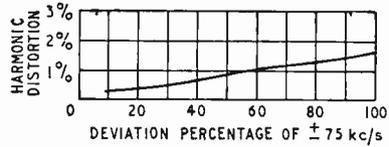


Fig. 10. Variation of harmonic distortion with deviation.

stated all signals levels refer to the open-circuit voltage from a 75- Ω source.

Absolute Sensitivity.—This is the minimum input-signal amplitude, deviated ± 35 kc/s at a frequency of 2000 c/s, which will produce an output of 50 mW with the receiver gain control at maximum. The measured value was $8\mu\text{V}$.

Maximum Deviation Sensitivity for 10% Harmonic Distortion.—This is the minimum input-signal amplitude, deviated ± 75 kc/s at a frequency of 400 c/s, which produces a total harmonic distortion of 10% or, if that figure is less than the input required to satisfy the previous test, the distortion occurring at the absolute sensitivity input level. The distortion at $8\mu\text{V}$ input level was 5%.

Sensitivity for Standard Signal-to-Noise Ratio.—This is the minimum input signal amplitude, deviated ± 35 kc/s at a frequency of 2,000 c/s, which will produce an output signal-to-noise ratio of 40 dB. The measured value was 10 μV .

Variation of Harmonic Distortion with Deviation.—Fig. 10 shows the total harmonic distortion as a function of deviation with the receiver gain control set to give 50 mW output with ± 30 kc/s deviation at 400 c/s. The input signal level was 10 mV.

Maximum Output Power for 10% Total Harmonic Distortion.—The measured value was 1.5 watts.

Modulation-frequency Characteristic.—After correction for a 50 μsec pre-emphasis time-constant, the response relative to that at 400 c/s was within the limits ± 1 dB from 30 c/s to 15 kc/s.

Selectivity.—The suppression ratio for an interfering signal is measured objectively as the ratio of unwanted-to-wanted signal amplitudes giving an output signal-to-interference ratio of 40 dB when the interfering signal is frequency modulated at 2,000 c/s with a deviation of ± 35 kc/s. The results for adjacent-, second- and third-channel interference (i.e. with 200, 400 and 600 kc/s frequency separations respectively) are given in Table 1, together with the measured ratio for the image channel. The wanted-carrier level in each case was 1 mV.

For comparison with the figures in Table 1, the measured frequency response curves of the i.f. amplifier and discriminator are shown in Figs. 11 and 12.

Local-oscillator Drift.—Local-oscillator drift was found to be comparable with that of the discriminator: the relative drift of local oscillator and discriminator (that is the change of input-signal frequency required to maintain zero d.c. output from the discriminator) was steady at about 30 kc/s after one hour from

TABLE 1

Frequency of unwanted carrier, relative to wanted carrier	-21.4 Mc/s	-600 kc/s	-400 kc/s	-200 kc/s	+200 kc/s	+400 kc/s	+600 kc/s
Ratio of unwanted to wanted-carrier levels (dB)	+28	> +40	+35	+6	+5	+34	> +40

switching on. Maximum drift was about 38 kc/s, occurring at about 8 minutes from the switching-on.

Local-oscillator Radiation.—In this test the voltage at the input terminals of the receiver due to the local oscillator was measured, the input terminals being terminated in 75 ohms.

The measured voltage was 1.7 mV.

Co-channel Suppression Ratio.—As for the test of selectivity, but with the interfering signal frequency differing from the wanted signal by less than 1 kc/s. The measured value was -6.5 dB.

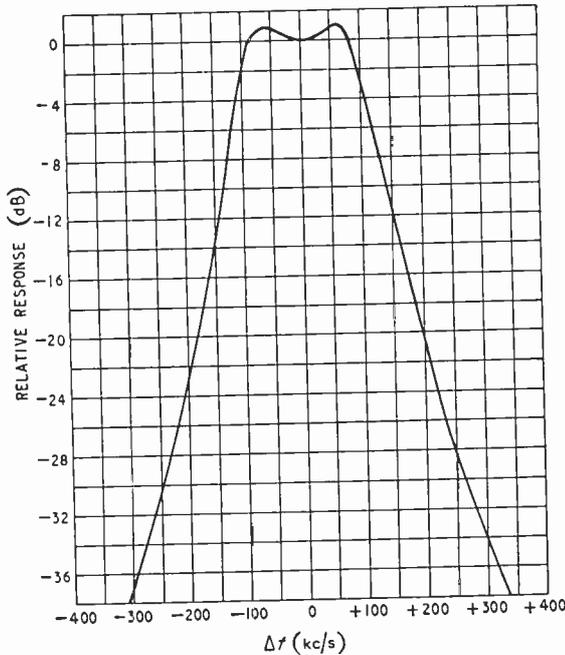


Fig. 11. I.F. amplifier frequency response.

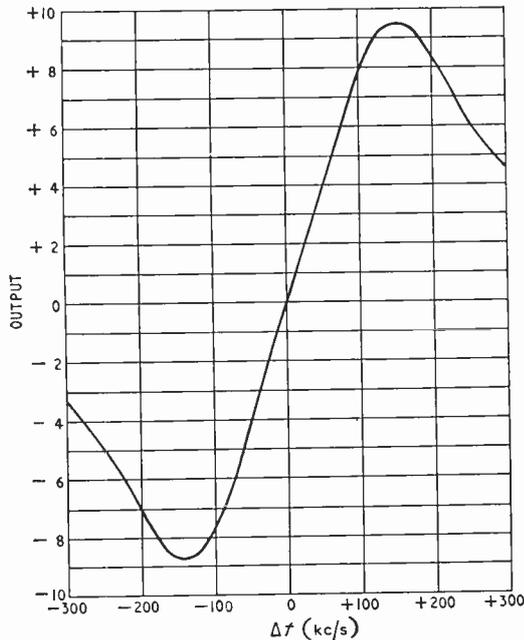


Fig. 12. Discriminator frequency response. Output is in arbitrary units.

TABLE 2

Input Signal Level	A.M. Suppression Ratio
30 μ V	35 dB
100 μ V	38 dB
300 μ V	41 dB
1 mV	43 dB
10 mV	48 dB
100 mV	49 dB

Suppression of Amplitude Modulation.—The a.m. suppression ratio is the ratio between the output due to a carrier which is frequency modulated ± 35 kc/s at 2,000 c/s and that due to a carrier which is simultaneously amplitude modulated to a depth of 40% at 2,000 c/s and frequency modulated ± 30 c/s at 100 c/s, the 100 c/s output being rejected by a high-pass filter. The results for various input signal levels are shown in Table 2.

Dependance of Output on Signal Level.—This is shown in Fig. 13.

Impulsive Interference Performance.—Fig. 14 shows

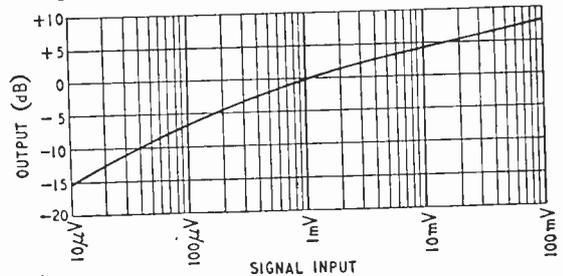


Fig. 13. Variation of a.f. output with input level. Output is referred to 1mV and input level is open-circuit voltage from 75- Ω source.

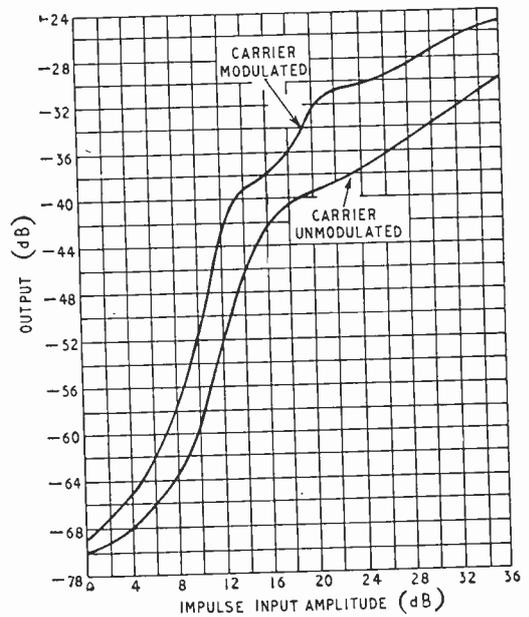


Fig. 14. Input/output characteristic for impulsive interference. Input carrier level 500 μ V, impulse p.r.f. 2,500/sec; relative output is referred to output with ± 35 kc/s deviation at 2kc/s and impulse input amplitude is referred to 1 μ V peak per kc/s bandwidth.

TABLE 3

Frequency of interfering signal relative to wanted signal (kc/s)	-400	-200	< +1 > -1	+200	+400	
Amplitude of interfering signal relative to wanted signal (dB) to give the subjective grades of interference	JP	+36.5	+4	-30.5	+6	+36.5
	P	+39	+5	-27	+7	+38.5
	SD	+40	+7	-22.5	+9	+40
	D	> +40	+9	-16.5	+11.5	> +40

the output due to impulsive interference, relative to that due to ± 35 kc/s deviation at 2,000 c/s, for various input impulse amplitudes. The measurements were made in the presence of an input carrier of 500 μ V, firstly unmodulated and secondly frequency modulated with ± 30 kc/s deviation at 12 kc/s.

Subjective Measurements of Selectivity and Co-Channel Suppression Ratio.—For these tests the receiver was fed with two signals, a wanted signal of 1 mV and an interfering signal of controllable amplitude which was set in turn to frequencies within 1 kc/s of, and spaced by ± 200 kc/s and ± 400 kc/s from, the wanted signal. Both signals were frequency modulated with programme in accordance with standard B.B.C. transmitter practice, the wanted programme being speech and the interfering programme light-orchestral music which gave a consistently high level of modulation. The

improved aerial system than with increased receiver gain.

The selectivity more than meets the requirements of the planning standards for v.h.f. broadcasting in the United Kingdom, i.e. a protection ratio of 0 dB for adjacent-channel signals.

The a.m. suppression ratio is maintained at or above the specified target figure of 35 dB down to an input level of 30 μ V. The a.g.c. is also operative over a similar range of input levels. While the constancy of output is not as good as that obtained with a static limiter, an input/output characteristic of the type shown in Fig. 13 does enable the user select the local transmission by tuning to the loudest programme. With a static limiter the output level is independent of signal strength and it is possible, particularly in periods of abnormal tropospheric propagation, to tune inadvertently to a distant transmitter on an adjacent channel with consequent fading and poor quality.

TABLE 4

Frequency of interfering signal relative to wanted signal (kc/s)	-400	-200	< +1 > -1	+200	+400	
Amplitude of interfering signal relative to wanted signal (dB) to give "P" interference with receiver mistuned as shown	Mistuned high	> +40	+14	-25	-5	+28
	Mistuned low	+28	-11	-25	+18	> +40

The performance in respect of local-oscillator frequency stability and radiation is somewhat below that which obtains in some current commercial receivers. Further development time spent on the r.f. portion of the circuit could have resulted in an improvement,

but this was regarded as a side issue, since the design is primarily concerned with illustrating the potentialities of the limiter and discriminator circuit.

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New Mullard Filmstrips

A NEW series of filmstrips designed to assist the teaching of radio engineering in technical colleges, Services training establishments, industrial apprenticeship courses, etc., is announced by the Mullard Educational Service.

The first of the series, "Thermionic Oscillators" (comprising 27 colour frames, arranged in two parts), is now available from the distributors, Unicorn Head Visual Aids, Ltd., 42, Westminster Palace Gardens, London, S.W.1, price 25s, including comprehensive teaching notes. The second deals with non-sinusoidal oscillators and others will cover modulation and transmission.

amplitude of the interfering signal was adjusted to give the following subjective grades of interference:—

- JP The interference was just perceptible in the quiet passages of the wanted programme.
- P The interference was perceptible in quiet passages of the wanted programme without careful listening.
- SD The interference was slightly disturbing when listening to the wanted programme.
- D The interference was disturbing.

The results given in Table 3 are the averages for four observers, the receiver having been tuned to give minimum output interference with the wanted and unwanted carriers within 1 kc/s, both unmodulated.

The tests were repeated with the receiver mistuned both above and below the correct tuning point by an amount just less than that required to give audible distortion with speech programme. Table 4 shows the level of interfering signal required to give "perceptible" interference in these two conditions.

Conclusions from Test Results.—The sensitivity of the receiver is regarded as adequate for domestic use. Signals below the level required for satisfactory operation are unlikely to be encountered within the service area of a transmitter unless the aerial is very inefficient or badly sited. In such cases improved reception is far more likely to be obtained with an

Automatic Pattern Recognition

NEW MORPHOLOGICAL SYSTEM USING A DIGITAL COMPUTER

By R. L. GRIMSDALE,* M.Sc., Ph.D., Grad.I.E.E.

THE human eye and brain are so efficient at recognizing printing and handwriting that it is not generally realized that recognition is a particularly difficult operation. Various patents have been filed in the past for machines which can read and for devices for aiding blind persons. The majority of these schemes were not exploited, and it is only in recent years, with the advent of digital computers, that the interest in this problem has been revived.

A number of machines have recently been produced commercially in this country and in America. The principal applications are the reading of information printed on cheques and other documents used in commerce. In addition to these applications there are many other important potential fields for more sophisticated reading machines. Intensive programmes of work are now directed towards obtaining systems for the mechanical translation of languages, but it would appear that it is essential, for economical working, to provide an input mechanism which can take the information direct from the printed page.

Another interesting possible future application is the sorting of mail. This might necessitate the printing of the names of the towns with reasonable clarity. However, this problem is not quite so difficult as it might appear, because use may be made of the fact that the town names include a considerable amount of redundant information; there would, for example, be no difficulty in recognizing MA***C****STER or *IV***R**POOL, and the machine could be arranged to reject all envelopes which it failed to identify with certainty.

A further application is that of feeding instructions and information to a digital computer, which at present is done via the medium of punched paper tapes or cards.

Before describing the operation of the present system, some features of other systems will be considered. One of the earliest, the Optophone†, a

device to assist blind people to read printed matter, consists of a set of five photocells, each controlling a separate audio frequency tone. As the device is moved across a line of illuminated print, the letters are effectively scanned by five horizontal lines and the tones vary as the parts of the letters are crossed. It is not believed that the device is widely employed because of the difficulties in using it. However, the Optophone cannot be regarded as a true recognition device, because all it does is to convert information from one form to another, with considerable loss of detail. The user must perform the recognition task from the sounds which he hears.

Comparison of Symbols

A large number of the recognition machines which have been devised or constructed are based on the principle of comparison of the unknown symbol with a set of standard symbols. In one particular version, the standard symbols take the forms of cut-outs round the periphery of a rotating disc. The remainder of the apparatus consists of a lamp, a lens system, and a photocell. As the disc rotates, images of the standard symbols fall on the unknown symbol. If the symbol is printed in black ink on white paper, varying amounts of light are reflected as the disc rotates. Recognition of the symbol is possible if the amount of light reflected from the image of one particular standard symbol is much less than from any other. The determination of the number of distinct symbols which can be identified is a problem of information theory, and a great deal of work has been done on designing specially formed symbols for maximum discrimination.

The modern counterpart of the rotating disc uses special symbols printed in magnetic ink on cheques. The symbols are recognized by passing them first through a field which magnetizes them, and then under a reading head. The waveform of the induced e.m.f. is strobed and examined and from this information the symbols are identified. This system, which has been adopted for reading cheques in the U.S.A., and is being developed in this country, is limited to the recognition of about a dozen specially formed symbols.

In another system produced by Solartron‡, the symbol is effectively divided into a number of areas and signals are produced depending on whether each of the small areas is black or white. The

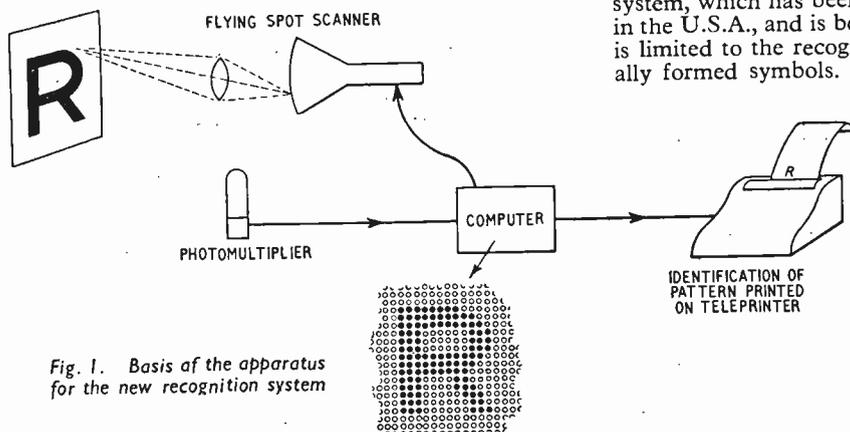


Fig. 1. Basis of the apparatus for the new recognition system

*University of Manchester. A more detailed account of the system is given in "A System for the Automatic Recognition of Patterns," by R. L. Grimsdale, F. H. Sumner, C. J. Tunis and T. Kilburn. *Proc. I.E.E.*, Part B, 106, p. 210 (March, 1959).

† Fournier D'Albe. *Proc. Royal Soc.*, 90 (1914).

‡ "Reading by Electronics," *Wireless World*, April, 1957.

symbols are then identified by a set of logical circuits.

In all these systems the symbols are effectively identified by a geometrical comparison. There are definite restrictions on the shape, size, and form of the symbols, and they must be correctly oriented in relation to the identification equipment. The new system which has been developed has, as its basis, the recognition of patterns by their shape or form. The system is very versatile because a P, for example, is recognized as a semi-circle and a straight line joined in a particular manner. This description is independent of the way in which the P is drawn and its size. The system is in no way limited to letters or numbers, but can be used for all simple patterns composed of straight lines and curves, and can be extended to include a wide range of patterns of diverse forms.

This morphological approach, or recognition by the shape of the pattern, may closely resemble at least one of the ways in which human readers recognize patterns. The resemblance is particularly apparent when a reader is presented with a strangely written or upside-down letter. In these cases a conscious study is made of the form of the symbol. Even with normal letters the human reader may carry out a detailed study of the shapes, although the process is so rapid that the reader is not conscious of the operation. However, in normal reading, a great deal of use is made of the context and whole words may be guessed before the individual letters are recognized.

Characteristic Features of Patterns

The name "pattern recognition," as opposed to "character recognition," distinguishes the new system from those already devised. Character recognition implies the identification of one out of a given set of symbols, each symbol having a definite form and size, as produced, for example, by one particular typewriter. Pattern recognition, on the other hand, is not restricted to a particular set of symbols. The patterns are recognized because they have certain characteristic features. The pattern of a letter R, for example, can be recognized even when written in different ways by several people. Furthermore, no special restrictions are imposed on the size of the pattern. Another useful feature is that the pattern need not be correctly orientated when presented to the recognition machine, provided it lies within its "field of view."

In order to demonstrate the working of the pattern recognition system, it has been simulated using a universal digital computer. This technique is one which is of great value as it enables the operation of complex systems to be demonstrated and studied at low cost, prior to the construction of special-purpose equipment.

Scanning System

The operation of the system is divided into a number of stages. First of all the pattern is transferred from the paper on which it is drawn to the store of the computer, a flying-spot scanner being used. The scan effectively divides the picture area into a matrix of points. According to the amount of light reflected, each point is classed as "black" or "white" and can then be represented by a binary digit having the value "0" or "1" (Fig. 1). The

pattern is stored within the computer as an array of points ("1" digits) on a background of "0" digits.

Although the pattern is stored, the machine cannot yet "see" its shape. The precise way in which the machine examines the pattern is dictated by the type of instructions available on the computer. In general the examination proceeds from bottom to top and from right to left. The pattern is subdivided into divisions of the type shown in Fig. 2 (a). Each division is specified by the length, and the slope or curvature of its edges. The information concerning the latter is determined by forming the values of $\frac{dx}{dy}$ and $\frac{d^2x}{dy^2}$ for the points at the edge of the division. Since the edge may be very irregular, due to the imperfections of the figure, an averaging technique is employed.

Figure imperfections may give rise to other difficulties. A break in the figure may result in two divisions being formed where there should only be one. To overcome this, use is made of a noise factor which gives a measure of the amount of imperfection which may be tolerated. The value of the noise factor is set automatically by a trial scan which determines the overall size of the figure. The noise figure subsequently may be modified if an unduly large number of divisions is produced.

In the next stage of the process the various divisions of the figure are assembled into the basic curves and lines of the figure. It is clear that if the same figure is presented to the flying-spot scanner at a different angle an entirely different set of divisions will be produced (Fig. 2 (b)). The present process is designed to ensure as far as possible that the same result will be obtained for all orientations. The result of this process is recorded as a statement of the number and type of component lines and curves of the figure and the way they cross or join.

At this stage the true recognition process begins. The action so far has effectively reduced a two-dimensional pattern to one-dimensional form. The statement can be considered as a one-dimensional form of pattern because it consists of a succession of symbols which describe the original figure. The true recognition process amounts to the comparison of the new statement with those stored within the machine. The comparison is done on a very flexible basis and a score is given for each test. This method permits the amount of agreement to be determined between the unknown pattern and a range of patterns which have already been presented to the scanner.

An important feature of the system is the ability to learn new patterns. In contrast with the methods for character recognition using geometrical comparison there are no built-in representations of the pat-

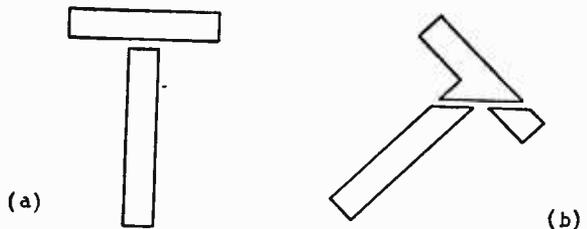


Fig. 2. Pattern divisions produced during examination; (a) with normal orientation, (b) when presented at a different angle to the scanner.

terns. Every pattern which is shown to the machine is converted to the statement form and compared with statements previously obtained and stored. If a satisfactory comparison is obtained the name of the pattern is printed out on the teleprinter attached to the computer. If, after having obtained the statement describing the shape of a new pattern, the machine is unable to find a sufficiently similar stored statement, it will indicate its inability to identify the new pattern. The machine can then be given the name of the new pattern. This act is equivalent to teaching the machine a new pattern, because at any subsequent time the machine will be able to identify this pattern even if it is drawn by a different person.

A valuable feature is the way in which the machine indicates its confusion between two or more possible identifications of a pattern. This will arise when a new statement registers high scores with two or more statements belonging to patterns already "known" to the machine.

Economical Storage

The reduction of the two-dimensional pattern to the one-dimensional statement form leads to an economical method of storing the patterns. A pattern with a resolution equivalent to a 50-line television picture and having an information content of 2,500 bits can be represented by a statement with 40 to 80 bits.

As the number of patterns which the machine "knows" become large the time to compare a new statement with all existing statements would become excessive. To reduce this time, a classification system is employed. Thus all patterns with four ends or two curved lines would be stored in separate classes. A new statement is only then compared with members of suitable classes. The definition of "suitable" is again based on a scoring system. The success or failure in finding the right answers in a short time is used to modify the scores, so that the machine "learns" to recognize faster.

The simulation of this system was programmed for the now obsolescent Manchester Ferranti Mark I

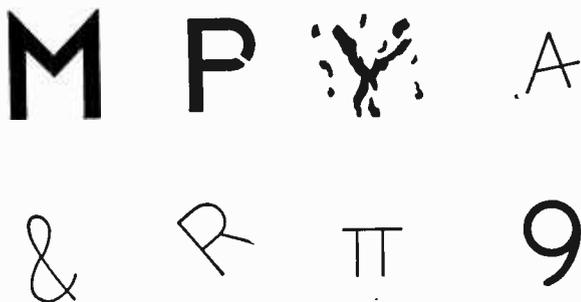


Fig. 3. Example of patterns which the system has shown itself capable of recognizing.

computer and the time to identify a pattern was about 1 minute. Using the Ferranti Mercury computer it can be done in 3 seconds. The provision of a more elaborate scanner, now under construction, with greater facilities for examining the patterns, will reduce this time to under one second, and finally a special-purpose digital computer, working in conjunction with this scanner, will give a further hundredfold increase in speed.

Whereas some of these times may appear long in relation to character recognition devices employing geometrical comparison, it must be remembered that the present system has very great versatility and can deal with any line pattern that can be resolved by the scanner. It has already demonstrated its ability to recognize such patterns as those shown in Fig. 3, some of which have been drawn by hand. It appears possible to be able to recognize good handwriting by a development of the same technique. It is well-known that bad handwriting presents considerable difficulties even to human readers, and it is only possible to recognize certain words by reference to the context in which they are written. Thus the complete recognition of even average handwriting is a formidable task to perform by machine, but might be possible with the development of linguistic study used in the machine translation of languages.

Microwave Data Tables

CALCULATIONS relating to a single specialized field of study tend continually to involve the same few basic mathematical functions of the quantities concerned. A considerable amount of routine sub-calculation can thus be saved by the use of specialized tables in which such functions have been already worked out. Such tables have up till now not been too readily available for microwave data, but this lack has now been remedied by the appearance of the book "Microwave Data Tables" by A. E. Booth, M.I.R.E., Grad.I.E.E. The author is a microwave development engineer for Sir W. G. Armstrong Whitworth Aircraft, Ltd.

Some of the tables in this book are of general as well as specialized interest. An example is the very extensive series of decibel tables which includes decibel gain or loss against power, voltage or current ratios. Also given are tables of v.s.w.r. (voltage standing wave ratio) to voltage and power reflection coefficients. We also meet some familiar tables appearing in a new guise corresponding to their more specialized use. For instance reciprocals appear as v.s.w.r. (<1) to v.s.w.r. (>1), and squares as voltage-to-power reflection coefficients. More specialized tables include frequency to guide wavelengths for the TE₁₀ mode in 9 standard

British sizes of rectangular guide, and a list of 28 standard British rectangular guides giving their dimensions, cut-off frequency, recommended operating range of frequencies and c.w. power rating. The contents of these latter tables illustrate the waveguide bias which has been given to this book.

In these tables measurable quantities are always chosen for the independent variables and these are tabulated to the normal limits of measurement accuracy. The corresponding dependent variables are given to one more figure than is normally required, so as to avoid imposing any accuracy limitations in practical design and development work. Notes on the use of each table are included, and the formulae used in calculation stated.

The conditions under which this book is likely to be used have not been forgotten: the tables are clearly printed on stout paper and strongly bound so as to stand up to constant use in the design office or laboratory.

The book contains 61 pages and 26 tables. It is available from booksellers at 27s 6d or direct from our publishers, Iliffe and Sons Ltd., at 28s 8d including postage.

Voltage-Tuned Oscillator

Five-to-One Frequency Range with Grid Bias Variation Point

By G. W. SHORT

THE oscillator to be described in this article is an R-C oscillator of the "Wien bridge" variety. This makes use of the frequency-selective properties of the network shown in Fig. 1. When connected as shown, the output is a maximum, and the phase shift is zero, at one frequency f_0 given by $1/2\pi\sqrt{(R_1 R_2 C_1 C_2)}$. If such a network is used as a positive voltage feedback path in an amplifier of adequate gain, oscillation takes place at f_0 .

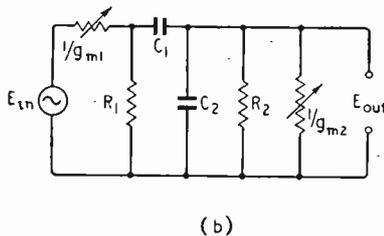
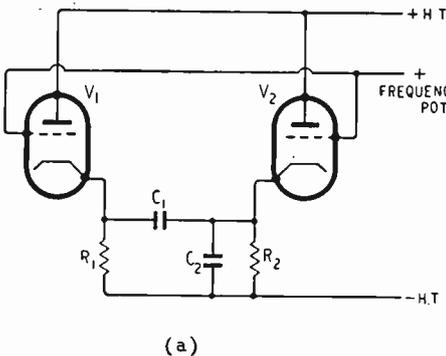
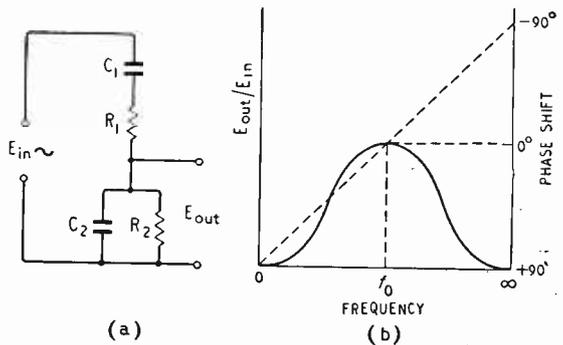
By using valve internal resistance for R_1 and R_2 (Fig. 1.) it is possible to achieve electronically-controlled variation of frequency. The most suitable internal resistance is that looking into the cathode of a cathode-follower or an earthed-grid amplifier, since this comes in convenient sizes and varies very widely with grid-bias voltage, being approximately equal to $1/g_m$. If a valve with a slope of 5 mA/V under its published normal-working conditions is chosen, then the cathode impedance varies from 200Ω to infinity (when the valve is cut-off). The frequency range is thus, in theory, infinite; but in practice the cathode impedances are always shunted by finite resistances, so giving a finite frequency range.

The frequency-selective circuit is obtained as shown in Fig. 2. The cathode impedances are shunted by R_1 and R_2 , which are made as large as possible. The grid-to-cathode voltages, and hence the slopes of the two valves, are changed simultaneously by applying variable positive (with respect to earth) grid bias. If $C_1 = C_2 = C$, and the valves have the same slope, then $f_0 = g_m/2\pi C$, neglecting the effect of the actual cathode resistors. (A formula including the effect of these is given in the Appendix).

The easiest way to inject a signal into the circuit is to apply it to the grid of the left-hand valve. The output can then be taken from the right-hand cathode. However, it seems a pity not to use the amplifying properties of the valves as a means of obtaining the loop gain necessary to cause oscillation. This leads to the circuit of Fig. 3, which is a complete oscillator. V2 then becomes an earthed-grid amplifier to which the network output is applied,

and V1 is a cathode-follower for driving the network. In a Wien-bridge network with both resistors and both capacitors equal, the network output is about a third of the input, so a gain of 3 is sufficient for oscillation. This requires a V2-anode load of less than $1k\Omega$ when the valve slopes are maximum, but when they are low a much greater load is necessary. The load resistance is therefore fixed by the low-slope condition, but this results in too large a gain at the high-frequency end of the band where the slopes are high, and the circuit tends to behave as a multi-vibrator. For this reason a limiter is included. This takes the form of two point-contact germanium diodes connected back-to-back effectively across the amplifier load. The resistance of a typical diode is about $10k\Omega$ under zero-bias conditions; but it falls when a signal is applied, reaching perhaps 300Ω when $1mA$ flows. The form of the grid voltage of V1 now approximates to a square wave, and we rely on the frequency-selective properties of the network and amplifier to get rid of the harmonics, taking a voltage output from the cathode of V2. Other methods of amplitude control may give a lower harmonic content in the output. However, ordinary methods such as grid-leak biasing cannot be used, since changing the grid bias also changes the frequency of oscillation. (If particularly-low harmonic content is required, R_3 can be adjusted so that

Fig. 1. (a) "Wien bridge" frequency-selective network and (b) its amplitude and phase responses.



Left: Fig. 2. (a) Practical arrangement for achieving voltage-controlled variation of R_1 and R_2 . (b) Equivalent circuit, showing where the input voltage can be injected. R_k should be much larger than $1/g_m$.

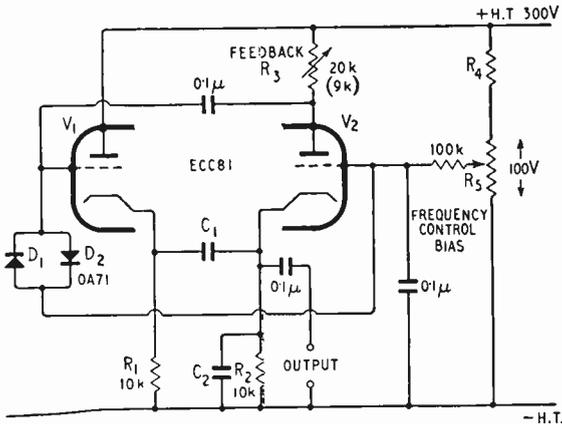


Fig. 3. Complete oscillator circuit. The diodes D_1 and D_2 form a limiter to prevent multivibrator action.

oscillation just occurs, but a different setting is required for each frequency).

An oscillator was constructed using the circuit of Fig. 3 with $C_1 = C_2 = 500\text{pF}$. The theoretical frequency (neglecting the effects of $R_{1,2}$ and the anode load of V2) now becomes $g_m/\pi\text{Mc/s}$, and this and the measured frequency are shown in Fig. 4. (In this formula g_m is in mA/V and C is in pF .)

Having got so far, it was of interest to find out the highest frequency at which oscillation could be obtained. At high frequencies, the gain falls off because of the shunting effect of stray capacitances, so there is no point in using high-value resistors. The anode and cathode resistors were reduced to $4.7\text{k}\Omega$, and oscillation was still obtained with anode currents of about 10mA . The capacitors C_1 and C_2 were progressively reduced until oscillation ceased. This raised the maximum frequency of oscillation to about 8Mc/s ; but it was felt that this could be improved upon. A frequency of about 13Mc/s was obtained using $C_1 = 50\text{pF}$, and nothing except the circuit strays for C_2 . The reason why this unequal combination of capacitances gives better results appears on re-examination of Fig. 1(a). As C_1 is increased, or C_2 reduced, the ratio $E_{o,v}/E_{in}$ gets bigger; because the impedance of the bottom part of the network relative to that of the top increases. Thus less loop gain is required when C_1 is greater than C_2 , and vice versa. It should be possible, with careful component layout, to improve on the figure of 13Mc/s somewhat. If much-higher frequencies are aimed at, then a valve of higher slope, such as the E88CC (12.5mA/V) should be used.

If mechanical control of frequency is required to provide the main sweep, either or both capacitors C_1 and C_2 can be made variable. It is generally easier to make only one capacitor variable, namely C_2 , since the rotor then can be earthed. The frequency ratio $f_{\text{max}}/f_{\text{min}}$ is then reduced to $\sqrt{(C_{\text{max}}/C_{\text{min}})}$, which is typically a little over 3. A suitable value for the fixed capacitor C_1 is $\sqrt{(C_{\text{max}}/C_{\text{min}})}$ which is about 160pF when an ordinary variable capacitor ($C_{\text{max}} = 500\text{pF}$) is used.

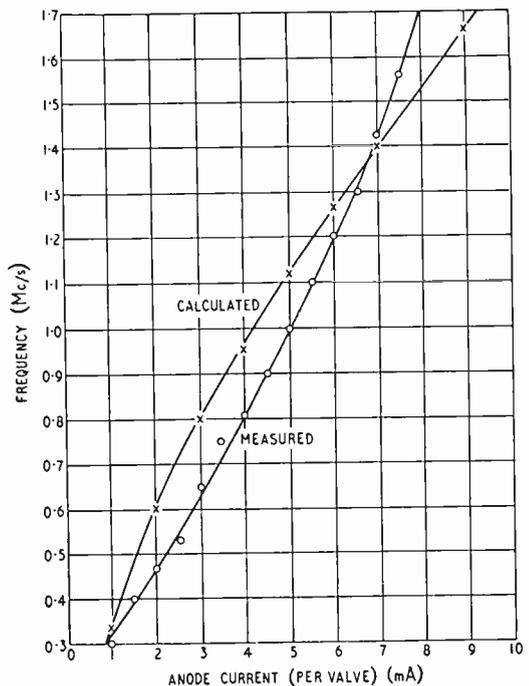


Fig. 4. Measured and calculated frequency/anode-current curves with $C_1 = C_2 = 500\text{pF}$.

A sine-wave output is best taken from the cathode of V2, as the harmonic content at this point is the lowest in the circuit. If a square-wave output is required, a small (in comparison with the cathode resistor) resistor may be placed in series with V1 anode feed. A maximum value of $1\text{k}\Omega$ is suggested as being reasonable. **Applications.**—The oscillator described was built to satisfy the writer's curiosity; but since it works satisfactorily it may be of some interest to speculate about possible uses for it. The obvious application is as a wide-range frequency-modulated oscillator for oscilloscope frequency-response measurements, panoramic receivers and the like (where a rapidly-varying potential is fed in the $100\text{k}\Omega$ filter resistor and $0.1\mu\text{F}$ capacitor are omitted).^{*} Others are the remote-controlled tuning of receivers, and signal-seeking receivers. For narrow-band applica-

^{*} To avoid unwanted feedback via the limiter it may be necessary to connect a small (100pF or so) capacitor from V2 grid to earth.

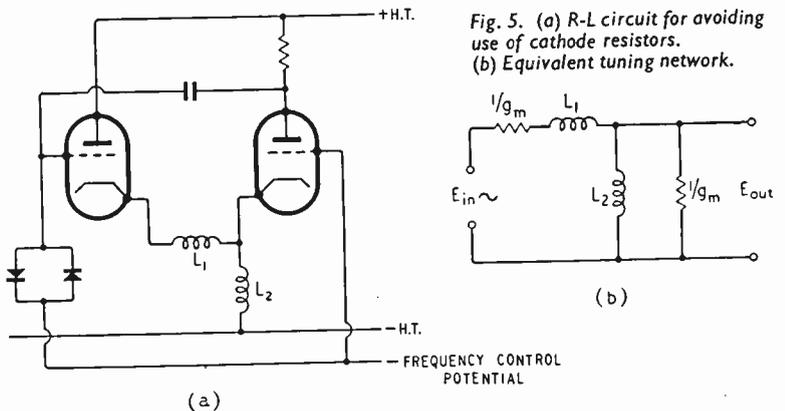


Fig. 5. (a) R-L circuit for avoiding use of cathode resistors. (b) Equivalent tuning network.

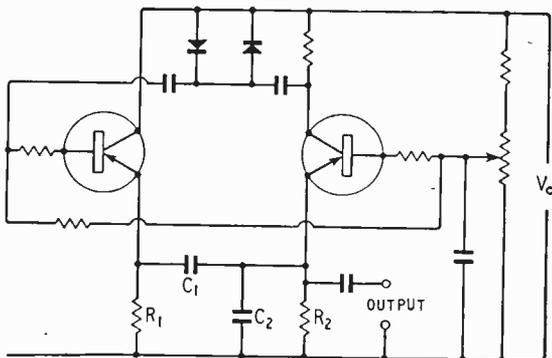


Fig. 6. Transistor-oscillator circuit (equivalent to Fig. 3).

tions, reasonably-high frequency-stability is required. The stability of the oscillator described here is obviously very poor by normal standards, since the frequency can be pushed about by changing the circuit voltages. However, when a stabilized h.t. supply was used the stability was better than expected, bearing in mind the fact that the frequency is a function of the valve slopes. The reason is probably that the mutual conductance of a valve is a function of the cathode current, and in the present circuit, the cathode current is rigidly controlled by the heavy d.c. negative feedback due to the large-value cathode resistors. To a first approximation, the current is simply V_g/R_{k2} , where V_g is the external bias voltage. The accurate expression is, of course $(AV_g + v_g)/R_{k2}$, v_g being the actual grid-to-cathode bias and A the "gain" of the valves as cathode-followers. It is unlikely that v_g will vary by more than a fraction of a volt as a result of normal short-term emission and heater voltage variations, and since V_g may be as much as 100V, the variations are small in comparison to the total voltage.

The d.c. supplies must be well smoothed as well as stabilized, otherwise hum voltages will frequency-modulate the oscillator, although it may be convenient to dispense with stabilization for the main h.t. supply provided that it is reasonably well regulated; the required tuning potential (100V) may then be developed across a gas-discharge stabilizer, such as a VR105/30. Other causes of f.m. are heater-to-cathode leakage, heater-to-grid leakage, and heater emission, the first being particularly undesirable because of the high-value cathode resistors. A possible way out would be to use an L-R tuning network (Fig. 5) and negative grid bias, or to "tie" the heater supply to the slider of R_s . But a more attractive method would be to use transistors instead of valves and avoid the possibility of cathode hum altogether. The circuit of Fig. 6 is suggested as a basis for experimental determination of circuit values.

The frequency ratio of five-to-one obtained in the experimental oscillator does not represent the practical limit. At the high-frequency end of the range, the frequency can be raised as far as the valve slopes will allow. If the slope of the valves used had been 10 mA/V, the top frequency would have been over twice that obtained with 5-mA/V valves. The low-frequency limit can be extended by increasing the value of the cathode resistors when the largest convenient values for C_1 and C_2 have been reached.

APPENDIX

The effect of $R_{k1,2}$ in the circuit of Fig. 2(b) is neglected above, and so is the effect of the anode load of V_2 on the cathode input impedance of V_2 . The effects on frequency can easily be allowed for. Referring to the equivalent circuit shown in Fig. 7, where r_k stands for the impedance

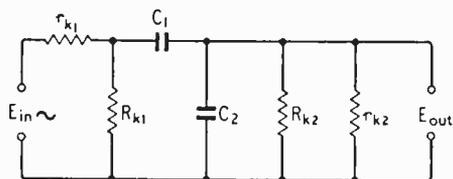


Fig. 7. Equivalent R-C oscillator network.

looking into the cathode, the frequency is obtained by calculating the resistance of R_{k1} and r_{k1} in parallel and substituting this for R_1 in the usual formula $f_0 = 1/2\pi\sqrt{(R_1R_2C_1C_2)}$ and calculating R_{k2} and r_{k2} in parallel and substituting for R_2 . The effect of the anode load, R_a , of V_2 on r_{k2} is to increase the impedance looking into the cathode so that it becomes $(R_a + r_{k2})/(1 + \mu)$ instead of just $r_{k2}/(1 + \mu) \approx 1/g_m$. The effect of the actual cathode resistors is to increase f_0 , and that of r_{k2} is to reduce f_0 , so to some extent they offset one another.

A more serious effect of R_{k1} is that it increases the attenuation of the network. E_{in}/E_{out} becomes:—

$$1 + r_{k1}/r_{k2} + r_{k1}/R_{k1} + C_2r_{k1}/C_1R_{k1} + C_2/C_1$$

where r_{k2} is the parallel combination of R_{k2} and r_{k2} . This has its greatest effect at the low-frequency end of the range, where r_{k1}/R_{k1} is greatest. But in practice one can easily make R_{k1} ten times r_{k1} , and the effect is then negligible for most purposes.



CLOSED-CIRCUIT TELEVISION at Dublin Airport forms part of a system, undergoing trial by Aer Lingus, for the remote display of weather information: this saves the pilots as much as a 20-minute journey to the Met. Office. Installed by Philips Electrical (Ireland) Ltd. the television equipment comprises two camera chains; also two-way speech facilities and a Muirhead facsimile-transmitting and receiving system are provided. A 21-in television display fed by a coaxial cable in the Operations Room provides direct information (the photograph shows the transmission of a weather briefing) and the "Mufax" is used to produce a detailed information folder which is carried in the aircraft.

Transistor A.F. Oscillator

For Use as a Morse Practice Set or a Bridge Source

By H. B. DENT

REQUIRING a small and compact audio frequency oscillator for general-purpose use in place of a rather cumbersome external mains-driven affair, thoughts naturally turned to the use of a transistor. A search through the available literature revealed a surprising lack of practical details of oscillators of this kind, except for one forming part of a larger equipment,* and it appeared that the only course open was to make a few preliminary bench tests of likely circuits before deciding on the final layout.

The first circuit tried is shown in Fig. 1 where an OC70 transistor is used with an orthodox feedback circuit using a triple-wound transformer. The tertiary winding was included to isolate the oscillator from external equipment and so minimize the effect of this equipment on the frequency of oscillation.

current measured by the meter is the collector current (I_c). The information gained from the curve is interesting as with R of $100k\Omega$ or less quite small minus tolerances in resistance can produce very large increases in collector current, so that with this type of oscillator the series resistor in the base circuit ought not to be less than $150k\Omega$ with a nominal collector voltage of 4.5V. Preferably it should be nearer $220k\Omega$, under which conditions the collector current is about $150\mu A$. This oscillator would be quite satisfactory for many purposes, especially where only a relatively small a.f. output is required.

These crude measurements served their purpose, however, by emphasizing the desirability of a more sure stabilization of the d.c. bias for the base and this led to a trial of the circuit shown in Fig. 3.

The component values were arrived at largely by

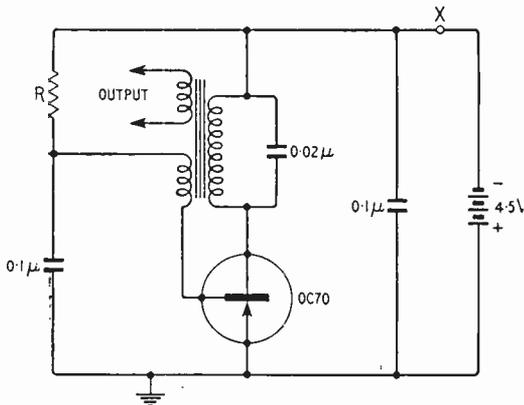


Fig. 1. Transistor oscillator circuit using triple-wound transformer.

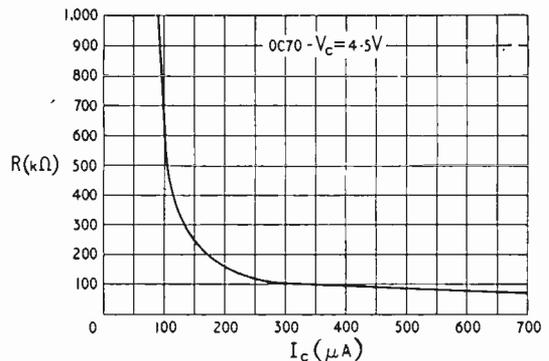


Fig. 2. Collector current with different values of resistor R .

It was required to find a suitable value for the resistor R , which determines the base-bias current of the transistor, as the few published circuits encountered had shown very wide difference in values for this resistor, even when a similar battery voltage was employed.

The battery lead was broken at the point x and a 0-1mA meter inserted. Fig. 2 shows the current taken by the transistor (oscillating) with different values of resistance at R . A pair of headphones connected across the output winding served for monitoring the audio signal. Unfortunately no means were available at the time of actually measuring the a.f. output as correlating its magnitude with the d.c. input to the transistor would have provided useful data.

In view of the high value of resistance used for R in all cases it can be assumed that the bulk of the

*"Transistor Transmitter," by L. F. Shaw, *Wireless World*, May 1958, p. 242.

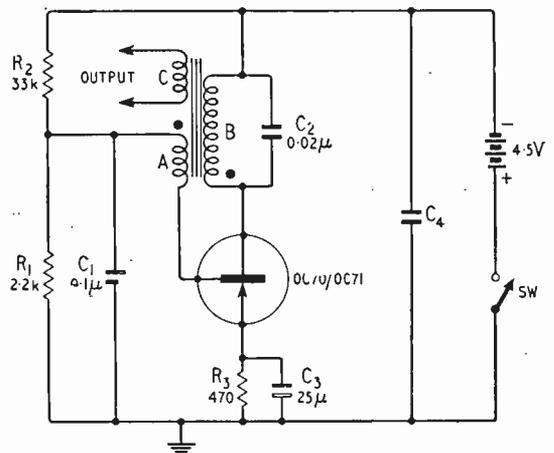


Fig. 3. Oscillator circuit with base current stabilized.

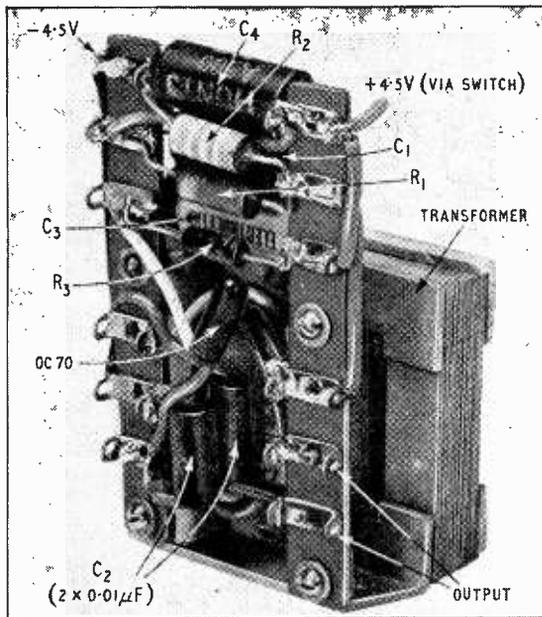


Fig. 4. A convenient form of construction for the transistor oscillator. Components can be identified from Fig. 3.

trial and error, although the working conditions were approximately determined from the maker's data sheets for a current load not exceeding 0.5mA with a 4.5-V battery. This presupposed a base current of less than $10\mu\text{A}$ so that the potential divider R_1 and R_2 need not consume more than about $100\mu\text{A}$ leaving about $400\mu\text{A}$ for the collector current. With the base voltage set to be just slightly more negative than the emitter the nearest preferred 20-% tolerance resistors for R_1 and R_2 were $2.2\text{k}\Omega$ and $33\text{k}\Omega$ respectively. R_1 was bypassed by a $0.1\text{-}\mu\text{F}$ capacitor and R_3 , which is included as a further safeguard for d.c. stability, by a $25\mu\text{F}$ capacitor.

With the particular OC70 transistor employed the total current through R_2 was $115\mu\text{A}$ and the collector current was $260\mu\text{A}$, making a total battery drain of $375\mu\text{A}$. The a.f. output was uncomfortably loud in high-resistance headphones and thus judged adequate for the purpose of energizing a CR bridge.

No value has been marked for C_4 as this depends on the particular use to which the oscillator is put. For energizing a CR bridge, which is but one of several applications subsequently found for similar units, any capacitance from $0.1\mu\text{F}$ to $10\mu\text{F}$ or more can be used. When, however, the oscillator is used as a Morse practice set, and the key inserted in place of the on/off switch (Fig. 3), C_4 should not be larger than $0.1\mu\text{F}$. If it is oscillation does not stop immediately the key is released after a dot or dash but is maintained by the charge on C_4 . If C_4 is only slightly too large it puts a "tail" on dots and dashes which upsets the relative spacing of the Morse characters and if speed is attempted dots and dashes merge and the signals become unintelligible.

The small transformer was made specially for this oscillator and consists of a 0.4-in stack of No. 74N "E" and "I" "no-waste" stampings (Magnetic and Electrical Alloys) but any similar sized core will do ($1\frac{3}{8} \times 2\frac{1}{8} \times 0.4$ in). Thin sheet Paxolin

was used for the end cheeks of the bobbin glued (Durofix) to a core tunnel made from thin cardboard covered with several turns of gummed paper. It was made on a wooden mandrel a shade larger, as regards width, than the tongue of the "E" stamping.

The base winding A was put on first and consists of 50 turns of No. 38 s.w.g. enamelled copper wire. Winding B, with 1,000 turns of the same wire, followed and finally winding C with 200 turns. The black dots adjacent to one end of A and B windings (Fig. 3) indicate the beginning (or inner) of each, all windings being in the same direction. No marking is required for winding C as its phasing with the other windings is not important, but correct phasing is essential for A and B or the circuit will not oscillate.

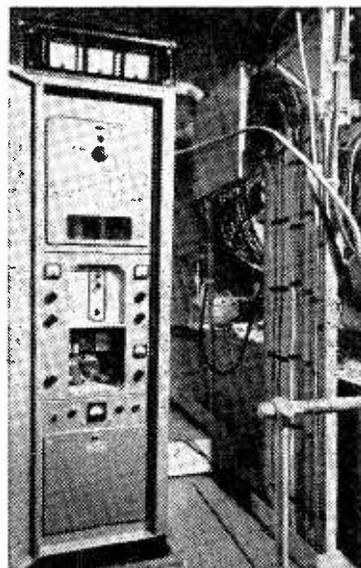
With windings and components as specified the frequency of oscillation is about 1,000c/s, but any frequency within reasonable bounds can be generated by using a suitable value of capacitance for C_2 .

The oscillator in its final form is shown in Fig. 4, which should be self-explanatory. The annotation enables the various components to be identified by reference to Fig. 3. With perhaps the exception of C, the capacitors are physically much larger than they need be as 150-volt working type was used whereas 6- or 12-volt types would be adequate. All resistors can be $\frac{1}{4}\text{W}$ or smaller.

MOON REFLECTION TESTS

THE transmitter used at Jodrell Bank for the successful communication tests during last May with the Air Force Research Centre at Massachusetts via reflections from the moon was designed and built by Pye Telecommunications, Ltd., Cambridge.

It has an output of 1kW at 201Mc/s and is frequency-modulated with peak deviations variable from $2\frac{1}{2}$ to 15 kc/s. The 250-ft aerial has a gain of 40 dB and a beam width of $1\frac{1}{4}^\circ$ at 200Mc/s (angle subtended by the moon is $\frac{1}{2}^\circ$).



Part of the Pye f.m. transmitter used at Jodrell Bank.

The receiver used for monitoring at Jodrell Bank had a noise factor of 6 dB and bandwidths of $\pm 2\frac{1}{2}$, 5 or 10kc/s. Measured signals at the input varied between 0.2 and 1.5 V which is in good agreement with 0.7 V derived from a calculated path loss of 250 dB.

LETTERS TO THE EDITOR

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

"Audion"

IN "Free Grid's" article of September he makes a reference to de Forest's "Audion" and the derivation of the word.

de Forest first used the word for his original two-electrode valve, a device not very dissimilar to the Fleming valve.

I was present in New York at de Forest's lecture on his two-electrode Audion at the American Institute of Electrical Engineers meeting in 1906 and I remember very distinctly the criticism made after the lecture by the famous loading coil inventor Dr. Pupin. Pupin concentrated entirely on the word, objecting to it strongly as a mixture of Latin and Greek—in fact he said it was a *bastard*—as he used the word with some emphasis it caused much laughter.

London, E.C.1.

H. J. ROUND.

"FREE GRID," in your September issue, wonders about the derivation of the term "Audion."

Over 40 years ago, I read an article in Mr. Hugo Gernsback's journal *Electrical Experimenter* written by Dr. Lee de Forest, in which the doctor wrote, as far as I can remember:

"My laboratory assistant, Mr. Harvey L. Gainer, suggested the beautiful and not inappropriate name "Audion," derived from the Latin "audio" (I hear) and "ion," the latter being the carriers of the electric current in a vacuum."

Unfortunately, I cannot at the moment find my copy of the magazine, to make the quotation strictly verbatim, but believe "Free Grid" can rest assured that this was the origin of the name.

Electronic communications had not then advanced to the point where it was necessary to make distinctions, such as audio, i.f., r.f., v.h.f., etc., to indicate different ranges of frequencies.

Windsor, Ont., Canada.

H. S. GOWAN.

Canadian Pacific Communications.

Long-distance V.H.F. Reception

IN the September issue your correspondent J. E. Le B. Terry invited opinions on the subject of long-distance v.h.f. reception.

Here in Aylesbury, which is situated about 65 km North West of London, Italian f.m. broadcasts are generally received between the months of May and September. This year they were heard on June 14th, 20th, 25th and 26th and again on July 22nd. Reception was particularly good on June 14th with Italian stations heard here from 0930 until 1358 G.M.T. At least 26 were being received at 1240 G.M.T. between 88 and 98 Mc/s.

Italian stations on Band II have been received as early as 0715 and as late as 2220 G.M.T. The best periods of reception being the mid-morning or afternoon.

I entirely agree with Mr. Terry that the behaviour of these signals is totally different to that associated with tropospheric propagation.

My own observations have shown that after remaining steady for a short period, signals will go into a sudden deep fade, returning almost immediately to their original strength.

In view of the distance involved, I find it hard to believe that the right type of weather conditions could maintain

tropospheric reception over such an area. Long-distance tropospheric reception rarely exceeds 900 km; 500 to 600 km being more usually observed by the writer. It would seem therefore that the reception of signals at considerably greater distances than the above can only be via the ionosphere.

It is interesting to note that long-distance reception in Band II occurs at the time of the year when sporadic-E is known to propagate television signals over similar distances in Band I. The theory that sporadic-E cannot reflect signals higher in frequency than about 60 Mc/s may therefore prove incorrect, especially in view of the fact that amateur radio operators in this country have made contact this year with Italian amateurs on the two-metre band (144-146 Mc/s).

I trust that these notes may interest your correspondent and other readers and in concluding I would like to thank the various European broadcasting organizations who have verified my reception reports of their f.m. stations.

Aylesbury, Bucks.

A. H. UDEN.

Finnagle's Law?

WITH reference to the availability of Test Card "C" ("Diallist," Sept. issue), it may not be generally known that this problem may be resolved mathematically as follows:

If the number of receivers to be set up is N, then—

$$N^2 + cf = \frac{tc}{d + tf} + a$$

where: *d* is the average distance in miles between sets.

t is the total time available in hours.

tf is the Traffic Frustration Factor.

c is the Coefficient of Asynchronization (this is an expression relating to the frequency with which the B.B.C. will transmit the Test Card whilst the I.T.A. is not so transmitting (or *vice versa*),

cf is the card recurrence frequency.

a is the accuracy in % loss or gain, of the service engineer's watch.

N.B.—Serious students of this and similar aspects of servicing, are referred to the standard work on the subject, "Alsoarbeitsitzundweyzt—Eine Teleteufelhandlungsphilosophie" (Ewigkeit u. Ewigkeit, Hamburg, Rm 65). This should be read in the original—some of the subtler nuances being virtually untranslatable.

Canterbury.

K. DICE.

I WOULD like to add, if I may, to Mr. J. Darr's delightful article on Finnagle's Law. The I.P. of I.O. (Innate Perversity of Inanimate Objects) is immortalized in a little verse which I heard a long time ago. The authorship escapes me, but the lines run thus:

I never had a piece of toast
Particularly long and wide,
But fell upon the sanded floor,
And *always* on the buttered side.

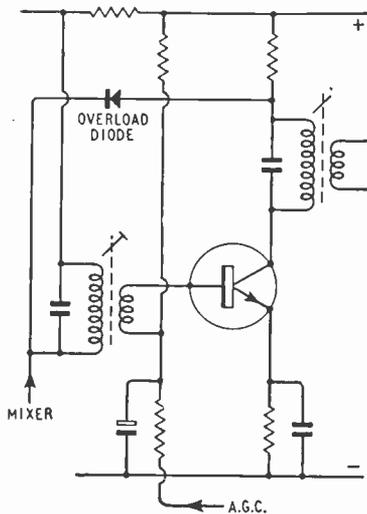
By the way, in our laboratory, the Fiddle Factor is never referred to as such; we always give it the more exalted title of "Cook's Constant."

Chelmsford.

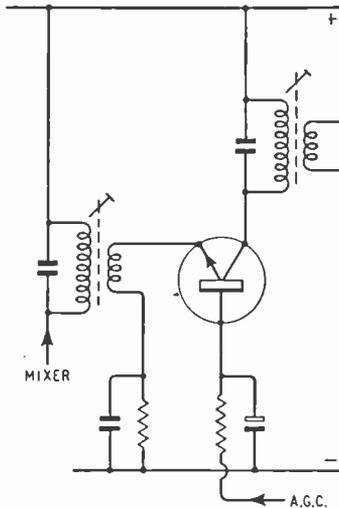
W. R. MASEFIELD.

Technical Notebook

Transistor A.G.C. Circuits present some problems which are not met in designing valve receivers—the major difficulty being that the transistor cannot effectively reduce the signal below a certain limit. In *I.R.E. Transactions on Broadcast and Television Receivers* for January, 1959, F. J. Banovic and R. L. Miller discuss two methods of applying a.g.c. to transistor i.f. amplifiers and they describe a new method invented by J. A. Worcester. The simplest and most common arrangement is to feed back the d.c. developed at the detector to the base of the first i.f. amplifier, which is connected in the earthed-emitter mode. An improvement to this circuit is the addition of an "overload diode," as shown immediately below. This gives some measure of delay, as the voltage drop across the i.f. amplifier collector



resistor holds the diode cut-off until a certain signal level is reached. When the voltage drop is reduced by the action of the simple a.g.c. on the i.f. amplifier the diode conducts, shunting the mixer o.p.; but this point depends on the d.c. amplification of the transistor, so an individual adjustment of the collector resistor has to be made for the best performance. The new method does away with the need for an overload diode and individual adjustment by reconnecting the i.f. amplifier as an earthed-base stage to i.f. and earthed-emitter to

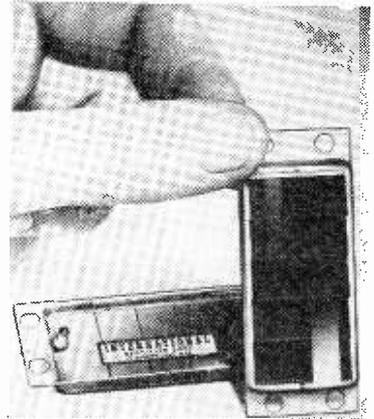


d.c., with the a.g.c. applied to the base. This causes the i.f. input impedance (input to the emitter) to vary widely with the a.g.c. action: thus, on a strong signal, the input impedance of the i.f. transistor is increased as its gain is reduced. The increase in input impedance disturbs seriously the matching of the i.f. amplifier to the previous stage (usually the mixer) to which it is matched for maximum signal-power transfer at maximum sensitivity, so reducing the signal transfer and giving the effect of a.g.c. applied to two stages. Alloy-junction transistors are more suitable for this circuit than rate-grown types, as alloy-junction transistors exhibit a greater change of input impedance for a given change in emitter current.

Realistic Interference Generator has been developed by Mullard Research Laboratories as an instrument for testing the performance of television sets in unfavourable reception conditions. Realism of ignition interference is achieved by generating sparks with a motor-car sparking plug, while the mains-borne type of interference is provided by an electric shaver motor. Interference signals are picked up by a coil from the sparking plug and by a resistor from the motor and fed to 75-Ω coaxial output sockets via separate attenuators and matching networks. The sparking plug voltage is generated by

a valve pulse generator, using a television line-output valve working into a step-up transformer. This generator (a multivibrator) can either be repetitively gated to give bursts of pulses, or varied in p.r.f. by a saw-tooth sweep waveform from a Miller transistor circuit. The gate circuit can be locked either to an external 50-c/s signal or to the supply mains (in either phase), and a phantaron delay circuit allows the timing of the gate pulse to be adjusted so that the burst of interference pulses can be located anywhere in the television frame period including the frame sync pulses. Duration of the interference-pulse burst can also be controlled. The p.r.f. of the interference pulses is made variable (between about 30c/s and 170c/s) to simulate the effects of gear changes in a motor-car, which, of course, are accompanied by changes of engine r.p.m. and ignition-spark frequency.

Silicon Solar "Batteries" of high efficiency are now available to provide the same power output, watt for watt, as dry-cell and mercury-cell batteries. Supplied by the International Rectifier Co. (Great Britain), the units are intended for powering transistorized equipment during daylight operation and for charging storage batteries for continuous day and night operation. Each silicon solar battery contains five series-connected 1cm × 2cm solar cells, encapsulated in an epoxy resin to provide a strong, weatherproof housing. The output voltage is 1.75 volts at a temperature of 30°C and 1.5 volts at 65°C (typical operating temperature in direct sunlight). Direct replacement may be achieved by substituting one solar-cell unit for each 1.5-volt dry-cell battery, and adding as many in parallel as may be required to supply the necessary load current. Each unit will supply a load current of



approximately 35mA in direct sunlight. In applications calling for the charging of storage batteries, the solar-cell units can be used in conjunction with sealed nickel-cadmium accumulators.

Simplified Transformer Testing

By J. SKINNER*

THE testing method described in this article was developed to meet the requirement of rapid, accurate testing of large quantities of small power and audio transformers.

In Fig. 1 the arrows represent the relative instantaneous direction of the terminal voltages of each transformer winding. It is obvious that the series connection of the two secondary windings will produce either the sum or difference of the two voltages, depending on the phase of connection. Thus if the number of turns on each secondary are supposedly identical, then zero voltage will appear at the terminals if the windings are connected anti-phase. If a voltage does appear, then the cause is due either to the windings not being identical, or to a non-sinusoidal waveform.

Waveform distortion readings may be eliminated by the use of a non-saturating flux density. Values found to be suitable are (i) 8-9 kilogauss (kg) for silicon iron, (ii) 13-14kg grain oriented material, (iii) 15-16kg for C-Cores. Any measurable reading should now be due entirely to turns differences, the magnitude of error being generally in proportion to the voltage developed.

Fig. 2 shows an alternative and more versatile arrangement. Transformer A is a perfect specimen and is retained as a standard, while B represents the unit to be tested, both units, of course, are expected to be identical. We are, of course, not limited to a single secondary winding. In fact, any number of windings and taps may be tested.

Returning once again to the zero voltage obtained from balanced windings, there is a possibility that one winding is open circuited, or that there is no supply voltage. In fact, the test is a negative one. In addition, a faulty winding will certainly produce a voltage, but the same voltage will be produced by either a negative, or a positive, turns error. Fortunately, all doubts can be easily dispelled by a simple modification. It is apparent that an "out of balance" voltage will be the result of a turns error in either the secondary winding, or in the primary winding.

* Radford Electronics, Ltd.

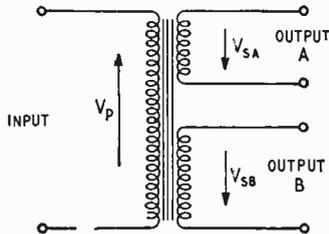


Fig. 1 Relative instantaneous voltages in a transformer is shown by arrows.

Defects Revealed by Connecting Output Windings in Anti-phase with Standard Component.

Furthermore, if we deliberately introduce a temporary error in the primary side of our standard unit, then "out of balance" voltages should appear at all test points. The voltage actually appearing at each point is predictable, and errors in turns ratio will be indicated by either an increased or by a decreased reading, thus indicating polarity of error.

It should be observed here that the indication of an error depends upon the turns ratio of the unit, and is therefore quite independent of variations in supply voltage. The magnitude of voltage readings

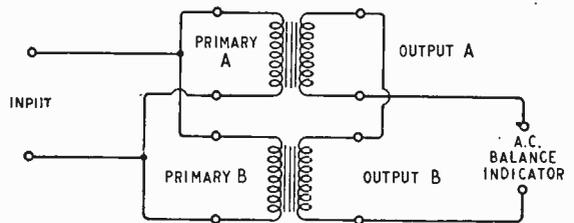


Fig. 2 Basis of testing procedure described in the text. Transformer A is a standard, transformer B the one under test.

are, however, subject to variations in proportion to the mains fluctuation.

The final form of our test set is as shown in Fig. 3. The deliberate error in standard unit A is effected by means of the tapped auto-transformer C. A switch is used to select either the under-voltage, which can be described as "Test Volts," or the ratio balance test voltage, which is described as "Test turns."

Finally a word of warning. If the unit "B" is accidentally connected "in phase" with the appropriate winding of "standard A," then the voltage applied to the indicator will be double that of each

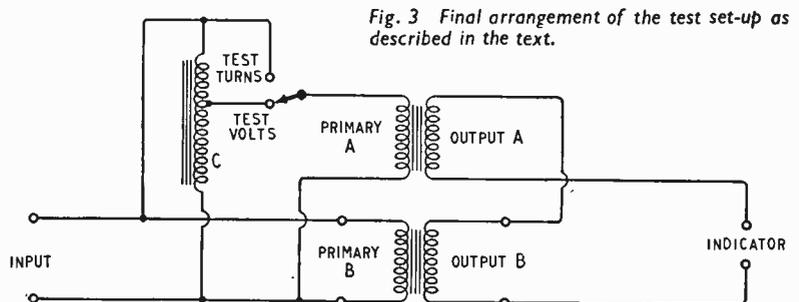


Fig. 3 Final arrangement of the test set-up as described in the text.

secondary. If the indicator is a moving-coil meter, adjusted to give a measurable reading of even 10% VA error, then a 200% VA overload will cause considerable damage. Alternative instruments, such as a valve-voltmeter, could, of course, be utilized, or a limiting device may be used.

Accuracies of the order of $\pm 0.5\%$ have been achieved by this method of testing, as many as seven test indications being made in one operation. Several

sets have actually been constructed by the author, and are still in use. They have been proved to be sensitive, accurate and extremely simple to use, even by unskilled operatives.

Acknowledgment.—The author expresses his appreciation of the facilities afforded for the development of this method by A. H. Radford, of Radford Electronics, Ltd., and for his assistance in producing this article.

Elements of Electronic Circuits

7.—AMPLIFYING DIFFERENCE VOLTAGES

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

THE cathode-coupled paraphase amplifier is sometimes known as a "cathode inversion circuit" or, more commonly, as a "long-tailed pair." Although it can perform a variety of rôles its main function is to accept and amplify the *difference* between the voltages appearing at the two grids, and to present them at the anodes as a balanced push-pull voltage.

The basic circuit is shown in Fig. 1. Two similar valves, with equal loads, R_L , and similar mutual conductances, have a common cathode resistor R_k . For the correct functioning of the circuit it is necessary for the cathode current (i.e., the total valve currents) to be as nearly constant as possible and independent of any changes caused by varying inputs to the grids. To achieve this, one end of R_k is taken to a large negative voltage and

the value of R_k is adjusted to give the required current sufficient for Class A bias in the absence of signal. A constant-current valve (pentode) can be used instead and is preferable. The constant current in R_k divides equally between V_1 and V_2 ; therefore if the anode current in V_1 is caused to rise, the current in V_2 must fall by a corresponding amount.

A symmetrical voltage applied to both grids will produce no effect in the anode circuits. Now suppose an asymmetrical voltage is applied to the grids, $+v$ to V_1 and $-v$ to V_2 :

$$I_{a1} \text{ will increase to } I_{a1} + g_m v$$

$$I_{a2} \text{ will decrease to } I_{a2} - g_m v$$

(Note that the total current remains constant.) The result of this is that the difference voltage is amplified and appears as a balanced push-pull signal at the anodes. The voltage between the anodes is ex-

pressed by the relationship $g_m R_L$ multiplied by the difference voltage at the grids.

Now suppose the voltage on V_2 grid is fixed while the voltage on V_1 grid is permitted to increase. Ultimately all the available current will flow in V_1 , and V_2 will become cut-off. The cathode voltage will continue to increase and follow the voltage on the grid of V_1 , in other words the cathode voltage will always tend to follow the more positive grid.

An important application of the cathode-coupled paraphase amplifier is to computer circuits, as a means of obtaining sum and difference voltages. Suppose we apply positive-going pulses to the grids of V_1 and V_2 . The difference in voltage appearing at the anodes is proportional to the difference between the input voltages. The voltage appearing at the cathode is proportional to the sum of the input voltages. Two trains of voltage pulses occurring at different intervals and applied to the two grids of the amplifier will therefore result in the production at the cathode, and between the anodes, of waveforms proportional to the sum and difference of the input trains.

Before passing on, next month, to somewhat different subjects, it is perhaps appropriate at this point to mention another useful type of two-valve circuit—the cascade amplifier. On account of the very high amplification which can be obtained with the minimum of positive Miller feedback from output to input, the cascade method of connecting two triodes, as shown in Fig. 2, is quite often adopted as an alter-

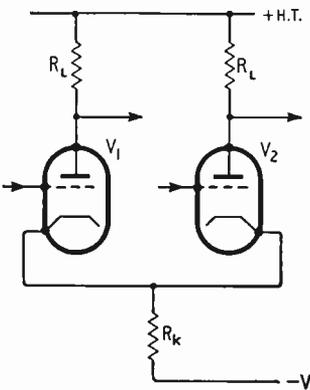


Fig. 1

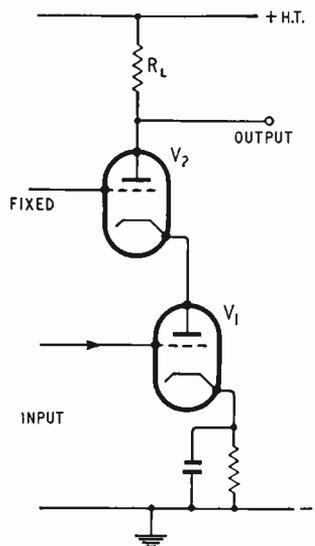


Fig. 2

native to the use of pentodes in wideband amplifiers.

By connecting two triodes having similar mutual conductances in cascade, it is possible to obtain an effective anode impedance of value approaching that of a pentode, thereby permitting the use of large anode loads. If the two triodes have individual slopes = g_m , amplification factors = μ and anode impedances = R_a , then when connected in this manner the composite circuit behaves as if it were a single valve of slope g_m , anode impedance μR_a and amplification factor = μ^2 .

It is theoretically possible to connect more than two valves in cascade, thereby obtaining very high amplification factors—the index by which μ is raised depending on the number of valves connected in this way.

If the circuit in Fig. 2 is examined it will be noted that the grid of V_2 is held at a fixed positive poten-

tial. The input signal is applied to the grid of V_1 and appears at the anode of V_1 in opposite phase but not amplified. The reason for this lies in the fact that the impedance presented to V_1 by V_2 is low. The anode load of V_1 is actually the cathode impedance of V_2 which approximates to $1/g_{m2}$. As this is a small load for V_1 the approximation $g_{m1}R_L$ can be assumed as representing the gain of stage V_1 . Substituting $1/g_{m2}$ for R_L , we have that the gain of stage $V_1 = g_{m1} \times 1/g_{m2}$, but as V_1 and V_2 are arranged to have identical slopes, i.e., $g_{m1} = g_{m2}$, therefore the gain of stage $V_1 = g_{m1} \times 1/g_{m1} = 1$. The stage V_1 does not amplify.

The inverted input signal appears at the anode of V_1 and hence at the cathode of V_2 . As the grid voltage of V_2 is held at a constant value, the V_2 cathode voltage variations appear at the anode of V_2 reversed in phase but amplified.

AMMONIA-MASER PROGRESS

SEALED-OFF OSCILLATOR UNDER DEVELOPMENT

THE development of a small, robust and lightweight frequency standard with a stability of better than 1 part in 10^9 is a thing many people dream of for use in navigation and communications. At present two devices—the ammonia maser and the caesium clock—offer the required stability, but until recently both have been regarded as research-laboratory items, rather than pieces of apparatus that could, for instance, be used in an aeroplane or at a u.h.f. communications link.

Ammonia masers have been demonstrated publicly*; but, although the size of the maser itself has been acceptable, it has been continuously pumped; the vacuum pumps and other ancillary apparatus bringing the total bulk up to that of a small wardrobe. However, work in progress at Glass Developments, Ltd., indicates that a sealed-off maser and its control and supply equipment will be possible within a volume of about 1 cu. ft., the maser itself being about 12-in long and 3-in diameter. Several improvements in internal design have made this possible—for instance, the shortening to a few inches long of the “tunnel” in which electrostatic separation of the active from the inactive molecules is carried out. The basic principle of operation of the sealed-off maser is that a charge of ammonia gas is placed in the device and frozen in a reservoir behind the collimator, which consists of an array of parallel tubes. As the gas evaporates it passes through the collimator to form a molecular beam which enters the electrostatic separator in the normal manner of the ammonia maser†. The unwanted “inactive” molecules are condensed on the liquid-nitrogen-cooled sides of the maser envelope. After about 100 hours of operation the stored ammonia is exhausted; then the maser is simply inverted in the nitrogen bath. The reservoir behind the collimator is now the coldest part of the

maser and, as the gas evaporates from the sides of the vessel it passes back into the reservoir and is frozen there. This re-circulation of the ammonia can be carried out any desired number of times and takes about one hour to complete.

Due to the re-circulation process, it may be possible to use ammonia compounded with the relatively expensive nitrogen isotope N^{15} instead of the more common N^{14} . Swiss work indicates that this will increase the stability of the maser output because the frequency spectrum exhibited by N^{15} ammonia is much narrower than that of the N^{14} variety, thus reducing the frequency-pulling effect that can be exerted by the cavity.

The high-voltage supply for the separator and the cavity-temperature control equipment will use transistors, and these items, together with a frequency divider to give outputs at integral frequencies such as 30Mc/s, 10Mc/s, 1Mc/s and 100kc/s locked to the maser, make up the rest of the equipment.

“Wireless World” Diary

TECHNICAL and general information of the kind so often needed by radio men but seldom readily available will be found in tabloid form in the 80-page reference section of the 1960 *Wireless World* Diary. Some idea of the diversity of information it includes will be gathered from this selection from the contents: aerial dimensions and aerial sharing circuits, licensing regulations, addresses of radio organizations in this country and abroad, world television standards, radar frequency bands, component coding, U.K. television and v.h.f. sound broadcasting stations and tabulated base connections for over 700 current receiving valves.

The Diary costs 6s 3d (leather) or 4s 6d (Rexine), including P.T. Overseas prices, including postage, are, respectively, 5s 8d and 4s 2d.

* See *Wireless World*, Vol. 65, p. 126 (March, 1959).

† “Masers” by “Cathode Ray,” *Wireless World*, Vol. 65, p. 197 (April, 1959).

Reception of Space Diversity

OBSERVATIONS OVER LONG-DISTANCE PATH TO EVALUATE

THE British Broadcasting Corporation recently provided a series of transmissions to test the effectiveness of transmitter space-diversity on reception at distant points. Both very widely-spaced and relatively closely-spaced transmitters were used in the tests. The transmissions were at a frequency of 9,510kc/s, directed towards the east coast of the United States. Transmitting conditions were switched at intervals of approximately fifteen minutes during the testing period each day.

Observations of the received signals were made at the National Bureau of Standards Laboratories in Boulder, Colorado, from November 3, 1958 to November 14, 1958. The recordings obtained during these observations have been analyzed for fading characteristics and intelligibility, and the results of the analysis are given in this article.

Test Procedures, B.B.C. Transmissions.—The transmitters were located at Daventry and Woofferton in England. Two transmitters at Daventry were used for close-spaced diversity tests and one at Daventry and one at Woofferton for the wide-spaced diversity tests. Centre-to-centre spacing of the two antennae systems at Daventry was 1,540ft with one antenna SSW of the other. The wide-spaced diversity transmitting systems were separated by approximately 65 miles in an east-west direction and all antenna arrays were directed on a bearing of 294°. The schedule of transmissions during the test period each day was as follows:—

2345 to 0015 G.M.T.—Daventry transmitter A
0015 to 0030 G.M.T.—Daventry transmitters A and B
0030 to 0045 G.M.T.—Daventry transmitter A
0045 to 0100 G.M.T.—Daventry transmitter A and Woofferton transmitter C

The transmitter carrier frequencies were all phase locked to each other.

N.B.S. Receiving Arrangements.—A horizontal half-wave receiving antenna, elevated one-half wavelength above the ground, was used for the observations at Boulder. The audio output of a Type SP600 receiver was fed to a magnetic tape recorder; this receiver had an intermediate frequency bandwidth of 8,000c/s. A second SP600 receiver, with an intermediate bandwidth of 800c/s, was used for carrier-envelope recordings. The a.g.c. voltage of this receiver was used to operate a strip-chart recorder. Receiver linearity and recorder-circuit time constant are such that voice modulation did not noticeably affect these recordings. The receiving system for the strip-chart recorder was calibrated on the basis of available received power in a matched load at the antenna terminals.

Results of Observations.—Rapid flutter fading, at about 5 to 10c/s, occurred on six of the twelve days that observations were made. A section of the great-circle path from England to Boulder is near the zone of maximum auroral activity, and flutter fading is characteristic of high-frequency ionospheric-pro-

$P_1 = 100 e^{-X^2}$, CUMULATIVE DISTRIBUTION OF ENVELOPE FOR RAYLEIGH FADING SIGNAL.

$P_2 = 100 [1 - (1 - e^{-X^2})^2]$, PERCENT PROBABILITY THAT ONE OF TWO UNCORRELATED RAYLEIGH FADING SIGNALS WILL BE GREATER THAN THE ORDINATE.

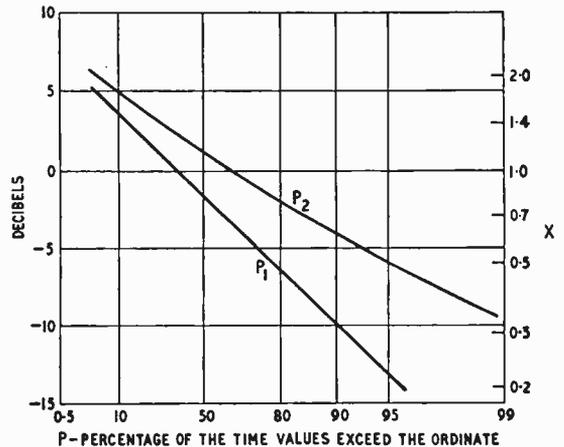


Fig. 1. Theoretical distribution of signal envelope.

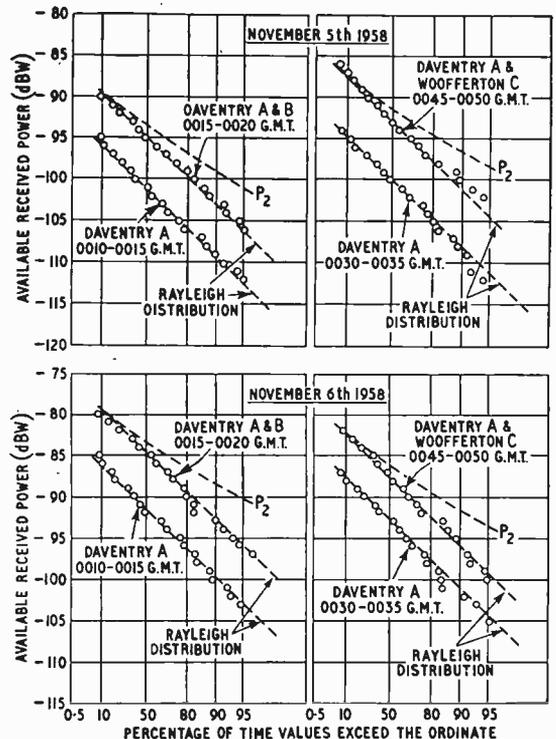


Fig. 2. Distribution of signal envelope amplitude.

Transmitters

By J. W. KOCH*

THE USEFULNESS OF THE SYSTEM

pagated signals passing through auroral disturbed regions. Critical analysis of the received signals was carried out only for days when the flutter fading did not occur.

The variations in the received envelope amplitude for a signal propagated by the ionosphere are expected to have a Rayleigh distribution in time¹. The fading signal may then be represented by the formula:—

$$P = 100 \exp(-x^2)$$

where P is the percent probability that the signal voltage will exceed the value x. This expression is plotted as the curve labelled P₁ in Fig. 1. The curve labelled P₂ is a plot of the expression:—

$$P_2 = 100(1 - [1 - \exp(-x^2)]^2)$$

This is the percent probability that one of two uncorrelated Rayleigh fading signals will be greater than x. If a system is operating as a two-order diversity system, the amplitude distribution of the received signal envelope would be expected to approach that of curve P₂.

The amplitude distributions of the received signals are plotted in Figs. 2 and 3 for all conditions of the test transmissions on November 5, 6, 7 and 12. The plotted points were obtained by sampling the strip-chart recordings at one-second

intervals. It is to be noted that the received signals are very nearly Rayleigh distributed during all periods. This indicates that the depth of fades did not change appreciably for any condition of transmission.

Variation of Median Signal Levels.—The variation of received median signal levels from one transmission condition to the next is given in Fig. 4. It is noted that in most instances the level is 5 to 6dB higher with two transmitters than with one. It is not known at the time of writing whether or not all transmitter powers and antenna systems were the same†. If they were, there is an apparent directive gain towards Boulder with two transmitters operating; otherwise a 3dB increase in signal level would be expected.

Fading Rates.—The observed fading rates (positive median crossings) are given in the following table.

TABLE

Average Fading Rates Observed on B.B.C. Transmissions at 9,510 kc/s				
Observation period-G.M.T.	Nov. 5, 1958	Nov. 6, 1958	Nov. 7, 1958	Nov. 12, 1958
0010-0015	c/s	c/s	c/s	c/s
0015-0020	0.943	2.11	1.08	1.66
0030-0035	0.806	1.33	0.98	1.61
0045-0050	0.905	1.19	1.40	2.08
	0.714	1.38	1.26	1.66

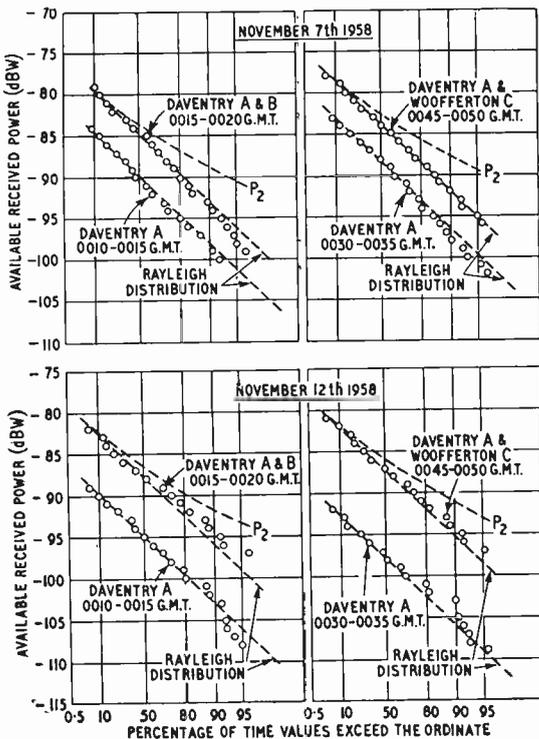


Fig. 3. Distribution of signal envelope amplitude.

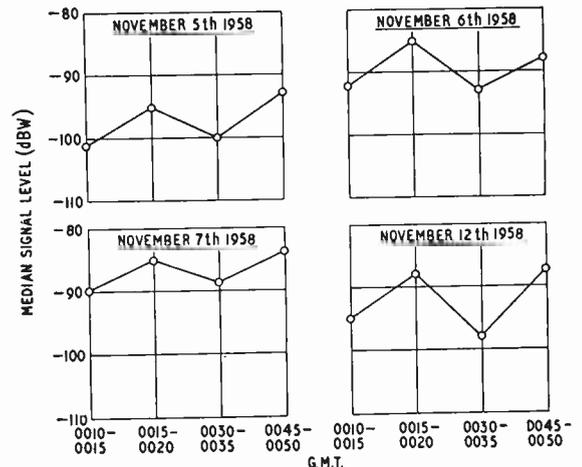


Fig. 4. Median signal level variations.

* Boulder Laboratories, National Bureau of Standards, U.S.A.
 † From information obtained antenna gains were almost identical at 20dB with reference to a dipole in free space. Transmitter outputs were not the same, however, some being 50kW others 70kW. Ed.

There is no significant difference in fading rate for any transmission condition.

Recordings.—Tape recordings of the received audio signals were reproduced for several observers. After comparative listening tests most observers indicated a preference for the transmissions when two transmitters were operating simultaneously. The difference in intelligibility and quality was not great, and it is believed the small improvement noted was due to the higher average signal level rather than to any significant difference in fading characteristics.

The rapid flutter fading observed for all transmission periods on some of the days caused a sharp

decline in intelligibility, and there was no real difference between any of the transmission conditions.

Conclusions.—There is apparently no advantage to transmitter space diversity for transmission over long distances *via* the ionosphere. The signals from the two transmitters combine in such a manner that the resultant field at the receiver is Rayleigh distributed; hence there is no realizable diversity gain. The fading rate was not significantly changed for any method of transmission.

REFERENCE

¹ "Ionospheric Radio Propagation," National Bureau of Standards Circular 462, p. 108, June, 1948.

Stereophony in the Open Air

A SUCCESSFUL sound-reproducing system was installed by Telefunken at the Federal Horticultural Show held this year in Dortmund.

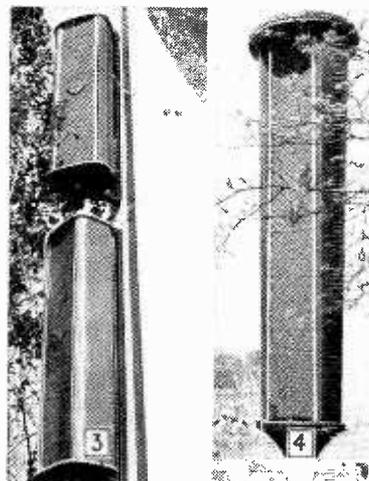
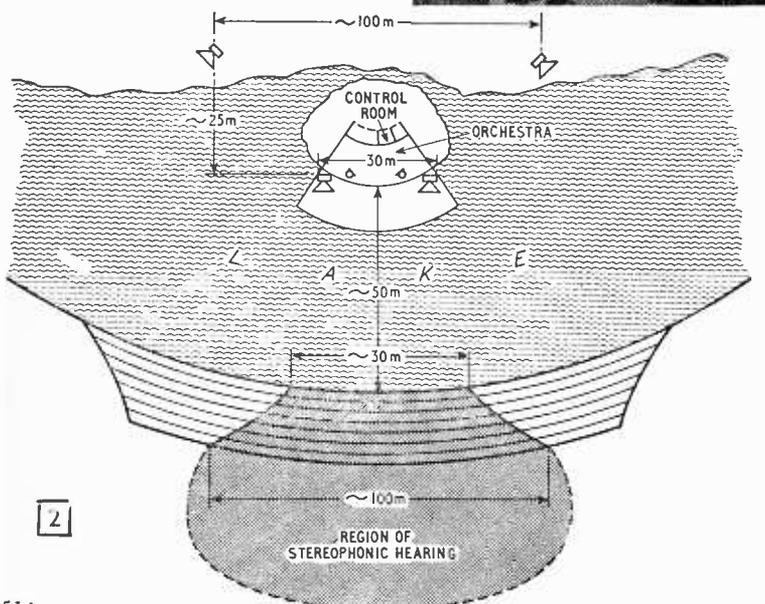
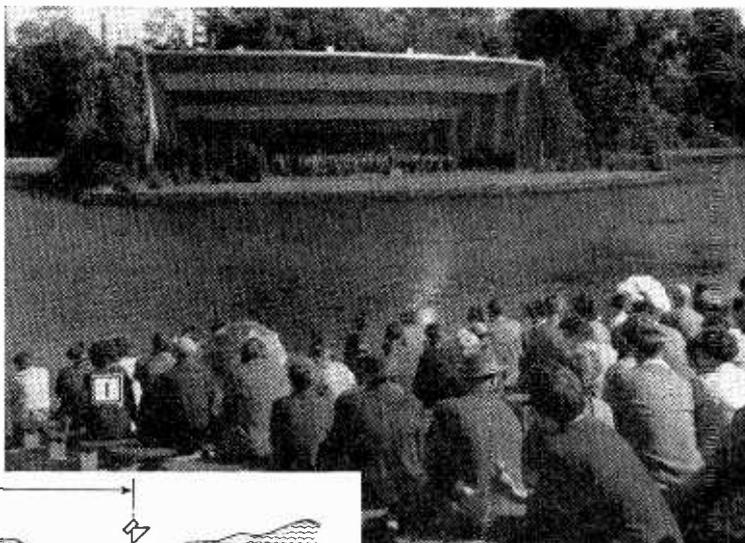
In view of the limited knowledge available of open-air stereophony, tests were first made on a building site in Hannover and the results obtained from these series of trials were used as the basis for the design of the Dortmund installation.

A power of 300 watts is provided for each stereophonic channel. Sound columns, which comprise a total of

48 units are used as loudspeakers. These sound columns are distributed over a base of 100 metres and permit stereophonic sound reproduction over an area with space for about

6,000 persons. The installation can be used either for sound reinforcement of the live orchestra on the stage or for reproduction of stereo records.

1. General view of the open air stage at Dortmund. In the right foreground a technician with microphone and transistor amplifier is giving instructions for quality control and balance. 2. Plan of the Telefunken open-air stereo installation at Dortmund. 3. Pair of column loudspeakers mounted on the sides of the stage. 4. Separately mounted column loudspeaker at one end of the 100-metre stereo base line.



MISSING SIGNPOSTS

By 'CATHODE RAY'

IT DOESN'T ALWAYS DO TO ASSUME EVERYONE KNOWS THE WAY

LAST June, while holding a joint post-mortem with my daughter on her A-level physics and maths papers, I found myself at one with her in disapproval, though not always for the same reason. If I had had to sit the exams (which, thank goodness, I hadn't) I'd have quite often wanted to ask the tight-lipped invigilator what one was supposed to assume. To me, some of the questions were by no means unambiguously put. The actual candidate, having for months past been practising on an endless succession of similar (though, she assured me, much easier) questions, was less worried by that particular aspect. It seems the assumptions were pretty well established according to some unwritten rules of exam papers.

Being rather slow on the uptake myself, perhaps I am excessively sympathetic with students about things they are supposed to know without being told. Nevertheless I feel sure quite a lot of apparent stupidity is really the fault of the teachers.

Take vector diagrams. Fig. 1 (a) and (b), showing an a.c. circuit and its vector diagram, come from a recently published elementary textbook on electrical engineering. I want you to notice particularly the arrow-heads in both diagrams. (But not the blacking-in to distinguish current from voltage, which is my own fancy.) Having looked up a number of other books, both British and American, elementary and advanced, and leaning either to power or electronic engineering, I can assure you that in this respect at least these diagrams are typical; so if the author recognizes them he will have the satisfaction of knowing he sins in bad company.

The accompanying text explains that OA represents the p.d. across R^* , and so on, ending with OE as the voltage V across the whole lot. And we are supposed to know (but how often are beginners told?) that the arrow-heads in the vector diagram are there to show which ends are not the pivots, *not* which way anything is moving.

What about those on the corresponding circuit diagram? The one marked "I" is presumably meant to show the direction of current flow (in the conventional sense, as a flow of positive electrical charges) which the author of the diagram has chosen to regard as positive. So if the vector diagram were to show that at any given moment the current was negative it would mean that it was flowing against the arrow-head. This device is commendable, especially if backed up by its consistent use for the other quantities involved.

How then about the arrows each side of "V". According to the system for "I", they would mean that the voltage was acting both ways at once! Perhaps (someone suggests brightly) they are to show that the voltage is alternating. Driving a d.c.? Notwithstanding the one-way current arrow, the generator symbol with its little picture of a sine wave makes

*Incidentally, how few books warn their readers that the "vectors" used in a.c. diagrams are not vectors at all in the strict sense! Without such a warning, one may well wonder how a non-vectorial quantity such as p.d. manages to appear in a diagram as a vector.

the a.c.-ness of the circuit quite clear. No; evidently the "V" arrows are used in yet another sense—to indicate the points between which V exists. Then why, if the author has taken the trouble to show us which he has chosen to be the positive direction of current flow, has he left the matter completely ambiguous as regards voltage?

Why, indeed!

Not having any of the numerous authors who do this sort of thing at hand for interrogation concerning the strangeness of their habits, I must try to guess what they might say. And as I don't find any of these guesses really adequate or convincing, we must hope that some spokesman will come forward to supply the missing key (if any) which so far seems to have been withheld.

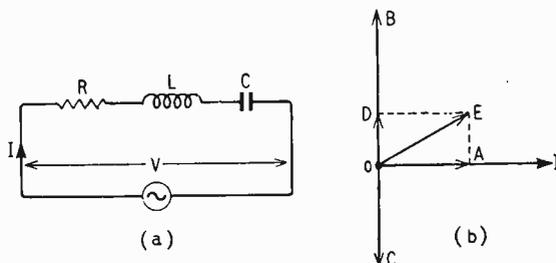


Fig. 1. A typical a.c. circuit diagram and corresponding vector diagram. What are all the arrow-heads for?

One reason (they might say) is that as soon as a choice has been made for "I," the nature of the circuit determines the direction of the voltage, as the vector diagram shows. If, before making a vector diagram or examining the circuit, a direction were assigned to "V," it would be pre-judging the result.

Well, of course, these authors might be excused for resenting my putting such a feeble excuse into their mouths, but I'm doing my poor best for them in very difficult circumstances. If they're not satisfied I'd be delighted if they would conduct their own defence.

Reverting to the role of prosecutor, I would reply that in many circuits (including the one under discussion) a current in one direction is accompanied during each cycle by voltage of both polarities.

"Splendid! splendid!" exclaim the authors, "That's just what we meant by the two-faced direction sign for V!"

But it really won't do. The sort of thing I want the vector diagram to tell me—and which, I imagine, is what most other people expect from it, too—is which terminal of the generator is positive at some phase of the cycle; say the one depicted, at which the current is just changing over from negative to positive.

The authors—or at least the one responsible for

this particular diagram—would probably then retort that if I had read his painstaking explanation of how this vector diagram was constructed, or if I had the least clue to elementary a.c. theory, I would know perfectly well that the e.m.f. of the generator would then be acting around the circuit in the direction of the current arrow, and so the left-hand terminal would be positive.

To which I would reply that if the only purpose of the vector diagram was to show something that was already abundantly obvious (or, alternatively, if it were not obvious, something that one had to go all through the construction of the vector diagram to find out) it would be about as much good as a portable signpost which needed a knowledge of where the roads led before it could be correctly set up.

If Fig. 1(a) had been supplied with an earth symbol attached to the right-hand terminal of the generator, then one could reasonably have been expected to gather that the polarity of the vector representing V was the polarity of the left-hand and relative to the other. But it just wasn't supplied. And even if it had been there would have been uncertainty about voltages between points not earthed.

It might be that our authors in the dock would take a different line of defence. They might point out to me (slowly and clearly, as to a small child or mentally retarded pupil) that a positive voltage would be that which, when in phase with a positive current, was in the same direction. That *could* settle the matter if more information were available than is in fact vouchsafed by the authors in question. Consider Fig. 2, together with the information from a vector diagram or otherwise that the voltage is in phase with the current. Which wire is positive; top or bottom?

If the "voltage" we have been talking about is an e.m.f.—the e.m.f. driving the current I —and its source is in one of the boxes in Fig. 2, and if we know which box, then we know the answer. If not, we don't.

Whichever wire is positive with respect to the other, each box inevitably has a voltage between its terminals equal and *opposite* to the voltage in the other box in its direction *around* the circuit. So linking the voltage between two points with a current

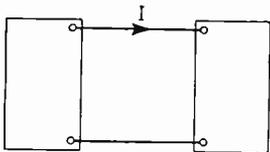


Fig. 2. Which connecting wire is positive when the current is positive?

arrow gives (in absence of further information) two exactly opposite answers. Such confusion would be avoided by the simple act of omitting one of the arrow-heads associated with V in Fig. 1(a). With Fig. 1(b) as it is, the right-hand arrow-head would be the one to go. If, however, the author had not been such a clever man that he knew it all before he started, but guessing blind had happened to put his one "V" arrow on the right, it would have meant that all the voltage vectors in Fig. 1(b) would have had to point the opposite way. That might not have been conventional but it would have been quite right.

Right, that is, according to the conventions of this particular author, which are not followed by all. They could easily be a cause of confusion in circuits

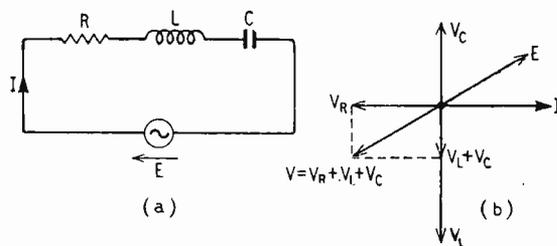


Fig. 3. Alternative and more helpful version of Fig. 1.

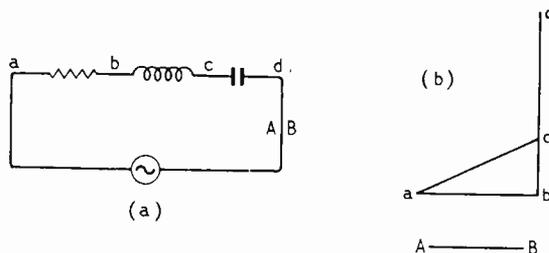


Fig. 4. Another and still more helpful version, if you know the conventions.

which, unlike this one, are not simply a single source of e.m.f. feeding current to passive circuit elements. His convention is to make each voltage vector represent the e.m.f. (coming from elsewhere) needed to drive the current through that part of the circuit. Adding them all up gives the total e.m.f. of the generator.

Personally I prefer to work according to Kirchhoff's Second Law in the form "The algebraical sum of the voltages around any closed loop is zero," because it is based on the obvious fact that the same point cannot be at two different potentials at the same time. So in Fig. 1(a) the e.m.f. of the generator would be equal and *opposite* to the sum of the separate voltages across R , L and C . This version is given as Fig. 3.

But that is only a compromise. The one completely unambiguous, consistent and universal system of vector diagrams, free from d.c.-like arrows and coincident vectors (I might as well be hung for a superintendent as a constable) is my own, expounded in the July-September, 1954, issues. Fig. 4 is how the same circuit looks in that version.

In such a simple circuit it doesn't matter much which system one uses; what does matter is that when the system is applied to circuits about which the vector diagram, once constructed, tells people something they can't easily see otherwise, it leaves no room for uncertainty or error. The circuits I am thinking of particularly are those containing more than one source of e.m.f., so that one cannot assume that the current will be flowing externally from the positive to the negative terminal of any source; some other source may be driving current back through it.

A very simple example of how useless the common system is can be seen by comparing the triode "equivalent circuit" in the same book with the valve circuit it is supposed to represent. They both appear here as Fig. 5. We only have to ask one simple question, to which we might reasonably expect

(Continued on page 517)

a clear and unmistakable answer: When E_i is positive, is V_o positive or negative? Or, since the diagrams are so drawn that the statement that E_i (or V_o) is positive hasn't even any meaning, let's try to be co-operative and word it this way (though we really ought not to be put to such trouble): When E_i is such that the grid is positive with respect to the filament, which end of the load resistance is positive?

Well, this equivalent circuit diagram can't even tell us that! We have to go back to electronics and work it out for ourselves. So what use is the diagram? It does tell us the amount of voltage amplification. But not its sign. If, in the absence of any help from the author, we were to do a bit of reasonable guessing, and assume that he was following the customary convention of reckoning the lowest part of the circuit diagram as "earth," then positive E_i would mean a relatively positive grid, and the end of R not earthed would (according to the diagram) be positive. Which is wrong.

When the system breaks down so lamentably with even such an extremely simple circuit as this, what hope is there with really complicated ones, having numerous branches, unearthed points, negative resistance, feedback, mutual inductances, etc? I just wouldn't know, and that was why I was driven to invent my own system. However, at this moment I'm not asking people to accept that but just to use any system so long as they put in all the necessary signposts.

There is one difference between these electrical signposts and the geographical sort that makes them either easier or more difficult—I'm not sure which. If the local authorities of York set up a signpost in their city marked "LONDON→", travellers couldn't be blamed for complaining if the direction so marked led straight to Edinburgh. The fact that all the other signposts in Great Britain were similarly reversed would hardly be considered satisfactory. But we have just had occasion to remark that electrical signposts can all be reversed without giving any proper ground for complaint. Considering that in a.c. circuits all the currents and voltages are continually reversing themselves, that is not surprising. The comparison does, however, emphasize the contrast between things that are necessarily so (facts) and things that can be as we choose (conventions). Quite a lot of confusion and argument result from failure to appreciate this.

Take language. "When I use a word," Humpty Dumpty said, "it means just what I choose it to mean." And (if Humpty Dumpty is taken to represent the people who speak any particular language) he was perfectly right. Although the present English-speaking people make the word "prevent" mean something quite different from what those living 300 years ago did, neither lot of people can be declared wrong, because both chose to make the word mean those things. The trouble comes when different people choose to make it mean different things at the same time without making that fact clear. "Democracy" is a notable example.

It would be extremely awkward (though perhaps a valuable discipline?) if everyone had to explain what they meant by all the words they used; and so we try by means of dictionaries and otherwise to achieve the maximum agreement, as a matter of practical convenience. We also try to achieve agreement in the use of mathematical symbols, but to make sure almost any reputable scientific book or

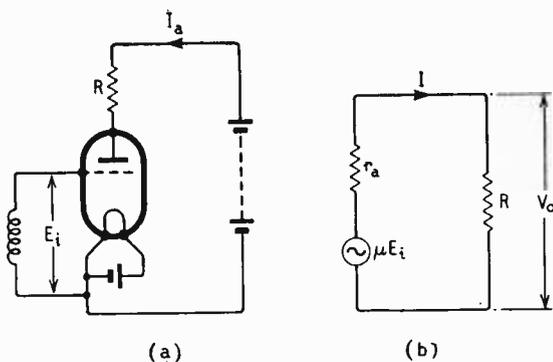


Fig. 5. Simple valve circuit and its "equivalent." In this form, does it really help?

paper is preceded by a list of those used and their meanings.

In all conventions it is desirable that they should be (1) accepted and used by all concerned, (2) convenient, and (3) logically based. Sometimes they are tolerated when they are inconvenient or illogical or both, because they are so widely used that great confusion would be caused trying to alter them. (As readers may have noticed, I am less impressed by this argument than some.) Sometimes, as with words such as "infer," "protagonist," and "anticipate," all three requirements are overthrown by sheer weight of ignorance, and one is never sure whether the correct-by-dictionary use of them will be properly understood.

More trouble comes when conventions and facts are confused. I mentioned some time ago the celebrated controversy about the nature of white light. Does the spectroscope develop coloured light from it, or does it pick out colours already there as ingredients? These alternatives were later seen to be two different ways of looking at the same thing, and the question of right or wrong shouldn't have arisen. In the same way one person might argue that a metal sheet reflects radio waves, preventing them from proceeding further; another might contend that the waves do go on, but are neutralized by waves re-radiated both forwards and backwards by the metal. It would be a pity to come to blows over it. Or over vector diagrams. But do, please, let all necessary signposts be present and their conventions made clear.

I.E.E. PREMIUMS

OVER half the premiums recently awarded by the I.E.E. for 1958 are for papers on radio or electronic subjects. The Institution's premier award, the Kelvin Premium (£25), was given to Dr. P. N. Butcher (R.R.E.) for his paper "Theory of three-level paramagnetic masers." The Blumlein-Browne-Willans Premium (£20) is awarded to Dr. D. Gabor, Dr. P. R. Stuart and P. G. Kalman for "A new cathode-ray tube for monochrome and colour television"; and the Heaviside Premium (£15) to Z. Godzinski, of Poland, for two papers on groundwave propagation.

The Electronics and Communications Section's Duddell Premium (£20) goes to Dr. A. E. Karbowiak for "Micro-wave aspects of waveguides for long-distance transmission"; and the Ambrose Fleming Premium (£15) to G. D. Monteath for "The effect of the ground constants, and of an earth system, on the performance of a vertical medium-wave aerial."

Manufacturers' Products

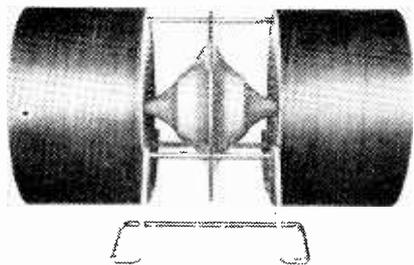
NEW ELECTRONIC EQUIPMENT AND ACCESSORIES

Two Tweeters

IN two new Burne-Jones treble loudspeaker units fixed curved-sided cones in front of the speaker cones provide uniform distribution of the sound in a plane at right angles to cones' axis and also some loading of the sound. The magnetic flux density in the speakers is 7500 gauss, and the recommended crossover frequency 900c/s.

In the "Treble 20" the single loudspeaker faces downwards on to two cone reflectors, the upper reflector having a central hole and being for the sound from the outer part of the loudspeaker cone, and the lower being for the sound from the voice-coil dome and inner part of the cone. When this loudspeaker unit is stood on a flat sound-reflecting surface, this surface acts to some extent as an extension of the lower cone reflector. This unit gives a uniform horizontal distribution of sound.

In the "Treble Twin" two nominally similar loudspeakers are used, thus giving a larger radiating area. Because the sound from the two speakers is combined, any differences between their responses are evened out. The two loudspeakers are connected electrically in phase and face each other; each also faces a single cone reflector as in the photograph. This arrangement gives a uniform distribution of sound in the plane at right angles to the loudspeaker and reflector cone axes (this plane is vertical and at right angles to the paper for this photo-



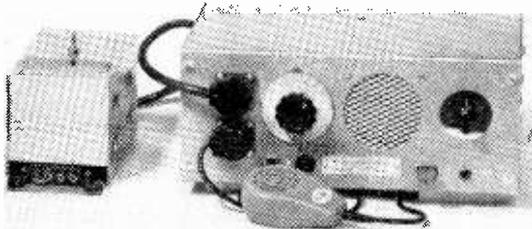
Burne-Jones "Treble Twin" tweeter.

graph). Moreover, the sound is beamed within a few tens of degrees ($\pm 20^\circ$ at 4kc/s) of this plane. The bracket for mounting this loudspeaker unit on the wall is shaped so as to allow the plane in which the sound distribution is uniform to be made horizontal or vertical, thus giving a choice between uniform or beamed sound in a horizontal plane.

The Treble 20 costs £9 10s 4d, and the Treble 20 £7 (both sums include purchase tax). These units are available from Burne-Jones & Co., Ltd., of 18 Brunswick Rd., Sutton, Surrey.

Amateur V.H.F. Transmitter-Receiver

THE equipment illustrated is a complete 2-metre transmitter-receiver designed for either mobile use in a car or as a fixed station. Designated the "Communicator Mark 2" it utilizes 16 miniature valves, 11 being in a double-superhet receiver covering 143 to 147Mc/s and 5 in a crystal-controlled transmitter, which together with loudspeaker are housed in a metal case measuring 13in \times 5 $\frac{1}{2}$ in \times 8in only. The transmitter output valve is a QQVO3-10A double tetrode operated at 15 watts with screen and anode modulation. Input impedance of the



R.E.E. 2-metre amateur transmitter-receiver, microphone and power unit.

receiver, and output impedance of the transmitter, is 75 Ω .

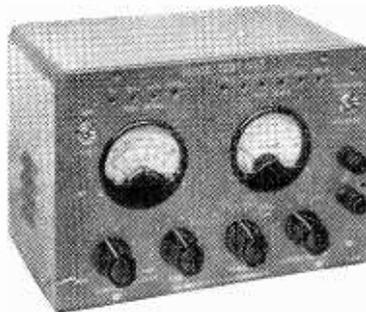
A press-to-talk switch on the hand microphone actuates relays in the equipment which make the necessary circuit changes for send and receive.

Power for mobile use is supplied by a 12-volt rotary converter taking 4A on receive and 5A on transmit. For fixed station use an a.c. mains power unit is available.

The price is £90 including rotary converter; the a.c. mains power unit costs £12 extra. The equipment is made by R.E.E. Telecommunications, Ltd., 15A, Market Square, Crewkerne, Somerset.

Diode Test Meter

RANGES from 50 μ A to 5A and 3 to 1200V for a full-scale meter deflection are provided in the Thompson (Instruments) Type ED8 diode tester for simultaneous current and test voltage measurements at dissipations

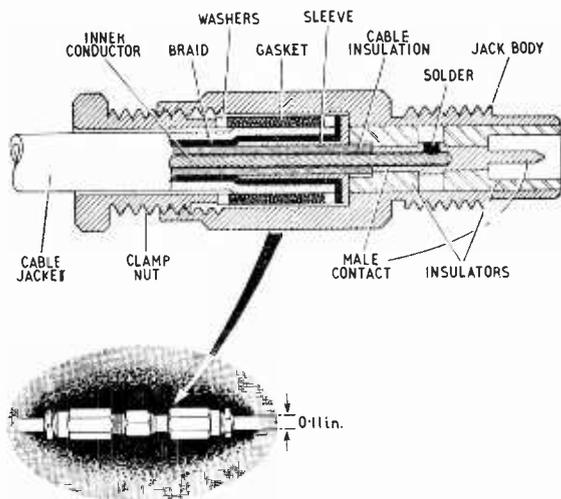


Thompson diode test meter.

up to 15W. A polarity reversal switch is provided so that both forward and reverse characteristics can be obtained without disconnecting the diode under test. This instrument costs £52 5s, and is manufactured by R. E. Thompson & Co. (Instruments) Ltd, Hersham Trading Estate, Walton-on-Thames, Surrey.

Sub-Miniature Coaxial Connectors

A RANGE of precision-made r.f. connectors to take sub-miniature coaxial cables of between 0.08in and 0.155in outside diameter are now obtainable from the Sealectro



Sealectro "Conhex" sub-miniature coaxial connectors
Types 3000 and 3001.

Corporation. Known as the "Conhex" series they are made of brass with beryllium-copper sockets and Teflon insulation. Metal parts are gold plated and the connectors are said to be suitable for use at microwave frequencies.

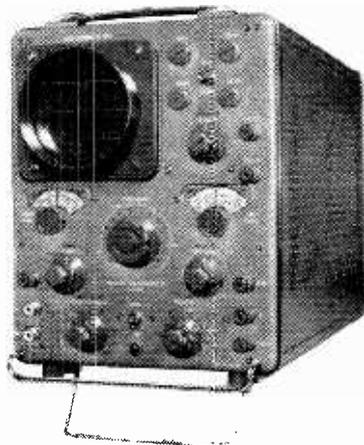
The connectors are available for cables of 50, 75 or 95Ω characteristic impedance and the matching is such that over the frequency range 1 to 9.3 Gc/s the voltage-standing-wave ratio is claimed to be within 1.1 and 1.3. Insulation resistance is better than $10^8 M\Omega$.

The sample illustrated comprises a Type 3000 plug and Type 3001 socket and is a cable-to-cable connector measuring only $1\frac{1}{8}$ in long overall and $\frac{3}{16}$ in diameter. Other types for chassis mounting are also available. When mated plug and socket parts are secured by a captive screwed collar.

Further details can be obtained from the Sealectro Corporation, Hershaw Factory Estate, Lyon Road, Walton-on-Thames, Surrey.

Measuring Oscilloscope

IN the Marconi Instruments TF1330 the d.c. Y-amplifier has a frequency response 3dB down only at 15Mc/s and a maximum sensitivity of 50mV/cm. The time-base sweep speed is variable from 1cm/sec to



Marconi Instruments TF1330 Measuring oscilloscope.

10^7 cm/sec in 15 ranges and can be increased up to 5×10^7 cm/sec using the X-expansion control. Both times and voltages can be measured to within $\pm 2\%$. If the trace should be deflected off the screen, a push-button switch is provided to reduce the sensitivity in a non-linear manner so as to return the trace to a corresponding position near the edge of the screen. The trace can then be easily returned to the centre of the screen using the shift controls. This instrument costs £300 and the address of its manufacturer is Marconi Instruments Ltd, St. Albans, Hertfordshire, England.

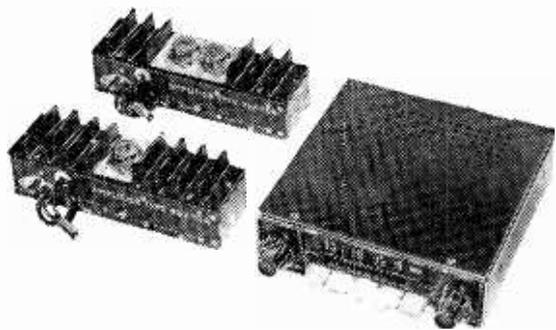
Transistorized Car Radio

TO the Radiomobile range of car radio receivers is now added a new series of hybrid units and a compact single-unit set, also of hybrid type.

Known as the 500T the units consist of a sensitive receiver, or control unit, giving push-button selection of five stations in the medium and long wavebands, as well as full coverage by manual tuning, and operating directly from a 12-volt d.c. supply. This employs four valves and an a.f. driver transistor. With this unit can be used one of two alternative transistor power-output amplifiers; either the Model A, which employs a single transistor giving 2.5 watts output, or the Model B which has push-pull transistors and gives 5 watts output. As can be seen from the illustration the power transistors are, in each case, mounted externally on finned aluminium "heat sinks."

The single-unit version, Model 50T, consists of a four-valve receiver with a single transistor output stage giving 1.75 watts, the whole consuming only 1.2A on a 12-volt d.c. supply. Manual tuning only is provided but medium and long wavebands are covered, although there is a model (52T) which is for medium waveband only. Likewise, in the unit series there is a medium waveband only unit, the 502T, for use where long waves are not required.

These units and sets occupy little space, the 500T receiver, for example, measures only $7\text{in} \times 7\text{in} \times 2\text{in}$ while the associated amplifier (A or B) Measures $2\frac{1}{8}\text{in} \times$



Smith's Radiomobile 500T series car receiver with alternative transistor power amplifiers alongside.

$7\text{in} \times 2\text{in}$. The overall size of the model 50T is $7\frac{1}{8}\text{in} \times 7\text{in} \times 2\text{in}$. Six-volt versions are also available.

Current prices are: Model 500TA (receiver with "A" amplifier) £21, plus £7 2s 10d U.K. purchase tax; 500TB ("B" amplifier) £23 1s 6d, plus £7 16s 11d U.K. purchase tax. The makers are, S. Smith and Sons (Radiomobile), Ltd., Goodwood Works, North Circular Road, London, N.W.2.

Two Very Low Frequency Generators

OUTPUT frequencies from 100c/s down to 10^{-4} or 10^{-5} c/s can be obtained from the Servo Consultants Model 111 or 110 generators respectively. In both



Servo Consultants very low frequency generator.

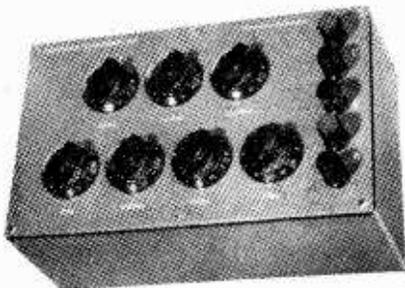
these generators the distortion is 1% at the maximum output of 30V and 10mA; the output impedance is 250Ω. The main part of both generators consists of a resolver whose rate of rotation is the signal frequency, f say, and whose stator is supplied with a 30V carrier signal at 2400c/s. The rotor output at a time t is then proportional to $30 \sin 4800\pi t \sin 2\pi ft$. The signal frequency f is obtained by rectifying this output using a phase-sensitive detector synchronized by the carrier signal. With this method of generation the amplitude of the output signal does not depend on its frequency but only on the carrier amplitude. This type of generator can also start and stop at any point on the waveform without introducing transients. Both these generators cost £265 and are manufactured by Servo Consultants Ltd, of 17 Woodfield Road, London, W.9.

Combined C and R Decade Box

DECADES of capacitance and of resistance are not usually combined in a single box but where bench space is strictly limited the combined unit has many advantages. A decade box of this kind introduced by R. E. Thompson and Company contains three decades of capacitance and four of resistance. In the general-purpose model the increments of capacitance are in steps of 0.001μF, 0.01μF and 0.1μF, while those of resistance are in steps of 100Ω, 1,000Ω, 10kΩ and 100kΩ respectively. Other combinations can be supplied by arrangement.

Normally polystyrene dielectric capacitors of 1% tolerance are fitted, but silvered-mica or other types can be substituted. All capacitors are normally 350-volt working and resistors high-stability ½W, 1% tolerance. There is an electrostatic screen connected to the "earth" terminal on the box between capacitance and resistance decades. Separate terminals are fitted for capacitance and resistance.

The box is made of stove-enamelled sheet steel with welded seams and measures 9½in × 6in × 5½in. Price

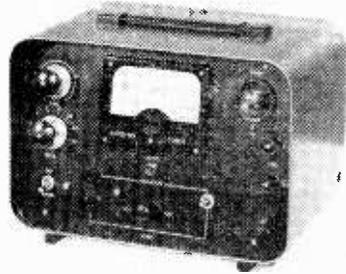


A combined capacitance and resistance decade box made by R. E. Thompson and Co

depends on the particular combination and type of components fitted, but the general-purpose model costs £18. The makers are R. E. Thompson and Co. (Instruments) Ltd., Hersham Trading Estate, Walton-on-Thames, Surrey.

Coil Bonding Equipment

ONE method of securing the turns of a coil wound with one of the new self-bonding wires is to pass an electric current through the coil. Sometimes it is advisable first



Avo coil bonding timer.

to check the insulation between coil and the mandrel (if metal) on which it is wound in order to ascertain what magnitude of bonding voltage is permissible.

The Avo "Bonding Timer" has been introduced to serve the dual functions of insulation measurement and time control of the bonding voltage. Insulation resistance can be measured up to 500MΩ and the application of heating current set for automatic control for periods ranging from 0.75sec to 2.5min.

The equipment is a.c. operated and mains voltage is normally used for coil heating, but provision is made for applying, if necessary, bonding voltages of lower value from an external source.

The makers are Avo Ltd., Avocet House, 92-96, Vauxhall Bridge Road, London, S.W.1.

Miniature Moulded Signal Lamp

THE small panel-mounting signal lamp fitting illustrated is a one-piece, thermoplastic moulding with metal inserts to take a low-voltage L.E.S.-cap bulb of the Hivac, Philips or Vitality with rating up to 1.2W. The ribbed plastic lens is a snap-in fit and is available either clear or in colours.

The signal lamp requires a hole approximately ⅞in in



Bulgin miniature moulded panel-mounting signal lamp.

diameter and it fits panels up to ⅞in thick. It is secured in position by a simple but effective push-on grip washer. Connection to the lamp is by means of two 3-in fly leads at the back. The body colour is normally black but alternative colours are available by arrangement with the makers, A. F. Bulgin and Co. Ltd., Bye Pass Road, Barking, Essex.

Transistor Stopwatch

By D. E. O'N. WADDINGTON,* Grad.Brit. I.R.E.

Measuring Time Intervals from 0.5 m sec. to 5 sec.

SINCE the development of escapement mechanisms, especially those using resonant control, mechanical methods of time measurement have been developed to a very high pitch. However, mechanical methods suffer from the disadvantage that they are slow to operate and measurement of short time intervals has passed largely into the hands of the electronic engineer. Many electronic interval timers have been designed, most of them having very high accuracy, but some are necessarily complicated and require special instruments for their adjustment. It is possible however to make a relatively simple "timer" which is not too difficult to set up.

There are two main "electronic" methods of measuring time interval. The first method approximates to the clepsydra, or water clock, in that a capacitor is charged through a resistor during the time interval to be measured, and then the resultant voltage across the capacitor is a function of the time. This method, although ideal for simple valve-operated timers is impracticable with transistors as the required high reverse impedances cannot easily be realised. The second method consists of counting the number of pulses of known repetition rate during the period to be measured and displaying this number either by means of a digital presentation or on a meter.

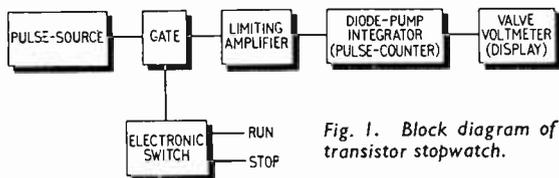


Fig. 1. Block diagram of transistor stopwatch.

The second method lends itself very well to transistor circuitry and it is used in the "Transistor Stopwatch." Owing to the complexity of a digital presentation a meter is used to indicate the time interval and it was found necessary to use two battery-operated valves to do this.

The transistor stopwatch is the electrical analogue of the mechanical stopwatch in that it counts the number of impulses of known frequency between the start and stop signals. However, it has an advantage over its mechanical counterpart as the "inertia" of the system is very low and a higher pulse repetition rate may be used. This factor allows measurement of very small time intervals with good accuracy. In the mechanical stopwatch there is only one pulse repetition rate available; but in an electronic device it is possible to vary this rate almost at will, so making it possible to use one meter scale for all ranges by switching the frequency of the pulse source.

The instrument may be sub-divided into six separate circuits and this breakdown is shown in block form in Fig. 1.

* Marconi Instruments, St. Albans.

Oscillator and Switch Circuits.—The pulse source is a free-running multivibrator (V3 and V4, Fig. 2). As the shortest time to be measured determines the highest frequency to be used, the type of transistor used limits the accuracy of the instrument. However, by using a count of 200 cycles for full-scale deflection of the meter on any time range, the uncertainty error is reduced to $\pm 0.5\%$ and a top frequency of 20kc/s permits a full scale reading of 10msec on the shortest time scale. The uncertainty error is due to counting a free-running frequency source instead of one which starts with the timing pulse. Hence it is possible to count one too many or too few cycles. There is little difficulty in making a 20-kc/s oscillator with commercial "audio" transistors although the waveform tends to deteriorate. As this is compensated for later in the circuit it has no deleterious effect on the operation of the stopwatch. The required frequency for any time scale is given by:—

$$f = n/t$$

where n is the number of pulses for f.s.d. and t is the time interval to be registered as f.s.d. In this instrument 200 pulses correspond to f.s.d. and the frequencies equivalent to the chosen time scales are given in Table I.

Table I

Time Scale	Frequency
5 sec	40 c/s
1 sec	200 c/s
500 msec	400 c/s
100 msec	2,000 c/s
50 msec	4,000 c/s
10 msec	20,000 c/s

The different frequencies are obtained by switching the base-collector capacitors C_1 and C_7 together to keep the mark-to-space ratio and the output amplitude constant. As the frequency stability of this circuit controls the accuracy of the instrument its supply should be kept constant and this is done by a Zener-diode voltage stabiliser (D3, on Fig. 2). The other cause of frequency variation is due to a change of base current with a change in temperature and this is reduced to a minimum by using a relatively-low-value base resistor. These measures limit the frequency variation to about $\pm 2\%$.

Usually only impulses are available from the external control circuit so some form of bi-stable circuit must be used for switching the timer on and off. This is done very simply by using a transistorised version of the Eccles-Jordan flip-flop circuit (V1 and V2, Fig. 2). A positive-going pulse of one volt will trigger the circuit quite effectively—shorting

the run or stop inputs to earth has the same effect—so that either electrical or mechanical switches may be used.

A single transistor can be made to act as a very effective gate (V5, Fig 2). When the base is biased towards the positive line the emitter-to-collector resistance is high and when it is biased sufficiently negative it acts almost as a short circuit. Thus by interposing this gate between the output of the multivibrator and the input to the amplifier, it is possible to switch the signal on and off quite simply.

The limiting amplifier (V6 and V7, Fig. 2) is a conventional two-stage direct-coupled amplifier. As the output waveform should be square with a constant peak-to-peak amplitude sufficient input is applied to the first stage so that it switches the second stage on and off. Thus the output is switched from the earth line to the 4.7-V negative line which is stabilised by means of the Zener diode. As a rapid response is important r.f. transistors are used.

Display Circuits.—The diode-pump integrator is used widely in frequency discriminators and pulse-rate meters. Here it is used as a pulse counter. In this application special precautions must be taken to ensure that the reverse resistance of the shunt diode is very high, of the order of thousands of megohms. It is difficult to find even silicon diodes which reach this requirement, so a vacuum diode had to be used; but here again difficulty was experienced as there is no suitable battery-operated vacuum diode readily available. Furthermore most vacuum diodes suffer from "splash" current which could easily cause erroneous readings. However, the writer has found that splash current can be reduced appreciably by running the filament of a battery pentode at half the specified filament voltage and connecting the control and screen grids to the negative side of the filament. This strapping does not impair the diode action of the valve in its application in the pulse-

counter. The capacitor which is charged from the diode pump must be a high-quality low-leakage type as any path liable to discharge it must be eliminated where possible. In this circuit the total parallel resistance is approximately 500 MΩ.

An electrometer valve would have been ideal for the valve-voltmeter as it has an extremely-high input resistance, however, electrometer valves are expensive so a conventional output pentode (V6) is used in a slightly unconventional circuit. As in the diode pump, the filament is run at half its normal supply voltage from a battery which is isolated from all other supplies. This allows the centre tap of the filament to be used as a neutral point from which the bias resistor is connected to earth. To set the zero, the meter is connected between the anode and a resistive chain and the sensitivity is adjusted by means of a variable resistor connected in parallel with the meter.

Photoelectric Trigger Circuit.—Although this is not essential for the operation of the stop watch it is a very-useful accessory, particularly when it comes to calibration. Normally a photoelectric cell does not produce a pulse of sufficient amplitude to operate the timer when the amount of light falling on it is changed so it was incorporated in a Schmitt trigger circuit. Under operating conditions the light falling on the OCP71 photo-transistor (connected as a photodiode) causes a current to flow through it with the result that the base of V10 is biased towards the negative line, so switching it on and hence switching off V11. When the light intensity is reduced, the current through the phototransistor is reduced; consequently the bias on the base of V10 will be reduced, switching it off and switching V11 on. This causes the voltage on the collector of V11 to move towards the positive line, thus giving the requisite pulse to trigger the stop watch. As the device will almost certainly be used in varying degrees of illumination a sensitivity

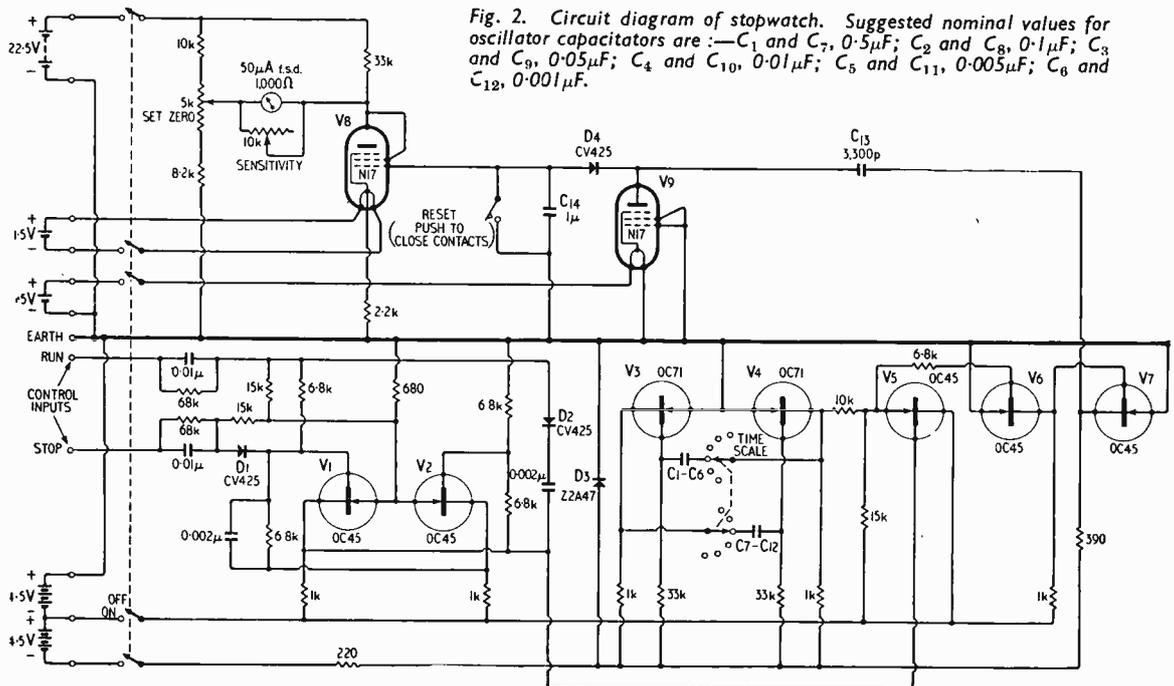


Fig. 2. Circuit diagram of stopwatch. Suggested nominal values for oscillator capacitors are:—C₁ and C₇, 0.5μF; C₂ and C₈, 0.1μF; C₃ and C₉, 0.05μF; C₄ and C₁₀, 0.01μF; C₅ and C₁₁, 0.005μF; C₆ and C₁₂, 0.001μF.

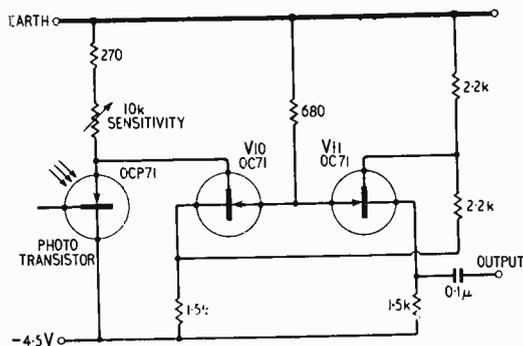


Fig. 3. Photoelectric trigger unit circuit. Note that OCP71 phototransistor is used as photodiode, i.e. base connection is left "floating."

control is included: this allows the sensitivity of the photo-cell circuit to be set so that a small reduction in illumination will operate the trigger.

Notes on Construction.—With the exception of the diode-pump and valve-voltmeter circuits there is nothing critical in the construction of the instrument. The transistor circuits may all be wired on tagboards. The best grouping consists of wiring the electronic-switch section on one tagboard, the pulse source, gate and limiting amplifier on another and the photoelectric trigger on a third.

It was found necessary to use either porcelain or p.t.f.e. valve holders for the pentodes and the 1- μ F integrating capacitor was mounted on porcelain stand-off insulators to reduce leakage. A locking device was fitted to the "meter-sensitivity" control to prevent accidental "readjustment" as this would lead to erroneous readings which would not be immediately obvious. The lead from the grid of the voltmeter pentode to the "reset" switch was screened and kept away from the oscillator circuit. A high-grade lead and switch were used to reduce leakage.

Calibration.—The first operation carried out was to check the frequency of the multivibrator. For this an oscilloscope and a calibrated a.f. oscillator were used with the output of the multivibrator connected to the Y amplifier of the oscilloscope and the a.f.-generator output to the X amplifier. The frequency of the oscillator was then adjusted until a stationary square trace appeared on the screen. The frequency of the multivibrator was adjusted by selecting the condensers C_1 and C_7 (larger capacities reduce the frequency and smaller ones increase it). It is not essential that the frequencies should be exact provided that the ratio between them is correct and Table II gives the relation of frequencies for various errors, including a lowest frequency of 50c/s (for calibration from the mains supply).

TABLE II

Correct	2.5% low	2.5% high	10% high
40	39	41	50
200	195	205	250
400	390	410	500
2,000	1,950	2,050	2,500
4,000	3,900	4,100	5,000
20,000	19,500	20,500	25,000

The standard time signals from Rugby, WWV or ZUO could be used for setting up the time scale; but this would involve the use of more complicated circuitry than is contained in the stopwatch. A pendulum was adopted as being the easiest and most practical method.

To minimise the errors, the longest time scale was used, i.e. 5 secs. It is, unfortunately, impractical to obtain f.s.d. directly as the pendulum required for a 5-second half cycle is about 81-ft long! However, a pendulum having a period of 2 sec. is quite practical. The required length is given by the formula:—

$$t = 2\pi\sqrt{l/g}$$

where t is the period, l the length and g the acceleration due to gravity.

Thus a 2-sec pendulum would be 99.45 cms. or 39.16 in. from the support to the centre of gravity of the bob. A pendulum was made by tying a 1-lb. weight to one end of suitable length of light thread and securing the other end to a rigid support. A light source and the photoelectric trigger were then arranged so that the pendulum hung between them. The time-scale calibration arrangement is shown in Fig. 4.

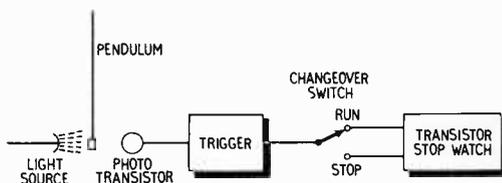


Fig. 4. Arrangement of apparatus for setting up time scale. Pendulum interrupts light beam when in the position occupied when at rest.

The setting up procedure used was as follows:—

1. Switch the stopwatch on and press the reset switch to discharge the condenser.
2. Set the zero of the meter and switch to the 5-sec. range.
3. Move the bob of the pendulum about 4in. from the rest position and release it. It will swing through the light beam, triggering the timer.
4. After the pendulum has completed $2\frac{1}{2}$ cycles operate the changeover switch so that the output of the trigger is connected to the "stop" input.
5. At $2\frac{1}{2}$ cycles (i.e. 5 sec.) the timer will be stopped. Then adjust the sensitivity control so that the meter indicates full-scale deflection.
6. Repeat the above procedure as a check.

As a further check switch to the 1-sec range and time one-half cycle of the pendulum. If the meter does not indicate full scale correctly, the oscillator frequencies should be re-checked.

The meter scale is very nearly linear (within 3%) but if the refinement of an exactly-calibrated scale is required the calibration points may be calculated from the formula:—

$$V = E\{1 - [C_2/(C_1 + C_2)]^n\}$$

where V is the voltage measured by the valve voltmeter, E is the supply voltage, i.e. 4.7 V, C_1 is the series condenser, i.e. C_{13} in Fig. 2, C_2 is the shunt condenser, i.e. C_{14} in Fig. 2, and n is the number of charging pulses.

The instrument was originally designed to measure the speed of arrows shot from a bow. The start

pulse was obtained by the feather cutting a beam of light, thus operating the photo electric trigger and the stop pulse was obtained from a micro-switch on the target which shorted the "stop" input to earth. This, however, is not the only use for the instrument as it can be used to measure the speeds of camera shutters (using two photo electric

triggers), the speed of relay operation, etc. In fact, the limit is usually set by the detecting arrangements; but as the run and stop inputs are at low impedance, it is possible to use long lengths of cable to operate them with no fear that the capacity will damp the pulses. Leads up to 100 yds. long have been used.

"MONO" TAKES A TOSS

AT the Colston Hall, Bristol on October 9th Mr. G. A. Briggs introduced his 17th concert of live and recorded music. In addition to his own evident enjoyment of any experiment in sound Mr. Briggs found three additional pretexts for this occasion: (1) to satisfy many requests from sound reproduction enthusiasts living in the West Country; (2) to offer for judgment for the first time by a public audience a comparison between live performances and mono and stereo reproductions of the same works; (3) to make amends to Harold Blackburn for the admittedly unsuccessful reproduction of his fine bass voice at the Festival Hall concert last May.

Special tape recordings were made at the Abbey Road Studios of E.M.I., using the best available microphone techniques for both single-channel and stereo, of excerpts from piano trios by Dvorak and Mendelssohn played by Gerald Gover (piano), Kenneth Popperwell (violin) and Terence Weil (cello), and also solos by Harold Blackburn. *Wireless World* was privileged to hear playbacks of these recordings both at E.M.I. Studios and in the Colston Hall, with the live performances for reference in both cases. In the small monitoring rooms at Abbey Road there seemed little to choose between mono and stereo, and opinions among those present were equally divided. In the Colston Hall, on the other hand, there could be no doubt of the superiority of stereo reproduc-

tion, and this was conclusively supported by a show of hands in the mixed audience. Although neither system could quite compete with the rich quality of Harold Blackburn's voice we had thought earlier that, in the monitoring studio, single-channel came nearest, but this decision was reversed at Bristol where stereo gave a much more natural rendering. Yet the conditions at Bristol, with large omnidirectional speakers, spaced widely apart in the large hall, would be considered by most people to be much less favourable than those of the monitoring studio with only three or four seats placed in the optimum position relative to the loudspeakers.

Although perhaps of less scientific interest than Mr. Briggs' own objective and carefully prepared experiments, a comparison of mono and stereo recordings (Archive) of the Geraint Jones choir singing a Handel chorus was illuminating. The mono recording, which was played first, was completely satisfying from a musical point of view, but the stereo recording which followed put a fire and vitality into the sound quality which was then quite evidently missing from the single-channel record.

Mr. Briggs is once again to be congratulated on a very successful and enjoyable concert, and for his unsparing efforts to find the best in sound reproduction—this time, as it happened, in two-channel stereo.

JERSEY AIR TRAFFIC CONTROL

TO meet the requirements of air traffic control at the busy airport at Jersey in the Channel Islands, a Marconi S264 radar system has been installed and was, on 26th

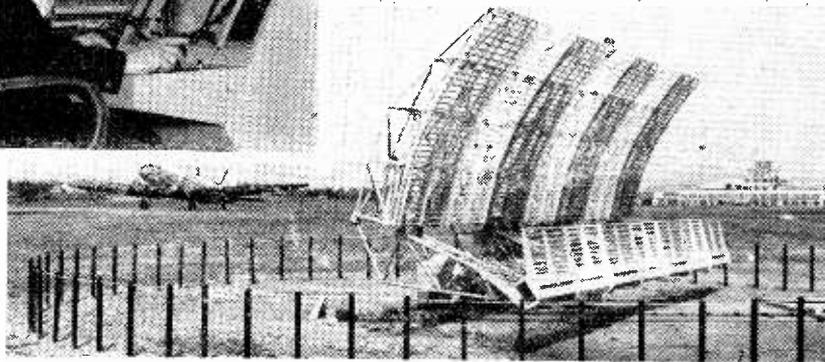
June, 1959, inaugurated by H.R.H. Princess Margaret.

In addition to very heavy holiday traffic for which a new air lane (Blue One) is proposed between London and Jersey, there is responsibility at Jersey for overflying aircraft on route Blue 32 (Paris to Shannon) and also for supervision of the Channel Islands control zone.

The S264 radar is 50kW installation with provision for conversion to 500kW if necessary. It operates on 50cm (for rain penetration) with a large aerial system of wide vertical aperture, giving coverage up to 40,000 ft at distances of up to 100 miles on medium-sized aircraft.



Marconi S264 long-range and terminal area surveillance radar system at Jersey Airport.



NOVEMBER MEETINGS

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

LONDON

11th. Brit.I.R.E.—“Physiological and acoustical aspects of hearing” by Dr. R. P. Gannon at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

11th. Physical Society Colour Group.—Discussion on the recent work of Dr. Edwin Land on colour projection at 3.30 at Institute of Ophthalmology, Judd Street, W.C.1.

12th. Physical Society Acoustics Group.—“The propagation of Rayleigh waves” by G. Mott at 4.0 at Imperial College, Prince Consort Road, S.W.7.

18th. Brit.I.R.E.—Half-day symposium on “Electronic digitizing techniques” at 3.0 and 6.0 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

20th. Institute of Navigation.—“Radiometry, radio-astronomy and infra-red techniques” by C. M. Cade at 5.15 at The Royal Geographical Society, 1 Kensington Gore, S.W.7.

20th. I.E.E. Graduate and Student Section.—“Plastic cables in the telecommunications industry” by G. J. Waddon at 6.30 at Savoy Place, W.C.2.

20th. Television Society.—“Television film production” by J. K. Byers (B.B.C.) at 7.0 at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, W.C.2.

20th. B.S.R.A.—“Loudspeakers” by S. Kelly at 7.15 at the Royal Society of Arts, John Adam Street, W.C.2.

23rd. Radar & Electronics Association Student Section.—“Marine and air radar simulators” by P. Tenger (Solartron) at 7.0 at the Norwood Technical College, Knight's Hill, S.E.27.

24th. Radar & Electronics Association.—“Waveguides for long-distance communications” by Professor H. E. M. Barlow at 7.30 at the Royal Society of Arts, John Adam Street, W.C.2.

25th. I.E.E.—“Radio aspects of the International Geophysical Year” by Dr. R. L. Smith-Rose at 5.30 at Savoy Place, W.C.2.

30th. Royal Institution.—“Faraday, through his manuscripts” by Dr. L. Pearce Williams at 5.30 in the Long Library, 21 Albemarle Street, W.1.

ABERDEEN

13th. I.E.E.—“The application of transistors to line communication equipment” by H. T. Prior, D. J. R. Chapman and A. A. M. Whitehead at 7.30 at Robert Gordon's Technical College.

BIRMINGHAM

13th. Society of Instrument Technology.—“Ultrasonic inspection techniques” by W. B. Emms at 7.0 in the Lecture Theatre of the Byng Kendrick Suite, Gosta Green College of Technology, Aston Street.

23rd. I.E.E.—“Learning machines” by P. Huggins at 6.0 at the James Watt Institute.

BRISTOL

18th. Brit.I.R.E.—“Data recording and presentation” by D. W. Thomasson at 7.0 at the School of Management Studies, Unity Street.

CHELTENHAM

27th. Brit.I.R.E.—“A vidicon television camera channel” by B. J. Pover at 7.0 at North Gloucestershire Technical College.

DUNDEE

12th. I.E.E.—“The application of transistors to line communication equip-

ment” by H. T. Prior, D. J. R. Chapman and A. A. M. Whitehead at 7.0 in the Electrical Engineering Department, Queen's College.

EDINBURGH

9th. Institute of Physics.—“Light waves, radio waves and photons” by R. M. Sillito at 7.15 at the University.

12th. Brit.I.R.E.—“The transistor and its use in communication and control equipment” by E. Wolfendale at 7.0 at the Department of Natural Philosophy, The University.

GLASGOW

10th. Institute of Physics.—“Light waves, radio waves and photons” by R. M. Sillito at 7.15 at the University.

11th. Brit.I.R.E.—“The transistor and its use in communication and control equipment” by E. Wolfendale at 7.0 at the Institution of Engineers and Shipbuilders, 39 Elmbank Crescent.

25th. I.E.E.—Faraday lecture on “Electrical machines” by Professor M. G. Say at 6.0 at St. Andrew's Hall.

HALIFAX

16th. Institution of Production Engineers.—“Electronic copying on machine tools” by R. Lawson at 7.30 at Percival Whitley College, Francis Street.

LIVERPOOL

10th. Brit.I.R.E.—“The use of transistors in communications and control” by E. Wolfendale at 7.0 at the University Club.

11th. I.E.E.—“Vision and position—two electronic aids to marine navigation” by Dr. R. B. Mitchell and C. Powell at 6.0 at The Temple, Dale Street.

MANCHESTER

12th. Brit.I.R.E.—“Progress in permanent magnet materials” by J. E. Gould at 6.30 at the Reynolds Hall, College of Technology, Sackville Street.

MIDDLESBROUGH

12th. Society of Instrument Technology.—“Analogue computers” by R. E. Hare at 7.30 at the Cleveland Scientific & Technical Institute, Corporation Road.

NEWCASTLE

11th. Brit.I.R.E.—“Electronic welding controls” by C. R. Bates at 6.0 at the Institution of Mining and Mechanical Engineers, Westgate Road.

18th. Society of Instrument Technology.—“The principles and manufacture of junction transistors” by P. I. Nicholson at 7.0 at The Conference Room, Roadway House, Oxford Street.

NEWPORT

25th. Society of Instrument Technology.—“Transistors” by S. S. Goldberg at 6.45 at the Newport & Monmouthshire College of Technology.

READING

23rd. I.E.E.—“An introduction to electronic computers” by R. C. M. Barnes at 7.15 at the George Hotel, King Street.

SALISBURY

11th. I.E.E.—“The planning and installation of a television transmitting station” by D. B. Weigall at 6.30 at S.E.B. Showrooms, 17 New Canal.

WOLVERHAMPTON

11th. Brit.I.R.E.—“Recent developments in semiconductor rectifiers” by J. Bulman at 7.15 at the College of Technology, Wulfruna Street.

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לפי-הרב

THE Editor, wearied of etymological alarms and excursions, and wishing to terminate them, has asked me to bring them to a close by commenting on the following notes he has received condemning my remarks in the correspondence columns of the July/August issue. Mr. Mark Thornton writes:

"Free Grid's exegesis on the word *φωνή* may seem very erudite, but on closer inspection it fails to convince in almost every detail. I will go through the more controversial things he says point by point.

(a) *φωνή* cannot, as every Greek scholar knows, be derived from a verb with an *a* stem like *φάω*, for the *a* and the *o* would contract into *ω* (as they do in *ωνή*) not into *ο*. The word is in fact derived from a verb *φένω* (never in fact found in the present tense) which is a by-form of *φείνω*, meaning both 'to slay' and 'to beat.' (All this is to be found in Liddell and Scott's Greek Lexicon—Ninth (latest) edition.)

(b) *φωνή* is derived from *φημί* (I speak), which is related to *φάω*. Thus it will be seen that *φωνή* and *φώνη* are in no way connected.

(c) *φωνή* may be transliterated 'phone' by 'Free Grid,' but it does not occur as such in any English word. The 'phone' in English is *φωνη*.

(d) There is not a hint in the whole of classical Greek literature that *φωνή* has anything to do with mouths; the only evidence that 'Free Grid' can adduce in support of his theory is an exceedingly unconvincing passage from Exodus. I admit that the Authorised Version translates this verse 'on the edge of the sword,' but this is erroneous for two reasons. First, 'έν' means 'in' not 'on'; secondly, in no other passage does *φωνή* mean 'edge.' No Greek scholar worth his salt would hesitate to translate this phrase 'in a slaughter wrought by the sword.' Clearly,



Readers' etymological excursions.

'Free Grid's' translation of *φωνή* as the 'mouth of the sword' is nothing more than a red herring.

(e) Similarly, classical Greek never used *φωνή* in the phrase 'voice of the sword.' The nearest to it is Homer's 'battle-cry (*φωνή*) of the Trojans and Achaeans.' Homer, as in that phrase, always used *φωνή* of people. Considering that he is the earliest extant Greek author, we may take it that 'voice' is the original meaning of *φωνή*. Indeed, Liddell and Scott only quote one example of an inanimate use of *φωνή* in the whole of classical Greek prose—Plato talks of the 'voices of musical instruments,' just as we do.

(f) This being so, 'Free Grid's' remarks about battles are rather pointless; and anyway in a battle surely the battle cries (animate) come before the clash of arms, not the clash of arms first as 'Free Grid' suggests. In a word, 'Free Grid's' case rests on nothing more than a mistranslation of *φωνή* and a distortion of the meaning of *φωνή*. There is therefore no need for anyone except 'Free Grid' to think of a monophonic gramophone as a 'one sound reproducer.' No doubt 'Free Grid' is still opposed to the word because it 'does not call to mind . . . the rich polyphonic sounds of music and well modulated voices'—but after all is it meant to? Monophonic does refer to the gramophone and not to the music. The polyphony of the music is important but in this case irrelevant."

Naturally I feel a little flattered at being condemned in such illustrious company as the translators of the Authorised Version whose interpretation of Exodus XVII, 13, the Editor's correspondent says is erroneous, and my quotation of it unconvincing.

He tries to "rub it in good and proper" when he says that no Greek scholar worthy of his salt would hesitate to translate this passage in the manner he suggests. But he rather overreaches himself for, of necessity, he condemns not only the translators of the A.V. of 1611 but also the equally learned men who endorsed the A.V. translation of this passage when they gave us the Revised Version in 1881, to say nothing of later translators such as the late Monsignor Ronald Knox, a scholar of no mean reputation who, as recently as ten years ago gave us his own independent interpretation in which he suggested only one trivial alteration—the substitution of "point" (of the sword) for "edge."

But the editor's correspondent stands self-condemned in the two reasons he gives for castigating the A.V. translators, and also myself for quoting them. He gives as his first

reason the alleged fact that *έν* means "in" and not "on." Unfortunately his own champions Liddell and Scott, for whom I have the greatest respect, let him down for they tell us that *έν* means "in," "on," "with" and several other things according to the context in which it is used.

This correspondent's second reason is that in no other passage does *φωνή* mean "edge"; but once more Liddell and Scott fail him as they give three other passages, namely, Numbers XXI, 24; Deuteronomy XIII, 15; and Deuteronomy XX, 13; but, of course, it must be admitted that these passages are all the work of the same "erroneous" translators.



Back to the very origins of Greek.

As for *φωνή* having no connection with *φάω* (and, therefore, with *φωνη*), Parkhurst, a learned Cambridge scholar of the 18th century, thought otherwise although he did not, of course, deny that its next of kin was *φένω* just as *φημί* is the next of kin of *φωνή*. Parkhurst takes us right back to the old Cadmean alphabet and the very origins of Greek in the second millennium B.C. in which the un'hellenistic letters *ω* and *η* did not exist, which, incidentally, Plato mentions in his Cratylus.

Some centuries later came Homer (circa 900 B.C.) by which time the new letters, and the new word spellings they brought with them, had thoroughly settled down, complete with all the etymological rules with which the Editor's correspondent is obviously so very familiar.

Finally, this correspondent appears to have read his *Wireless World* as carelessly as he has his Liddell and Scott, otherwise he would know that I never said anything about the "rich polyphonic sounds of music and well-modulated voices" as he obviously implies. We must, I think, agree to differ like the learned mental specialists in a recent *cause célèbre* in the Courts.

The Editor has also passed to me a very interesting letter from Dr. Leslie Knopp who writes:

"Free Grid's reply to Mr. Pawley's letter is both misleading and inaccurate, although Mr. Pawley's statement is not strictly correct.

"The primary meaning of φωνή was the sound of the voice (principally of men) subsequently it was used to mean any articulate sound, and by some careless writers, to mean any sound or tone. φωνή should be used only for articulate sound as opposed to ψόφος for inarticulate sound and, Mr. Editor, you can kindly inform Master Free Grid that the Greek texts of LXX are very corrupt—but a literal translation of Theodotion's version of Ex. XVII, 13 would be:

"Whereafter the chosen [men of] Joshua made uncomfortable Amalech [and his] people with the slaughter swords [which have very sharp edges] or φωνήσπιγγων for sound from inanimate objects.

"Free Grid had better get off his war-horse! Although Xenophon used φωνή to mean the cry of men in battle, φύλοπις is more correct for din of battle or φλούσβος for confused noise.

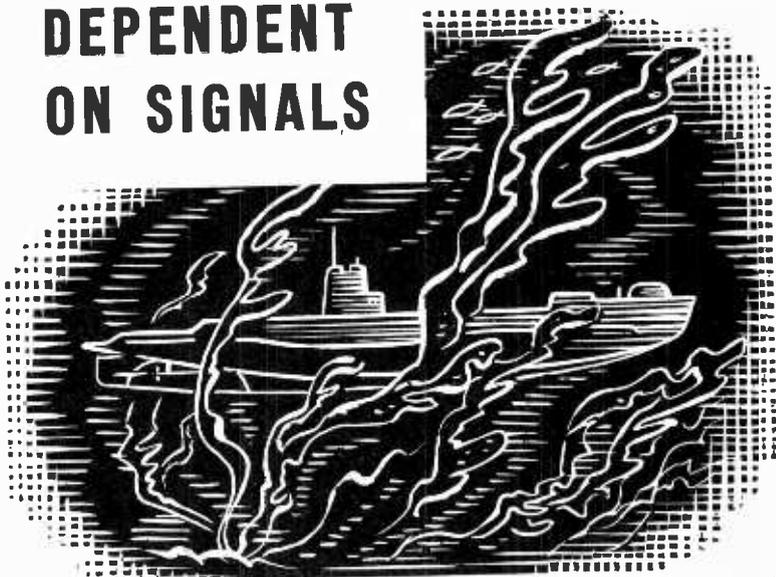
"φωνή means slaughter or murder (always in the plural) and comes from the verb φονεύω which has nothing whatever to do with the anatomy."

Dr. Knopp makes criticisms similar to some, but not all, of those put forward by Mr. Thornton but he condemns also those people responsible for certain corrupt texts of the Septuagint, and in this I have a sneaking sympathy with him. Since this contentious Greek text of Exodus XVII, 13 has proved such a stumbling block, I have reproduced it at the head of these notes in Hebrew, the tongue in which it was originally written. This should make everything clear to everybody. [If not, will they kindly join with me in calling it a day! —Ed.]

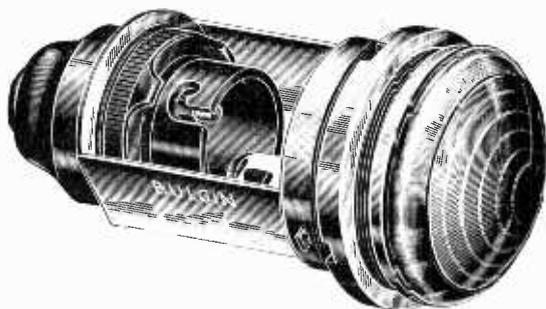
Cacophonous Caterwauling

WHY is it that nothing seems to be done about the irritating whistles from neighbouring television sets which plague listeners to programmes on the medium-wave band of "blind" broadcasting? Every reader of *Wireless World* knows its cause and the technical problems surrounding its absolute removal; but why don't we who have passed the "eleven plus" and therefore prefer the civilized musical programmes of blind broadcasting to the pædomœous puerilities of so many television programmes raise such a clamour that the P.M.G. is forced to do something about it under the powers which he undoubtedly has? Don't tell me that the obvious answer is to listen on the v.h.f. band; there are some of us who prefer our music from the continent.

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RANDOM RADIATIONS

By "DIALLIST"

Service Without Tears

ABOUT this time last year, if I remember aright, I praised the steps that some radio and television manufacturers had taken to make things easier for the serviceman when he's engaged in trouble-tracking. I'm glad to see that the good work goes on this year. There are sets which can be removed easily from their cabinets, hinged panels and many other aids to getting quickly at their innards. But I still don't like to see four-contact components, such as transformers, soldered into sockets in printed circuits. As one dealer put it, to get them out you really need a soldering iron with four adjustable bits! There's always the risk, too, that when they're being removed or replaced the printed wiring may be accidentally damaged. However, there are some components on the market which overcome the disconnection problem by using spring-loaded contacts. One of the latest examples is a potentiometer with spring-loaded contacts on the printed-circuit chassis of R.G.D. and Regentone sets. The interesting point is that the potentiometer is mounted so that the contacts are applied to the *edge* of the printed circuit board, not to its face. Actually, they fit into little indentations cut along the edge of the board. When the solder in each indentation is melted the contact springs away from the printed circuit.

TV Totals

OFFICIAL figures for the increase of television receivers in Europe since 1954 make interesting reading. The latest figures are naturally a little stale, for it takes some time to collect and publish the information. Our own G.P.O.'s licence figures, for example, are generally a good few weeks behindhand. However, at the end of 1954 there were 3,239,000 TV sets in Europe this side of the Iron Curtain and the latest figure is 14,291,000—an amazing advance in about four and a half years. Our own country has always been at the head of the list, with Western Germany, whose sets increased from 1,211,935 to 2,125,130 during 1958, next, but a long way behind. Third comes Italy with 1,098,899, and fourth France, where

receivers numbered 988,594 when the list was drawn up, and are now probably well above the million mark. At first sight it's rather surprising that there should be only 50,304 sets in a prosperous country like Switzerland; but there must be large tracts of mountainous country where reception is still impossible unless the Italian scheme of a fly-power satellite station for almost every valley is adopted.

Not Too Loud

IN 1952 the Society of Music Enthusiasts (of which P. G. A. H. Voigt was at one time chairman) was founded in Toronto. Until recently it was a flourishing concern; now lack of support has forced it to close down, which is a pity. It's rather surprising, too, considering what a vogue there is for hi-fi. Talking of hi-fi—which to some people too often means excessive volume—calls to mind some verses by Christine Britton issued some time ago by the Society of Music Enthusiasts. Her "Neighbour's Lament" is very much to the point.

Nowadays, it's smart to be
Hep to high fidelity;
Run and buy them, do not falter—
Naked chassis, plywood altar!

Learn the jargon; rant and rave
About the baffles that you crave,
Speak of speakers reverently
Own a minimum of three.

Twist the knobs eternally
Speaking sonic symmetry
Accept the plaudits of the town—
But for S.M.E.'s sake TURN IT DOWN!

It's Skill You Pay For

"THE dealer replaced a component costing 1s 3d and charged me 10s 6d for the job." One often hears that sort of grouse from people who don't believe that the serviceman has to be paid for all the time he's away from his workshop, if he comes to your house, that he has to have some pretty expensive testing and measuring instruments available and that above all a fault in a sound or television set may take a long time to track down. There's too much competition nowadays for dealers to be tempted to make excessive charges. There may be odd ones here and there who do, but they don't as a rule stay long in the game, for a bad reputation is soon built up and that's

their undoing. What people are apt to forget is that they're paying a good man for his skill.

Bogus Degrees

ANYONE who looks at the advertisement pages of some American papers and magazines can't help being struck by the number of concerns which offer to help those who enrol with them to get degrees or qualifications in a vast variety of subjects. The American Council on Education has recently made an exhaustive survey and reports that whilst there are many reputable organizations there are swarms of dishonest concerns which, they reckon, are cheating students in other countries to the tune of £25M a year—and getting away with it. Such students, officially estimated at 750,000 every year, are induced to pay good money for a completely "phony" degree, not worth the price of the paper on which the diploma is engraved. I don't imagine that many of the victims who become alleged Masters of Electronic Technology, or Doctors of this, that or the other come from this country, for they'd find it very hard to get their spurious qualifications accepted by prospective employers here. Still, one never knows.

Bankers and Electronics

THE Big Banks are becoming very electronics minded these days. Closed-circuit television enables the manager to have your account put before his eyes when you go to his office in the hope of increasing your overdraft. And recently one of the Big Five has placed an order for a transistor Emidec computer. It is to be installed at a central point in London and will deal with the 40,000 accounts of 15 branches. Each branch will send in its facts and figures *via* the teleprinter and the answers will be returned to it in the same way. The cost is pretty big—£125,000 for the computer alone and additions and gadgets may bring it up to nearly double that figure. But it will save a lot of time—and time, we're told is money. Electronic devices have a great deal to offer to big businesses and it's good to see that this is becoming more and more widely appreciated.

Pocket size...

pocket wise!

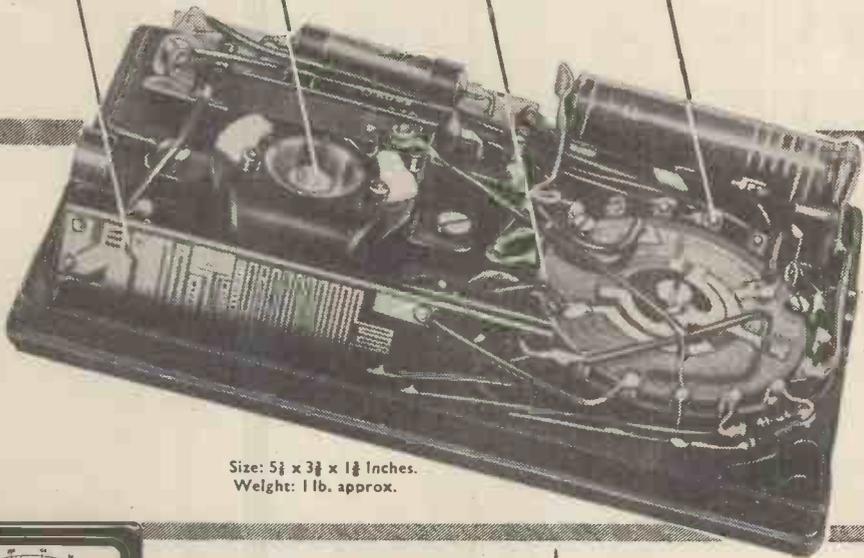
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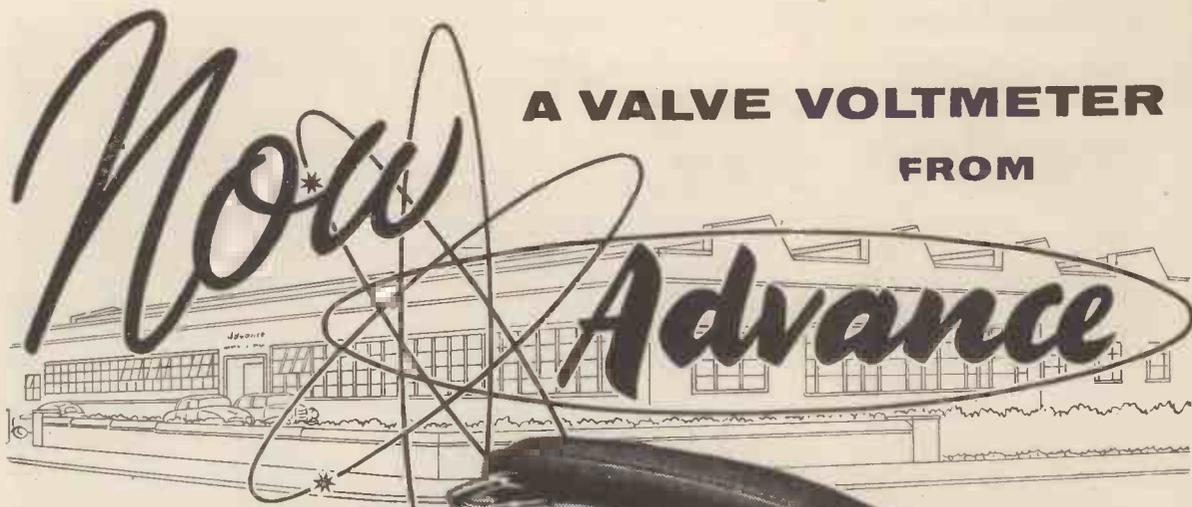
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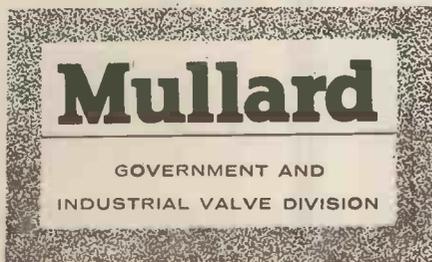
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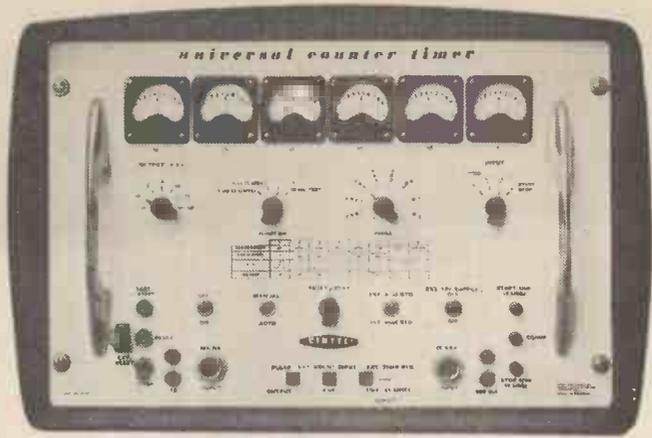
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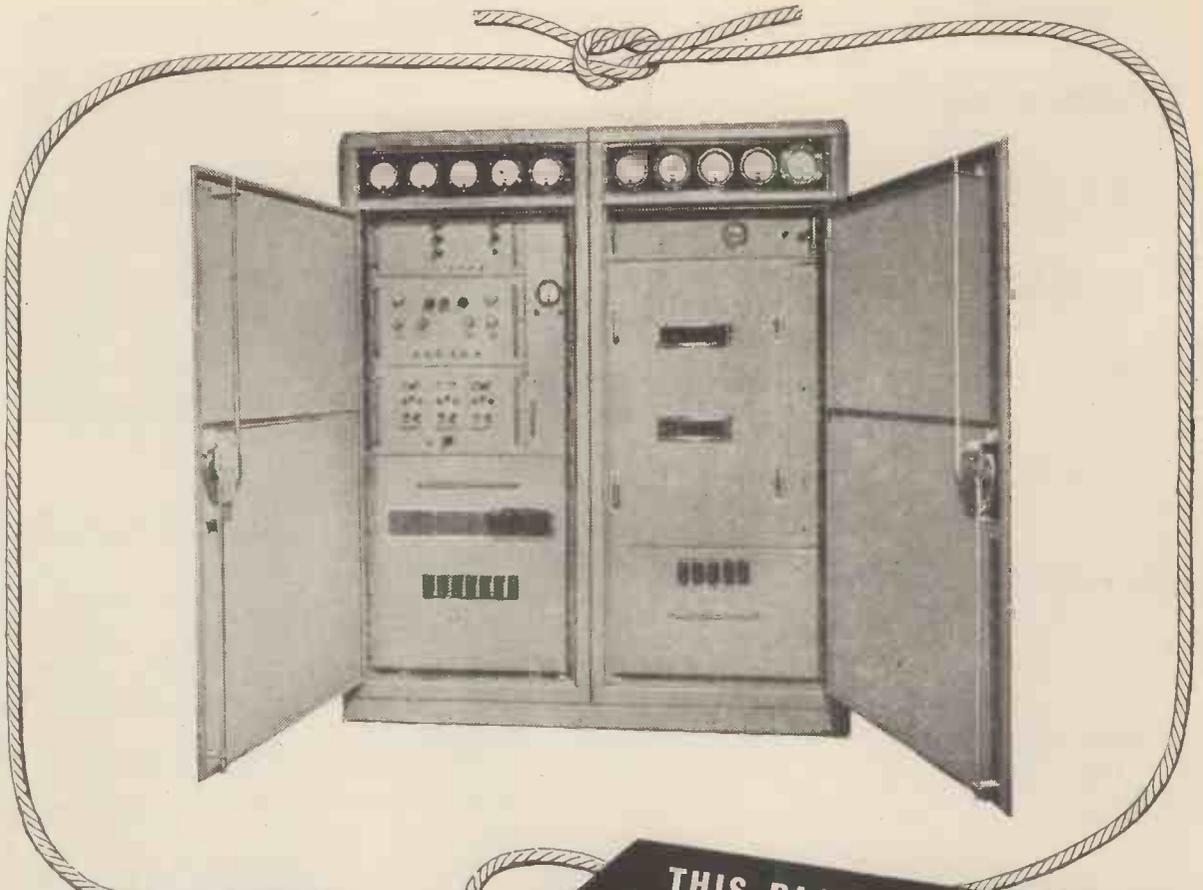
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OVER AND OVER
AGAIN!**

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

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

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

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

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

IT WILL PAY YOU TO EXAMINE THIS SET NOW

Mr., Mrs., Miss

Address

Occupation

Your Signature

(Or Parent signs if you are under 21)

Tick (✓) where applicable

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

R34/RV54

(A) FOLD ALONG HERE

HOW TO FOLD

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

No Postage Stamp necessary if posted in Gr. Britain or Northern Ireland.

(B) FOLD ALONG HERE

BUSINESS REPLY FOLDER
Licence No. W.C. 1129

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

(C) FOLD ALONG HERE

FINALLY POST QUICKLY!

Postage will be paid by George Newnes Ltd.

DETACH THIS PAGE



The Ferranti 3 DIGIT VOLTMETER Type D101

The need for instruments capable of measuring voltages with a high degree of accuracy and with a fast reading time has long been apparent. The Ferranti 3 digit voltmeter has been developed to meet this requirement. The advantages of this precision instrument will undoubtedly prove attractive to those engaged in the fields of automatic testing and monitoring, analogue to digital conversion, calibration of moving pointer instruments and many similar applications.

Special Features

- Automatic Ranging and Polarity
- High Accuracy and Resolution
- Fast Reading Time
- Complete Reliability

SPECIFICATION

Display	Three digit plus automatic polarity indication and automatic decimal placement.
	D.C. Volts in 3 ranges
Automatic Ranges	0.01 — 9.99 V 10.0 — 99.9 V 100V — 999 V
Accuracy	0.1% of full scale reading on any range.
Average Reading Time	0.7 seconds.
Input Impedance at Balance	10 Megohms.
Input	110 — 250V A.C. 50—60 c/s 50W.
Weight	50 lbs. approximately.
Style	Bench cabinet 17" x 13" x 10½" high with optional brackets for standard rack mounting.

In view of continuing development, the right is reserved to alter the specification or design of this instrument.

FERRANTI LTD · FERRY ROAD · EDINBURGH 5

Telephone: DEAn 1211

ES/T64

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

Cosstor 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 μ sec.
Output deflection: 6 cm (4 cm at 10 Mc/s).
Sensitivity: calibrated 100 mV/cm to 10 V/cm.
Sensitivity control: in steps 3:1 and 10:1 with continuously variable intermediate control.
Input Attenuator impedance: 1.2 M Ω and 65 pF.

Y2 AMPLIFIER

Identical with Y1 amplifier.

SIGNAL DELAY

200 μ sec approximately. Not more than 10 μ sec differential between channels.

PRE-AMPLIFIER (2)

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

PROBES (OPTIONAL EXTRA)

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

TIME-BASE

Triggered.
Range: 0.03 μ sec/cm to 15 msec/cm in eleven steps. Triggered from positive or negative signals derived externally or from Y1 amplifier.

Sensitivity: pulse—1 cm. deflection or 2 V external. Sine wave—2 cm deflection or 2 V r.m.s. external at frequencies up to 5 Mc/s. Expansion amplifier, continuously variable gain up to 5 times. Time-base output available at front panel on slow speed ranges. Delayed time-base: continuously variable delay 2 μ sec to 150 μ sec. Delay jitter not greater than 1 part in 1,000. Sensitivity pulse—1 cm deflection or 2 V external.

X AMPLIFIER

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

CALIBRATION

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

POWER SUPPLY

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

SIZE AND WEIGHT

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

ACCESSORY

Camera Model 1428.

COSSOR INSTRUMENTS LTD

The Instrument Company of the Cosstor Group

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

Telephone: CANonbury 1234 (33 lines).

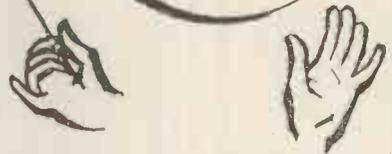
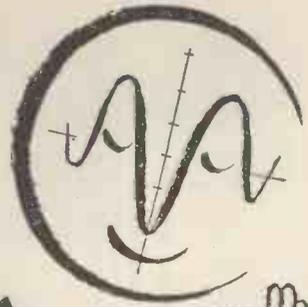
Telegrams: Cosstor, Norphone, London.

Cables: Cosstor, London.

Code: Bentley's Second.
TAS/CL.11

Four first-class performers

These four Cossor Oscillographs, each designed for an important range of applications, offer first-class performance backed by rigid adherence to published specifications.



MODEL 1065 PULSE OSCILLOGRAPH

Tube: single-beam, P.D.A.
Bandwidth: d.c. to 15 Mc/s (—50%).
Sensitivity: 250 mV/cm.
Overshoot: less than 3%.
Time-base: triggered or repetitive over range 40 cm/sec to 5 cm/μsec.
X Amplifier: gain 5, continuously variable.
Time-base delay: 2 ranges, continuously variable.
Calibration: voltage and time, by calibrated shifts
Probe: 1.5 MΩ, 12 pF

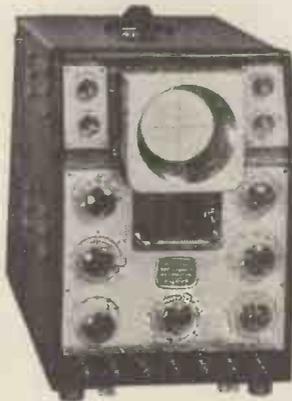
MODEL 1058 FOR THE TV & RADIO ENGINEER

Tube: single-beam
Bandwidth: d.c. to 6 Mc/s (—50%).
Sensitivity: 250 mV/cm.
Time-Base: triggered or repetitive, over range 30 cm/sec to 1.5 cm/μsec.
Special facilities for triggering from TV line or Frame pulses on IV.D.A.P. composite video waveform.
X Amplifier: gain 5, continuously variable.
Calibration: time and voltage calibration facilities.



MODEL 1049 INDUSTRIAL DOUBLE-BEAM OSCILLOGRAPH

Y Amplifier: A1: d.c. to 200 kc/s (—30%) at gain 900; A2: d.c. to 400 kc/s (—30%) at gain 30.
Time-Base: repetitive or triggered in 18 ranges, down to 7.5 sec/sweep.
Intensity modulation: three modes including beam bright-up.
Calibration: time and voltage, by calibrated shift (X and Y1) and multiplier (Y2).



MODEL 1035 GENERAL PURPOSE DOUBLE-BEAM OSCILLOGRAPH

Y Amplifiers: A1: 5 c/s to 5 Mc/s (—30%), Maximum gain 3,000. A2: 5 c/s to 250 kc/s (—30%) at gain 30, with trace inversion facility.
Time-base: repetitive or triggered in 9 sweep ranges from 100 msec to 10 μsec.
Time-base delay and pulse bright-up facilities.
X Amplifier: gain 5, continuously variable.
Calibration: voltage and time, by calibrated shifts.

Let us send full details of Cossor Instruments or arrange for a representative to discuss your special needs.

COSSOR INSTRUMENTS LTD

The Instrument Company of the Cossor Group

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

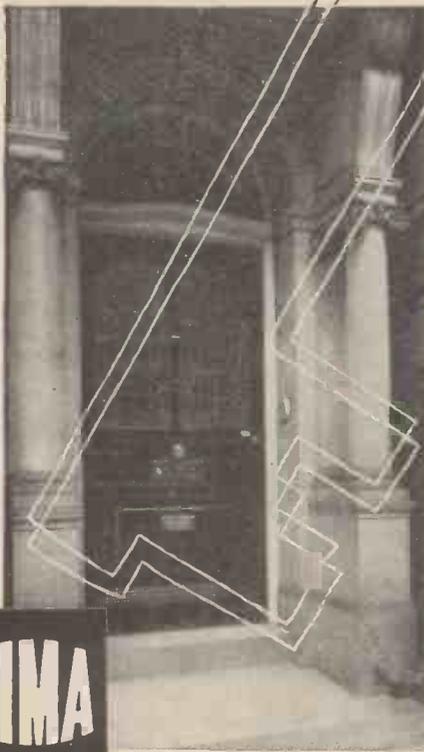
Telephone CA.Nonbury 1234 (33 lines)

Telegrams: Cossor, Norphone, London.

Cables: Cossor, London.

Codes: Bentley's Second. TAs/CI.19

ask SIMA



INSTRUMENT CENTRE
20 QUEEN ANNE STREET, LONDON W.1

Telephone: IMPerial 6000

Press Enquiries: LANgham 4251

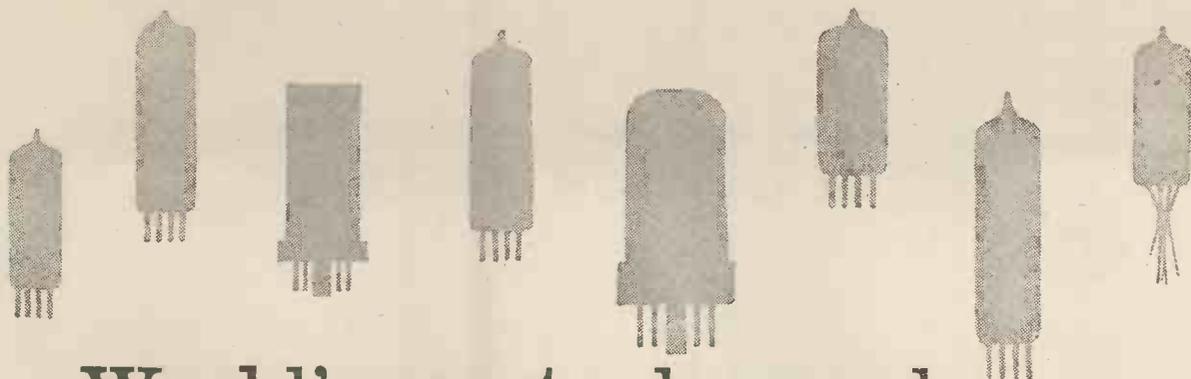
the key to information

and advice on :

- ★ Electronic and nuclear instruments
- ★ Navigational and survey equipment
- ★ Optical and ophthalmic instruments
- ★ Laboratory, medical and X-ray apparatus
- ★ Instruments for process control and automation
- ★ Kinematograph and allied instruments
- ★ All industrial instrumentation

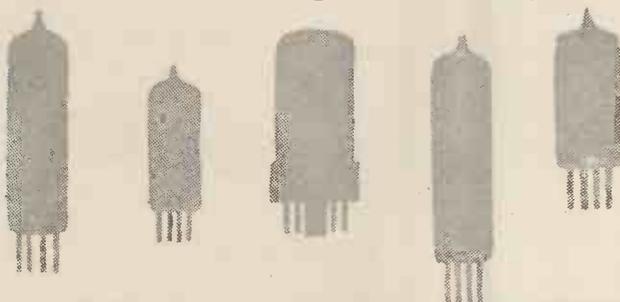
Space donated by: COSSOR INSTRUMENTS LTD.
OSCILLOGRAPHS AND ELECTRONIC INSTRUMENTS

THE SCIENTIFIC INSTRUMENT MANUFACTURERS' ASSOCIATION



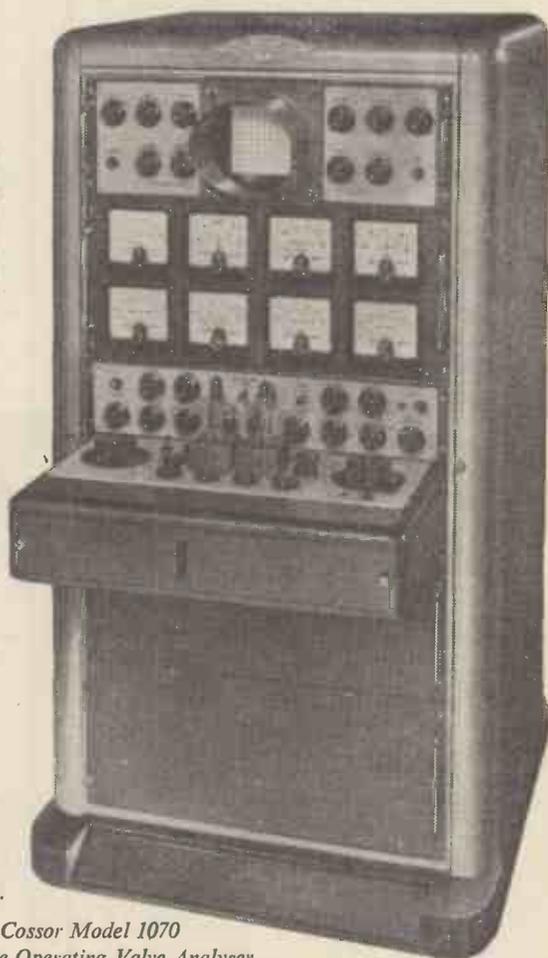
World's most advanced Valve Performance Analyser

First model delivered to
The United Kingdom
Atomic Energy Authority



The new Cossor Valve Analyser provides the electronic engineer with very much fuller information on valve behaviour than has previously been obtainable. It submits valves to the conditions under which they will actually operate in modern 'pulse' type circuits in, for example, radar and computer equipment and reveals their precise characteristics when so operated. The Instrument is particularly valuable in investigations of *positive* grid drive operation of such valves.

Now being manufactured to meet a demand from all over the world, Model 1070 is a fine example of Cossor technical development in the Instrument field.



*Cossor Model 1070
Pulse Operating Valve Analyser*

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.

TAS/CI.25

Fully Radiused
Rectangular Cases

1470A 6" x 4" x 3" £1 9 6



1470B 6" x 4" x 5" £1 13 6



1480A 8" x 5" x 5" £2 4 6



1480B 8" x 5" x 7" £2 7 6



1490A 12" x 7" x 5" £2 11 6



1490B 12" x 7" x 7" £2 15 6

new small and miniature standard cases
at really **LOW PRICES!**

15 new Imhof standard cases with panel sizes from 6" x 4" to 24" x 10½". Just look at these examples . . . compare the new low prices. Here's real value for money! Whatever the size—whatever the quantity—all these new cases are built to the same, robust specification and high finish as the existing Imhof Standard Range. Top quality and rock-bottom prices result from Imhofs streamlined methods and full tooling for large-scale production in Europe's most modern factory fully equipped for quality manufacture of cases, racks and consoles

IMHOFS

These new cases have been designed as a result of the fast development in miniaturisation of electronics and electrical instruments. The cases are of two types: with sloping front panels, and rectangular cases with vertical front panels. Both types are available in standard duo-tone finishes. Imhofs have also produced a new type chassis incorporating fixing brackets especially for these new cases

7 days delivery — generous quantity discounts !

STOP PRESS! Now available, 9 new ultra-miniature cases—MINIBOXES—of two-piece construction. Sizes from 3" x 1½" x 2½" to 17" x 4" x 5". Prices from 6/9 to 25/- . Complete details on request

Alfred Imhof Ltd Dept M 11 Ashley Works Cowley Mill Road Uxbridge Middx Uxbridge 6231

Export & London Showrooms: 112-116 New Oxford Street WCI Museum 7878

IMHOFS AGENTS OVERSEAS

AUSTRALIA: Aladdin Industries (Pty) Ltd, Stanmore NSW
BELGIUM: Rogelec, Ghent
CANADA: Measurement Engineering Ltd, Arnprior
DENMARK: Tage Schouboe, Copenhagen N

FINLAND: Oy Scienta Ab, Helsinki
GERMANY: Sunvic Regler GMBH, Solingen
HOLLAND: J. Th. van Reijzen, Delft
NEW ZEALAND: Imarex Ltd, Auckland C3
NORWAY: Birger Christensen, Oslo
PORTUGAL: Projectos e Construcões Lda, Lisbon

SWEDEN: Elektronlund AB, Malmö C
SWITZERLAND: Walter Blum, Zurich 2/39
U.S.A.: Bud Radio Inc, Cleveland 3, Ohio
BRIT. GUIANA: Davsons Carribean Agencies Ltd, Georgetown

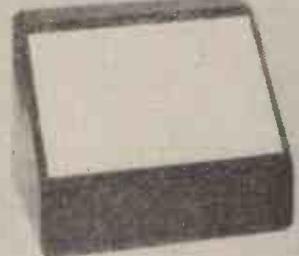
Fully Radiused Sloping Panel Cases



1450B 10½" x 19" Panel Size £5 4 0



1410C 7" x 19" Panel Size £3 12 8



1450A 10½" x 12" Panel Size £3 18 10

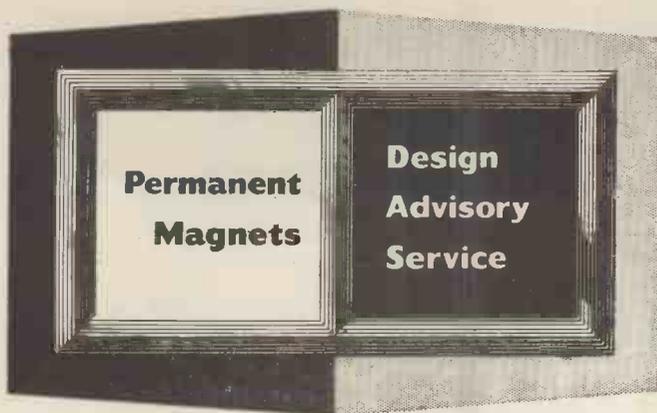


1410B 7" x 12" Panel Size £2 18 6



1410A 7" x 6" Panel Size £2 5 3

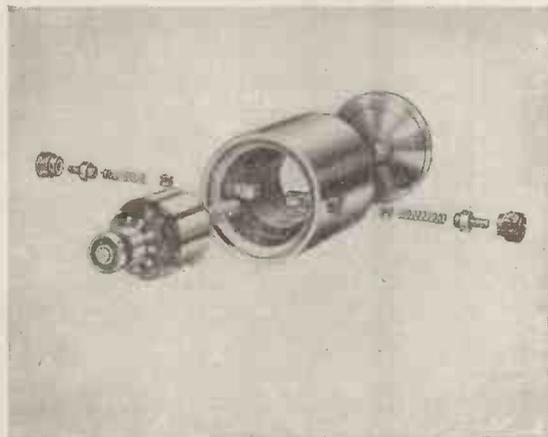
No. 19



D.C. Motors

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.

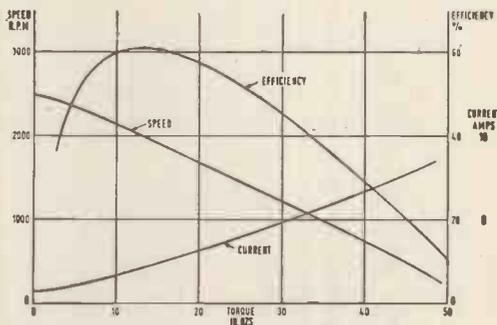
The introduction of Mullard "Magnadur" magnets has resulted in the development of quite revolutionary designs in many types of apparatus, amongst which the design of permanent magnet motors is an outstanding example.



Photograph of d.c. motor using "Magnadur" ring magnets in place of the normal field windings.

This design uses a "Magnadur 1" cylinder inside a mild steel shell which forms the return magnetic path. This assembly is diametrically magnetised to provide the maximum pole area. Due to the high intrinsic coercive force and low recoil permeability of "Magnadur 1" (which are of the order of 3,200 oersteds and 1.2 respectively), a comparatively large air gap, (for example of 0.1"), can be employed without appreciable loss in the field strength measured in the gap, or reduction in performance, or efficiency of the motor.

The graph indicates the typical performance obtained from a motor similar to the one illustrated.



Other advantages of this design are:—

1. Commutation troubles due to armature reaction are eliminated as "Magnadur" has practically unit recoil permeability.
2. Eddy-current and hysteresis losses are eliminated from the stator.
3. The armature can be removed and replaced without affecting the motor performance, making inspection and maintenance a simple routine operation.
4. The coil ends on the armature can very easily be arranged to cut magnetic flux, so that extra torque and efficiency are achieved.
5. The temperature rise of the motor on continuous running tests is lower than for a similarly rated motor using an energised field coil.
6. The motor is reversible without the necessity of switching field windings and will give high torque and efficiency with virtually sparkless commutation in either direction.
7. High power-to-weight ratio.

In addition to the above advantages, it is generally found that in quantity production, a considerable saving in cost can be made when compared with conventional types of motors.

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

Avantic

AUDIO AMPLIFIER STANDARD

Suitable for use as:

- * Laboratory Standard
- * 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

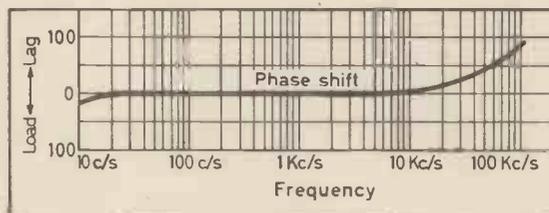
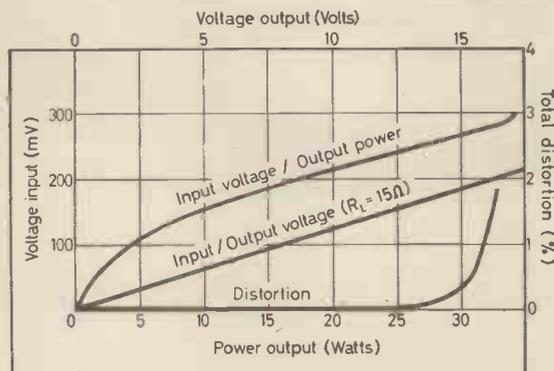
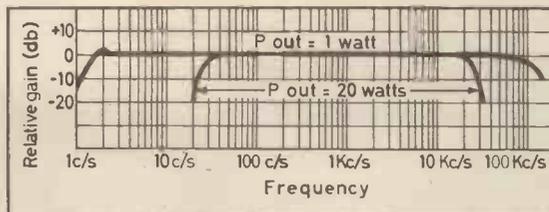
Rise Time:

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.

Price: 30 gns. 440V. at 30mA. d.c.

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

BEAM-ECHO LIMITED • 13 SOUTH MOLTON STREET • LONDON W.1.

Telephone: MAYfair 1039

Telegrams: Hibeam Wesdo London



TOMORROW'S INSTRUMENTATION TODAY

For many years B & K Laboratories have been privileged to supply and maintain advanced instrumentation for numerous important research and engineering applications.

We are proud that this work is contributing to the international success of many British products from the best high-fidelity sound equipment to the finest in modern transportation.

In the past, B & K Laboratories' instruments were often installed after other equipment had been tried; initially the cost of higher accuracy did not appear justified, and only by experience did the need for more precise results become evident.

Nowadays however, with improved instrument versatility and increased production, the cost disparity between "very good" and "excellent" has diminished considerably.

B & K LABORATORIES LTD.
4 TILNEY STREET,
PARK LANE, LONDON, W.1
Grosvenor 4567

For voltage and current measurements, a wide range of instruments is produced. The C.31 electrometer (illustrated) will detect currents of the order of 1×10^{-17} amperes and will measure 0.02mV. At the other end of the scale the J.1003 v.t.v.m. is designed for measurements up to over 200 kilovolts from 10c/s to 20Mc/s.

For radioactivity studies we offer a fully integrated range including scalers, rate-meters, automatic sample changers and print-out timers.



For metallurgical work, the M.800 Portable Transistorized Thickness Gauge will determine plating or sheet thicknesses from 0.0005" to 0.1000" with high accuracy. The "Radac" M.302 equipment will determine deviations from standard hardness, strength, purity and alloy composition.

For phase angle measurements the model FB. 120 (illustrated) provides accurate meter indications over the frequency range 0.2c/s to 50Kc/s. Other types enable similar measurements up to 500Mc/s.

For special purpose instrumentation not listed, enquiries are welcomed with details of any measurement problems.

The "Elema" Industrial Version Direct Ink-Writing Oscillograph with its unique ability to accurately reproduce traces at frequencies up to and beyond 1,000c/s, enables highest precision conversions at lower frequencies. Traces from multi-channel types can overlap and several chart speeds are provided up to 2 metres per second. No photographic developing devices or chemicals are needed and ordinary chart paper may be used.



SIGNAL SOURCES

KSS Series, 10 Units cover from 1,050 to 17,500 Mc/s.
EHF Series, 9 Units cover from 18,000 to 50,000 Mc/s.

SIGNAL GENERATORS

MSG-1 950 to 2,400 Mc/s.
MSG-2 2,000 to 4,600 Mc/s.
MSG-34 4,200 to 11,000 Mc/s.
PMX (2) 4,450 to 11,000 Mc/s.
PMK (2) 10,000 to 21,000 Mc/s.
SG-1218 12,400 to 17,500 Mc/s.
EHF (7) 18,000 to 39,700 Mc/s.

SWEEP GENERATORS

CSG Series, 5 Units cover from 1,000 to 16,000 Mc/s.



SPECTRUM ANALYSERS

TSA-1 10 to 1,000 Mc/s.
TSA-2 910 to 4,560 Mc/s.
TSA-3 4,370 to 22,000 Mc/s.
TSA-4 21,000 to 33,000 Mc/s.
TSA-5 33,000 to 44,000 Mc/s.

Interchangeable tuning units cover each band using the same basic display unit and power supply.

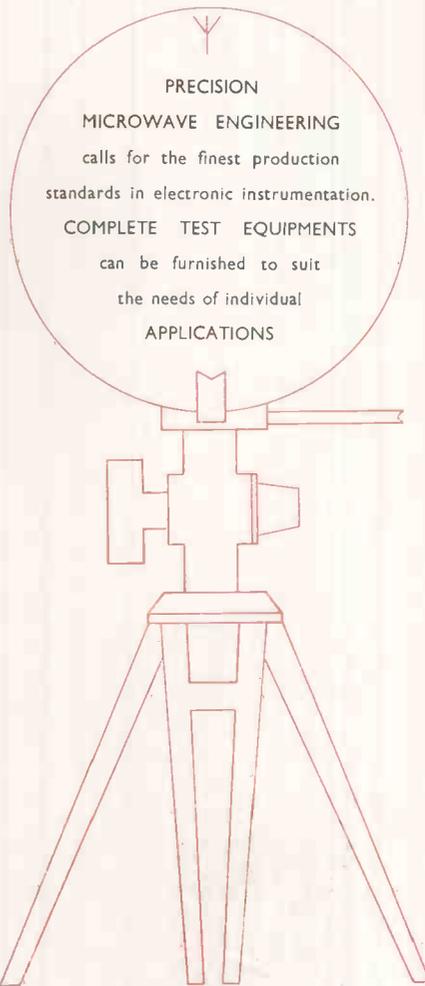
★SA-84, Multiband covers 10-40,880 Mc/s.
DA-70, 50,000 to 100,000 Mc/s.

MICROWAVE RECEIVERS

R. Eight plug-in tuning units cover 400 to 46,700 Mc/s.
FIM covers L, S, M and X bands.

SPECIAL INSTRUMENTS include:—

K-200 Microwave Tube Tester.
P-3 Transistorized Power Meter.
VS-2 Ratio Scope.



The SL range of waveguide test equipment comprises automatic standing wave indicators, direct-reading frequency meters, motorised waveguide switches, sliding screw tuners, adjustable shorts, rotating joints, double stub tuners, mixers, attenuators, etc., for frequencies from 2,450 to 18,000 Mc/s.

The DB range of waveguide test equipment includes adaptors, attenuators, standing wave indicators, wave meters, reference cavities, mounts, mixers, multipliers, couplers, elbows, filters, horns, phase shifters, rotating joints, movable shorts, waveguide switches, etc., for frequencies up to 140,000 Mc/s.

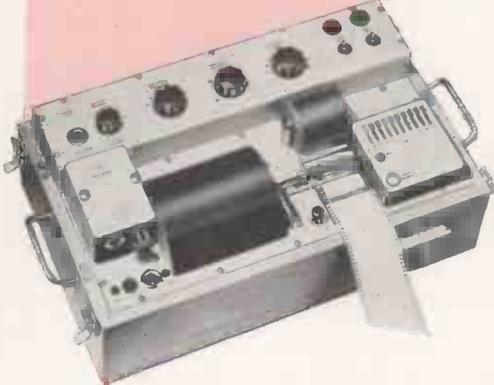
16d



Beat Frequency Oscillator 1014 can feed subjects under test directly or via constant sound sources (e.g. 4211, 4215) using compressor circuit through sweep range 20c/s-20Kc/s. Synchronous frequency response measurements are obtained using Level Recorder 2304, with additional items where required. (Other types for 2c/s-2Kc/s and 200c/s-200Kc/s).



Calibrated Accelerometers (sensitive up to 70mV/g for temperatures up to 250°C) may be used with integrating Pre-amplifier 1606 for readings of acceleration, velocity and displacement.



Level Recorder 2304 will automatically record spectra from test pieces, Measuring Microphones, Accelerometers, Strain Gauges, etc., by means of electrically synchronised **Octave/Third-Octave Spectrometer 2111**, containing 16c/s-35Kc/s filters and special v.t.v.m. Self-contained **Audio Frequency Response Tracer** will provide a c.r.t. spectrum display where desired.

All main instruments are available separately or combined, (e.g. for 19" rack mounting with tape recorder for frequency multiplication, etc.). A complete range of accessories, (e.g. linear and logarithmic potentiometers, polar diagram attachments, test boxes, switches, inverters) is available for direct interconnection.

THE COMPLETE SYSTEM FOR ACOUSTIC AND VIBRATION ANALYSIS,
ABSORPTION AND REFLECTION MEASUREMENTS AND FREQUENCY
RESPONSE DATA

Standard Measuring Microphones with special amplifiers 2603/2605. Associated equipment includes Artificial Ear 4141, Calibration Apparatus 4151, and Noise Reference Source 4240.



Standard Automatic Vibration Exciter Control 1016, 5c/s-5Kc/s and 5-10Kc/s with 44-speed selective scanning sweep. Accelerometer feedback with computation for mode control (acceleration, velocity or displacement) with provision for automatic changeover.



T A P E I N S T R U M E N T A T I O N

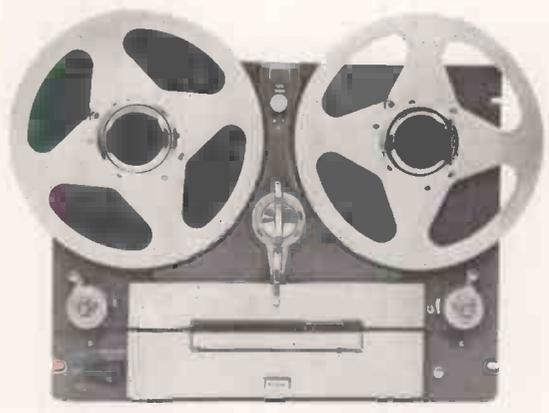


The P.S.200 Series Instrumentation Magnetic Tape Data Recorder/Reproducer (illustrated) supersedes the more bulky laboratory recorders and offers greater convenience and dependability. Up to 14 tracks of information can be recorded at speeds from $1\frac{7}{8}$ i.p.s. to 60 i.p.s. Speed control accessories are available for synchronised playback. The data can be recorded in direct, FM, PWM or digital form. This equipment is designed for tape instrumentation applications demanding the highest degree of accuracy. The unique transport design incorporating a self-threading magazine with precision reels, eliminates time-consuming tape threading and at the same time offers the facility of endless-loop recording by means of a simple change of magazine.

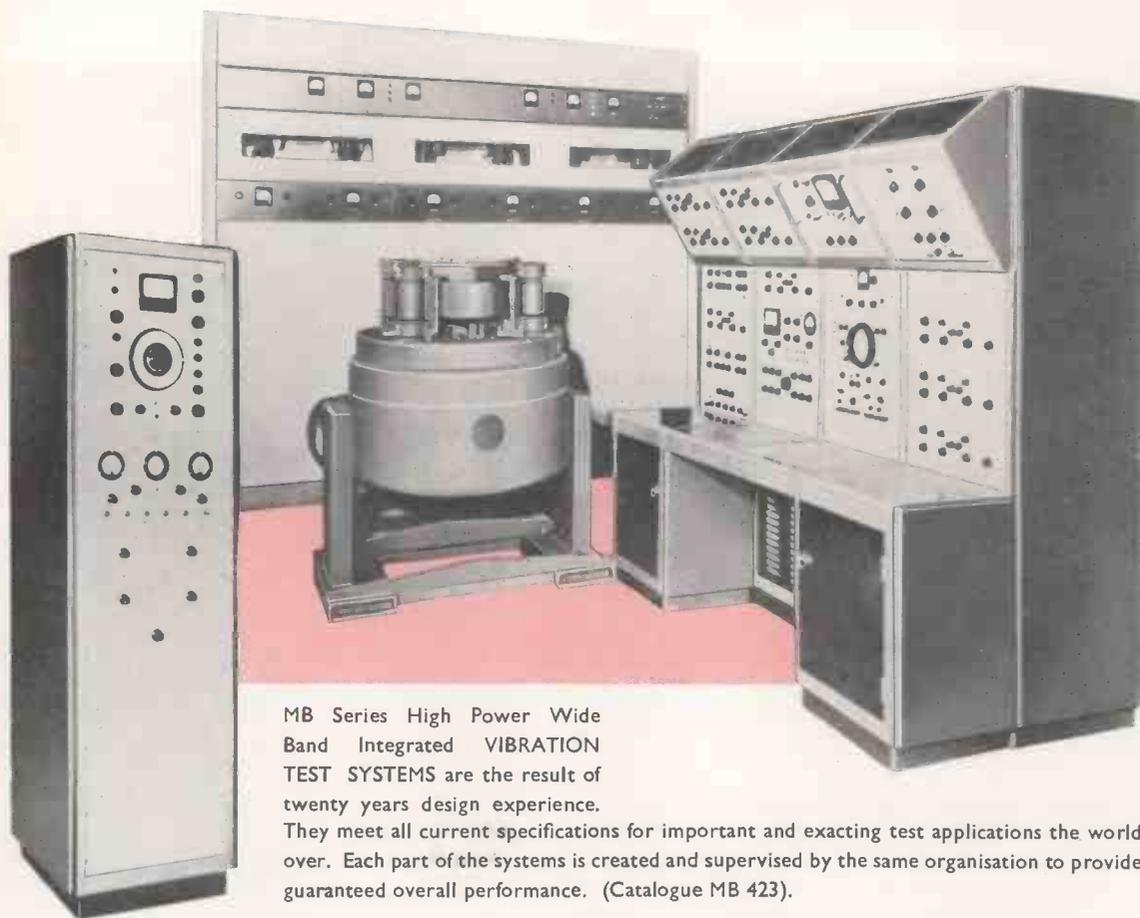
Shock mounts enable the instrument to be used as an airborne recorder; Grant slides are available for 19" rack mounting. A 7-channel recorder measures only $17\frac{1}{2}$ " x $15\frac{1}{2}$ " x 10", weighs 65 lbs. and requires 250 watts of power (30 watts on stand by) and can be supplied for 24V DC operation.

For advanced digital magnetic tape applications, the Potter Series 908 Tape Handler operates at speeds up to 150 i.p.s. with character transfer rates up to 45 Kc/s on $\frac{1}{2}$ " tape and 90 Kc/s on 1" tape. A higher pulse packing density is made possible by a unique precision guide system. Forward and reverse capstans allow differing speeds without acceleration delays. Stop distance: $0.125" \pm 0.035"$. Incorporates folded vacuum tank slack loop system. Several other models are produced, with fully transistorized electronics. Associated equipment includes computer tape testers, very high speed alphanumeric printers (48,000 characters per minute) counters and magnifiers.

For basic instrumentation applications, various models are available for direct record/reproduce applications using $\frac{1}{4}$ " tape with various tape speeds. Frequency Response ± 2 dB from 30 c/s-17 Kc/s at $7\frac{1}{2}$ i.p.s., with signal to noise 56dB and flutter and wow better than 0.2% r.m.s.



Periodically B. & K. Laboratories have new vacancies for engineers for electro-mechanical, acoustics, tape recording, microwave and nuclear applications. Engineers are invited to submit details of experience and background for future consideration. Please write to the Technical Director, B. & K. Laboratories Limited, 4 Tilney Street, Park Lane, London, W.1.



MB Series High Power Wide Band Integrated VIBRATION TEST SYSTEMS are the result of twenty years design experience. They meet all current specifications for important and exacting test applications the world over. Each part of the systems is created and supervised by the same organisation to provide guaranteed overall performance. (Catalogue MB 423).

For resistive strain gauge measurements, Strain Gauge Apparatus 1516 provides direct readings of strain irrespective of gauge factor, with a variable 3 kc/s carrier voltage transformer fed to the bridge. Measuring range 100μ strain to $30,000\mu$ strain f.s.d. A special Balancing Unit (1530) provides for accurate remote reading. Multipoint manual and automatic selectors and panels enable a large number of consecutive measurements to be made. With provision for external recording or display. (Ask for B. & K. TR/157).

BASIC TEST INSTRUMENTS FOR PRODUCTION TESTING, LABORATORY & SERVICE SHOP USE



A range of basic test instruments (voltmeters, megohmmeters etc.) built on the same precision standards as the more specialised instruments is available for general use. (Catalogue B. & K. ES/8).

Various instruments are available for production testing in different fields of application. The Deviation Bridge (1504) illustrated, is used extensively for electronic component testing. High speeds are attainable by the use of Test Jig (3902). Four models with interchangeable scales cover extensive R, C and L ranges, for accurate impedance and phase angle measurements. (Catalogue B. & K. ES/8).



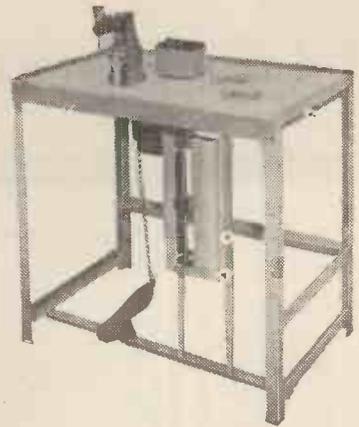
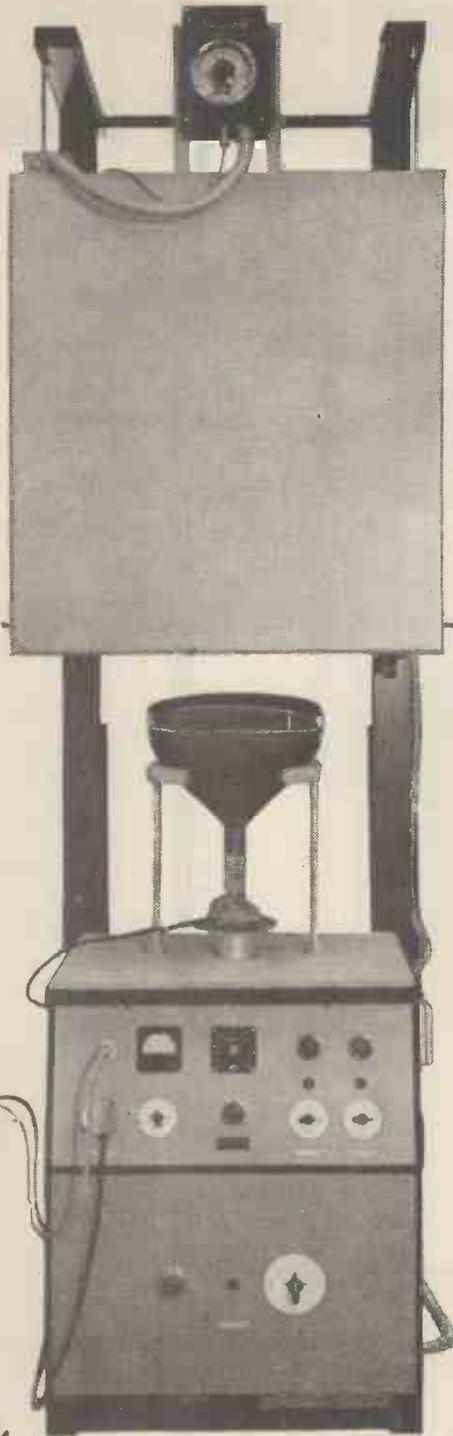
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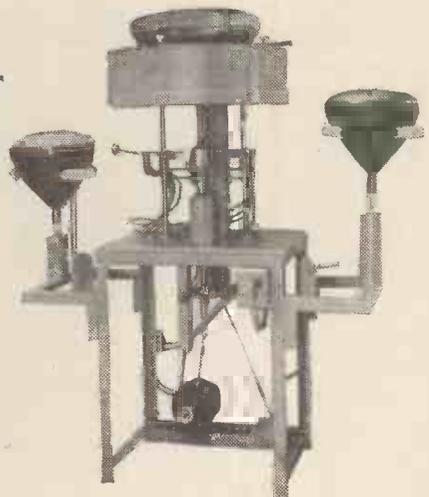
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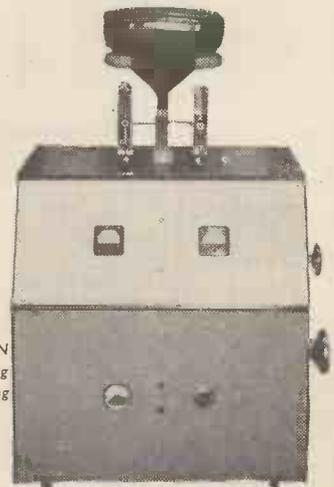
SECOND STAGE of reconditioning C.R.T.s (washing, settling, aquadag coating, drying, baking and Aluminising plant) is also obtainable from us. We design, manufacture and supply Vacuum Machinery to Major Companies in Great Britain and Overseas.



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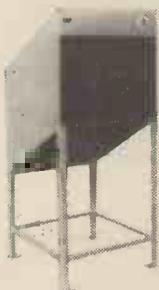
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This is the enthusiastic opinion of an expert, an independent reviewer, after thoroughly testing the Simon S.P.4. Throughout the Hi-Fi world, this superb new tape recorder, with its combination of high performance and range of exclusive features, is sparking off similar praise from those who have seen and heard it. Look at this list of star features—then come and see it for yourself at your nearest dealer—try it, test it and you too will join the crowds of Simon enthusiasts.

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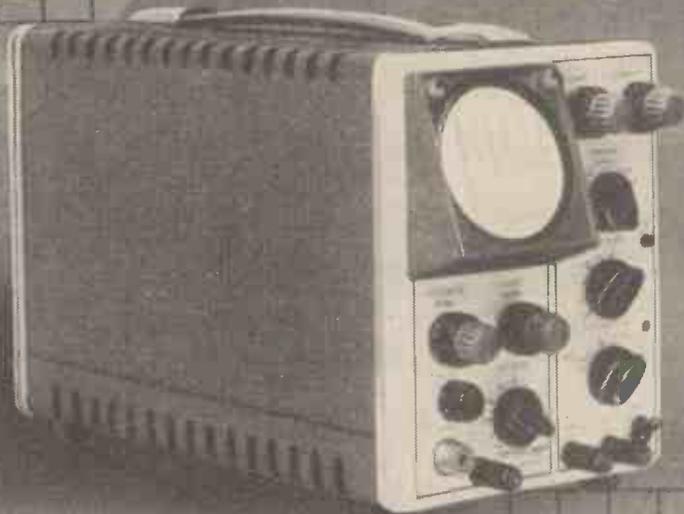
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- VFO or Crystal control. **£78.10.0**

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Total cost if purchased separately.....	£44 9 0

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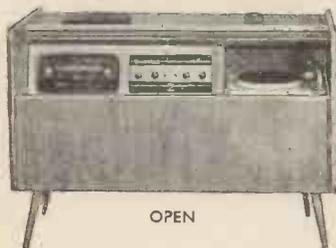


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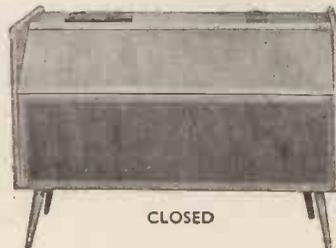
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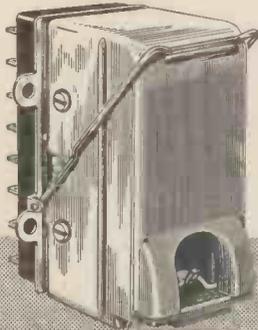
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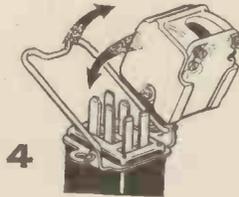
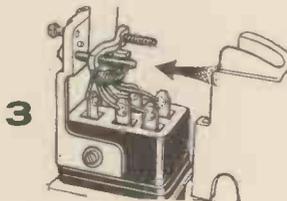
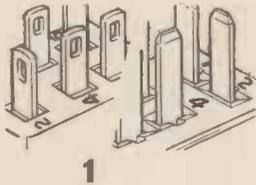
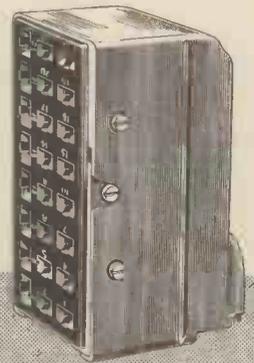
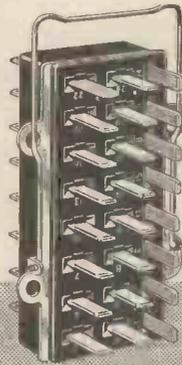
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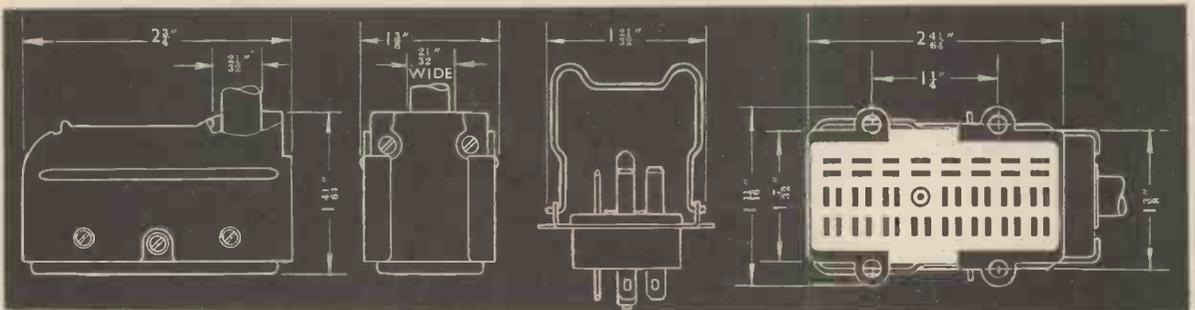
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5 Amps D.C. or A.C. (R.M.S.) per
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Average contact resistance:
Below 0.002 Ohms.



- 1** Terminal numbers are moulded into plug and socket bodies, both next to soldering tags and on mating face. This facilitates wiring and cableform testing without removing covers.
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- 4** A wire retaining loop clips over the radiused corner of the cover and engages positively with a cast groove.

British Patent 700999



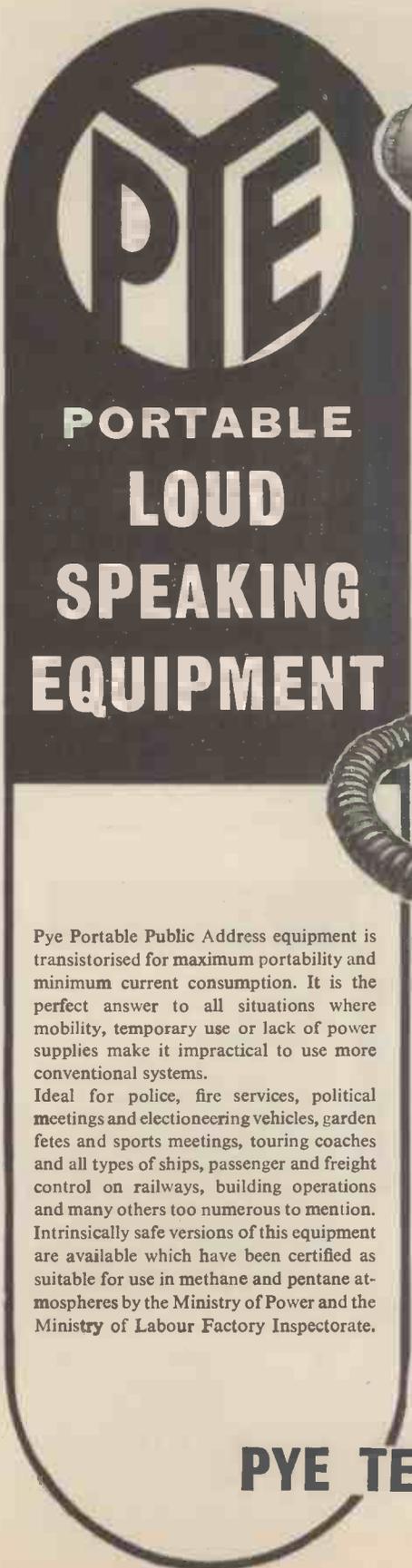
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Pye Portable Public Address equipment is transistorised for maximum portability and minimum current consumption. It is the perfect answer to all situations where mobility, temporary use or lack of power supplies make it impractical to use more conventional systems.

Ideal for police, fire services, political meetings and electioneering vehicles, garden fetes and sports meetings, touring coaches and all types of ships, passenger and freight control on railways, building operations and many others too numerous to mention. Intrinsically safe versions of this equipment are available which have been certified as suitable for use in methane and pentane atmospheres by the Ministry of Power and the Ministry of Labour Factory Inspectorate.



3 WATTS The Hand Portable Electronic Megaphone weighs only 5 lb. The transistor amplifier gives more than 3 watts output. It uses standard torch batteries which last about six months.

The Portable Electronic Megaphone with adjustable stand and separate microphone is suitable for all temporary occasions. It can be stood, mounted at an angle or easily carried. It is similar to the Hand Portable and is completely self-contained.



10 WATTS The Portable Transistor Amplifier weighs only 5½ lb. and measures 8" x 3½" x 6". It will deliver 10 watts output for a consumption of 1.8 amps from a 12 volt battery. It is ideal for use in moving vehicles or on sites where a mains supply is not available. A comprehensive selection of microphones and loudspeakers is available.

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"Ranger" v.h.f. dashboard mounting Radiotelephone

Brief Specification

PTC 8001/2: 10 watt F.M. PTC 2001/2: 5 watt A.M.
Available from 25—174 Mc/s. Simplex or Duplex operation
"Split-channel" selectivity Up to 6 switch-selected channels
Power supply: Models for 6, 12 or 24 volts operation.

The Pye "Ranger" radiotelephone has been designed to meet the specifications of the American F.C.C. and the British G.P.O. It is suitable for use under all climatic conditions and is vibration proofed. Its features include light weight, low battery drain and low cost of installation and maintenance. Optional features are alternative channel spacing; public address and rebroadcast facility on A.M. types; and a choice of fist microphone or telephone handset. The PTC 8001/2 and PTC 2001/2 form part of a complete series which include boot-mounting types and fixed stations.

PYE TELECOMMUNICATIONS LIMITED
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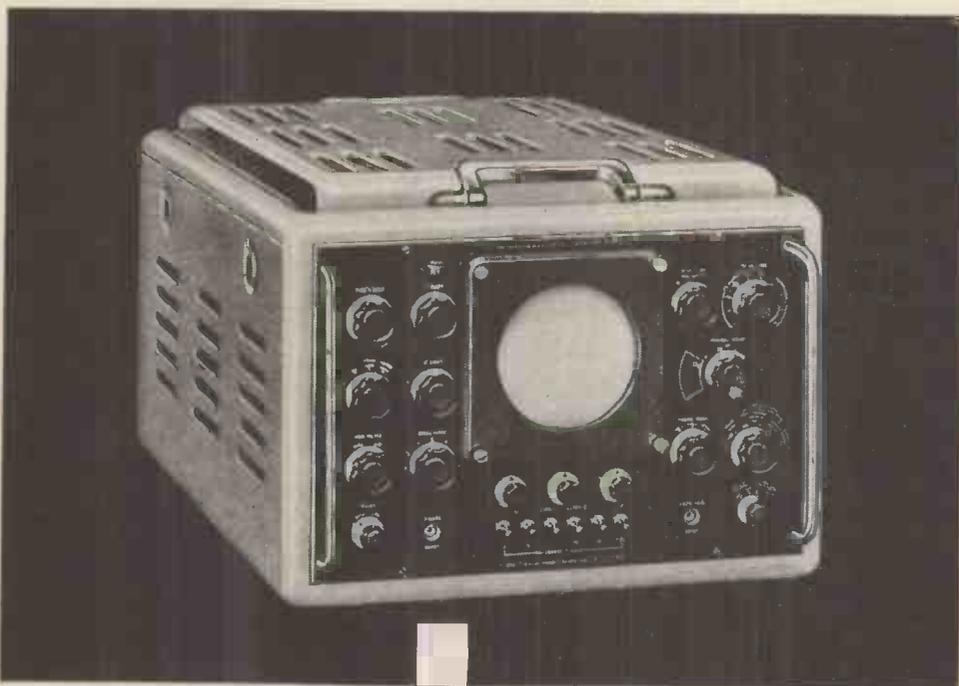
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FEATURING PYE TELECOMMUNICATIONS EQUIPMENT



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

Video Transmission Oscilloscope

Brief Specification:

"Y" Amplifier:

Frequency response: 1 c/s.—10 Mc/s. ± 1 dB.

Sensitivity: 50 mV./cm.

Waveform response: $K=0.25\%$

Time Base:

Range: 1 μ sec.—100 m. sec.

Trigger: Internal, External or Free Running.

Delayed Trigger: Variable, 5-85 μ secs.

The Pye PTC 1205 Video Transmission Oscilloscope is designed for testing video performance of transmitters, microwave links, land lines, repeater stations and studio equipment. Standard graticules simplify testing when the instrument is used in conjunction with the Pye PTC 1201/3 Pulse and Bar Waveform Generator.

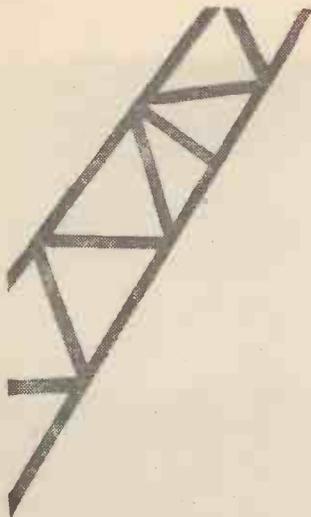
Special features include internal calibration of amplitude and frequency, calibrated delay scan, hum filter, 10 kc/s square wave oscillator and timing wave generator frequencies of 1, 6 and 10 Mc/s. As the response of the amplifiers is sensibly flat up to 10 Mc/s, the instrument is suitable for use on 405, 525 and 625 line systems.

PYE TELECOMMUNICATIONS LIMITED

NEWMARKET ROAD • CAMBRIDGE

Telephone: Teversham 3131

Telegrams: Pyetelecom Cambridge



In view of the increased world-wide demand for **HALTRON RADIO TUBES**, we are happy to announce that we are now operating from our new and enlarged premises. This enables us to offer a much wider range of receiving, transmitting and special purpose tubes, backed by prompt deliveries. Come to our unique organisation and get all your valve requirements from one reliable source.

We invite your specific enquiries for valves tested to CV, JAN, and MIL specifications.



Our Organisation is A.R.B. Approved.

*If you are not already on our Mailing List, please send
for latest Price and Stock Lists.*

HALL ELECTRIC LTD

Haltron House, Anglers Lane, Kentish Town, N.W.5

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GULLiver 8531 (10 lines)
Cables:
Hallelectric, London
TELEX 2-2573



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**SUFLEX NYLON DRIVE CORD and
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FOR HARD VALVE MODULATOR CIRCUITS



the E.E.V. C1133 has the same specifications as the 4PR60A. It also meets all the requirements of military and commercial specifications with the additional advantage of smaller bulk. Conditioning at 30 kV and rigorous testing ensure thoroughly reliable operation right up to the maximum peak anode voltage and current ratings of 25 kV, 18 A.

'ENGLISH ELECTRIC'

Typical Operation

D.C. Anode Voltage	20 kV
Peak Anode Voltage	25 kV
Screen Voltage	1.25 kV
Grid Voltage	600 V
Pulse Anode Current	16 A
Peak Anode Current	18 A
Pulse Output Power	300 kW
Duty Cycle	0.001
Pulse Length	2 μsecs

A lower rated version, the C1111, is also available.

Abridged Data

Type	Plug-in replacement for	Overall Length Max.	Overall Diameter Max.	Net Weight	Heater Voltage	Anode Voltage Max. D.C.	Peak Anode Voltage Max.	Peak Anode Current Max.	Screen Voltage Max.	Anode Dissipation Max.
C1133 (CV2416)	4PR60A 715C CV427 CV2752	152 mm	65 mm	9 oz.	26	20 kV	25 kV	18 A	1500 V	60 W
C1111	715C CV427 CV398	152 mm	65 mm	9 oz.	26	17.5 kV	20 kV	15 A	1500 V	60 W

ENGLISH ELECTRIC VALVE CO. LTD.

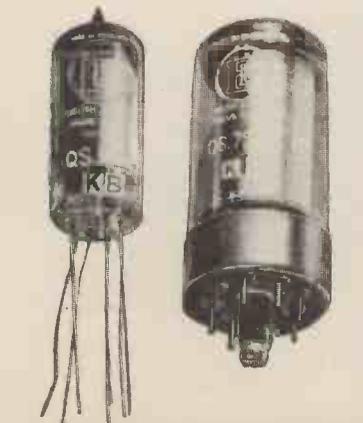
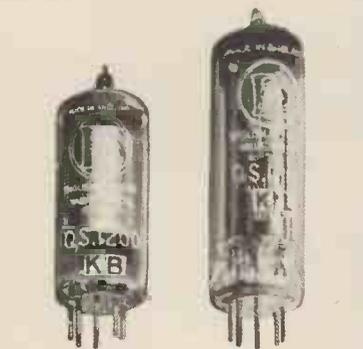


Chelmsford, England
Telephone: Chelmsford 3491

Voltage Stabilisers and Reference Tubes

ENGLISH ELECTRIC VALVE CO. LTD.

The most extensive range provided by any manufacturer in Great Britain. Send for full technical data.



E.E.V. type	Previously known as	American equivalent	Service type	Striking voltage (V)		Operating voltage max. (V)	Ignition electrode voltage (V)	Ignition electrode series resistance (megohms)	Tube current max. (mA)	Tube current min. (mA)	Regulation max. (V)	Base
				o	•							
OA2	QS1207	OA2	CV1832	185	225	150	—	—	30	5	6.0	B7G
OA2WA+	QS1210	OA2WA	CV4020	165	225	150	—	—	30	5	5.0	B7G
OA3	QS1205	OA3	CV3798	105	160	75	—	—	40	5	6.5	Int. Octal
OB2	QS1208	OB2	CV1833	133	210	108	—	—	30	5	3.5	B7G
OB2WA+	QS1211	OB2WA	CV4028	133	210	108	—	—	30	5	3.0	B7G
OC2	—	OC2	—	115	145	75	—	—	30	5	4.5	B7G
OC3	QS1206	OC3	CV686	133	210	108	—	—	40	5	4.0	Int. Octal
OD3	QS150/40	OD3	CV216	180	225	150	—	—	40	5	5.5	Int. Octal
QS75/20	—	—	CV284 (CV5083)	110	160	75 (70)	—	—	20	2	6.0	B7G
QS75/60	—	—	CV434	117	—	75	—	—	60	5	5.0	B8G
QS83/3	—	—	Improved CV449	115	160	83	—	—	8	1	1.5	B7G
QS92/10	—	—	CV188 (CV1070)	140	—	92 (100)	—	—	10	1	5.0	British 4-pin
QS95/10	—	—	CV286	110	—	95	150	0.25	10	2	5.0	B7G
QS108/45	—	—	CV422	120	—	108	150	0.10	45	5	5.0	B8G
QS150/15	—	—	CV287	170	—	150	240	0.25	15	2	5.0	B7G
QS150/45	—	—	CV395	170	—	150	200	0.10	45	5	5.0	B8G
QS1200	—	—	CV2225	180	225	150	—	—	15	5	5.0	B7G
QS1201+	—	—	—	110	160	75	—	—	15	2	4.5	B7G/F
QS1202+	—	—	CV4052	133	210	108	—	—	15	2	3.0	B7G/F
QS1203+	—	—	CV4053	180	225	150	—	—	15	2	4.5	B7G/F
QS1204	—	—	—	133	210	108	—	—	25	5	3.0	B7G
QS1209/5651	5651/ QS1209	5651	CV449	115	160	84	—	—	8	1	3.0	B7G
QS1212+	—	5651WA*	CV4048	115	115	85	—	—	10	1	4.0	B7G
QS1213+	—	—	CV4054	115	115	85	—	—	10	1	4.0	B7G/F

+ This is a rugged and reliable type. B7G/F denotes flying leads. o In normal lighting. • In total darkness. * Near equivalents.

Stabilovolts

E.E.V. type	Service type	Gap	Striking voltage min. (V)	Operating voltage (V)	Anode current max. (mA)	Cathode current min. (mA)	Regulation per gap over full current range (average) (V)	Base
†STV280/40	CV1068	A4 to K	420	280	35	5	4.0	B5
		A3 to K	320	210	40			
		A2 to K	210	140	60			
		A1 to K	110	70	60			
†STV280/80	CV1069	A4 to K	420	280	70	10	4.0	B5
		A3 to K	320	210	70			
		A2 to K	210	140	90			
		A1 to K	110	70	100			

† Indicates a recent addition to the range

ENGLISH ELECTRIC VALVE CO. LTD.



Chelmsford, England
Telephone: Chelmsford 3491

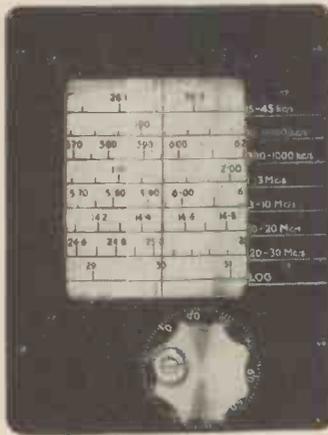
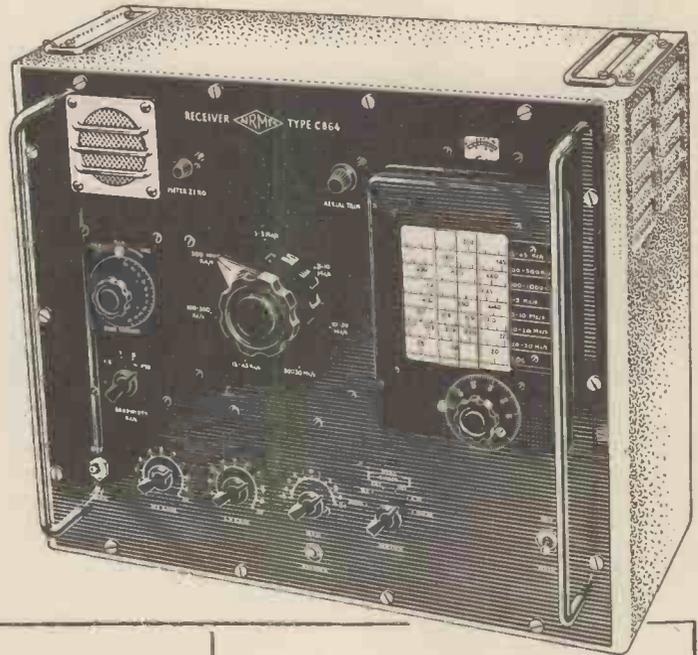
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COMMUNICATIONS RECEIVER Type C864

All round the World this Airmec receiver is known and used for its remarkable performance at an extremely low cost.

Superior Sensitivity
Superior Signal-to-Noise Ratio
Superior Second Channel Rejection



Main tuning control showing a portion of the seven frequency scales, the coarse and fine logging scales and the movable cursor.

- Frequency coverage from 15—45 kc/s and 100 kc/s—30 Mc/s.
- Frequency setting accuracy better than 1 kc/s.
- Film scale giving actual scale length of 4ft. on each frequency range.
- 90 : 1 slow motion drive with logging scale.

ADDITIONAL FEATURES

- Separate incremental tuning control for use with crystal calibrator.
- Double frequency changer circuit.
- Stabilised local oscillator H.T. voltages.
- Image rejection over 100 db.
- Exceptionally high sensitivity and signal/noise ratio.
- Variable selectivity.
- S meter incorporated.
- Very stable B.F.O.
- Muting facilities provided.
- Built-in loudspeaker.
- 2 watts output.
- Turret band switching.

PRICE : £150

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A NEW ALL-BRITISH



TRANSISTOR!

This new Sylvania-Thorn NPN Germanium Alloy Transistor Series GT 422 has been designed and made in Britain for power switching applications. It is precision built of hermetically-welded construction in a rigidly-controlled production environment; its reliability and long life is ensured by careful inspection and testing at all stages of manufacture.

MAXIMUM JUNCTION TEMPERATURE: 85°C

MAXIMUM COLLECTOR CURRENTS UP TO 6 AMPS.

MAXIMUM COLLECTOR-EMITTER VOLTAGES UP TO 60 V

Several ratings are available. Write for further details to:

Sylvania-Thorn Colour Television Laboratories Limited, Dept. GT3
Great Cambridge Road, Enfield, Middx

SYLVANIA-THORN



MAXIMUM RATINGS					
	GT 423	GT 422	GT 424	GT 425	GT 426
MAXIMUM COLLECTOR-EMITTER VOLTAGE <i>(Transistor conducting)</i>	60V	60V	60V	36V	36V
MAXIMUM COLLECTOR CURRENT ¹	6A	6A	3A	6A	3A
DC CURRENT GAIN AT RATED COLLECTOR-CURRENT					
MAXIMUM:	120	35	60	35	60
MINIMUM:	35	11	18	11	18

Technical drawings showing dimensions for the transistor:

- Top view: 2 HOLES .156" DIA, 1.010" MAX, .430" NOM, 1.184" / 1.190" MAX, 1.530" MAX, .521" MAX
- Side view: .460" MAX, .625" MAX, .135" MAX, .900" DIA MAX, 2 LEADS .040" DIA

NPN GERMANIUM ALLOY TRANSISTOR SERIES GT 422

Stabilized POWER PACKS



PP1 FOR
THERMIONIC
VALVES

£150 NETT IN U.K.

Leaflet W60

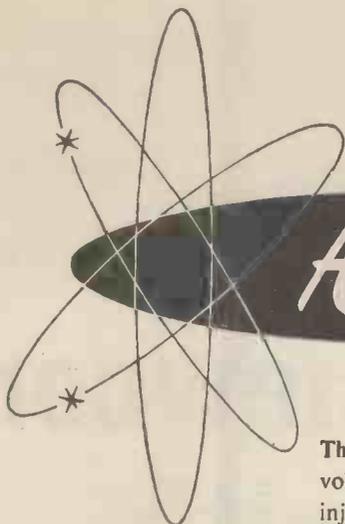
- ▶ High-power 0-600 volts stabilized 300 mA max.
- ▶ L.T. supplies stabilized — two independent outputs at 6.3 volts 4 amps.
- ▶ H.T. source resistance less than 0.1 ohm at d.c. and less than 0.5 ohm up to 30 kc/s.
- ▶ H.T. source resistance may be varied up to a maximum of 40 ohms.
- ▶ Mains ripple of up to 6 volts can be superimposed on H.T. line.
- ▶ Overload protection of H.T. line by resettable cut-out.

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Advance

Two new stabilized power packs with outstanding features for the development engineer.

The Type PP.1 has the unique features of stabilized L.T. voltages, variable H.T. source resistance, and mains ripple injection on the H.T. line.

The Type PP.3 is fully transistorized and provides simultaneous d.c. voltages of either polarity, and is fully protected against accidental short-circuit.



PP3 FOR TRANSISTORS

£110 NETT IN U.K.

Leaflet W62

- ▶ Two independent variable d.c. supplies 0-30 volts 1 amp.
- ▶ Positive and negative supplies provided simultaneously.
- ▶ Up to 60 volts d.c. by series connection.
- ▶ Fully protected against short-circuits.
- ▶ Ripple less than 1 mV peak-to-peak.
- ▶ Both voltage and current monitored simultaneously.

We shall be pleased to arrange for our Area Sales Engineer to demonstrate these models to you.



THE EDISWAN S11E12 (CV4060)
Special Quality Beam Tetrode

a newcomer with a first class reference

The S11E12 is the latest addition to the range of Ediswan valves designed specifically for use in series or shunt control circuits.

The S11E12 has an international octal base and the important parameters are as follows:

Heater Voltage (volts)	V_h	6.3
Heater Current (amps)	I_h	1.6
Anode Voltage, maximum (volts)	V_a (max)	800
Screen Voltage, maximum (volts)	V_{g2} (max)	300
Mutual Conductance (mA/V)	g_m	13.5
Anode Dissipation (watts)	P_a (max)	28
Cathode Current (mA)	I_k (max)	300

EDISWAN
MAZDA
INDUSTRIAL VALVES
AND CATHODE RAY TUBES
SIEMENS EDISON SWAN LTD

An A.E.I. Company

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The new valve is specially designed to resist shock and is quality tested at all stages of manufacture to ensure maximum reliability and life expectancy. It is available from stock. Further information on this and other valves in the CV 4000 range will be gladly sent on request.

Stentorian

HIGH FIDELITY AT REALISTIC COST

The items illustrated were exhibited at the Northern Audio Fair, Harrogate. They are representative of the wide range of W. B. Hi-Fi equipment. Our experience in sound reproduction covers 33 years; such a background is a guarantee of quality.



Stentorian Cambic Cone Hi-Fi Units.
The famous H.F.1016 at £7.12.3.
Other types from £1.2.6.



Tweeter Units from 33/3 to £12.12.0.



Prelude Horn-Loaded Cabinet £19.0.0.
H.F.817 Speaker £10.16.6.

T.359 Cone Tweeter Unit 33/3.



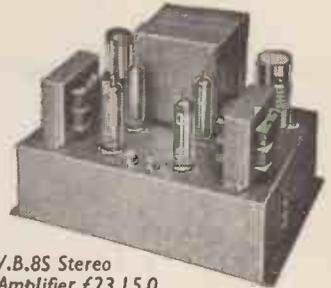
Ready-to-assemble cabinets in polished walnut from £5.10.0 to £16.16.0.



Stentorian Extension Speakers from 60/-.



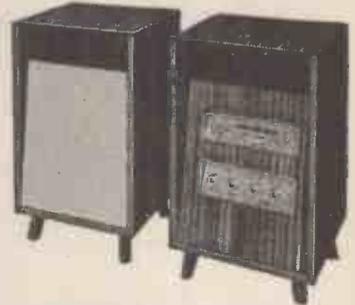
W.B.8 Amplifier £19.19.0.



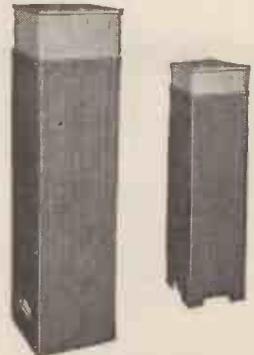
W.B.8S Stereo Amplifier £23.15.0



W.B.8S Stereo Control Unit £22.15.0



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COLUMN LOUDSPEAKERS
Cabinet for H.F.816 Unit £18.18.0.
Cabinet for H.F.610 Unit £9.19.6.



W.B.121

WHITELEY ELECTRICAL RADIO CO. LTD • MANSFIELD • NOTTS

Telephone : MANSFIELD 1762-5

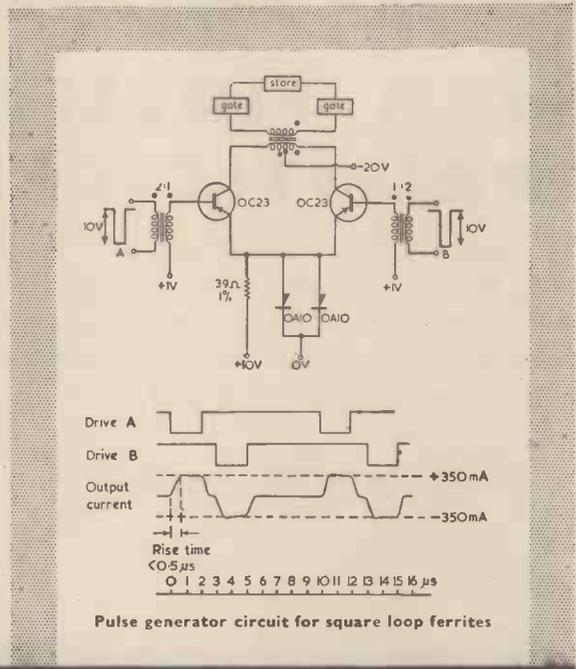
Demonstrations at our London Office (109 Kingsway, W.C.2.) every Saturday from 9 a.m. to 12 noon.

High frequency—High gain

OC23 Computing Transistor

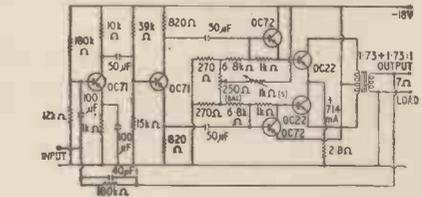
The OC23 is designed and specially tested for driving square-loop ferrite computing elements and storage matrices. Its high f_α and power handling capabilities, however, suit it for a number of additional computing applications.

- Ferrite drive transistor providing 1-amp pulses with rise time $<0.8 \mu\text{sec}$.
- Half and full current pulse generator transistor for ferrite stores of up to 40,000 bits capacity.
- Gating transistor for use with ferrite stores.
- Clock pulse generator transistor for medium speed computers.



OC22 High quality industrial A.F. Transistor

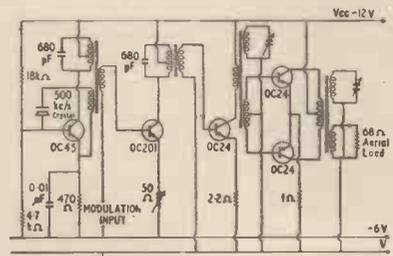
The f_α of 2 Mc/s of the OC22 ensures that the negative feedback used in quality a.f. amplifiers does not cause h.f. oscillation. In addition, the α' gives a generous final gain even allowing for the inevitable reduction through negative feedback, thus reducing the power required from the drive stage. An extremely linear α'/I_0 characteristic is yet another reason for using the OC22 in transistorised industrial a.f. equipment where quality is of paramount importance.



4-watt experimental a.f. amplifier circuit
 Total harmonic distortion at 4W output (measured at 400 c/s) ... $<1.0\%$
 Frequency response (400 c/s ref. level) ... $\pm 2 \text{ dB } 20 \text{ c/s to } 20 \text{ kc/s}$
 Feedback factor (with 2.5 k Ω source) ... 20 dB
 Sensitivity (input current for full output) ... 30 μA

OC24 Communications Transistor

The OC24 is particularly suited for communications applications. Two of these transistors are, for example, used in the output stage of a marine distress transmitter where they provide 4 watts c.w. at 500 kc/s. The OC24 can, of course, be used for modulated c.w. or telephony. Another example of the application of the OC24 in the field of communications is a 12 channel telephone repeater amplifier which conforms to the full C.C.L.T. Specification. This amplifier has an output of 0.5 watt at 120 kc/s.



4-watt 500 kc/s Transmitter

Power transistors

10 watts dissipation

2 Mc/s average f_{α}

High frequency cut-off, high α' , high dissipation and low bottoming voltage are all combined in the Mullard OC23—a leading transistor of its kind in the world.

The OC23 and its companion types OC22 and OC24 are now being made by Mullard in extremely large quantities and are immediately available at economic prices. Telephone or write Mullard House for full information and assistance in selecting the type most suited for your particular application.



Germanium P-N-P Alloy Junction Transistors

Characteristics (at $T_{\text{junction}} = 25^{\circ}\text{C}$) for OC22, OC23 and OC24.

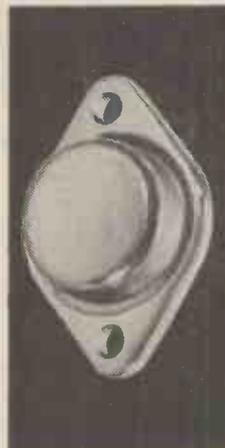
GROUNDING BASE

Collector Leakage Current (at $V_c = -10\text{V}$, $I_e = 0$)	...	...	Typical $I_{c(o)}$	30 μA	Max. 100 μA
Emitter Leakage Current (at $V_e = -10\text{V}$, $I_c = 0$)	...	...	$I_{e(o)}$	20 μA	100 μA

GROUNDING EMITTER

Collector Bottoming Voltage (at $I_c = 1.0\text{A}$, $I_b = 30\text{mA}$)	...	...	V_{ce}	-400mV*	—
Current Amplification Factor (at $V_c = -2\text{V}$, $I_c = 100\text{mA}$)	...	...	α'	200	Min
(at $V_c = -2\text{V}$, $I_c = 1.0\text{A}$)	...	...	α'	150	50

* -400mV for OC23 and OC24 only. OC22 = -600mV.



MULLARD LIMITED
 Semiconductor Division
 Mullard House · Torrington Place
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Mullard
 semiconductor
 division

RCA



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

SINGLE SIDEBAND

Communications system

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

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



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



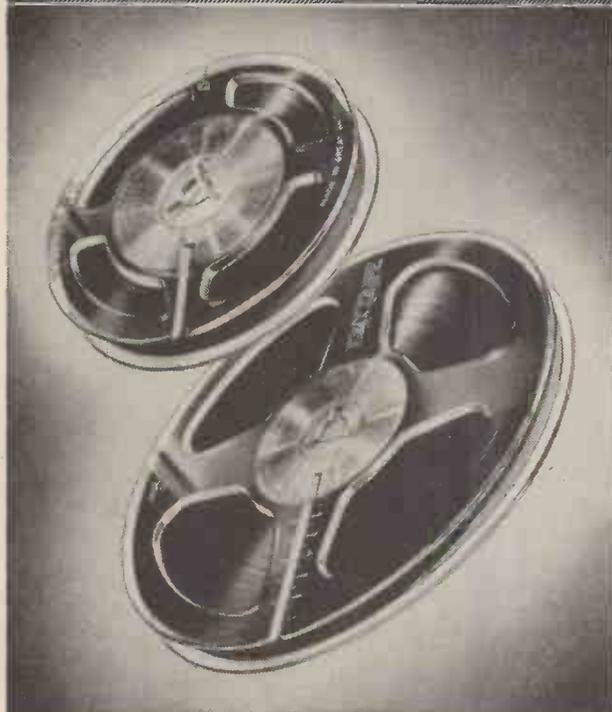
◀ Automatic remote antenna tuner AAT-L100

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



RCA GREAT BRITAIN LTD. LINCOLN WAY, SUNBURY-ON-THAMES, MIDDX. Tel: Sunbury-on-Thames 3101
An Associate Company of Radio Corporation of America.

Emitape



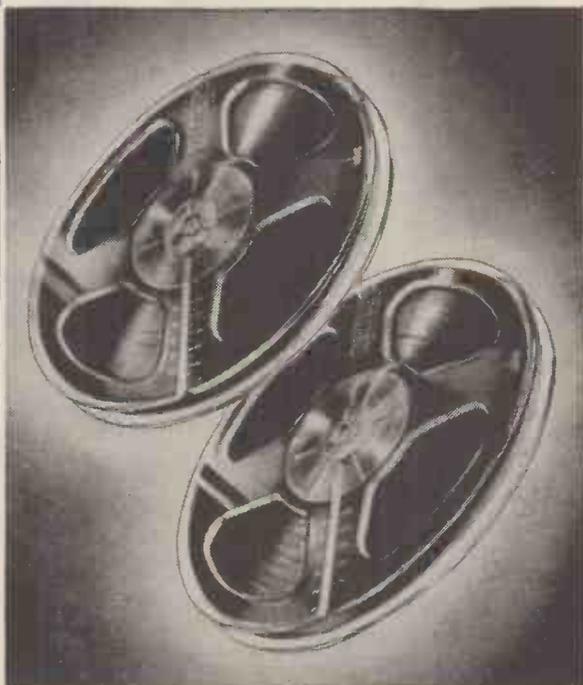
the magnetic recording tape with the highest technical standards

- * High sensitivity
- * Low noise level
- * Low 'print through' factor
- * Anti-static
- * Freedom from curl and stretch

"88" GENERAL PURPOSE

"99" LONG PLAY

Type No.	Title	Size	Length approx.	Price in EMICASE	Price without EMICASE
88/3	"Message"	3" dia.	175'	—	7 6
99/3		3" dia.	250'	—	9 6
88/3N		3½" dia.	175'	—	7 6
99/3N		3½" dia.	250'	—	9 6
88/6	"Junior"	5" dia.	600'	£1 3 6	£1 1 0
99/9		5" dia.	850'	£1 10 6	£1 8 0
88/9	"Continental"	5½" dia.	850'	£1 10 6	£1 8 0
99/12		5½" dia.	1200'	£1 17 6	£1 15 0
88/12	"Standard"	7" dia.	1200'	£1 17 6	£1 15 0
99/18		7" dia.	1800'	£2 12 6	£2 10 0
88/18		"Professional"	8½" dia.	1750'	—	£2 17 6
99/24	8½" dia.		2400'	—	£3 12 6



Emicase

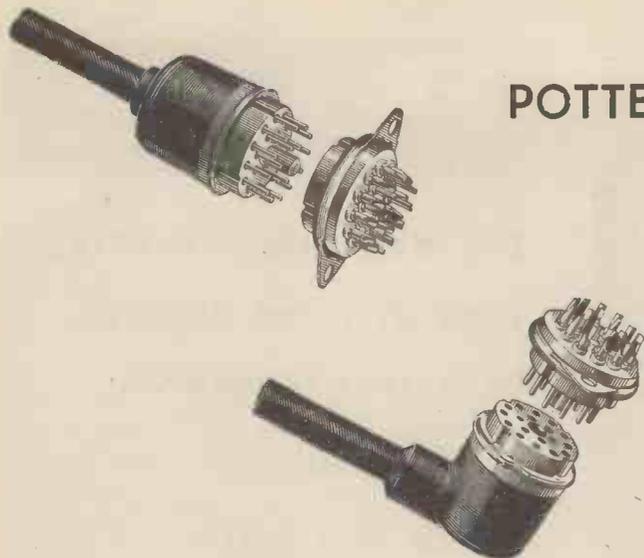
now available separately!

the polystyrene container that solves tape storage problems, protects spools from dust and allows easy identification of leader tapes.



7" - 4s. 0d; 5½" - 3s. 6d; 5" - 3s. 6d.

E.M.I SALES & SERVICE LTD
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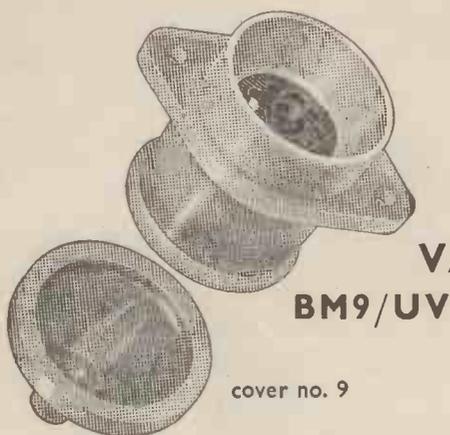
POTTED PAKONECTORS

18 WAY

* No cover and cable clamp worries. We connect your cable to plug or socket and put the assembly in polythene. * 18 connections in less than 1 inch diameter. * Standard B9A valveholder mounting. * Nylon loaded PF. mouldings. * Cadmium plated or gold pins and contacts.

McMURDO

ELECTRONIC



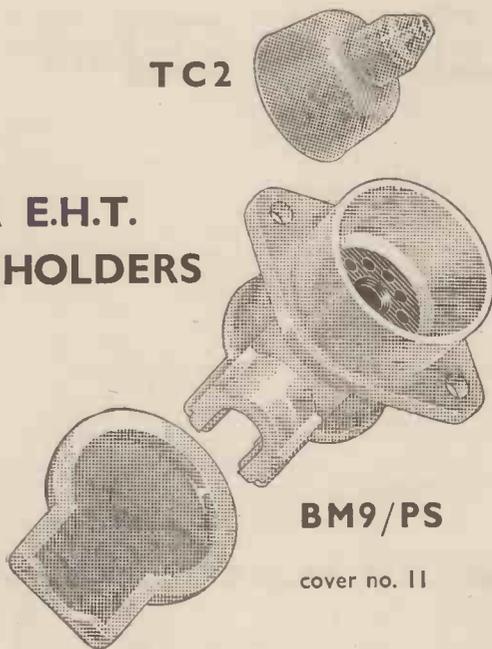
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Polythene Shrouded B9A. Valveholder
for Television E.H.T. Rectifiers.

B9A E.H.T. VALVEHOLDERS

BM9/UV

TC2



BM9/PS

cover no. 11

Send for full details to:—

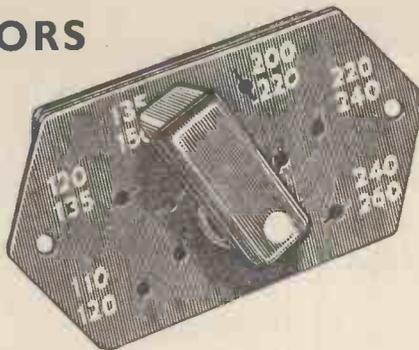
The McMurdo Instrument Co. Ltd.,



14 WAY B279001

BLACK P.F. MOULDING

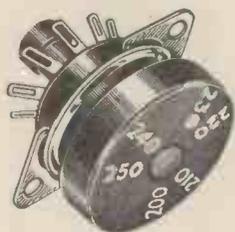
VOLTAGE SELECTORS



6 WAY XVS/6

NYLON LOADED P.F. MOULDING

COMPONENTS



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BLACK P.F. MOULDING

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- for Industrial Research

*A new simultaneous
dual-channel
tape recorder*

Series 3C/FN



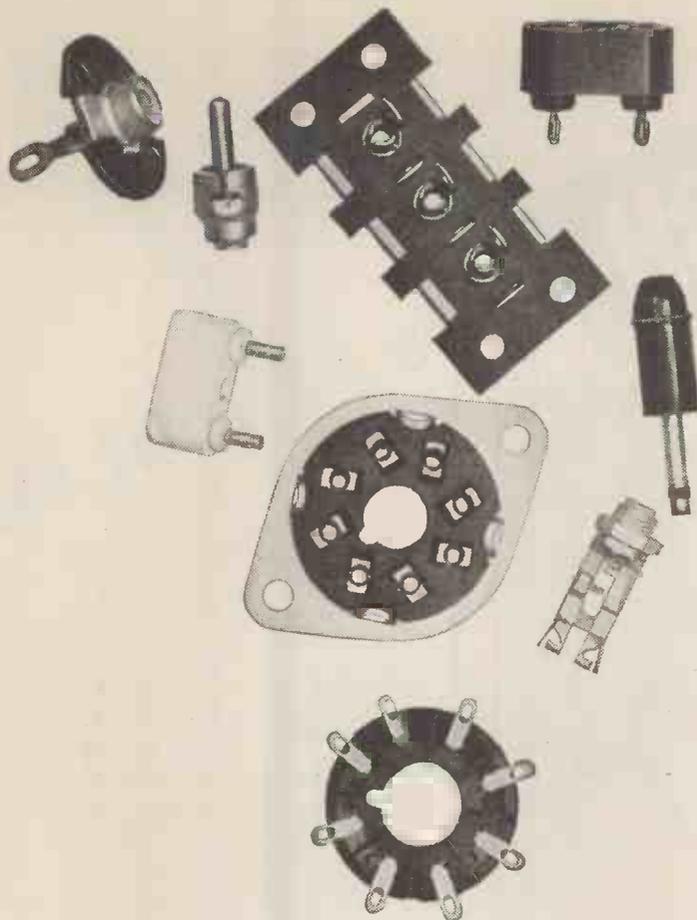
THE Ferrograph Series 3C/FN, illustrated here, is a simultaneous dual-channel instrument, using staggered heads, which offers special facilities to those engaged in medical, aeronautical and other scientific research. Besides the normal ability to record simultaneously time pulses on one track and intelligence on the other, it becomes immediately obvious that many forms of comparative measurement, stereophonic sound, or indeed, any two activities capable of being translated into electrical phenomena (within its

frequency and phase shift limitations) can be recorded simultaneously and replayed when required. Thus, the scope of such an instrument, when used for Research purposes, is almost unlimited.

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Manufacturers are invited to write for details of our complete range of components



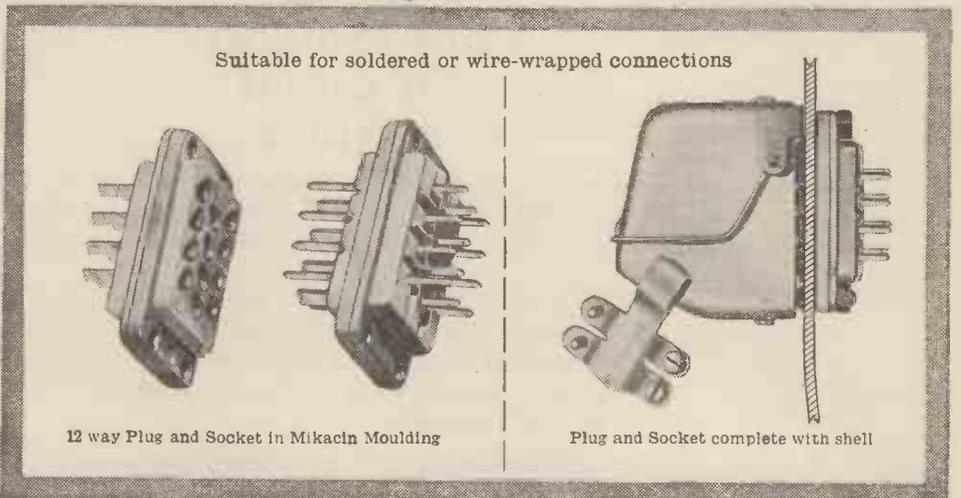
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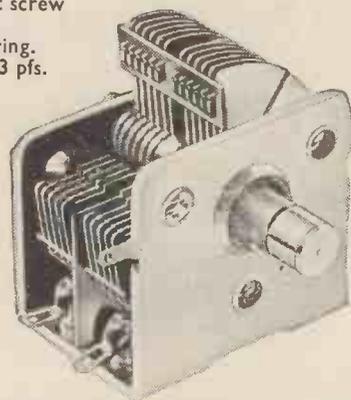
COMPONENTS



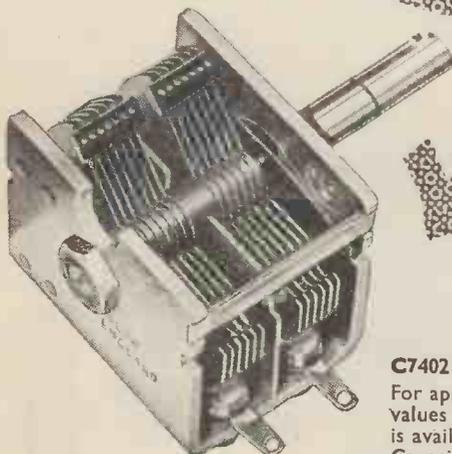
S5011/3 Trimmer
P.T.F.E. dielectric screw type trimmer for suspension in wiring. Capacity 1 pf to 13 pfs.



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.

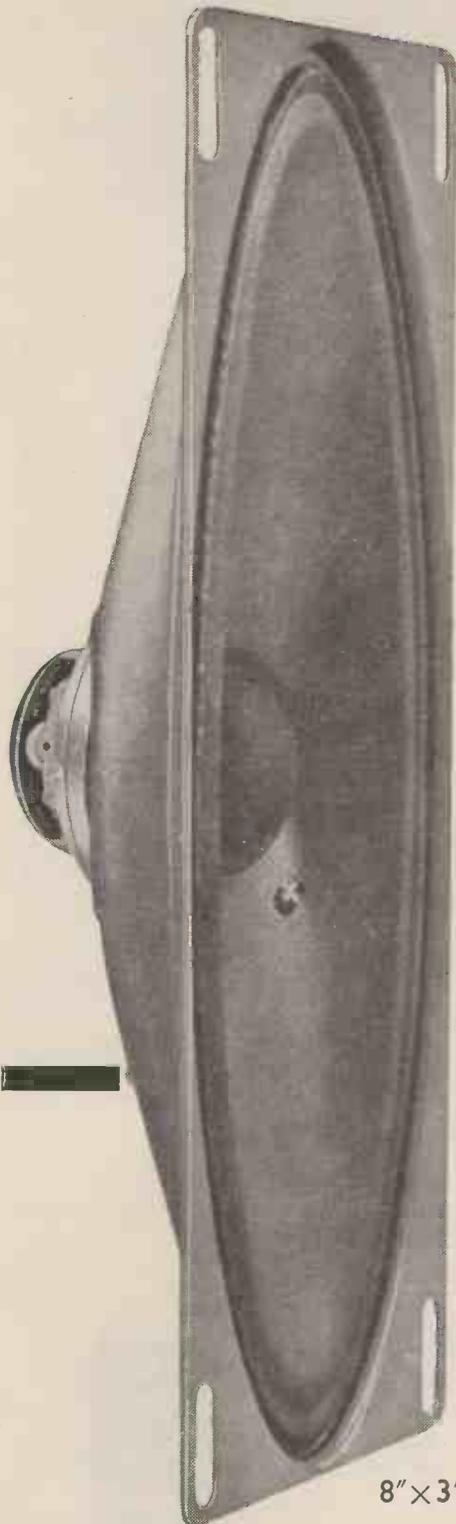


TS6-12 Miniature Terminal Strips
Centres are 5/32", available in single, 2, 4, 6, 8, 10 and 12 units with insulators of aluminium oxide possessing high strength in relation to size. Larger versions can be supplied both in single stand-off and strip form with voltage ratings up to 4 K.V. working.

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8 x 3C	8500g	2.5 WATTS	22/6	7/3
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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

TRADE DISCOUNT 33 $\frac{1}{3}$ %



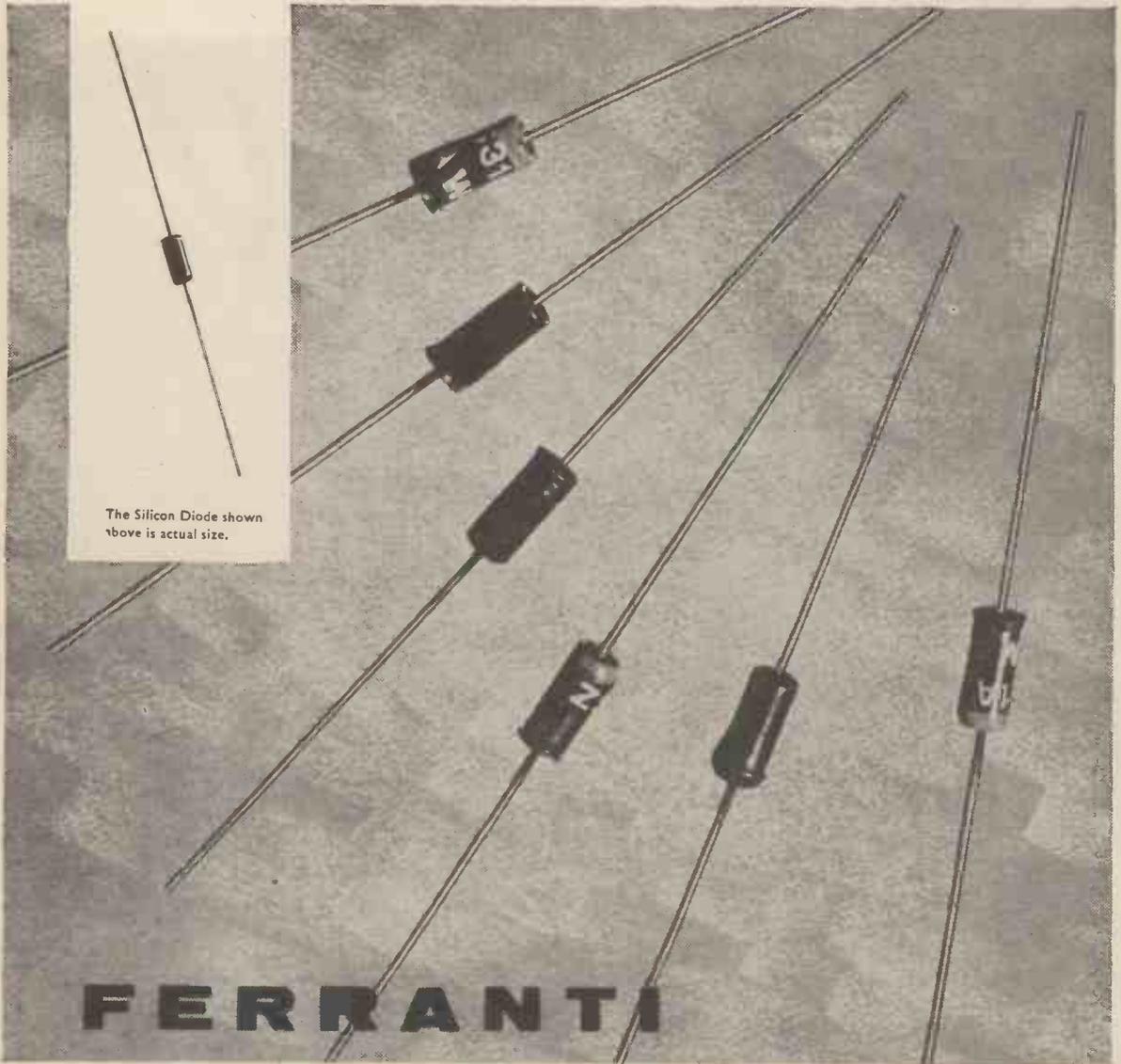
7" x 4"



5"

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

Tel: Tottenham 0505/9 (5 lines)



The Silicon Diode shown above is actual size.

FERRANTI

Silicon Diodes ZS30 series

for MINIATURIZED Circuitry

SPECIAL FEATURES

- AUTOMATIC WIRING TECHNIQUES
- HIGH TEMPERATURE OPERATION
- HIGH RECTIFICATION EFFICIENCY
- HIGH POWER TO SIZE RATIO
- HIGH FORWARD CONDUCTANCE
- RUGGEDISED CONSTRUCTION

Ferranti Miniaturized Circuit Diodes are designed for automatic wiring techniques. These diodes, in addition to being run at maximum ratings for forty-eight hours, are rigorously tested to satisfy the following conditions:

Vibration	Grade I (Aero Engines)
Shock	> 500 g.
Humidity	Class HI
Temperature Range	-70°C to + 135°C.

P.I.V. Range 50-400 Volts : Max. Mean Rectified Current 500mA



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 LONDON OFFICE: KERN HOUSE, 36, KINGSWAY, W.C.2. Telephone: TEMple Bar 6666



... a new approach to better listening



The COLAUDIO provides a new incentive to listening, creates a new realism in reproduced sound, adds a new beauty to music and the finer nuances of speech. Combining a 15 in. direct radiator bass loudspeaker with two direct radiator, pressure-type high frequency reproducers in column form, the COLAUDIO is the culmination of over thirty years' research, development and manufacture of loudspeakers for all purposes. Its perfection of tone can be truly appreciated only by an aural test—once heard, you will never be satisfied until you instal one in your own reproducing equipment.

ESSENTIAL DATA

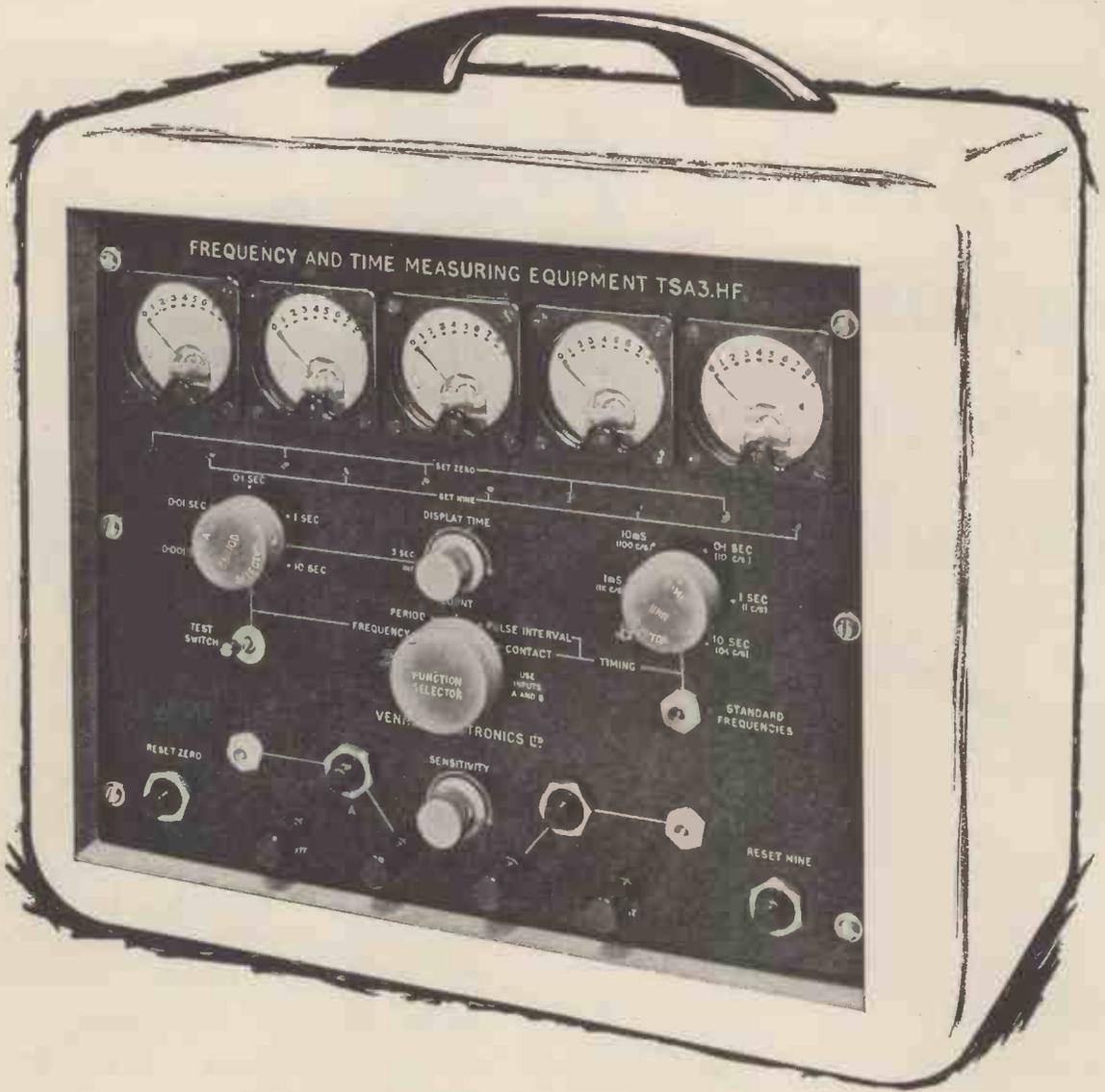
NOMINAL SIZE	15"
PEAK POWER HANDLING CAPACITY	25 watts
VOICE COIL DIAMETER	3"
TOTAL FLUX	290,000 Maxwells
FREQUENCY RESPONSE	30-15,000 c/s
BASS RESONANCE	35 c/s
IMPEDANCE AT 400 c/s	15 ohms

CELESTION

COLAUDIO

Rola Celestion Ltd. THAMES DITTON, SURREY, ENGLAND.

Telephone: Emberbrook 3402/6

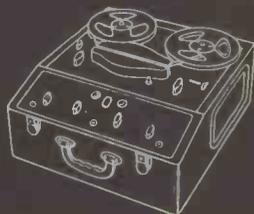
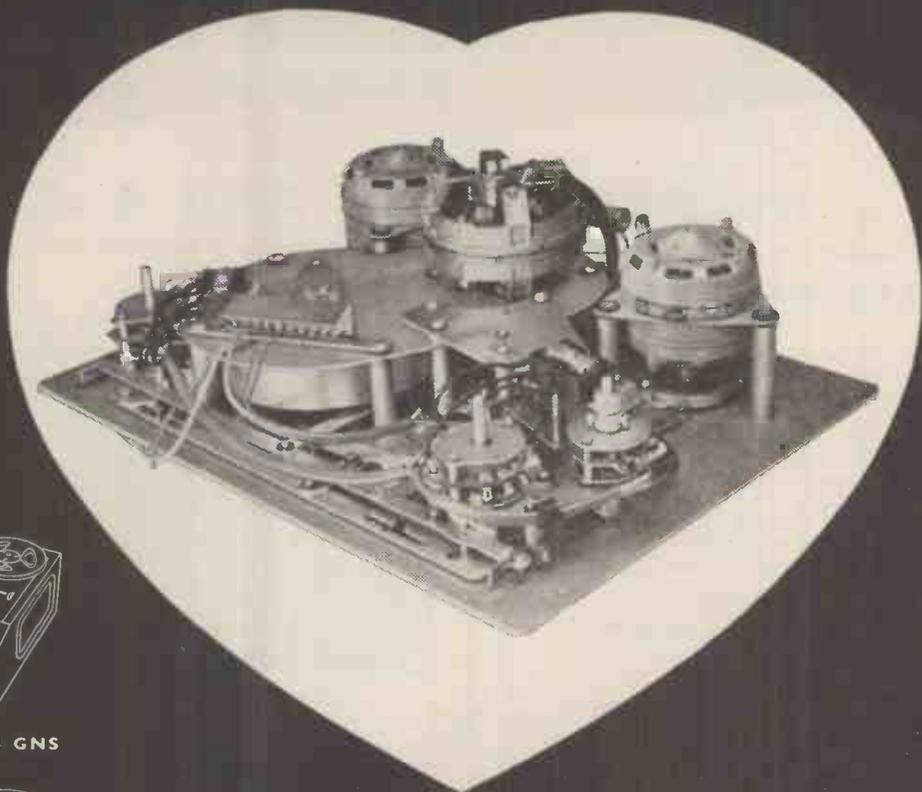


Frequency measurement up to 1Mc/s
- for less than £300
and time measurement into the bargain!

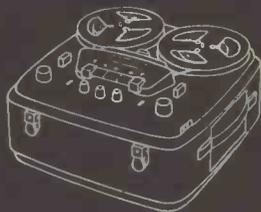
Other models available from £245



Electronics



BRENELL MK. 5 64 GNS



BRENELL 3 STAR 58 GNS

**The Heart of a good Tape Recorder
is its Deck**

For the enthusiast who loves to experiment—who wishes to build up his own tape recording unit—to construct into his own furniture or to add to existing hi-fi equipment, the Brenell Mk. 5 Deck presents truly remarkable value. Its versatility of application has firmly established the Brenell in the hi-fi market as a general purpose deck with immense advantages. Superbly made, it is conclusive evidence of the skilful design for which Brenell are noted.

BRENELL MK. 5 DECK. 4 operating speeds: Extra heads can be fitted: 8½ in. spools accommodated: Only two switches (interlocked for safety) are employed. These control record, playback, wind and rewind and have extended shafts for fitting extra wafers if necessary. Large statically and dynamically balanced flywheel for speed stability. Instant stop without spillage. Fast rewind (45 sec. for 1,200ft.). Tape Deck with provision for extra heads 28 gns. Complete record/playback amplifier with power unit £24. Stereo rec./playback (including mounting rack) £93/16/-.

PERFORMANCE IS TRUE-TO-LIFE PERFORMANCE

The Brenell Deck is of course incorporated in their famous Mk. 5 Recorder. The Rank Organisation are regularly purchasing the Mk. 5 tape recorder for use in their cinemas.

Brenell

GD23

Sole Manufacturers: BRENELL ENGINEERING CO., LTD., 1A, DOUGHTY STREET, LONDON, W.C.1.

Telephone: CHA 5809 and HOL 7358



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S.S.8 STEREO R.G. CHASSIS 26 Gns.

8 Valves. Ganged Bass and Treble Controls.
Dual Volume Controls with Concentric Knobs.
3 Wavebands: L.M. and F.M.
Built-in Ferrite Aerials.

Extremely High Sensitivity on F.M.

3 Position Amplifier Switch.

1. R.H. Channel only (Monaural)

3½ watts Gram or Radio.

2. R. & L.H. Channels (Monaural)

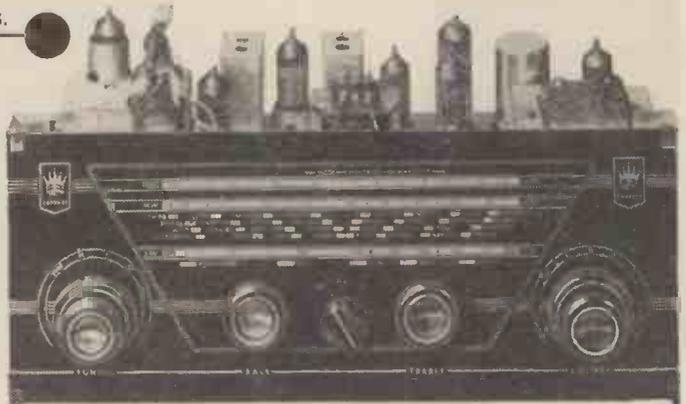
7 watts Gram or Radio.

3. R. & L.H. Channels (Stereo)

7 watts.

Dipole and all leads supplied.

Dial size 15in. x 6in. 15 ohm. outputs.



R.G.9 A.M./F.M. CHASSIS 25 Gns.

9 Valves. Push Pull Output. 6 Watts.

Built-in Ferrite Aerials.

Magic Eye Tuning.

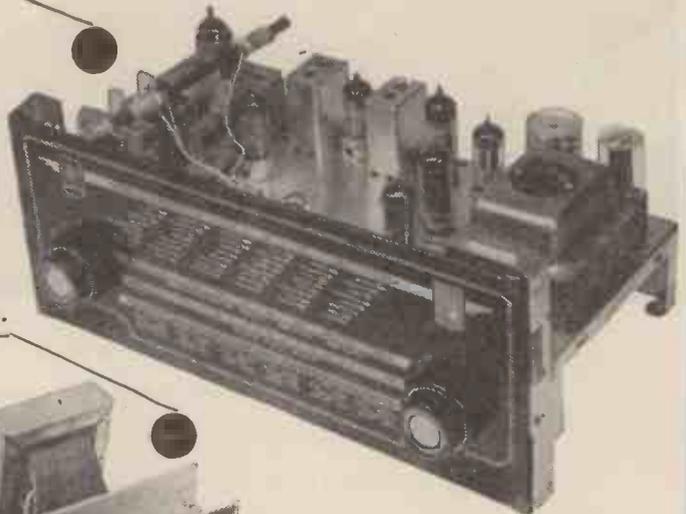
Extremely High Sensitivity on F.M.

4 Wavebands: L. M. S. & F.M.

Dipole and all leads supplied.

Dial size 15in. x 6in.

15 ohm. output.



T4 F.M. TUNER CHASSIS 13 Gns.

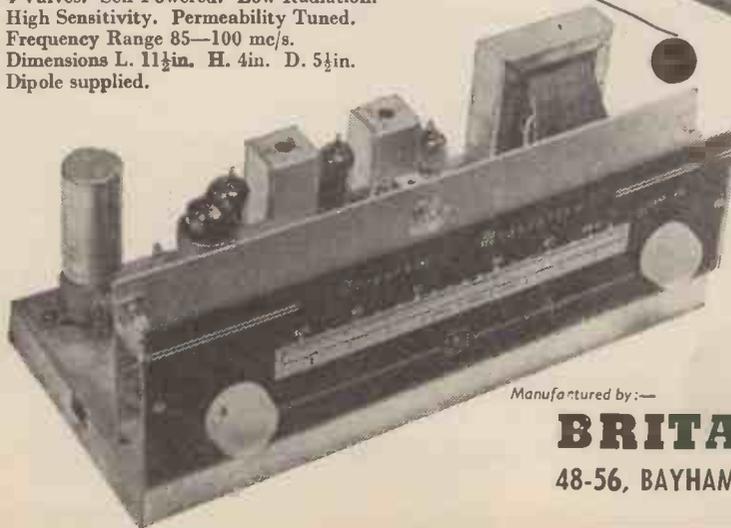
4 Valves. Self Powered. Low Radiation.

High Sensitivity. Permeability Tuned.

Frequency Range 85—100 mc/s.

Dimensions L. 11½in. H. 4in. D. 5½in.

Dipole supplied.



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FMT5.5v. A.M./F.M. Tuner Chassis—19 Gns.

SA4. 4 Valve Stereo Amplifier—£8.0.0d.

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6 CHANGE-OVERS LIGHT DUTY. 6 MAKES OR 6 BREAKS HEAVY DUTY.
2 CHANGE-OVERS HEAVY DUTY AND 2 CHANGE-OVERS LIGHT DUTY.

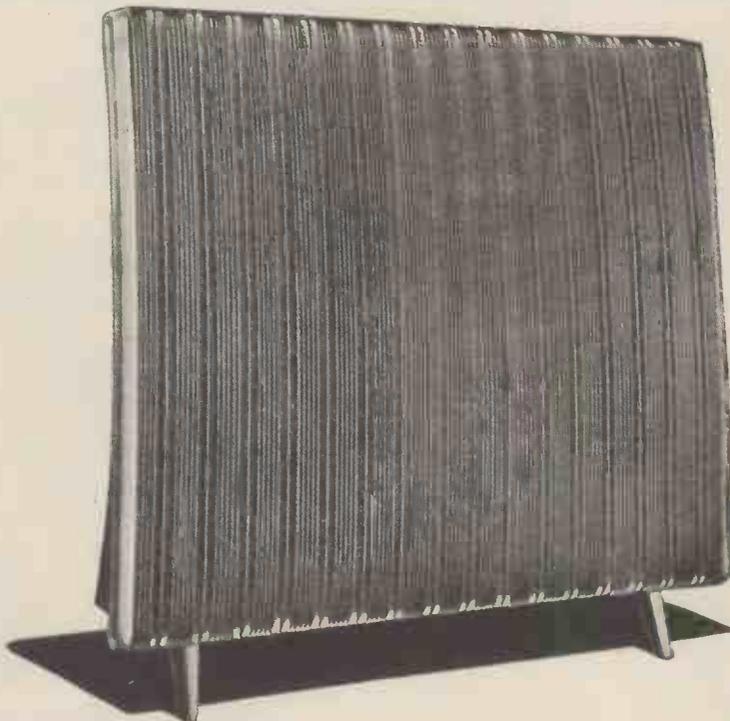
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listening enjoyment and
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QUAD

**ELECTROSTATIC
LOUDSPEAKER**

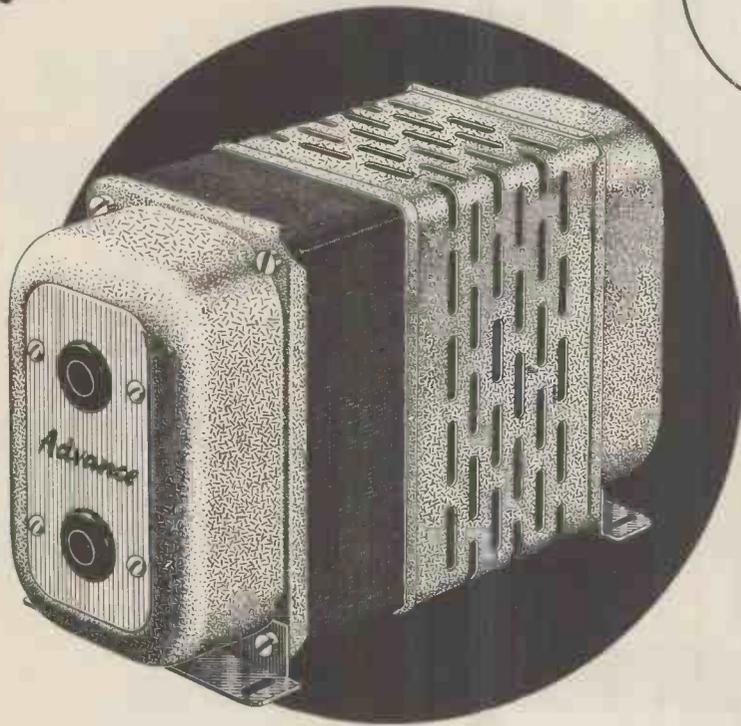
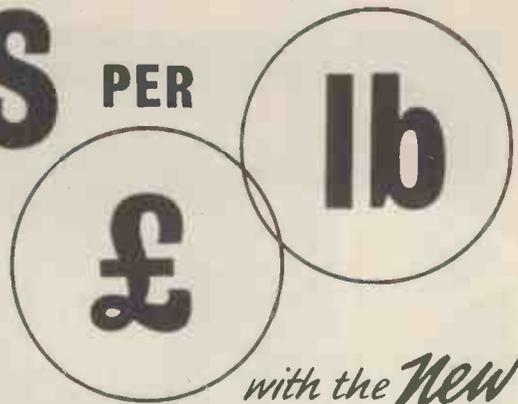
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The Quad Electrostatic Loudspeaker is essentially an instrument designed for the home* of the music-lover with every emphasis towards the natural quality desirable for serious listening to music of all types. Of modest size, this loudspeaker is suitable for use in the average-sized lounge; it is capable of providing distortionless reproduction under such conditions up to a volume level similar to that experienced in the concert hall.

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from 'NO LOAD' to 'FULL LOAD'
- WILL OPERATE CONTINUOUSLY
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and **COST LESS!**

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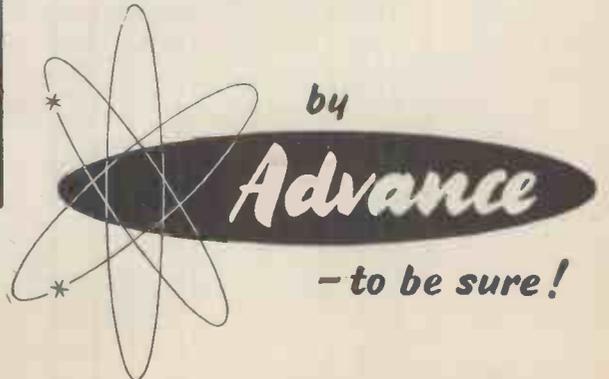
	MODEL CV.25/E	MODEL MT.281/E
Input Voltage	190-260V	190-260V
Output Voltage	6V	6V
Output Capacity	25W	25W
Dimensions	5½" x 3¾" x 4¾"	7" x 5½" x 4¾"
Weight	5lb	7lb
PRICE	£6.5.0	£8.0.0

Full details in Folder W-63 available on request

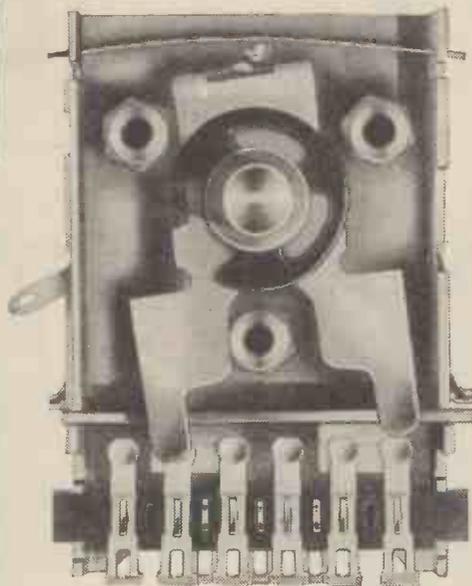
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MAINS STABILIZATION DIVISION

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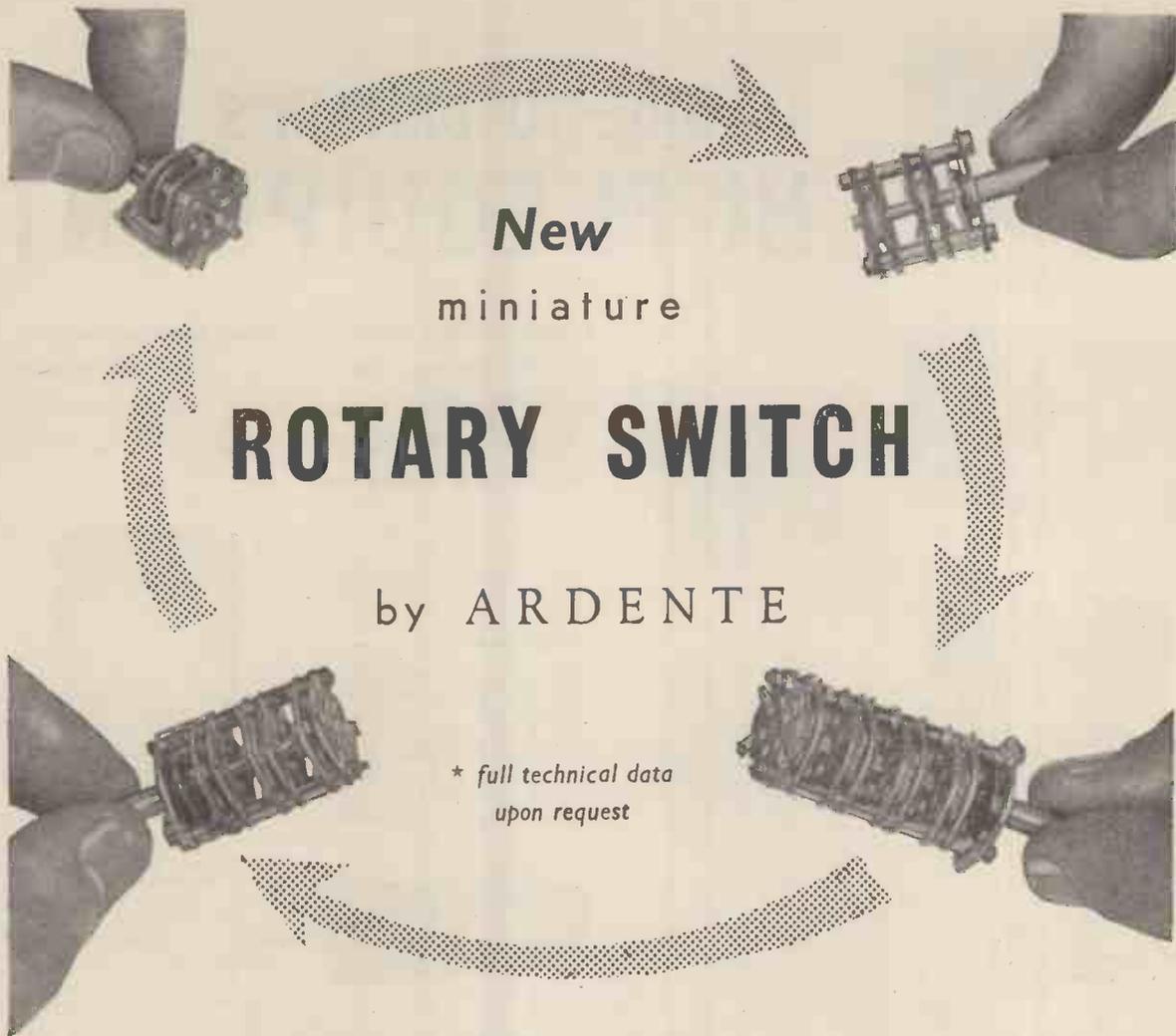
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A GUIDE TO BRITAIN'S BEST HI-FI EQUIPMENT



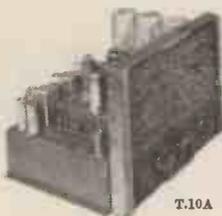
LF.15.CS.



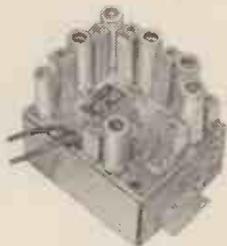
LF.16.CS.



LF.20.CS.



T.10A



FM.2.LV.

AMPLIFIERS

LF.15.CS. 4 valve Push-Pull LF Amplifier. 10 watts output. 1 volt R.M.S. input for full output. Auxiliary power supply for tuners, etc. Operates with Tone Control TC.15.CS or TC.16.CS, or TC.20.CS. **£20.5.0.**

LF.16.CS. 4 valve Push-Pull LF Amplifier. 10 watts output. 1 volt R.M.S. input for full output. 2nd channel stereo use. Operates with tone control unit TC.16.CS. **£17.10.0.**

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CLS.15. 15 watts max. 12" + one 5" High Flux speakers. **£35.5.0.**

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CLS.15.

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TC.16.CS. Stereo Tone Control Unit. The most advanced stereo-amplifier yet available.

4 valve, Twin Channel. 6 Controls. Selectors for Volume, Balance, Treble and Bass. Operates with Amplifiers LF.15.CS, LF.16.CS, LF.20.CS. Unique records, Tape or Radio input features. **£27.0.0.**

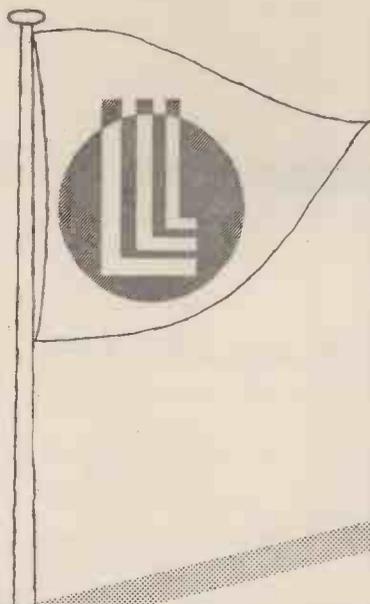
TC.15.CS. Tone Control Unit. 2 valves, 6 controls. Selectors for Mixers, Volume Filter, Treble and Bass. Inputs for pick-ups, tape and radio. Operates with LF Amplifier LF.15.CS or LF.20.CS. **£17.10.0.**

TC.20.CS. 4 valve Controller Mixer. 6 Controls. (Level, Filter, Treble, Bass, Mix Level). Equaliser. Push-button switch and Channel Selector. Fully comprehensive input and output facilities. Operates with Amplifier LF.20.CS. LF.15.CS. **£29.0.0.**



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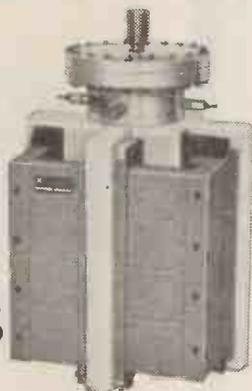


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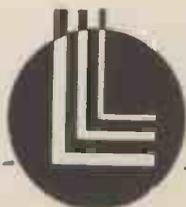
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- Self-contained - A.C. Power Unit and Dual A.F. Amplifiers.
- Built-in monitor speaker and tuning indicator.



Facilities:

Reception of:

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- (b) SSB partially suppressed carrier signals (up to 26 dB) using upper or lower sideband—reconditioned or local carrier with AFC or local carrier without AFC.
- (c) SSB totally suppressed carrier signals using upper or lower sidebands—local carrier without AFC.
- (d) ISB partially suppressed carrier signals (up to 26 dB)—reconditioned or local carrier with AFC or local carrier without AFC.
- (e) ISB totally suppressed carrier signals—local carrier without AFC.

For the reception of DSB/SSB and ISB signals with Communication Receivers such as the Redifon type R.151, R.145 or R.150, or any Receiver which will provide 0.1 Volt R.F. Input between 95-950 Kc/s.

The RA.10 is completely self-contained with A.C. Power Unit and built-in dual A.F. Amplifiers, thus eliminating the need for interfering with existing Receiver power and audio wiring. Separate audio outputs associated with the upper and lower sideband are provided and a monitor speaker may be switched to either channel as required. The use of transistors reduces the size, weight power consumption and heat dissipation to a minimum.

Input Impedance:
75 ohms.

Input Level:
0.1 Volt, r.m.s.

Unwanted Sideband Rejection:
Better than 50 dB.

Intermodulation products:
Better than 30 dB down.

Automatic Frequency Control:
Up to ± 3 Kc/s.

A.F. Response:
300-3000 c/s. within 6 dB.

A.F. Output:

- (a) 1.5 W. at 3 ohms for external loudspeaker.
- (b) 0.5 W. at 3 ohms for internal speaker.
- (c) 6 mW at 600 ohm balanced (upper sideband).
- (d) 6 mW at 600 ohm balanced (lower sideband).
- (e) Low impedance headphones output, internal speaker muted when in use.

Tuning Indicator:

A meter is provided to assist in tuning the adaptor.

Power Supply:
100/125 and 200/250 V.
50/60 c/s. Single Phase, A.C.

Power Consumption:
30 W. approx.

Dimensions:
19in. wide x 3½in. high x 13¼in. deep.

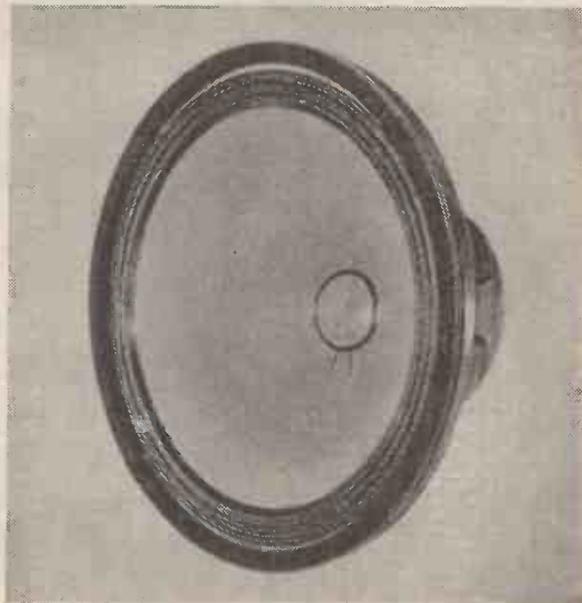
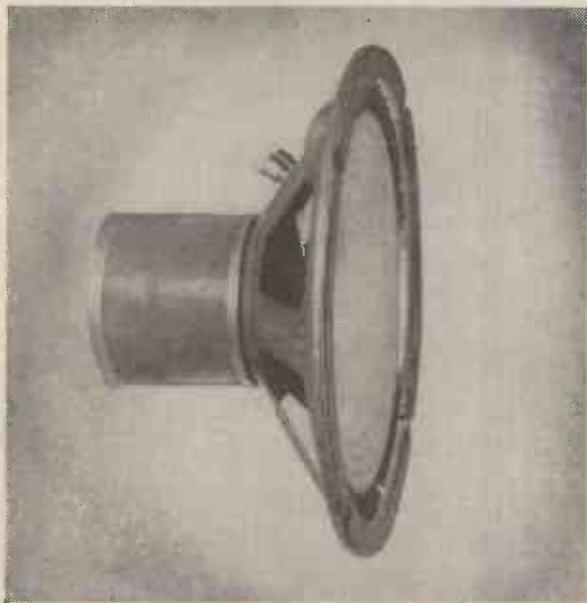
Weight:
27 lbs.

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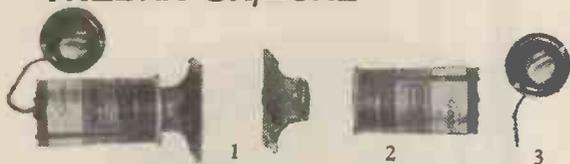
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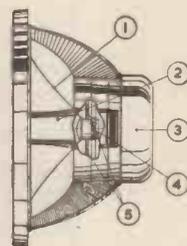
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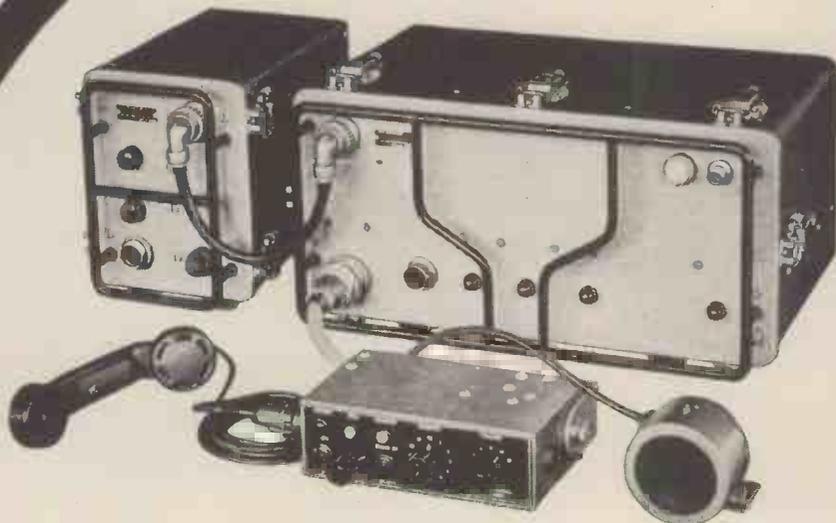
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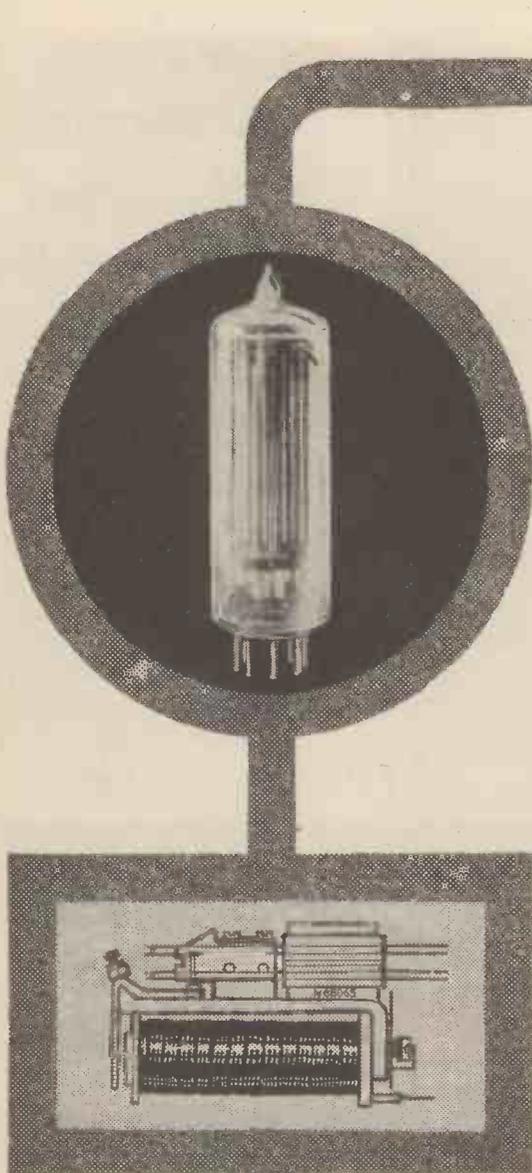


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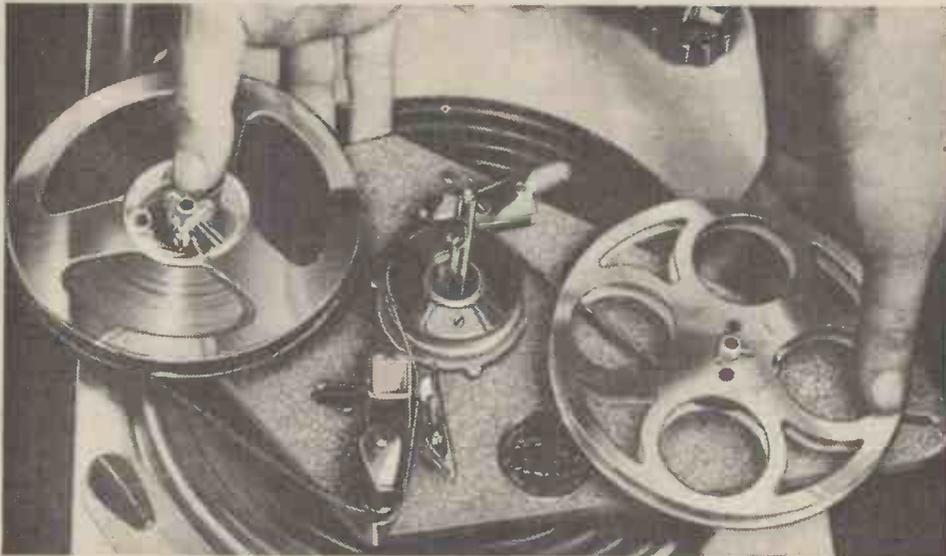


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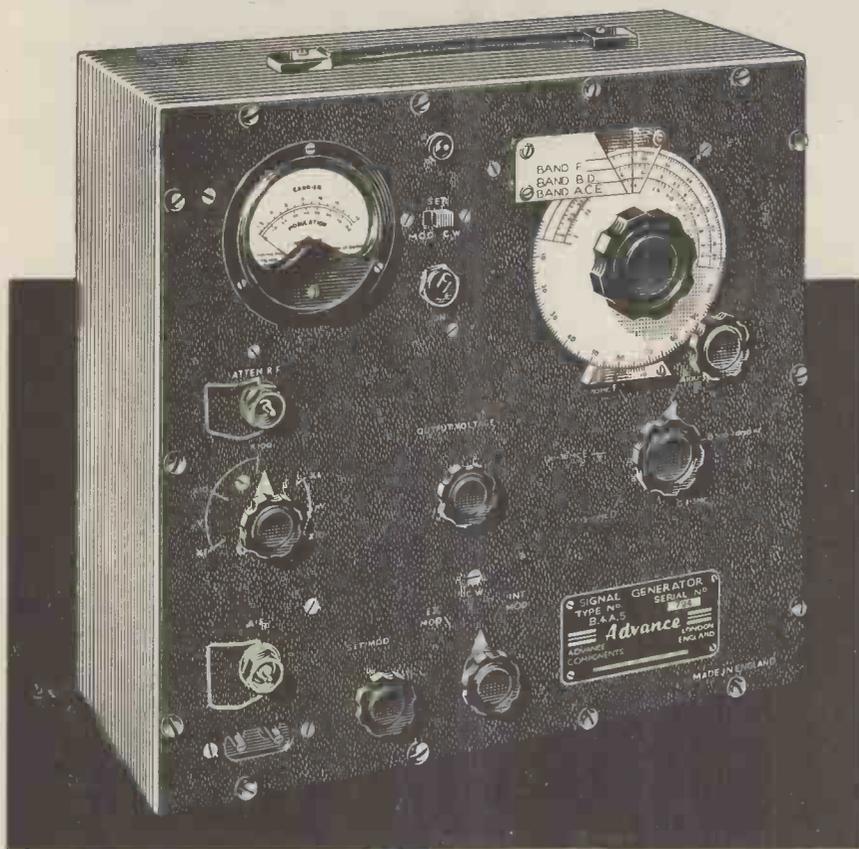


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The R.F. SIGNAL GENERATOR...



TYPE B4

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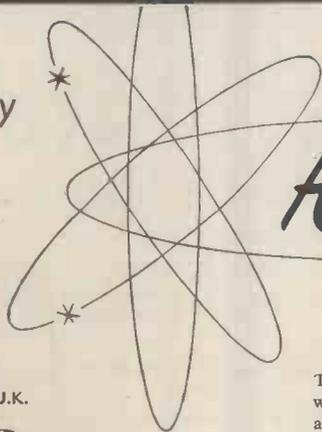
100 kc/s to 80 Mc/s
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Calibration accuracy of both
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Full technical details in Leaflet W38
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EXTERNAL MODULATION: Model A: 10 c/s to 30 kc/s; modulation depth 0 to 80%.

Model B: 10 c/s to 10 kc/s; modulation depth 0 to 80%

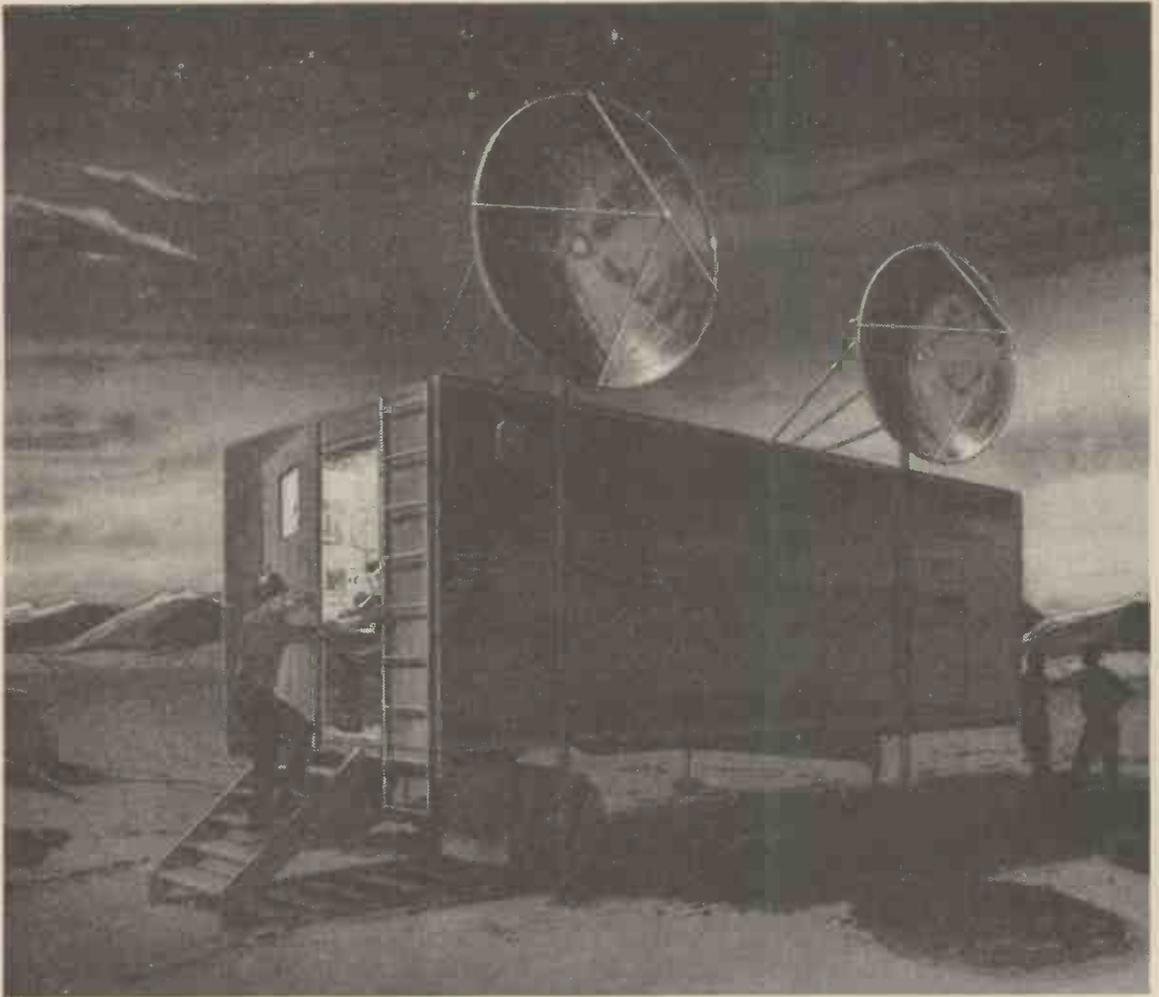
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GD70



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			—data
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Transportable—48 telephone channels	—teletype	Tactical and	—48 voice channels
		Transportable	—teletype
			—data

FEATURES

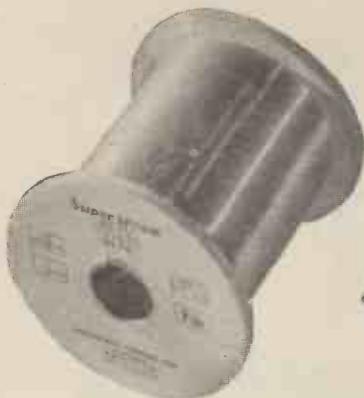
- Frequency—4400-5000 mc
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- Range—100 to 200 miles

A Westinghouse communications specialist will gladly furnish complete information on MICROSCATTER radio. Phone your nearest Westinghouse office, or write to Canadian Westinghouse Company Limited, Electronics Division, Hamilton, Canada.

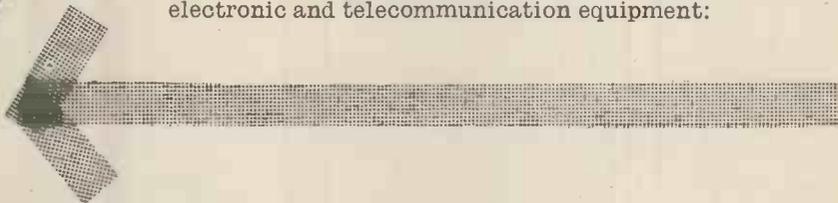
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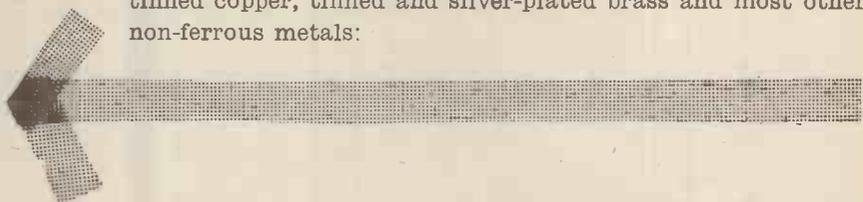
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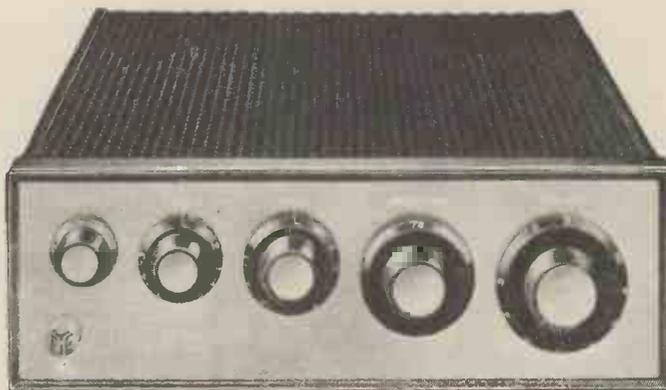


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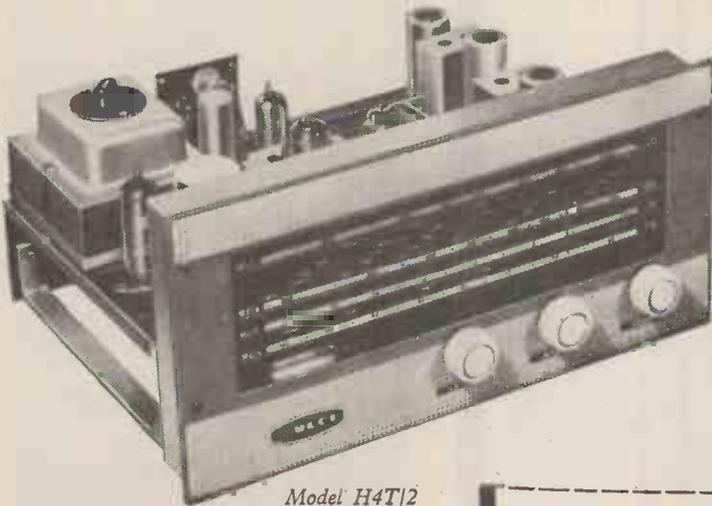
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The GFT.560/2 is of unit construction and consists of three basic cabinets — r.f. unit, modulator unit and power supply units — which can be used in combination for multi-frequency working and a number of types of emission.

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Output Impedance 600 ohms balanced.

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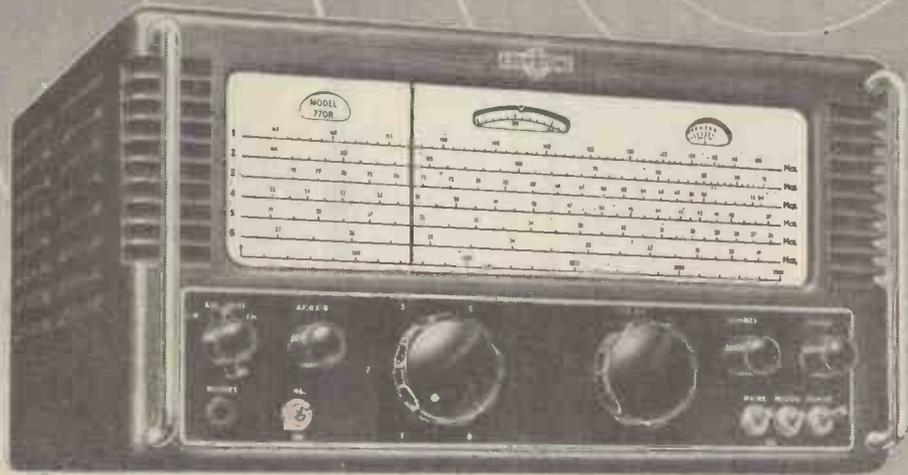
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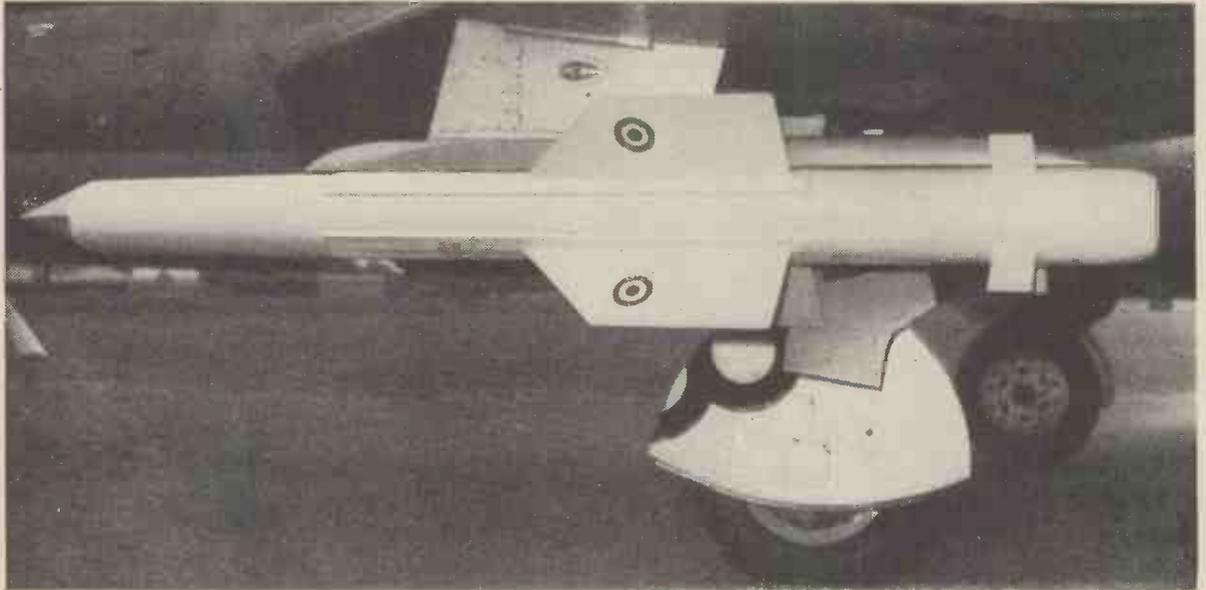
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Tough &

Tiny!

Plessey

“MP”

Miniature Preset

Potentiometers

General Specification

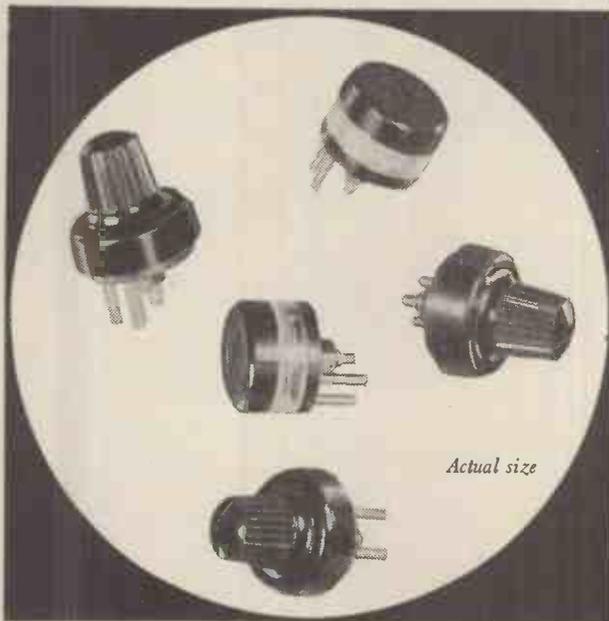
- Standard resistance values*
1 kΩ 2.2 MΩ (in preferred values)
- Tolerance ± 20%
- Law Linear
- Rating (total track) ¼ watt at 55° C
(subject to max. voltage not being exceeded)
- Maximum voltage 500 V
- Terminal resistance 50 Ω max.
- Total rotation 290° min.
- Max. resistance change
due to loading, humidity, etc. 10%

*The specification of the Red Spot 'MP' is as above except in the following three particulars:

- Rating (total track): ¼ watt at 70° C.
- Max. voltage: 750 V.
- Terminal resistance: 10 Ω max.

The critical selection of all the materials used in construction together with scrupulous process control results in a robust and highly welcome addition to the wide range of high quality components made available to engineers by Plessey.

For full details send now for leaflet 171.



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Eminently suitable for all applications where space is at a premium, these sturdy components are easily mounted on insulated panels and can be arranged in groups of four or more as required for television preset panels.

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For more stringent applications in the field of electronic instruments, a further development of this fine component is now available and is known as the Red Spot 'MP'.*

Plessey

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COMPUTER TRANSISTORS



The Semiconductors range of Computer Transistors, designed and tested to the special requirements of computer engineers, is the key to a new order of computer speed and reliability. Overall reliability is further increased by making possible a substantial reduction in the number of associated components.

The two types of Silicon Alloy Transistor shortly going into production will make it possible to extend this high-speed computer performance into ambient temperatures well above 100°C. Samples are available now.

	TYPE	DESCRIPTION	RISE TIME microseconds	Vc max	Ic max
HIGH-SPEED LOW-LEVEL SWITCHING GERMANIUM	SB 344 SB 345	General purpose transistors for conventional logic circuits.	50	5v	5mA
	SB 240	Designed for directly coupled circuits. Controlled input, saturation and hole storage characteristics.	30	6v	15mA
	MA 393	High gain transistor for high-speed driving of parallel circuits.	30	6v	50mA
	2N 501	Ultra-high speed transistor with controlled input and saturation characteristics.	10	12v	50mA
HIGH-SPEED LOW-LEVEL SWITCHING SILICON	SA 495	General purpose 10Mc/s transistor for conventional logic circuits.	100	25v	50mA
	SA 496	15Mc/s transistor for directly coupled circuits. Saturation resistance typically 10 ohms. Controlled input and hole storage characteristics.	80	10v	50mA
CORE DRIVING GERMANIUM	2 N 597 2 N 598 2 N 599	min f α 3Mc/s } 250 mW high frequency alloy transistors with high gain and low saturation resistance min f α 5Mc/s } min f α 12Mc/s }	{ 400 * 250 * 100 *	20v 20v 20v	400mA 400mA 400mA
	2 N 600 2 N 601	min f α 5Mc/s } 750 mW versions of 2 N 598 and 2 N 599. Peak current 3 amps. min f α 12Mc/s }	{ 250 * 100 *	20v 20v	400mA 400mA

* rise time to 400mA

Full technical details and applications assistance available on request.

Semiconductors Limited

G HENEY MANOR
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T E L E P H O N E : S W I N D O N 6 4 2 1 / 2 .



2 $\frac{3}{4}$ inch

ETEL
3AFPI

High Sensitivity General Purpose Instrument Tube 3AFPI

The 3AFPI is an inexpensive 2 $\frac{3}{4}$ -inch instrument tube with an unusually high sensitivity. A drive of only 50 volts on the Y-plates will give full screen deflection thus materially simplifying the design of deflection amplifiers and making possible simple equipment which will operate into the megacycle region.

The comparative simplicity of associated circuitry, combined with the low cost of the tube itself, recommend the 3AFPI for a wide variety of applications.

Write for full data to the address below.

ABRIDGED DATA

The 3AFPI is suitable for symmetrical or asymmetrical operation.

Heater

V_h = 6.3V I_h = 0.55A

Typical Operation

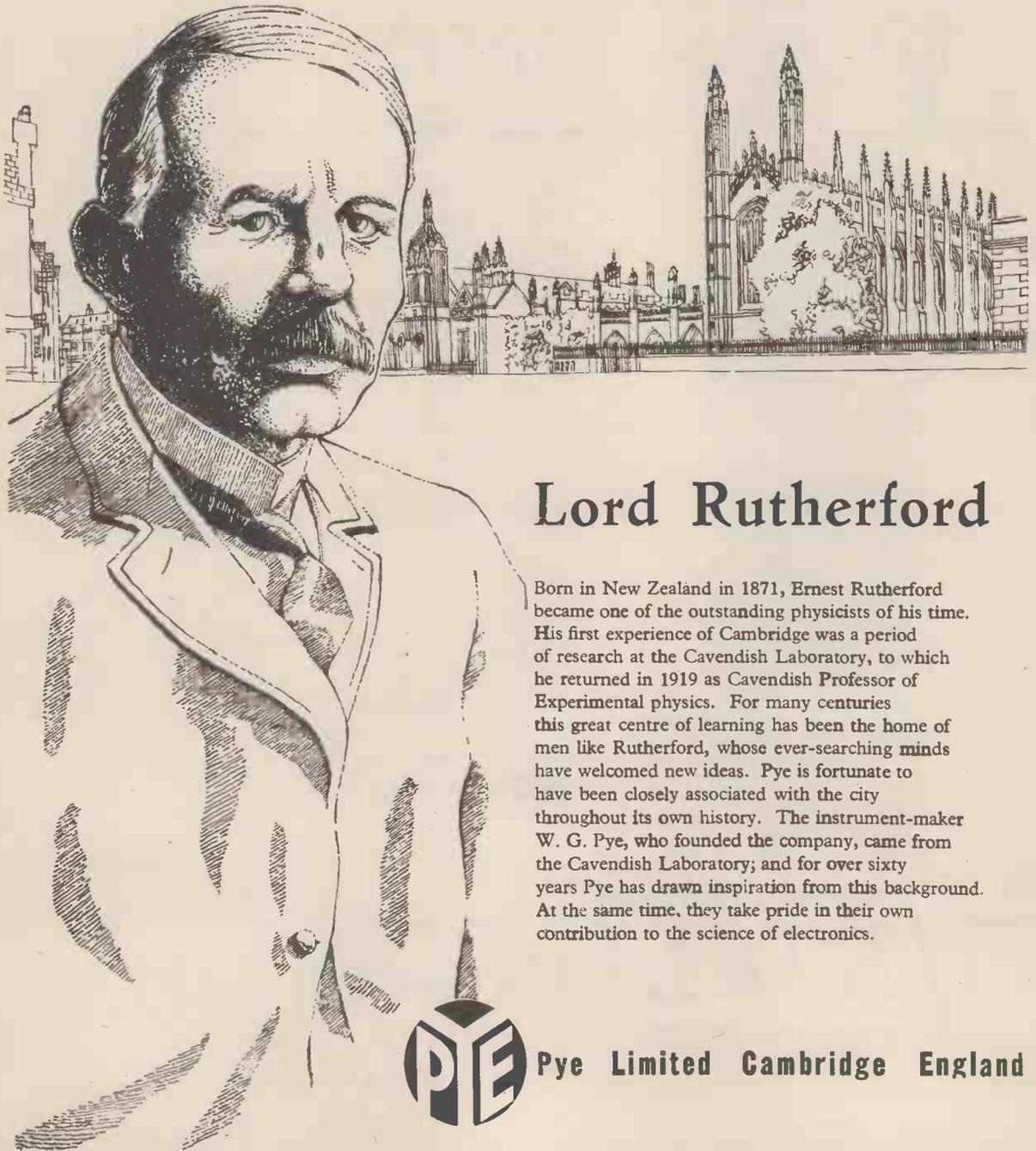
V_{a1+a3} 1000V
V_{a2} 210 to 320V
V_g -28 to -65V
S_x 20V/cm
S_y 11.5V/cm

ETEL

Cathode Ray Tubes

CAMBRIDGE

Centre of Scientific Research



Lord Rutherford

Born in New Zealand in 1871, Ernest Rutherford became one of the outstanding physicists of his time. His first experience of Cambridge was a period of research at the Cavendish Laboratory, to which he returned in 1919 as Cavendish Professor of Experimental physics. For many centuries this great centre of learning has been the home of men like Rutherford, whose ever-searching minds have welcomed new ideas. Pye is fortunate to have been closely associated with the city throughout its own history. The instrument-maker W. G. Pye, who founded the company, came from the Cavendish Laboratory; and for over sixty years Pye has drawn inspiration from this background. At the same time, they take pride in their own contribution to the science of electronics.



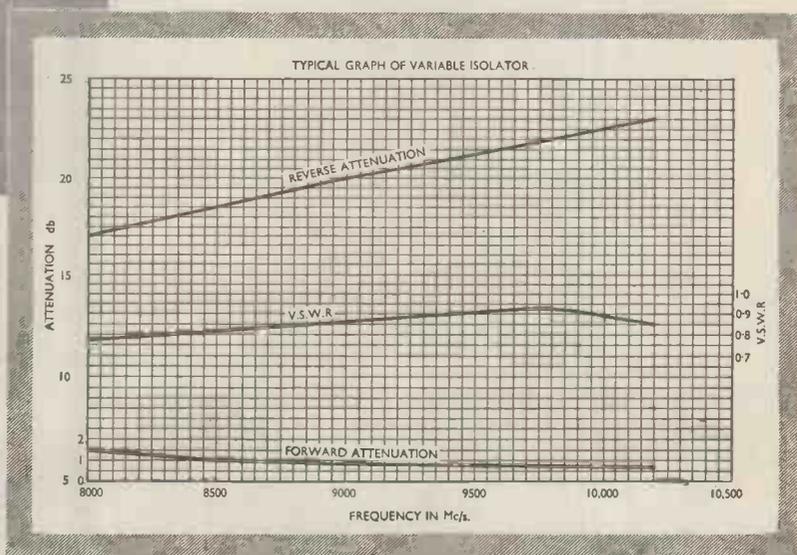
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Isolation at Microwaves

L324 X-band isolator

This isolator is a ferrite loaded waveguide component with unidirectional characteristics designed to isolate an X-band microwave source from reflections caused by mismatch. It is a versatile component suitable for incorporation in equipment or for use as a laboratory aid. It is tunable for peak performance over X-band.



For information on other microwave components including circulators, co-axial mixers, switches, folded tees, etc., write to the address below.

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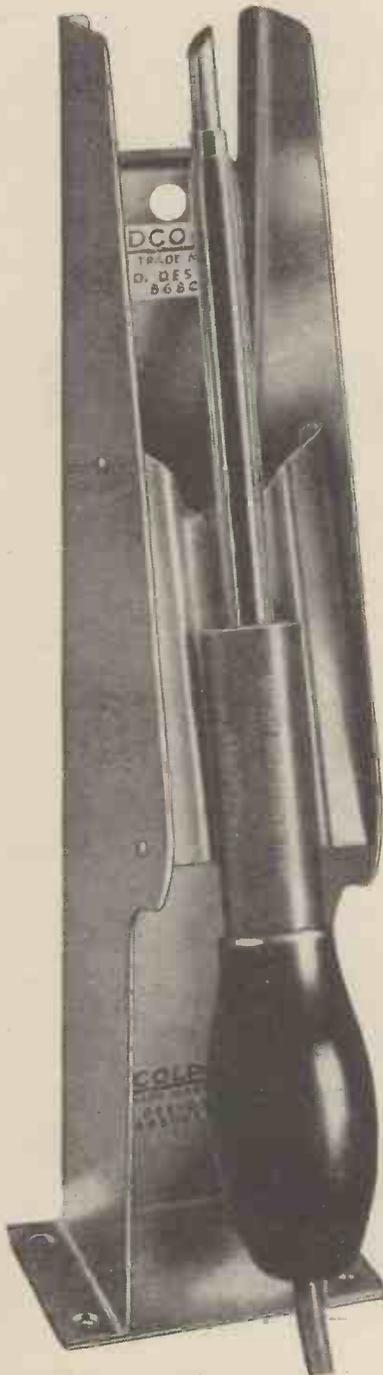
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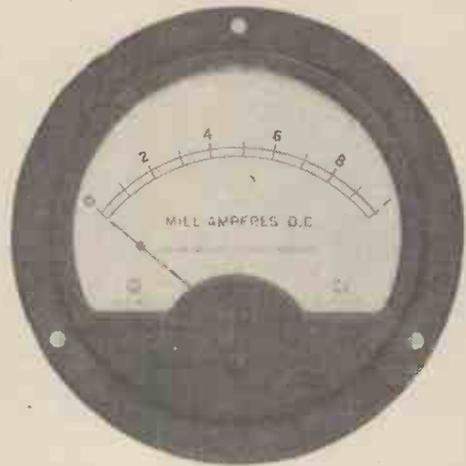
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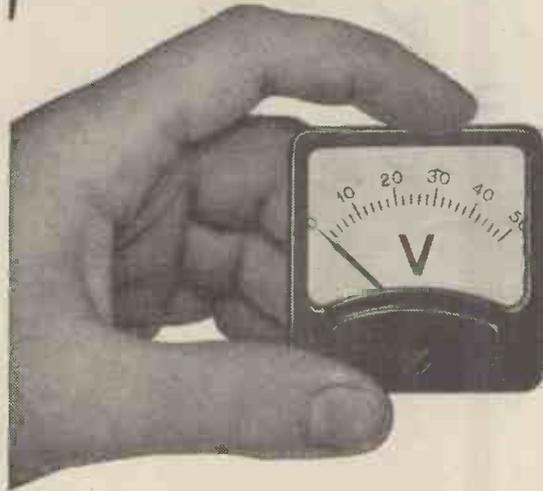
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RESISTANCE TO IMPACT SHOCK OF 200g in any plane.

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SPECIFICATIONS B.S. 89-1954 and other International Specifications.

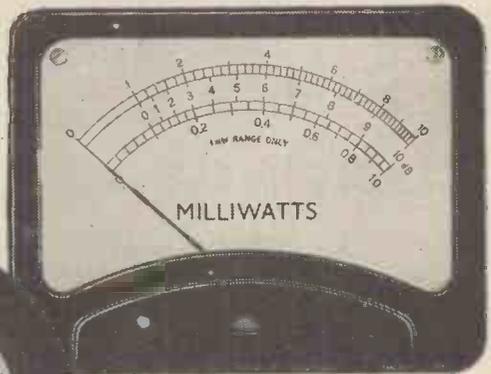
TYPES

Moving coil for D.C. applications.
Rectifier moving coil for A.F. applications.
Thermo-couple operated moving coil for R.F. applications.

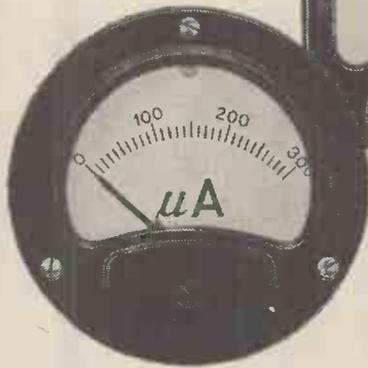
SIZES

Square: 2", 2½" and 3½" nominal scale length.
Round: 2½" and 3½" nominal scale length.
Rectangular: 5" x 6" or 3" x 4" nominal case size.

Design registrations pending.



Above: 3" x 4" rectangular absorption wattmeter



Left: 2½" round moving coil microammeter

Over 50 standard ranges in any of the seven case types.

Delivery ex stock for standard ranges.

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INS.43A

A NEW *Armstrong* AF208

VHF/MW RADIOGRAM CHASSIS

In announcing the new AF208, the most economically priced chassis we have ever produced, our aim is to bring traditional Armstrong quality and design to a larger circle of enthusiasts than ever before. The hand-built construction, the superior finish and the high quality components are the same as those used for our more expensive models. We confidently assert that there is no similar product on the market today which equals in value the Armstrong AF208.

TECHNICAL SPECIFICATION

Full VHF band (87-108 mc/s) and medium waveband ● 5 watts output.
 ● Frequency Response 30-22,000 c.p.s. ± 2dB ● Negative Feedback 15dB ● Harmonic Distortion 0.5% ● Hum Level 60dB down ● Separate wide range bass and treble controls ● Output for tape recording (Independent of volume control to allow monitoring at any level) ● Tape playback input for use with tape recorder or tape deck with tape pre-amplifier ● Two compensated pick-up inputs (switched, to allow two separate pick-ups to be connected) ● Continental reception of good programme value ● Absolute freedom from drift on VHF ● Satinised brass dial surround and veneered fascia board available ● Dimensions 12in. x 8in. x 7in. high.

The name ARMSTRONG is the registered trade mark of
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price 22 gns.

For details of other models in our range of radiogram chassis, see our page 203 advertisement.

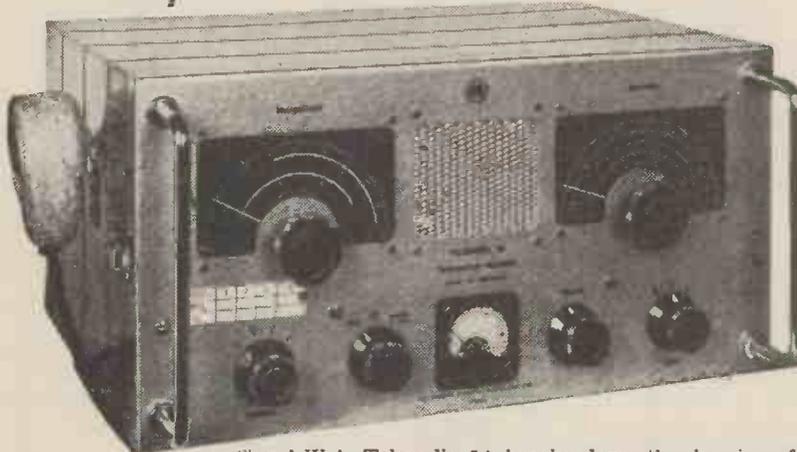
Post this coupon or write for descriptive literature and details of Home Trial facilities, Hire Purchase Terms and Guarantee or call at our Holloway Showroom for full unhurried demonstration and professional advice on your installation. Open 9-6 weekdays and 9-5 Saturdays.

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Speech communication



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- **SIMPLICITY**
Only six controls, no technical skill required.
- **SIZE**
In one attractively finished case, 9" x 16" x 20".
- **RECEPTION**
High-performance receiver tunes over a useful portion of the short-wave band, to provide general entertainment.
- **COMPLETE SERVICE**
A.W.A. provides a complete equipment ready for connecting to the battery. Full details given on aerials.
- **BATTERY POWER**
The 5A works on a 12 Volt battery. Only 3.2 Amps. drain when receiving.

The A.W.A. Teleradio 5A breaks down the barrier of isolation in outback areas. Trained operators are not required. The equipment uses the most modern valves and design features to provide simplicity of operation and efficiency.

Made by Australia's largest manufacturer of telecommunication equipment, the A.W.A. Teleradio 5A is a low-power H.F. transmitter-receiver for distances up to several hundred miles over land or sea, and is in use by Government and private networks in many places. Write for details.



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ES36.58

ELECTRONIC COUNTER TYPE TF 1165

Counts up to 9,999,999 sinewaves or pulses

- Counts random or periodic events presented to it in the form of pulses or sinewaves at rates up to 1 million/sec.
- Measures time when internal 1-Mc/s timing oscillator is fitted.
- Measures frequency, time and waveform period when used with the Marconi TF 1220 Timing Unit, as illustrated.

Its clear 7-decade readout can be displayed for a preselected time and cleared by an auto-reset system. Accuracy, dependability and versatility make the Counter applicable to a wide range of laboratory and industrial problems, yet its simplicity of operation makes it suitable for use by non-technical personnel. Send for leaflet Gr64.

COUNT CAPACITY:
9,999,999 for sinewave or pulse inputs.

INPUTS:
Pulse: 1 Mc/s max. p.r.f., 5 to 50 volts peak.
Sinewave: 10 c/s to 1 Mc/s, 0.5 to 30 volts r.m.s.

GATE OPERATION:
By 'run' and 'stop' switches, or 10- to 50-volt two-line pulses.

DISPLAY TIME:
Manual gate: unlimited.
Auto-reset: 1.5, 5, 7 and 9 sec.

OUTPUTS:
Reset pulse and decade outputs are available for external use.

DECIMAL POINT LAMPS:
Energised by external Timing Unit; divide displayed count by factors of 10, 100, 1,000 or 10,000.



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MAXI-Q
REGD.

COIL PACKS

CP.3/370 pF and **CP.3/500 pF**. These 3 waveband Coil Packs are available for use with either 370 pF or 500 pF tuning condensers. The coverages are: Long Wave 800-2,000 metres; Med. Wave 200-550 metres; Short Wave 16-50 metres. Designed for use with "MAXI-Q" glass scale type S2. Retail price of each unit: 32/- plus 10/8 P.T.—total 42/8.

CP.3/G. As above but with Gram. position, suitable for use with 500 pF tuning condenser: 39/- plus 13/- P.T.—total 52/-.

CP.3/F. This Coil Pack is for use with a 500 pF tuning condenser and covers the standard Long, Med. and Short wavebands with the addition of the band 50/160 metres. This covers the Trawler band, Aeronautical and the 80 and 160 metre Amateur bands: 49/- plus 16/4 P.T.—total 65/4.

CP.3F/G. As CP.3/F but with Gram. position: 57/- plus 19/- P.T.—total 76/-.

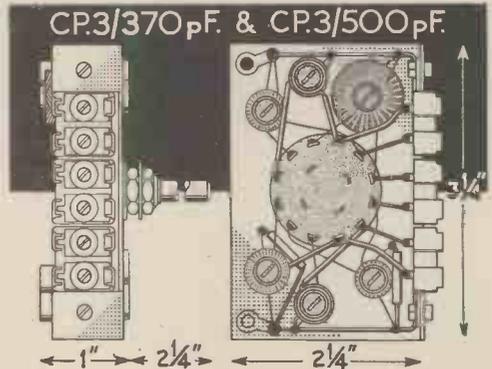
CP.4/L and **CP.4/M**. These compact 4-station Coil Packs are available for either 1 Long Wave and 3 Medium Wave Stations (CP.4/L) or 4 Medium Wave Stations (CP.4/M). They are fully wired and require only four connections for use with any standard frequency changer valve. 25/- plus 8/4 P.T.—total 33/4.

CP.4L/G and **CP.4M/G**. As CP.4/L and CP.4/M but with provision for Gram. position. 31/- plus 10/4 P.T.—total 41/4.

See Technical Bulletin DTB.9 for details of all Coil Packs, 1/6.

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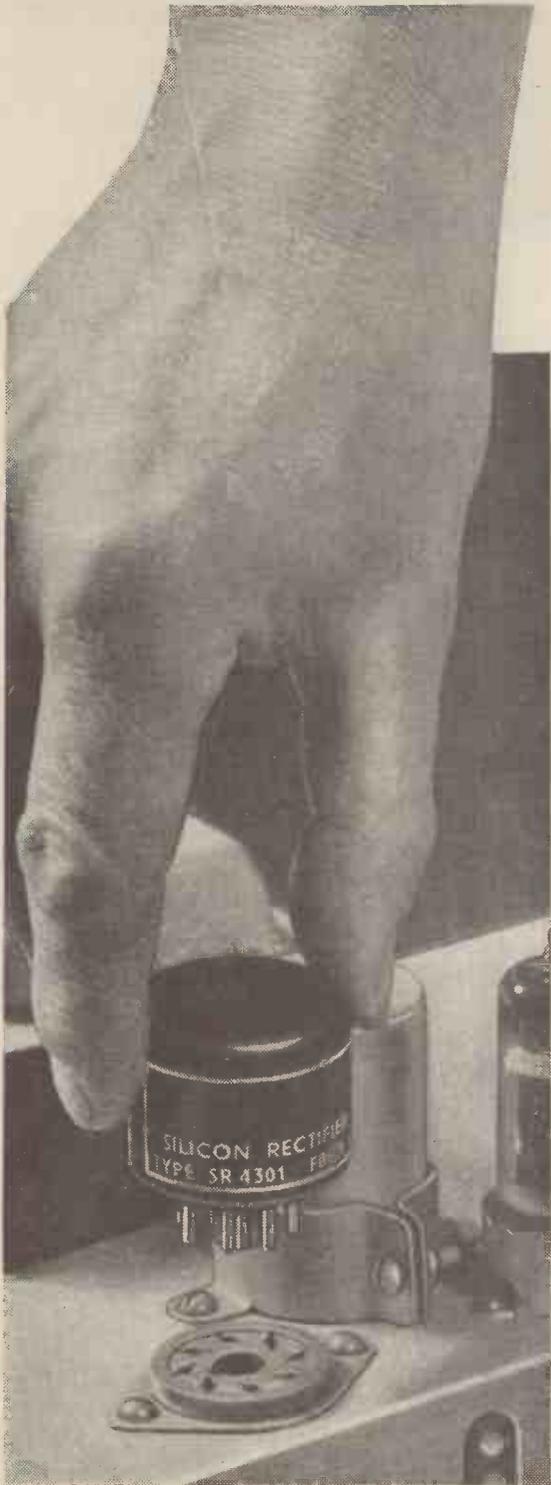
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6 x 6 x 12in. Sloping Front	24 9
4 x 4 x 2 1/2in. Rectangular	6 8
6 x 4 x 3in. Rectangular	8 10
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FOR SPEEDY AND DEPENDABLE INSTALLATION

**EQUIPMENT for T/V RELAY
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WIDE BAND AMPLIFIERS

Mark III—40 to 220 mc/s (covering ALL Bands 1, 2 and 3) Gain 20 db±, 2db, 75 ohms in and out. Rack Mounting.

Mark IV—A cheaper version of the impeccable Mark III. Same performance, steel case.

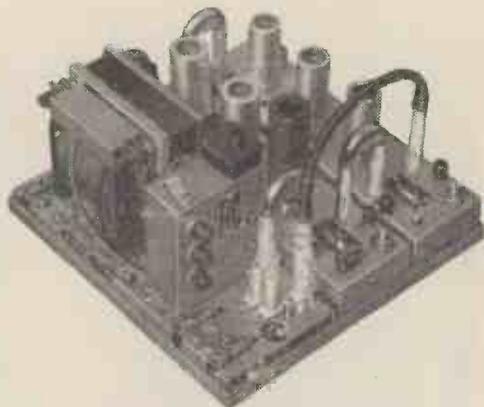
Type 4—40 to 70 mc/s (Band 1) Gain 33 db±1 db. Wall Mounting. Indoor or Outdoor Cases. Line powering facilities. 75 ohms in and out. Extensively used for urban T/V relay systems.

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● **MAST HEAD AMPLIFIERS.** Mast Head Units only gain 9 db or with base unit giving total of 20 db gain.

● **SINGLE CHANNEL AMPLIFIERS AND REPEATERS.** Gain up to 56 db with and without A.G.C. Any channel in Bands 1, 2 and 3.

● **CO-AXIAL CABLE ACCESSORIES.** Equalisers, Splitters, Combiners, Tappers, Load Units, etc. Outdoor or indoor types.



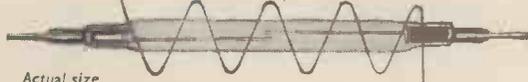
WIDE BAND REPEATER Type 12/5A with Repeater Type 5FM incorporated (covering Bands 1 and 2)

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XS2

Dry Reed Relay Insert

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



Actual size

maximum current...	...	250 mA
maximum resistive load	...	15 W
maximum closed resistance...	...	50 mΩ
minimum open resistance...	...	5 × 10 ¹¹ Ω

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.



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Ruislip 3366

COMPACT SPEAKER SYSTEMS

with clean bass

In each of the models mentioned in this advertisement L.F. output is produced by a special 12in. unit type WLS/12 fitted with a heavy cone and a new type of suspension which permits large linear excursions and gives a low fundamental resonance of 25/30 c/s.



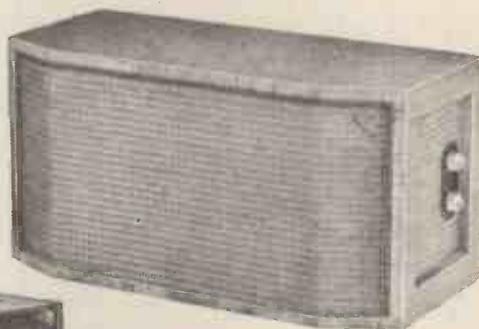
Model W2

A two-speaker model complete with treble volume control.

Cabinet size 23½in. x 14in. x 12in. Weight 42 lb. complete.

Impedance 15 ohms. Max. input 15 watts.

Price **£29.10.0** complete, tax free.



W3

A three-speaker system complete with mid-range and treble volume controls.

Cabinet size 28in. x 14in. x 12in.

Weight 48 lb. complete.

Impedance 15 ohms. Max input 15 watts.

Price **£39.10.0** complete, tax free.

W4

A four-speaker system complete with mid-range and treble volume controls.

Cabinet size 35in. x 24in. x 12in.

Weight 65 lb. complete.

Impedance 15 ohms. Max. input 15 watts.

Price **£49.10.0** complete, tax free.



Each model is available in a choice of Walnut, Oak or Mahogany Veneers. Also available in Whitewood slightly cheaper. Tropical models with resin bonded plywood approximately £2 extra.

Wharfedale

WIRELESS WORKS LTD
IDLE BRADFORD YORKS

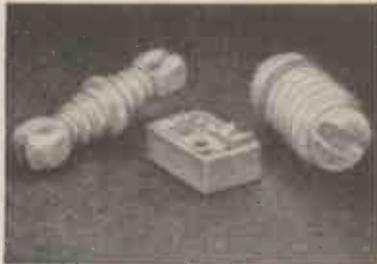
Catalogue giving full technical details, response curves and oscillograms of the above models, available on request.

Telephone: Idle 1235/6.

Grams: 'Wharfedel,' Idle, Bradford.

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etc., etc.

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FULL RANGE OF THE BEST HI-FI
SPEAKER SYSTEMS INCLUDING THE
GOODMANS A.L/120
AS DESCRIBED ON PAGE 70 OCTOBER ISSUE

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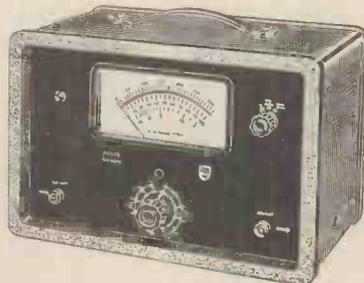
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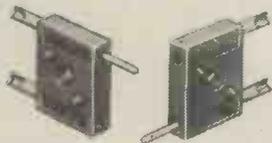
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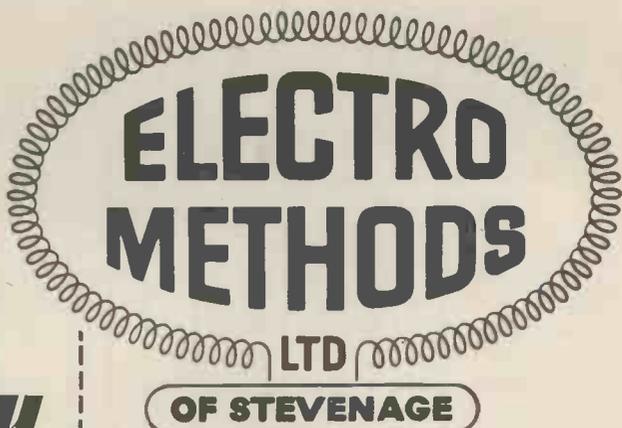
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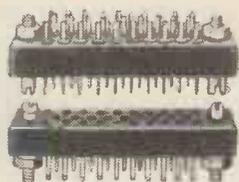
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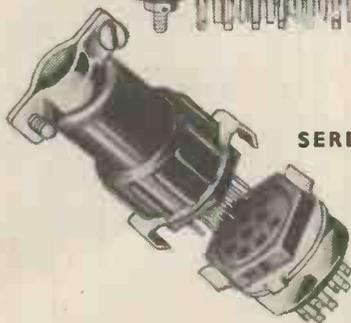
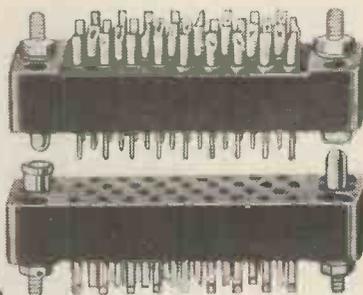


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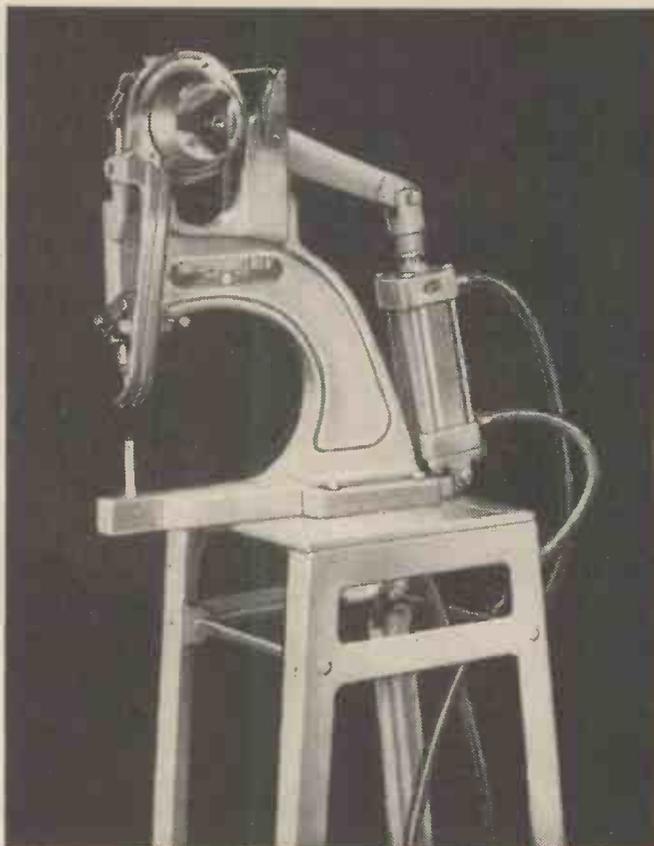
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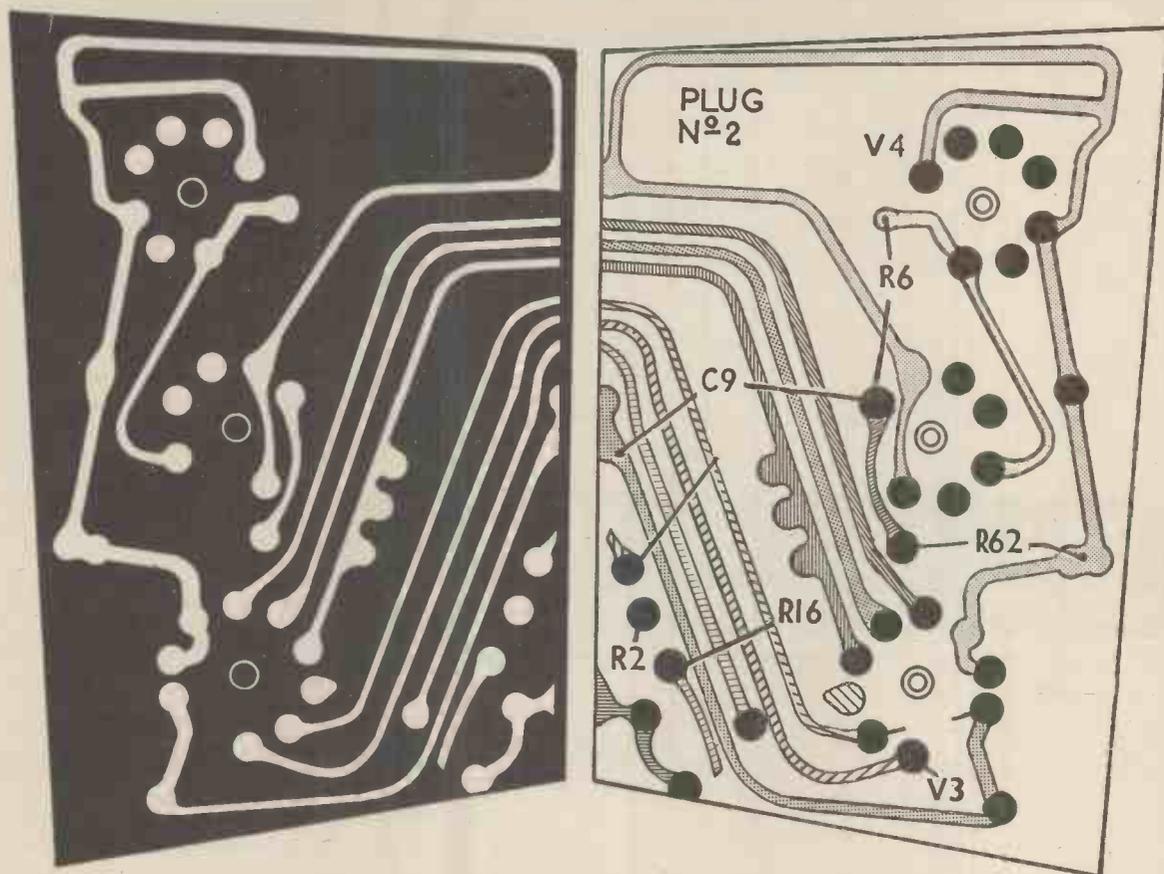
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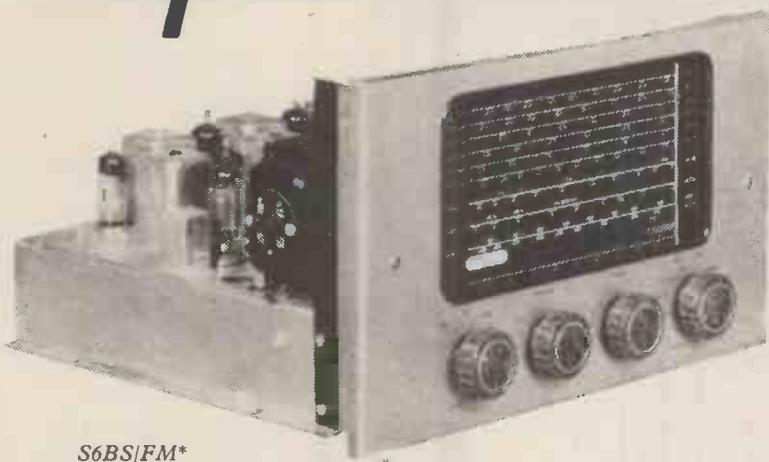
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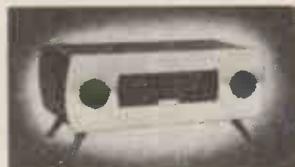
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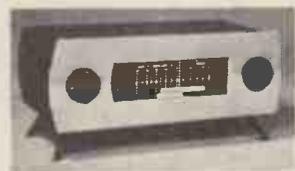


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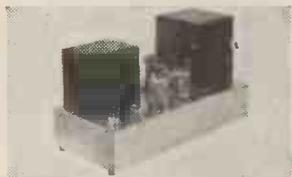


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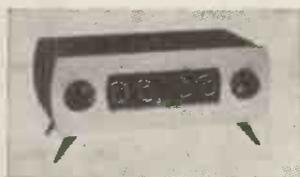
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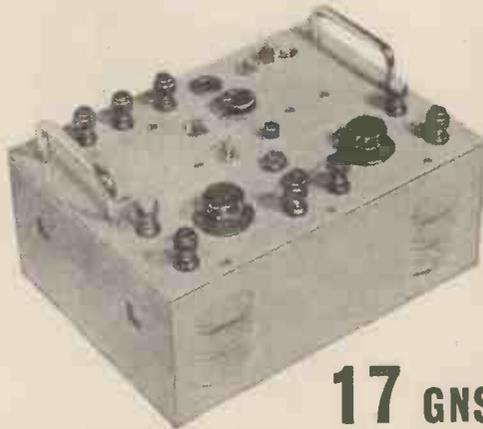
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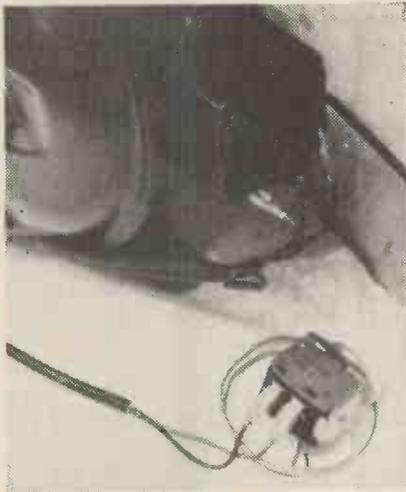
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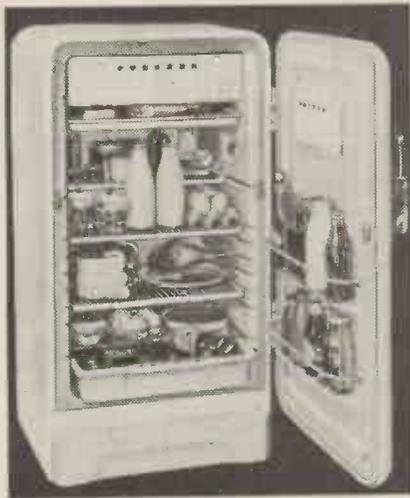
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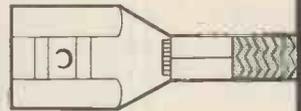
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Accurate measurement of sound equipment speed deviations

Small constant speed deviations of the lowest 'wow' components of sound recording or reproducing equipment are accurately measured and indicated by the Fluttermeter—down to zero frequency response. The Fluttermeter is equally suitable for use with machines employing photographic or magnetic sound tracks on film, tape, wire, or disc recording. The Gaumont-Kalee Fluttermeter type 1740 is an entirely new design. More compact, and lighter in weight, its cost is considerably less than all previous models.

Dimensions Height 10½" 26.04 cm.
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Gaumont-Kalee Fluttermeter Type 1740

Brief Technical Data

- Operating carrier frequency...3,000 c.p.s. 15%
- Minimum Input signal.....50 mV R.M.S.
- Input Impedance.....1 Megohm
- Input amplifier bandwidth—3dB at 2,500 & 3,500 c.p.s.
- Effective limiter range.....110 dB
- Meter scaling—"Peak wow"...0 to +1% (centre zero)
- "Wow and Flutter"...0 to 1% R.M.S. and 0 to 2%
- Crossover frequency.....20 c.p.s.
- Flutter meter response.....-3 dB at crossover
-3 dB at 200 c.p.s.
- "Wow" meter response.....1 dB at 5 c.p.s.
- C.R.O. output frequency response.....level down to zero frequency
-3 dB at 200 c.p.s.
- 3,000 c.p.s. oscillator output level.....5V R.M.S. into .5 Megohm
100 mV R.M.S. into 500 ohms
- Accuracy.....Meter presentations
+2% f.s.d.
- Power consumption.....35 watts
- Operation.....45 to 60 c.p.s.



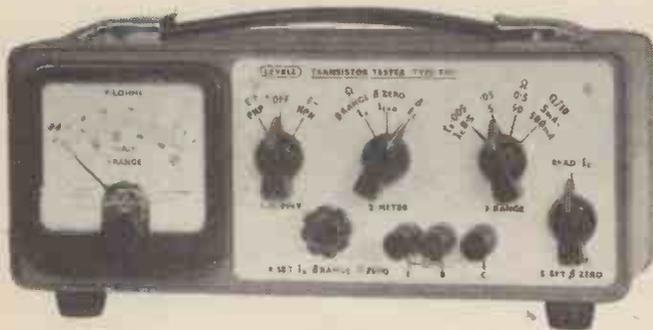
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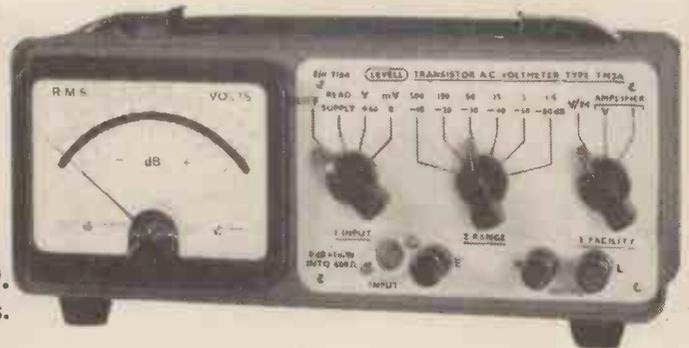
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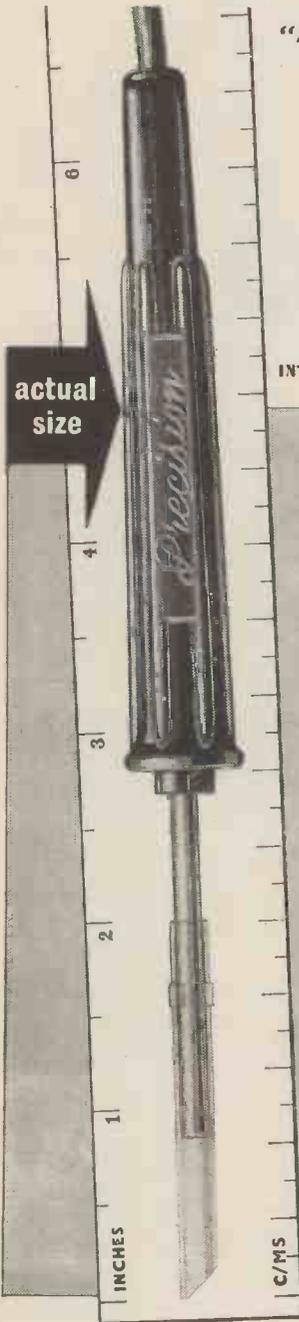
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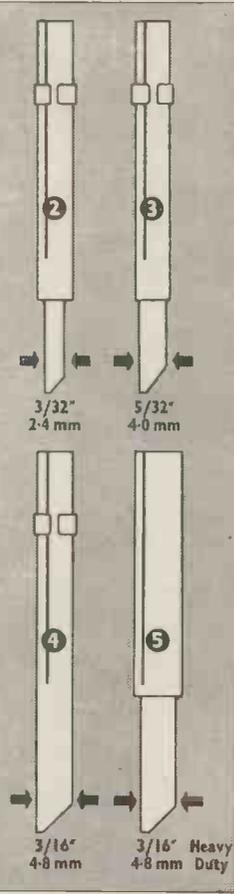
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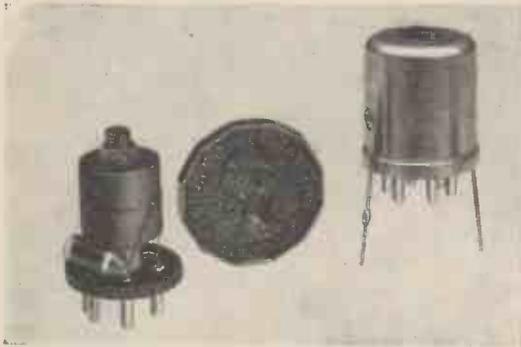
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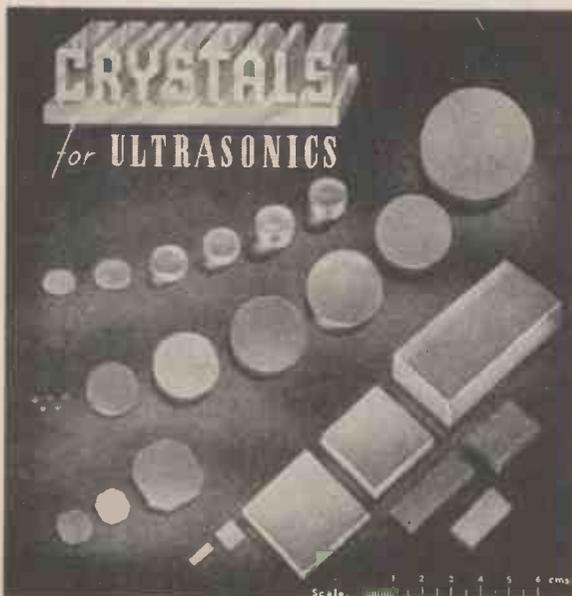
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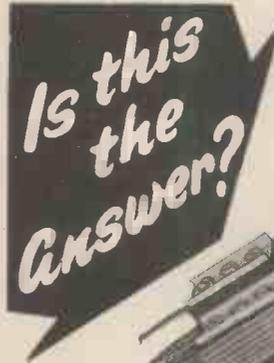


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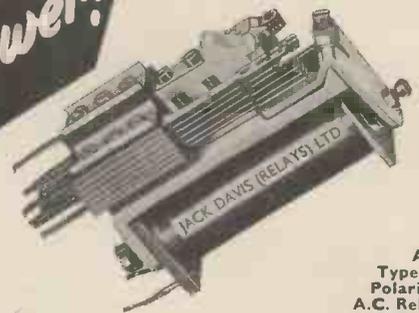
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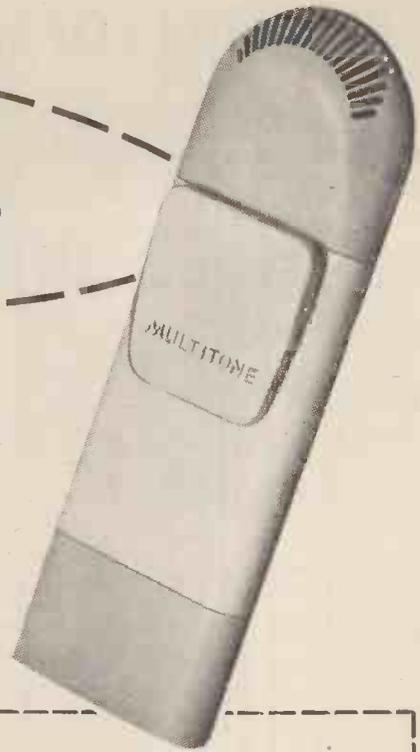
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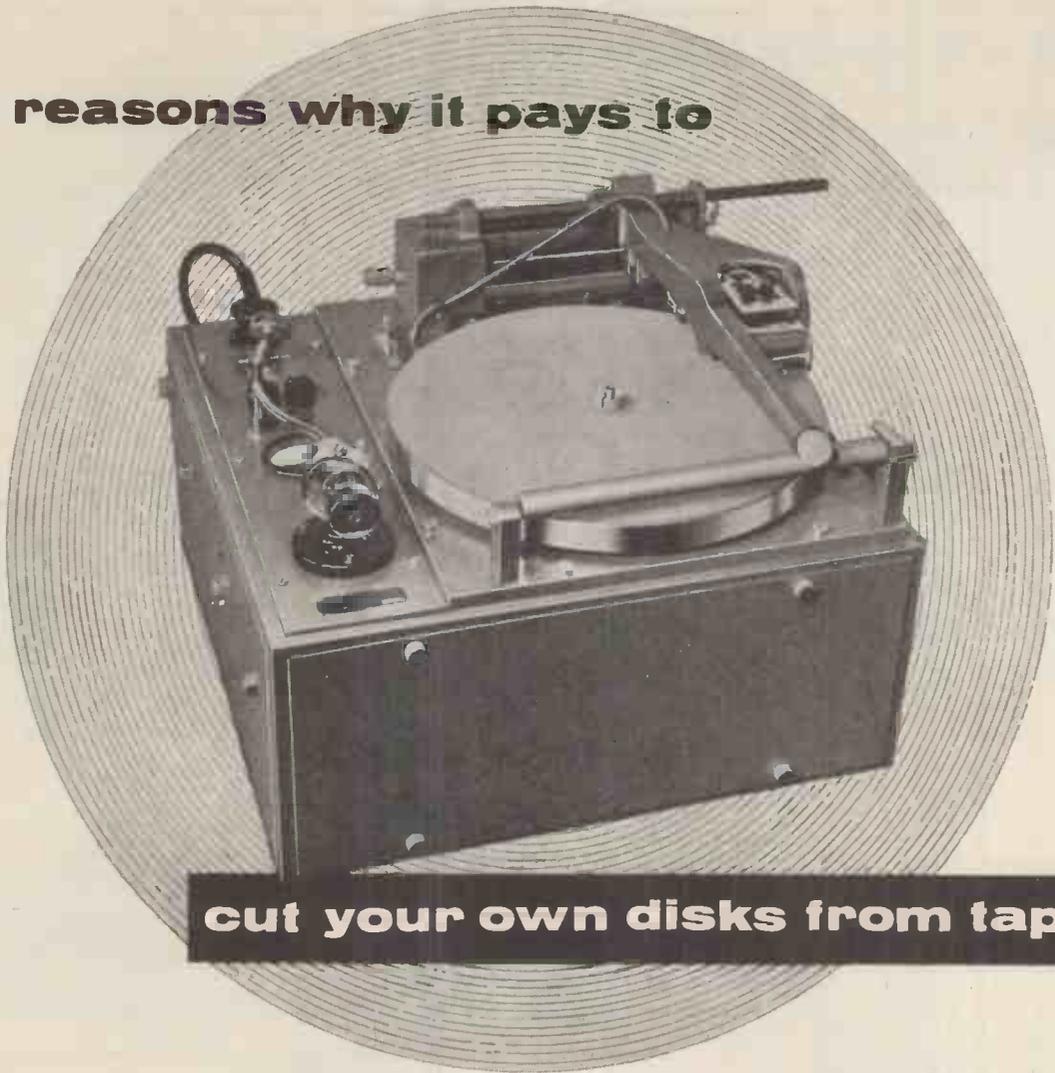
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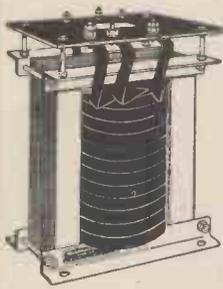
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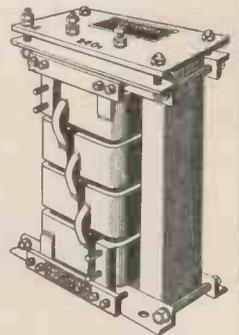
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55 V.	15 A.

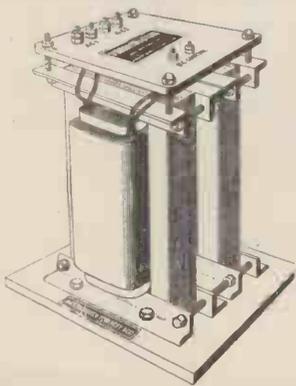
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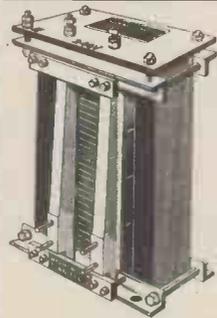
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TRANSDUCTORS



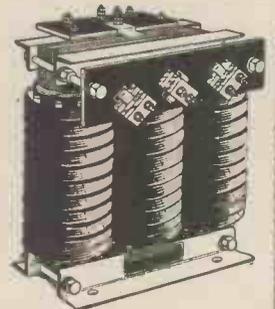
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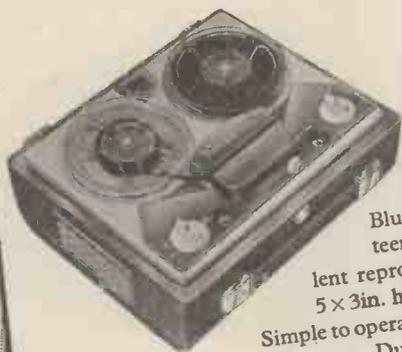
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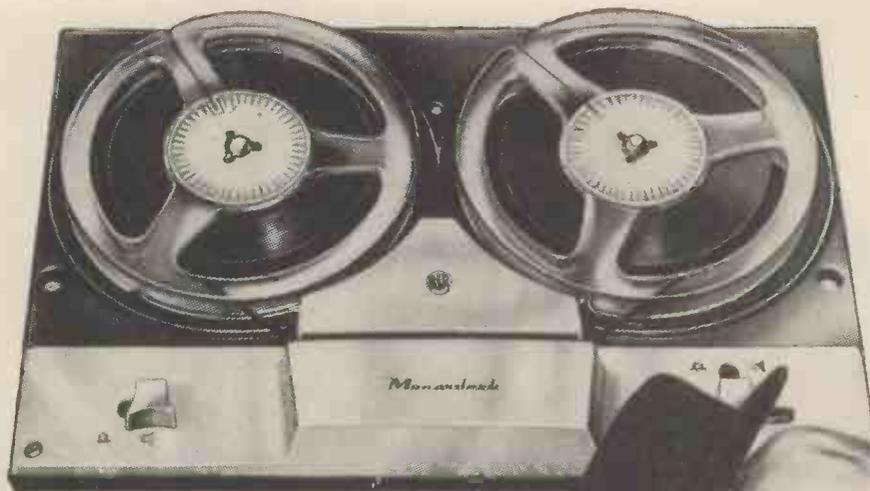
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Wireless World

ELECTRONICS, RADIO, TELEVISION

NOVEMBER 1959

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OF PUBLICATION

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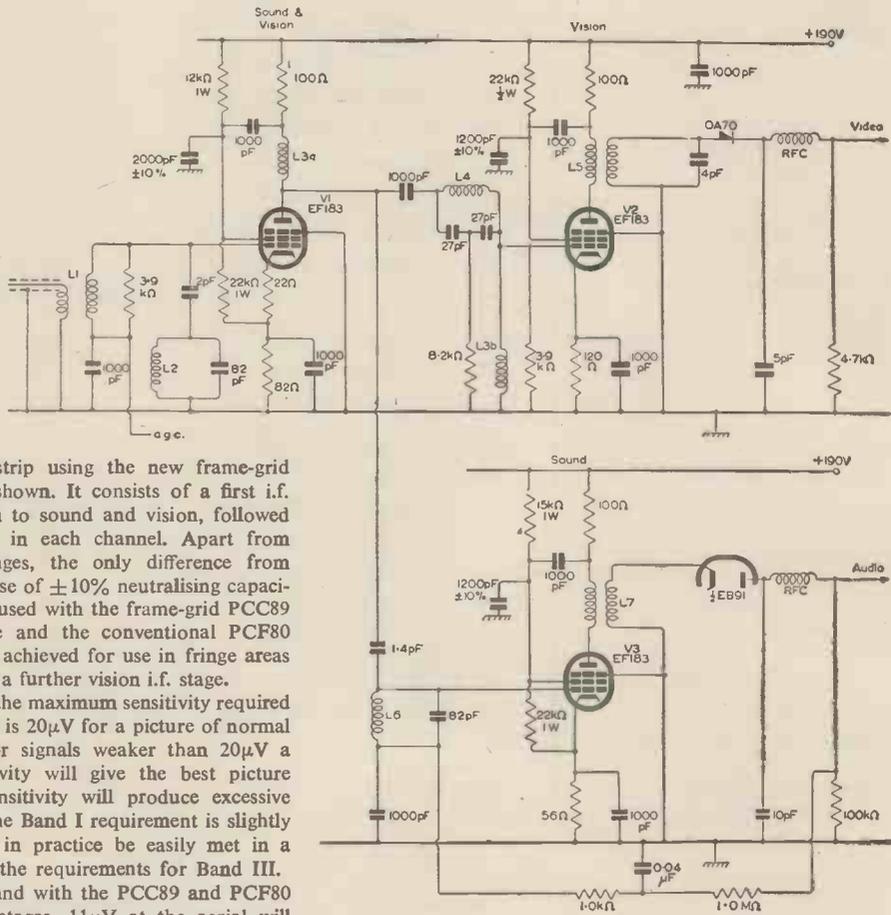
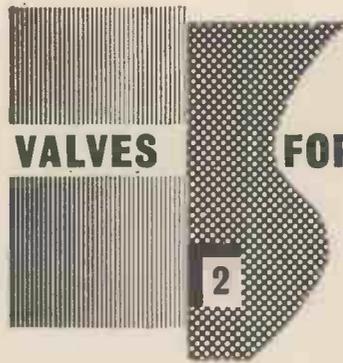
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FRAME GRID VALVES FOR TELEVISION

The first advertisement in this series discussed the frame grid valve in general terms, and outlined the advantages which it brings in the tuner and i.f. stages of a television receiver. We shall now look at the i.f. stages in more detail, with particular reference to the needs of fringe areas.



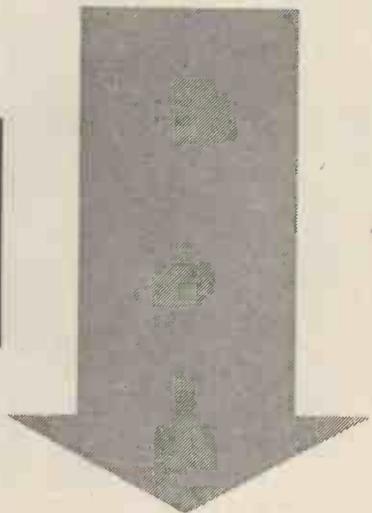
A circuit for an i.f. strip using the new frame-grid variable-mu EF183 is shown. It consists of a first i.f. stage which is common to sound and vision, followed by a second i.f. stage in each channel. Apart from component value changes, the only difference from normal practice is the use of $\pm 10\%$ neutralising capacitors. When the strip is used with the frame-grid PCC89 in a cascode r.f. stage and the conventional PCF80 mixer, adequate gain is achieved for use in fringe areas without the addition of a further vision i.f. stage. For Band III reception the maximum sensitivity required of a fringe area receiver is $20\mu\text{V}$ for a picture of normal contrast level. Even for signals weaker than $20\mu\text{V}$ a receiver of this sensitivity will give the best picture possible. (A higher sensitivity will produce excessive noise on the screen.) The Band I requirement is slightly less stringent and will in practice be easily met in a receiver which satisfies the requirements for Band III. With the strip shown, and with the PCC89 and PCF80 in the r.f. and mixer stages, $11\mu\text{V}$ at the aerial will provide 2.0V of video. A typical receiver with a conventional valve line-up (PCC84, PCF80, EF85 first i.f., EF80 sound i.f., EF80 vision i.f.) requires $63\mu\text{V}$. Thus the conventional receiver fails to cover the required signal range for fringe areas, and it would need another i.f. stage. The frame-grid receiver, on the other hand, covers the range and has an adequate margin for production tolerances.

It will be noticed that the conventional PCF80 has been retained in the mixer stage. If the frame-grid PCF86 is substituted, then the second i.f. stages can be modified

to take the conventional EF80, with the EF183 retained in the first i.f. stage. With this new line-up, a 2.0V video output is obtained with $9\mu\text{V}$ on Band III and $5\mu\text{V}$ on Band I.

The circuit shown provides adequate a.g.c. on sound, and approximately 80dB vision gain control without serious cross-modulation. Comparable performance is obtained with the PCF86 variant. Both versions are notably superior to conventional line-ups.

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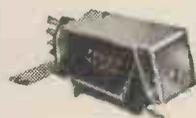
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Swans dancing (Tchaikovsky), infernal (Sibelius) or even dying (Saint-Saens) — they all come dramatically to life with ACOStereo equipment. ACOStereo Type 71* cartridge for instance, fits many popular arms and plays a key part in converting conventional players into stereo. ACOStereo Type 73 is an outstandingly successful universal cartridge for stereo, LP and standard records, extensively used in many leading instruments.

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in the
sitting room?'

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in the
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"BELLING-LEE" NOTES

No. 10 of a Series

In No. 9 we mentioned various tests that have to be carried out on a component before it can be said to be suitable for use in an equipment that might have to serve in, say, the Navy, Army, or Air Force, in any part of the world, from tropical swamps to the Arctic, from the beaches to 65,000 feet, or higher. There may be special applications calling for special properties, for example, in missiles exceptionally high temperature may be met.

Components in missiles must have a long "shelf-life." We hope they will never be used, but if, in ten years they go into action, they must not fail. Reliability over a long period is of prime importance. This means that contact surfaces must not tarnish, springs must not tire and seals must remain seals.

Components for use in atomic reactors may have to withstand intense radiation as well as intense heat—and they may not be accessible. Generally components come into two classes, those for professional use and those for domestic use. The greatest hazard to which domestic plugs have to stand up to is the sweeper.

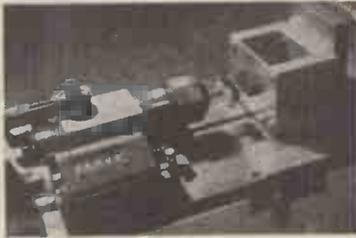
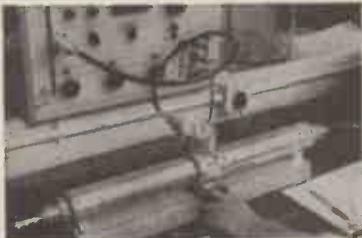
Below we show photographs of some of the test equipment in constant use in our laboratories.



Showing an assortment of specimens being examined in a humidity chamber, where humidity and temperature is varied under control. These tests show up deficiencies in plating finishes, deterioration in contact surfaces, etc.



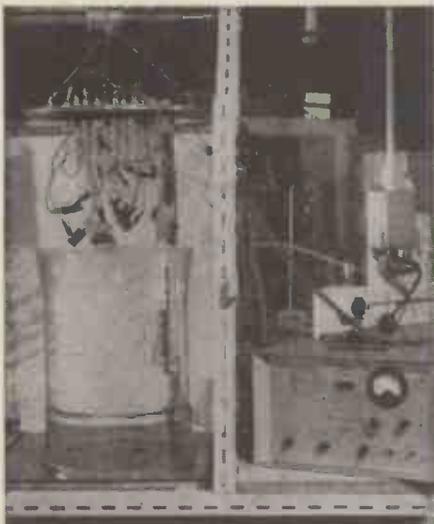
In this compartment specimens are subjected to salt spray (atomised) for a period of two hours, after which they are kept in a moist warm atmosphere for a week, this cycle being repeated four times. It is a very severe test.



(Above left). In the foreground is a slotted line used for voltage standing wave ratio (V.S.W.R.) measurements up to 3000 Mc/s.

(Above right). This device is used for the mechanical endurance testing of plugs and sockets. Designed and made in our own workshop, it is entirely automatic and will engage unipole components with a rotating action.

(Left). This piece of apparatus simulates altitudes over 100,000ft. A selection of components is about to be lowered and sealed to the low-pressure chamber. High-voltage stand-off insulators are available to enable voltage breakdown tests to be carried out.



Advertisement of BELLING & LEE LTD., Great Cambridge Rd., Enfield, Middx.



"BELLING-LEE" UNITOR PLUGS & SOCKETS

These plugs and sockets were first designed for and type-approved by the Ministry of Supply as inter-unit connectors. The addition of covers and retainers make them suitable as cable connectors. Applications include guided missiles, electronic computers, aircraft, "potted" circuits, communications equipment, electro-medical equipment, radar equipment, atomic energy research, and television transmitting stations.

Unitors are available in 4, 8, 12 and 18-pole assemblies, each including two large pins. Also in 25-pole assemblies including four large pins.

Specification: D.E.F.5321.

Current rating:

- Small pins: 3 amp. each
- Large pins: 10 amp. each

Max working volts: 500V. peak

Insulation resistance:

Greater than 100 megohms at 500V. after tropical exposure.

Contact resistance (initial):

- Small pins: 2 milliohms
- Large pins: 1 milliohm

Contact resistance (after cycling):

- Small pins: 5 milliohms
- Large pins: 3 milliohms

Insertion and withdrawal force:

1 lb. per contact pair (max.)

Colour: Black

Finish:

Pins, silver-plated. Sockets, beryllium copper. Solder spills, tin-dipped

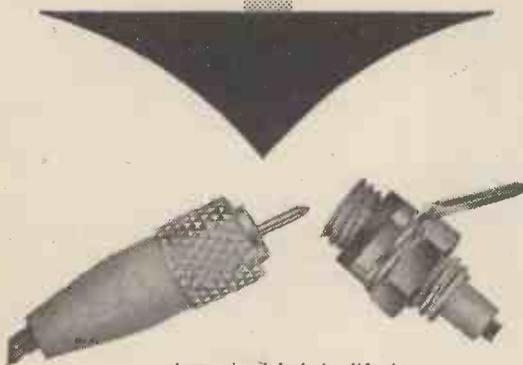
Most "Belling-Lee" products are covered by patents or registered designs, or applications

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SUB-MINIATURE COAXIAL CONNECTORS



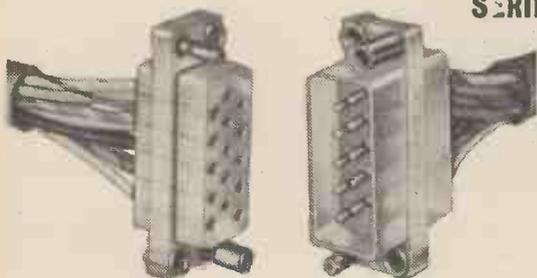
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As a contribution towards increasingly compact equipment, Plessey have introduced this new, highest quality and fully comprehensive range to allow a new approach on applications hitherto restricted by the limitations of existing connectors.

Designed for the matched impedance coupling of high frequency coaxial cables operating in the super high frequency bands, these connectors—

- * have a working voltage of 650 volts Peak at sea level, and matched impedance coupling of 50 ohm lines is accommodated.
- * have hard gold plated contacts on silver plate to give maximum performance with minimum voltage drop.

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Developed specifically by Plessey to meet the demand for a safe, inexpensive connector for commercial applications, this new series embodies excellent electrical and mechanical characteristics, and the many unique features that make it really outstanding include:—

- * Plug pins and socket inserts are polythene shrouded to dispense with gaskets and ensure insert anchorage.
- * Mismatching is prevented by corner pins and corner sockets.
- * Extreme simplicity of wiring, demands less-skilled operation than the orthodox methods of soldering pins *in situ*.

For further information, please write for Publication numbers 128 and 114.

Plessey

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Aspects of design 16

This is the Sixteenth of a series of special features dealing with advanced problems in television and radio circuit design to be published by Siemens Edison Swan. The Ediswan Mazda Applications Laboratory will be pleased to deal with any questions arising from this or other articles, the Seventeenth of which will appear in the December 1959 issue.

DRIVE CIRCUITS FOR SCANNING OUTPUT STAGES—LINE DRIVE CIRCUITS

REQUIREMENTS

The drive circuit for a modern line output stage serves to generate a waveform which determines the timing and duration of conduction of the output valve. The drive circuit can take many forms determined mainly by economic considerations. Foremost among these considerations is whether the circuit is to be synchronised directly by line synchronising pulses or to be controlled by a phase detector in a "flywheel" synchronising circuit. With direct synchronisation we have to consider ease of synchronising with readily available synch signals and the possibility of feeding back line frequency voltages to the frame scan stage via the synch source. If we decide on a flywheel circuit we have to be sure that it lends itself to frequency control by a slowly varying control voltage. High sensitivity of frequency to control voltage is not necessarily the thing to aim at because circuits with high sensitivity to control voltage usually show high sensitivity to unwanted interference such as hum and microphony. We should, rather, look for low sensitivity to valve ageing and supply voltage changes.

The waveform supplied to the output stage must fulfil the following requirements: (1) the output valve must be cut off rapidly and must remain cut off for the duration of the flyback interval, (2) because of the high voltage pulse on the anode of the line output pentode a much greater negative voltage is required for cut-off during flyback than during the rest of the trace. Accordingly line drive stages should be capable of driving the grid of the output valve to at least -135 volts during the flyback interval.

Circuits available

The drive waveform is generated by first allowing a capacitor to charge exponentially through a high resistance from the H.T. line and then discharging it by a switching circuit on receipt of a line synchronising pulse. The switching circuit also determines the repetition frequency when synch pulses are absent. This circuit usually takes one of three forms: (1) a blocking oscillator, (2) a multivibrator or (3) a discharge valve (usually a triode) in which oscillation is maintained by feedback from the line output transformer. Basic representative circuits are shown in Figures 1, 2 and 3 respectively.

1. Blocking Oscillator

In this circuit (Fig. 1) a conventional blocking oscillator circuit generates the output waveform by drawing its pulses of anode current from the output capacitor C_1 . Between discharge pulses the capacitor charges towards H.T. through R_1 . If we are to obtain a rapid cut-off of the line output valve the blocking oscillator must come to full conduction rapidly and hence the time of conduction must be fairly short. Typical conduction times for the blocking oscillator are from two to three microseconds which means that after this time the voltage on the output capacitor begins to rise again and may be quite high by the time the voltage on the output valve anode has reached its peak. This explains why it is usually more difficult to ensure complete cut-off of the output valve with this circuit.

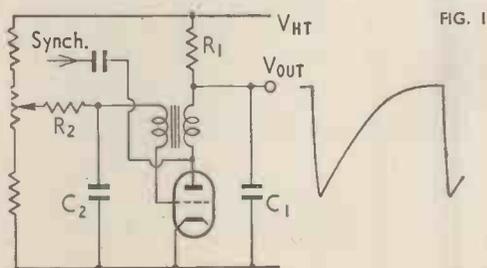
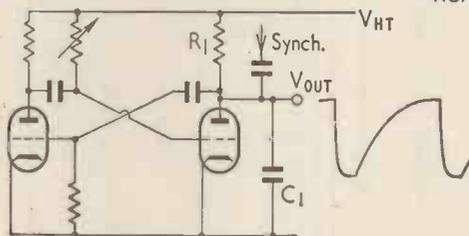


FIG. 1

2. Multivibrator

A multivibrator, either anode coupled or cathode coupled can be designed so that one valve conducts for say 10% to 15% of the period and the other valve for 90% to 85%. The valve with the short conduction period can, accordingly, be used as the discharge valve for the capacitor C_1 , on which the drive waveform is formed (see Fig. 2). Between conduction pulses the capacitor charges towards H.T. through the anode load resistor R_1 of the valve. The discharge valve is brought rapidly into conduction and conduction is maintained for a long period (10-15 μ S). In this way we can achieve a fast cut-off of the output valve and also maintain the grid at the negative extreme of voltage for the whole flyback period.

FIG. 2



3. Feedback from Output Transformer

In this circuit (Fig. 3) the positive pulse fed back from the output transformer during flyback drives the discharge triode V_1 hard into conduction ensuring rapid discharge of C_1 and produces a flow of electrons into the grid capacitor C_2 . After the end of flyback this accumulated charge on C_2 holds V_1 cut off whilst the output capacitor C_1 charges towards H.T. through R_1 . The charge on C_2 gradually leaks away through R_2 until V_1 again conducts. The discharge currents are of longer duration than in the blocking oscillator so that it is easier to maintain cut-off during flyback. In this respect the circuit is superior to the blocking oscillator but not so good as the multivibrator. It is often difficult to ensure self-starting with this circuit although it can be improved by including the feedback (shown dotted) from the screen grid of the output valve. There may also be large differences between synchronised and free running frequencies.

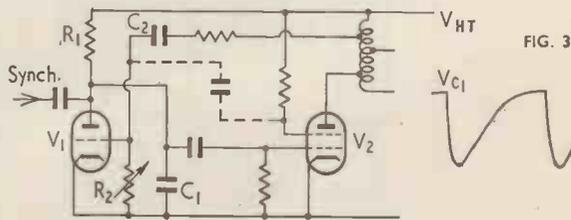


FIG. 3

Comparisons

The blocking oscillator and anode coupled multivibrator both lend themselves to control by a phase discriminator but the cathode coupled multivibrator is rather more sensitive to hum and microphony and is therefore not so suitable.

In directly synchronised circuits the blocking oscillator often causes difficulties because it presents a low impedance to the synch source and there is a high inductive transient at its anode after firing. These difficulties are not so severe in the multivibrator.

Suitable valves for line drive circuits are the Ediswan Mazda 6/30L2 double triode or the triode portion of the 30FL1.

SIEMENS EDISON SWAN LIMITED An A.E.I. Company
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EDISWAN MAZDA 10F18

The 10F18 is a variable mu H.F. Pentode, on a B9A base, intended for use in AM/FM a.c./d.c. receivers.

Heater Current (amps)	I_h	0.1
Heater Voltage (volts)	V_h	13

MAXIMUM DESIGN CENTRE RATINGS

Anode Dissipation (watts)	$P_a(max)$	2.25
Screen Dissipation (watts)	$P_{g_2}(max)$	0.5
Anode Voltage (volts)	$V_a(max)$	250
Screen Voltage (volts)	$V_{g_2}(max)$	250
Heater to Cathode Voltage (volts r.m.s.)	$V_{h-k}(max)r.m.s.$	150

INTER-ELECTRODE CAPACITANCES (pF)

Grid 1 to Anode (with external can) ..	C_{g_1-a}	0.0017
Grid 1 to Anode (without external can) ..	C_{g_1-a}	0.0019
Anode to Earth (without external can) ..	C_{a-E}	4.3
Grid 1 to Earth (without external can) ..	C_{g_1-E}	5.0

Inter-electrode capacitances measured in fully shielded socket.

TYPICAL OPERATION

Anode Voltage (volts)	V_a	175	175
Screen Voltage (volts)	V_{g_2}	100	175
Grid Bias Voltage (volts)	V_{g_1}	-1.3	
Anode Current (mA)	I_a	12	
Screen Current (mA)	I_{g_2}	3.5	
Mutual Conductance (mA/V)	g_m	4.4	
Bias to give Mutual Conductance 100 μ A/V (volts)	V_{g_1}		-19.5

Valve Anode Resistance

($\delta v_a / \delta i_a$) (k Ω)	r_a	400
Input Capacity Working (Hot) (pF)	$C_{in}(\omega)$	7.1*

Change in input capacity produced by biasing valve to cut off (pF)

Input Loss at 38 Mc/s with cathode pins strapped (k Ω)	ΔC_{in}	1.7*
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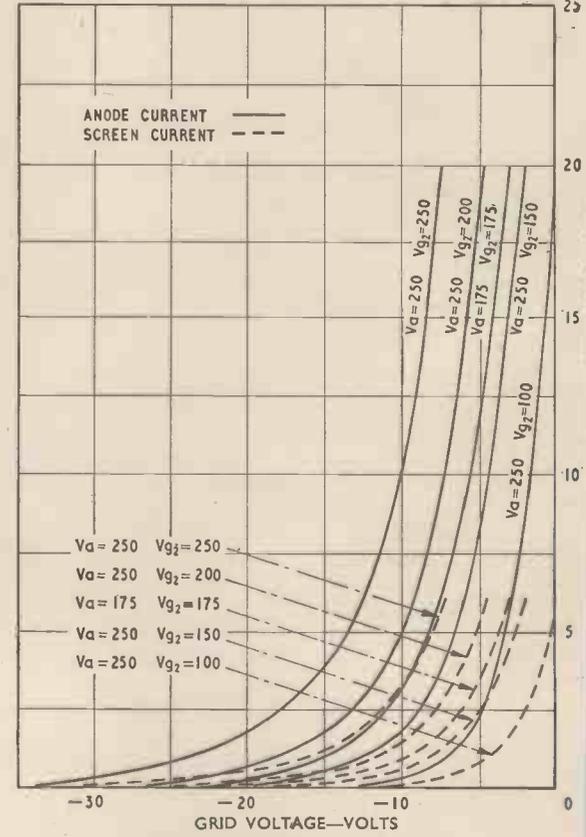
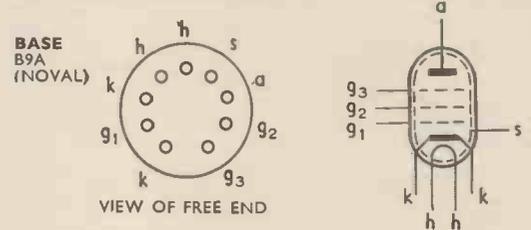
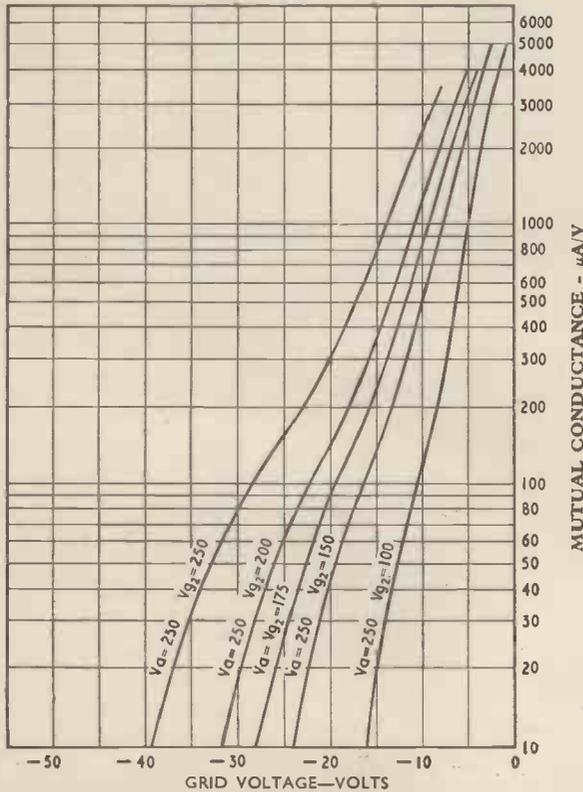
Note: If only one cathode pin is required it is recommended that pin 3 be used.

* Inter-electrode capacitance with holder capacitance balanced out.

MAXIMUM DIMENSIONS (mm)

Overall Length	56
Seated Height	49
Diameter	22.2

Characteristic Curves of Average Ediswan Mazda Valve Type 10F18



SIEMENS EDISON SWAN LIMITED An A.E.I. Company
 Technical Service Department, 155 Charing Cross Rd., London, W.C.2.
 Telephone: GERrard 8660. Telegrams: Sieswan, Westcent, London.

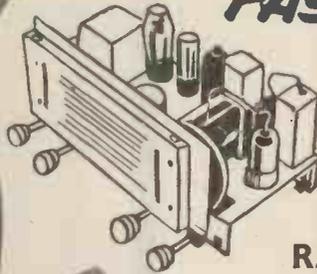
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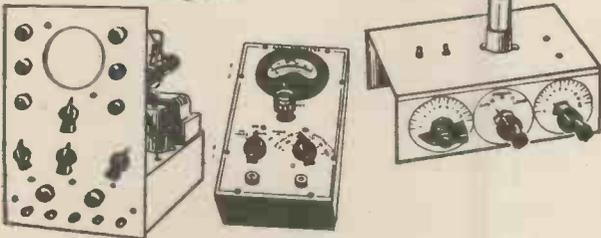
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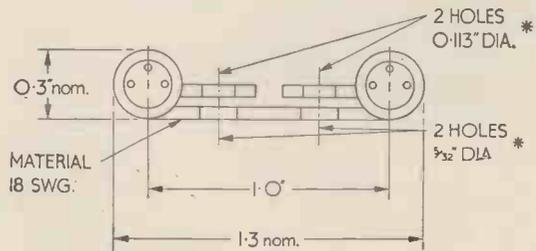
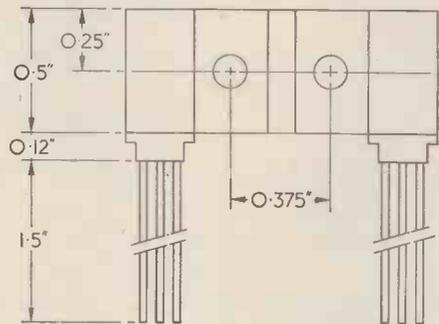
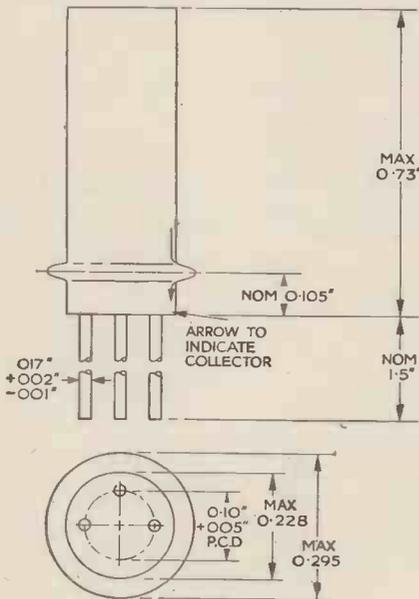
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Maximum Peak Collector/Emitter Voltage with Base driven to cut off (Common Emitter Circuit) or with $R_{b.e} < 500 \Omega$	(volts)	-35
Maximum Peak or Mean Emitter/Base Voltage	(volts)	-12
Minimum d.c. β at $I_c = -200\text{mA}$, $V_e = -1\text{v}$		40
Minimum d.c. β at $I_c = -50\text{mA}$, $V_e = -1\text{v}$		48
Maximum Junction Temperature	(°C)	75
Thermal Resistance in Free Air	(°C/mW)	0.2

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Maximum Peak or Mean Collector/Base Voltage (Common Base Circuit)	(volts)	-35
Maximum Peak Collector/Emitter Voltage with Base driven to cut-off (Common Emitter Circuit) or with $R_{b.e} < 500 \Omega$	(volts)	-35
Maximum Peak or Mean Emitter/Base Voltage	(volts)	-12
Minimum d.c. β at $I_c = -200\text{mA}$, $V_e = -1\text{v}$		40
Minimum d.c. β at $I_c = -50 \text{mA}$, $V_e = -1\text{v}$		48
Maximum Junction Temperature	(°C)	75
Thermal Resistance with Heat Sink when clamped to aluminium plate of 12 sq. in. minimum area	(°C/mW)	0.1

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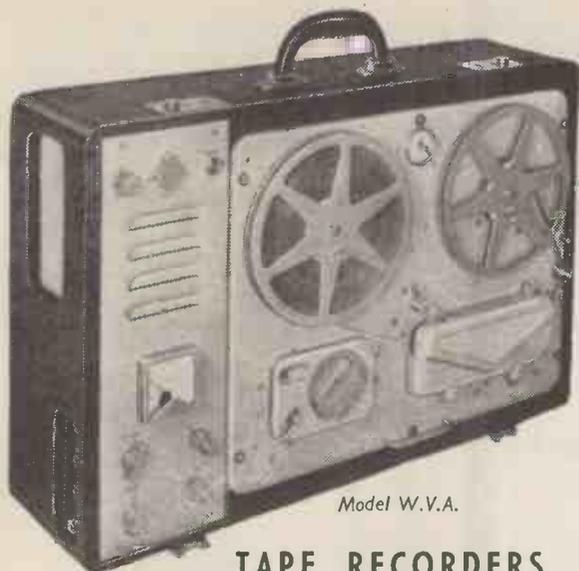
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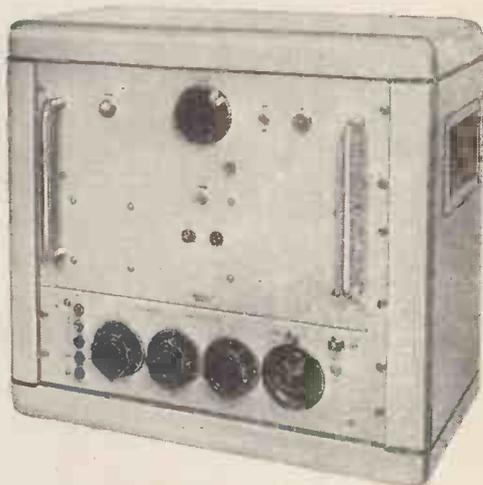
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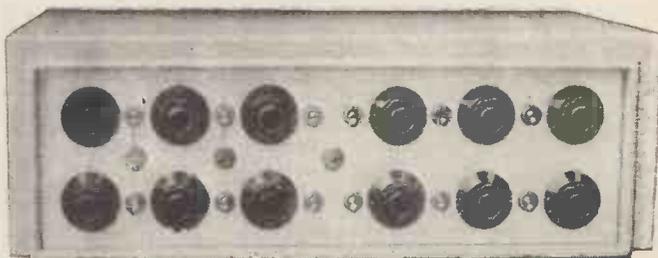
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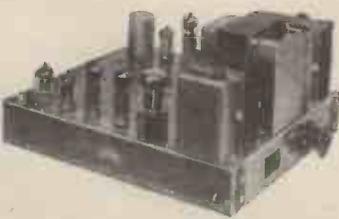
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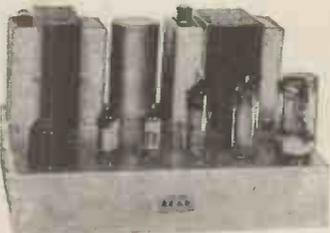
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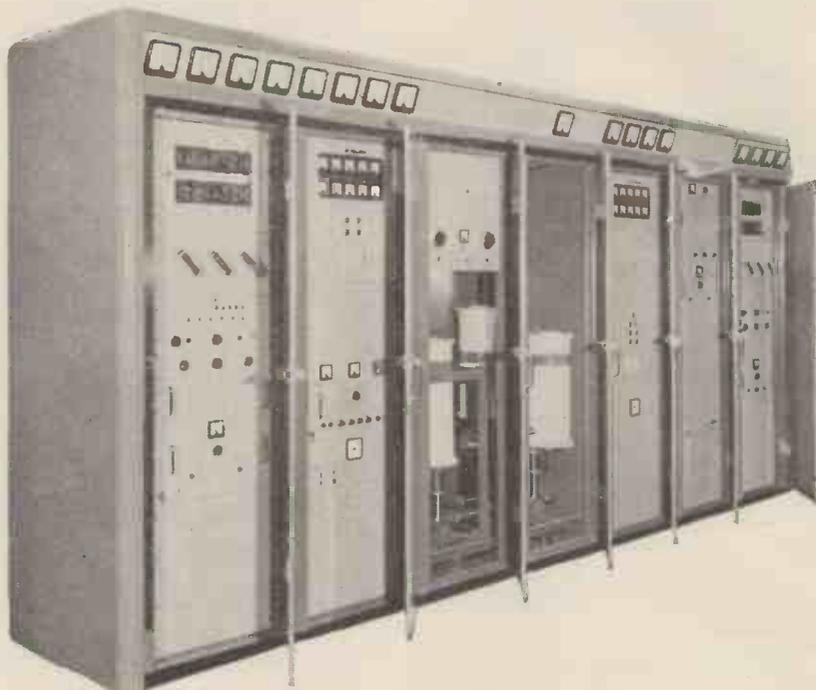
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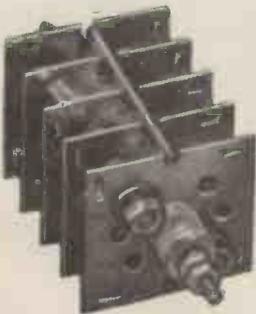
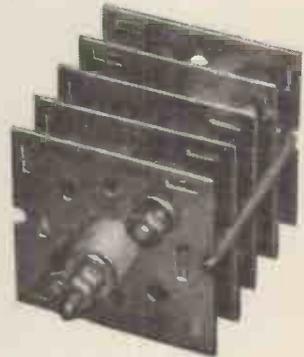
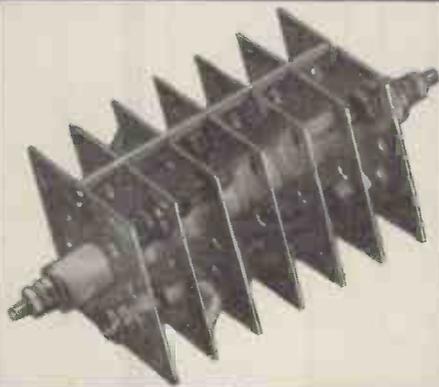
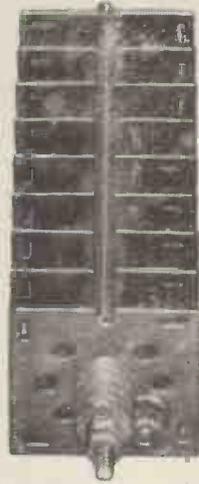
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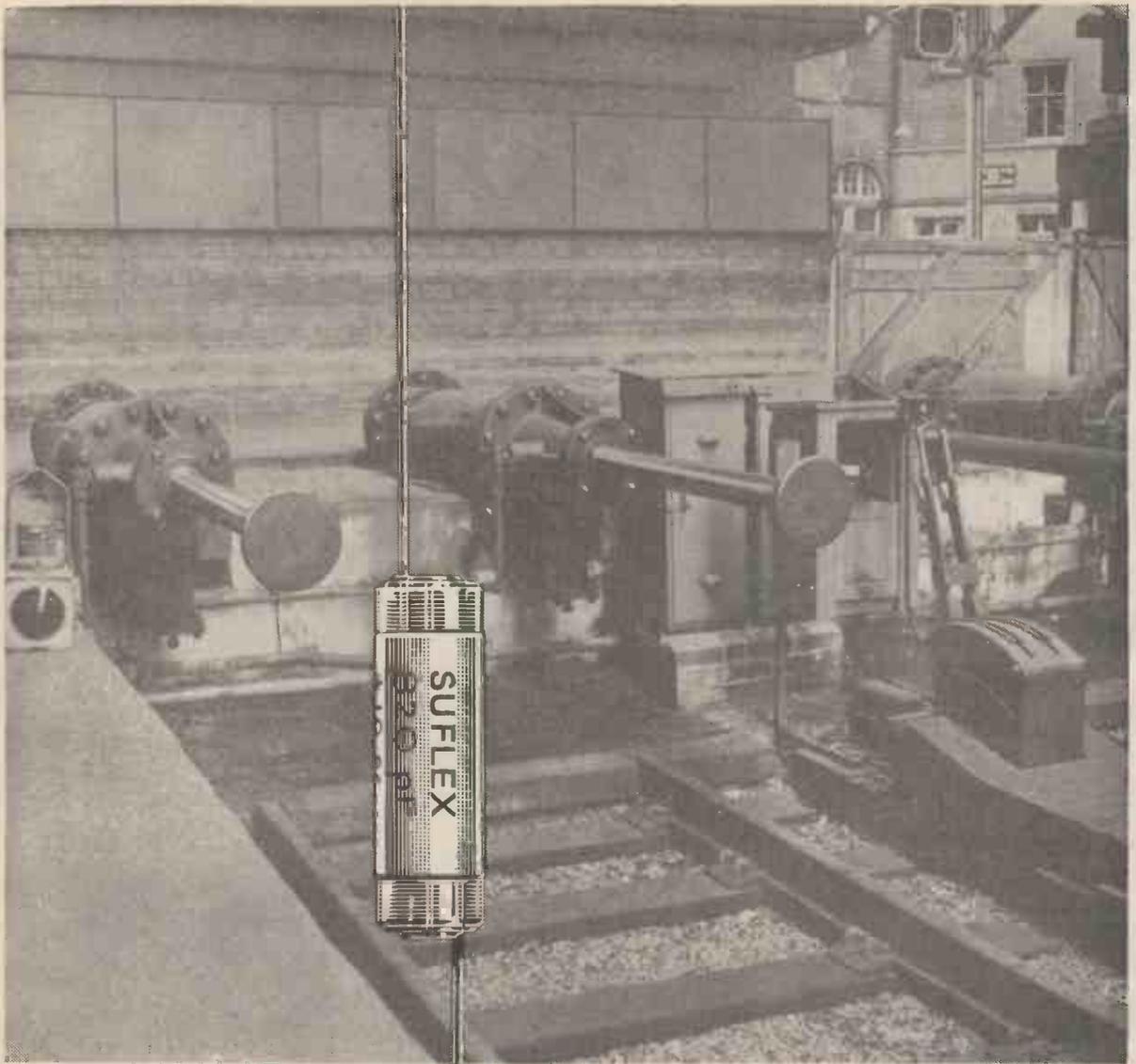


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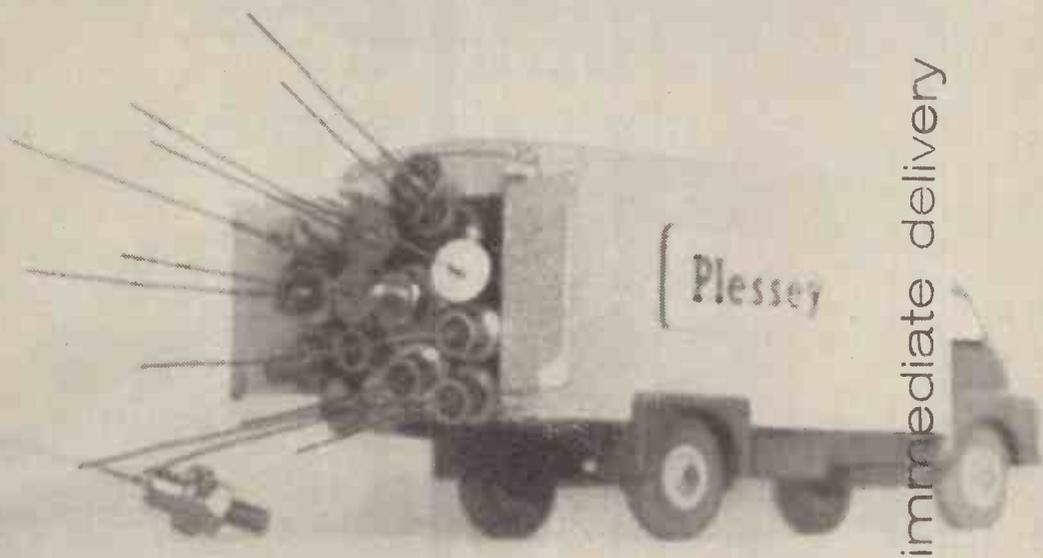
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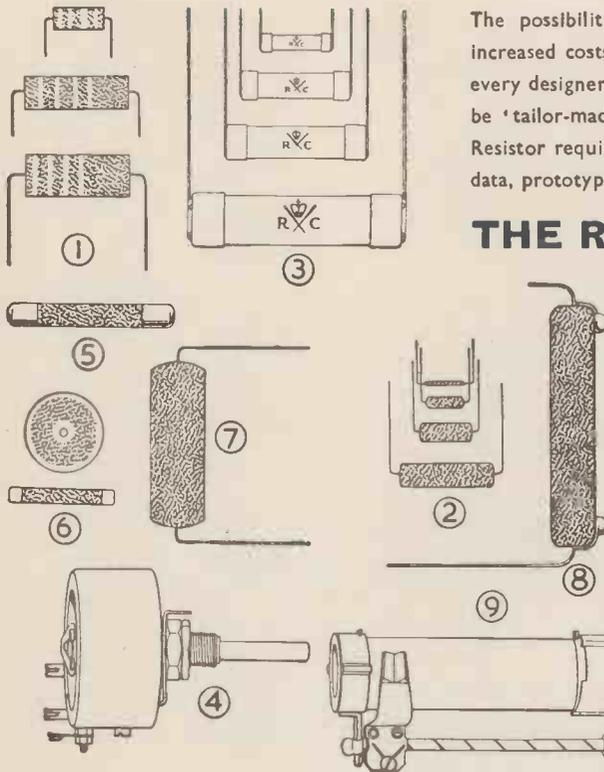
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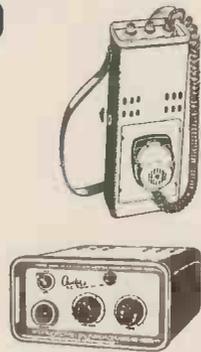
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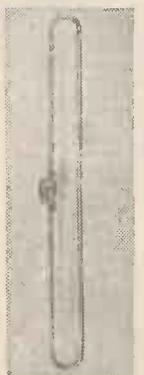
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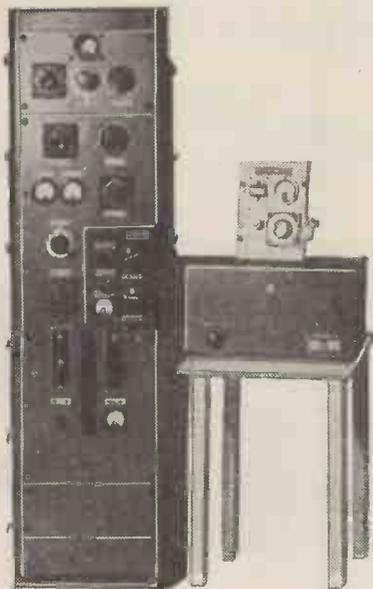
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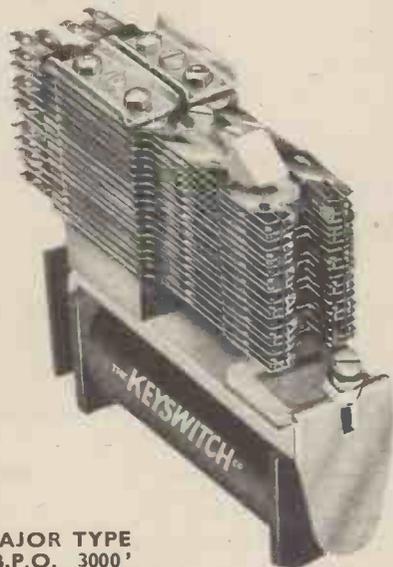
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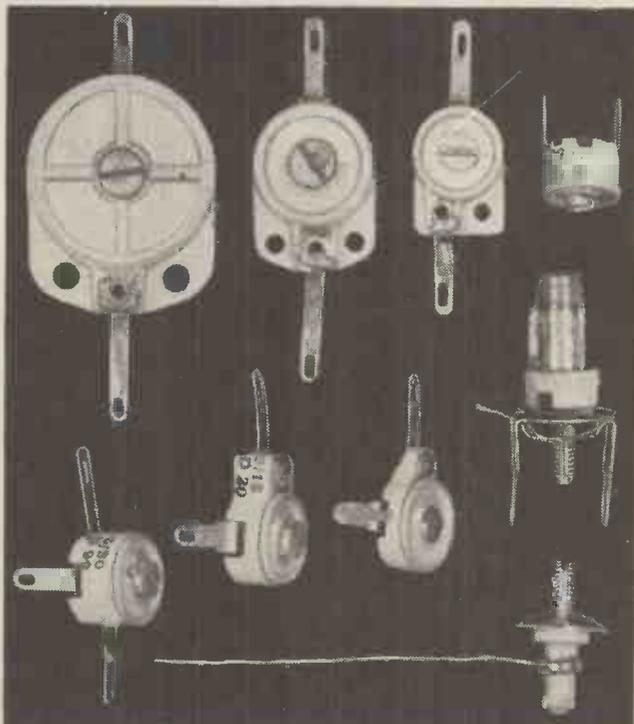
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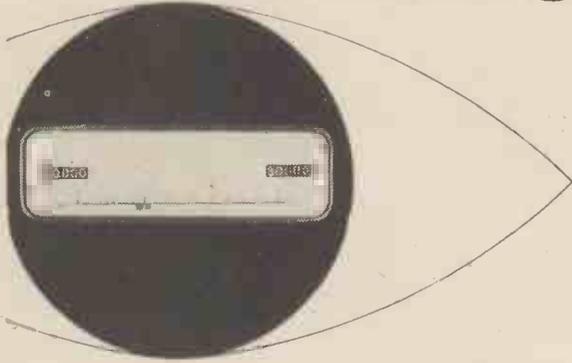
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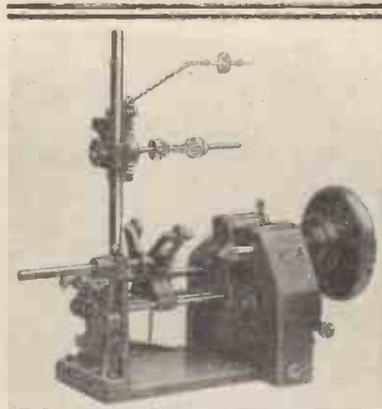


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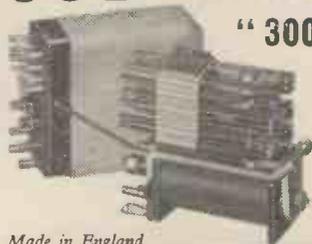


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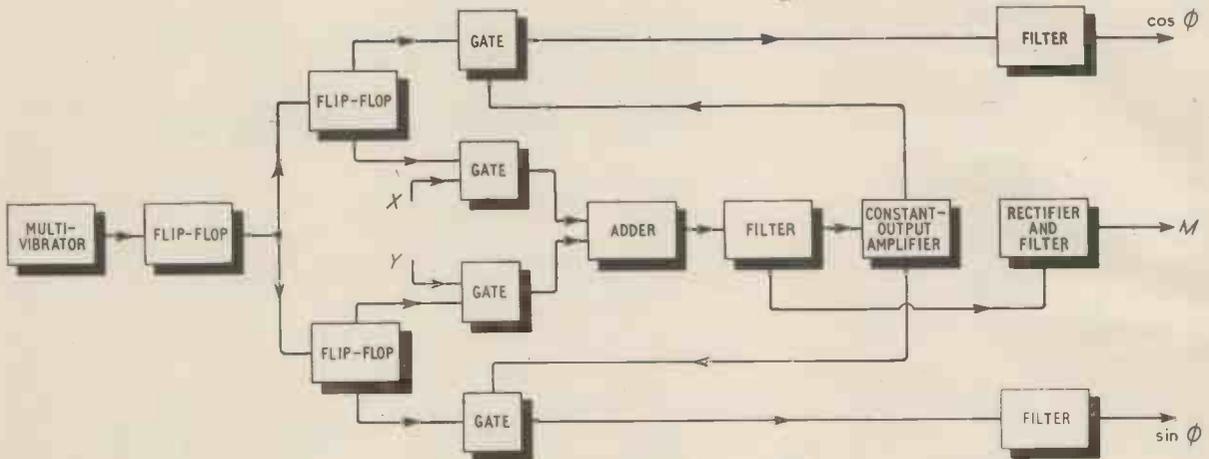
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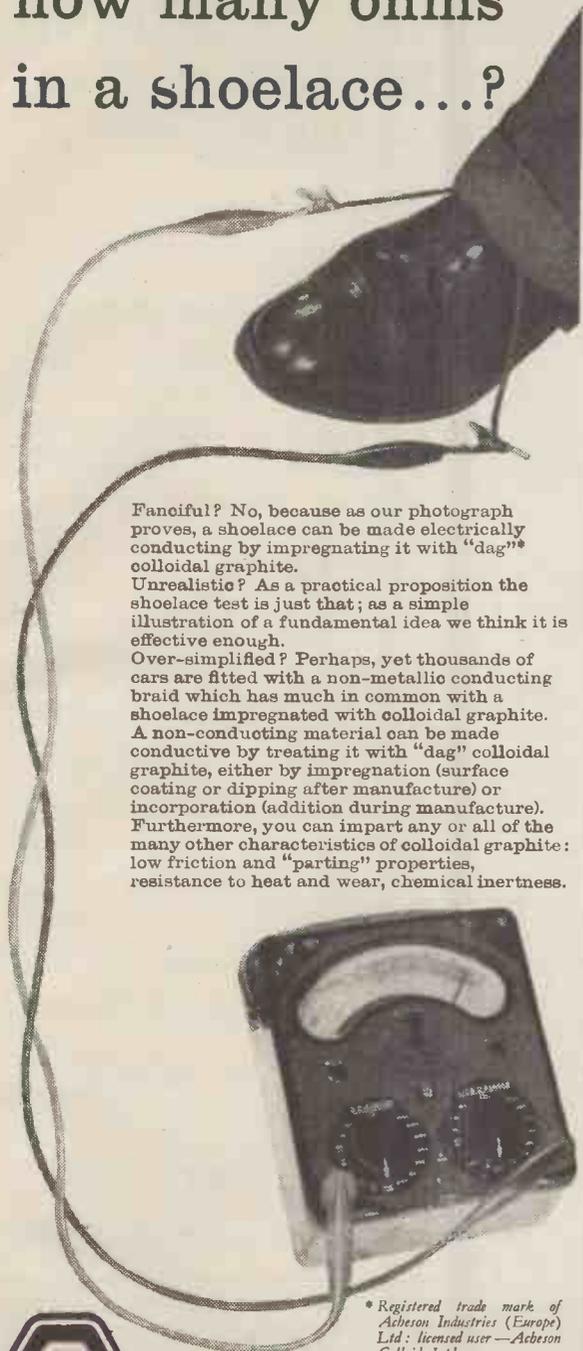
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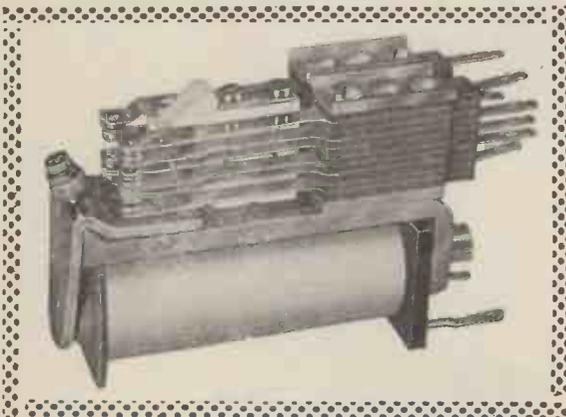
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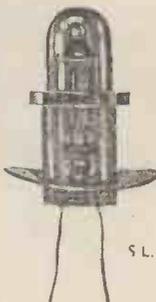
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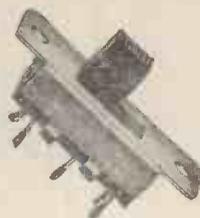
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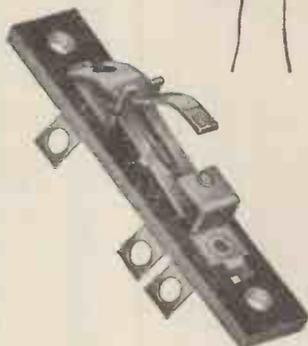
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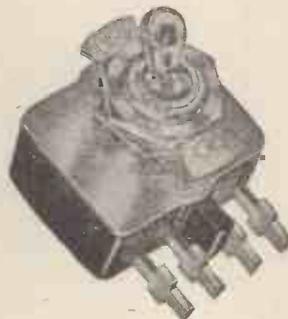
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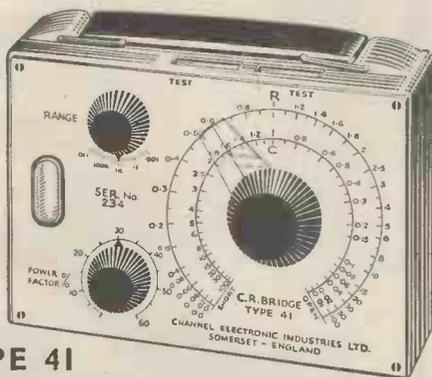
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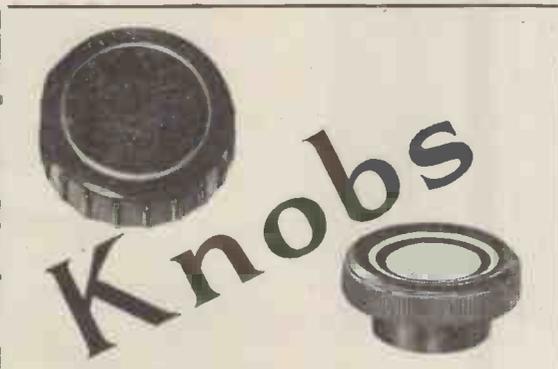
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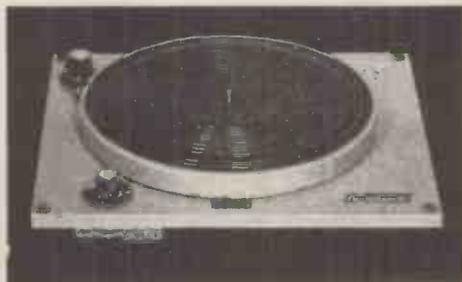
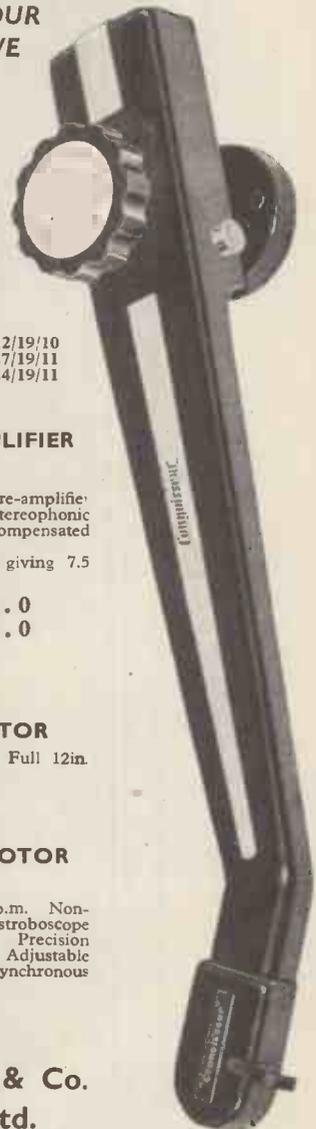
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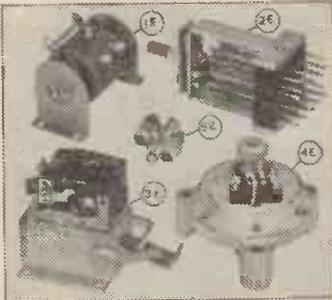
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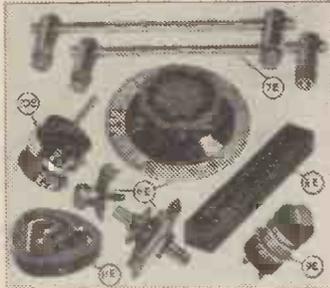
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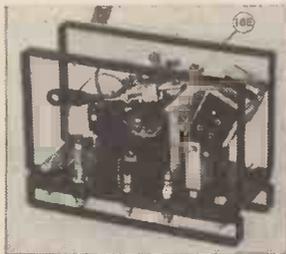
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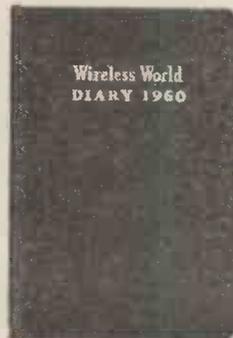
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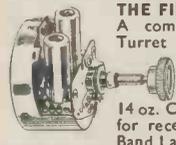
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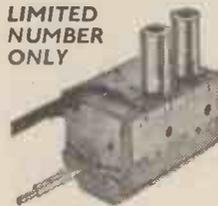
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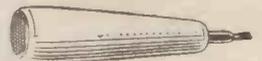
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Complete with PCC84 and PCF80 valves. I.F. 33-38 Mc/s. Complete with 8 sets of coils: 5 Band I channels and channels 8, 9, 10 Band III. New and unused. Today's value over £7.

LASKY'S PRICE 49/6 Post 3/6.

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ACOS CRYSTAL STICK MIKE, type MIC.39/1, complete with cable. Listed at £5/5/-.

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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.

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We hold the largest selection of leading makes, including ARMSTRONG, DULCI, EMPRESS, etc. A.M. chassis (I.M.S.) from 7 Gns. A.M./F.M. chassis from 14 Gns. A.M./F.M. STEREO from 22 Gns.

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ROUND

3 1/2 in. 4 in. 5 in. 6 1/2 in. 8 in.
17/6 19/6 14/6 16/- 16/6

ELLIPTICAL

7 x 4 9 x 6 10 x 2 1/2 10 x 6 10 x 7
15/6 27/6 27/6 25/- 32/6

Post extra.

All other sizes of elliptical, round and rectangular speakers in stock.

HIGH FIDELITY TAPE RECORDER HEADS

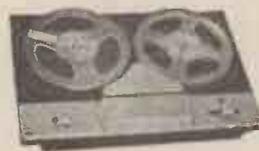
Leading make, new and unused, upper or lower track RECORD/PLAYBACK, high impedance. Double wound and will reproduce up to 12,000 c.p.s. at 7 1/2 i.p.s. Azimuth adjustments. Output 5 millivolts at 1 Kc. at 7 1/2 i.p.s. ERASE, low impedance.

LASKY'S PRICE

Per pair 39/6 Post 1/3.

Worth double. Please specify upper or lower track.

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Latest B.S.R. "MONARDECK", SINGLE-SPEED TAPE DECK, 3 1/2 i.p.s., takes 5 1/2 in. spools. Simple controls.

LASKY'S PRICE £9.19.6

Tape extra. Carr. & Insur., 12/6



Latest COLLARO STUDIO TAPE TRANSCRIBER. 3 motors, 3-speed, 1 1/2, 3 1/2, 7 1/2 i.p.s., takes 7in. spools. Push button controls.

LASKY'S PRICE £15.15.0

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Instruction Booklet with circuit diagrams for Amplifiers supplied.

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

PLASTIC TAPE SPOOLS

2/9 3/6 4/3 4/- 5/6
3in. 5in. 5 1/2 in. 7in. 8 1/2 in.
7in. Metal Spools, 1/9 each. Post extra.

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COLLARO. Incorporating auto and manual control. Complete with Studio crystal p.u. and sapphire stylus. LIST £13/17/-.
LASKY'S PRICE £7.19.6
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B.S.R. 4-spd. mixer Auto-Changer type UA8, complete with latest B.S.R. "ful-6."
Carr. & Pkg. 5/- £6.19.6
Ditto, wired for Stereo and with Stereo cartridge, £7/19/6.



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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 120, Mk. II £-9/19/6
Model 121, Mk. II £10/19/6
121, Mk. II, STEREO ... £11/19/6
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2 valve, ECL 82 and EZ80 rectifier, double wound mains transformer 100-250 A.C., tone control, record equalisation switch. Size 7 1/4 x 3 1/2 in., max. height 4 1/2 in. Controls mounted separately. **LASKY'S PRICE** complete with knobs 55/-

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MATCHED PAIR FOR STEREO 5 Gns.
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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.
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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
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Built to Mullard's exact specification, with 3 Mullard valves EL84, EF86, EZ81, and complete with front panel. £8.8.0
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MOTOR only 55/-
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SPECIAL OFFER

Motor and Pick-up 75/- Post free, together

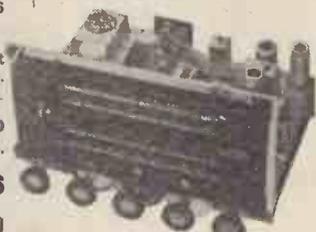
COLLARO 4/564 or GARRARD 4SP 4-spd. single player, auto, stop, T.O. crystal, £6.9.6
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STEREO SINGLE PLAYER
E.M.I. 4-speed with auto start and stop, wired for Stereo and fitted with Acos Stereo t.o. cartridge.
LASKY'S PRICE £6.19.6
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All makes and types in stock. Write for our bargain list.

PICK-UP CARTRIDGES. BELOW HALF PRICE!
B.S.R. "ful-6" TC8, turnover crystal cartridge with L.P. and standard styl. Limited number. List 39/7.
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COMBINED AM/FM TUNER, CONTROL UNIT AND PRE-AMPLIFIER (Self powered)

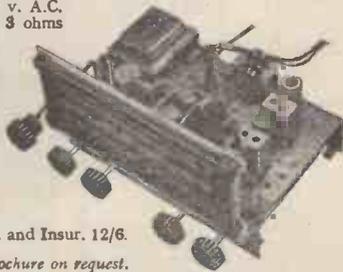


Mdl. H11 Famous make. Note these star features:
★ FM plus Long, Medium and Short
★ High Fidelity Pre-Amplifier
★ Independent Bass and Treble Control.
★ Pick-up Matching Device and Switch positions for LP and 78
★ Tape Record and Replay facilities
★ For use with any Hi-Fi Amplifier
★ Magic Eye Tuning Indicator

For A.C. 200-250 v. 7 B.V.A. glass miniature valves, ECC85, ECH81, EBF89, two EF86, EM81, EZ81, and two matched Diodes. Glass dial, 11 1/2 in. x 5 1/2 in., fine readings and 'LOG' scale. Length 12 in., depth 9 in. from dial front (10 in. including knobs and spindles), height 7 in.
LISTED AT £29/3/10.
LASKY'S PRICE 20 GNS.
Carr. and Ins. 12/6.
Available on H.P. terms.

7-VALVE AM/FM RADIOGRAM CHASSIS

Famous make. For 200-250 v. A.C. Output 4 watts matched to 8 ohms speaker. 7 valves: ECC85, ECH81, EF89, EABC80, EL84, EZ80, EM81, magic eye tuning indicator. Covers medium, long and FM bands. Length 12 in., height 7 1/2 in. front to back 8 1/2 in. Limited number only.



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LASKY'S PRICE

£16.19.6 Carr. and Insur. 12/6.

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

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EASY - TO - BUILD
SETS : TUNERS : AMPLIFIERS

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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**

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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/-**
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FERRANTI 12in., types T12/44 and T12/54. LASKY'S PRICE **84/-**
Carr. & Insur. 12/6.
Many others. List on request.

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Guaranteed for 12 months.

Type	Price	Carr. & Ins.
42in. round	£6 10 0	12/6
14in. rect.	£8 10 0	12/6
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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**
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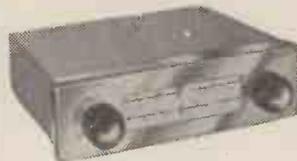
Large stocks of "Tygan" and "Some-weave." Any size piece cut. Sample and prices post free.

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ALL JASON KITS IN STOCK. Send for Brochures



LASKY'S CAR RADIO

CAN BE BUILT 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.

Send 1/6 for Instruction Booklet giving full details, illustrations, dimensions, circuit diagram and shopping list.

- ★ T.C.C. Printed Circuit and Condensers
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- ★ Medium and long waves
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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, 3½ x 3½ x 1½in. deep. LIST 9 GNS. LASKY'S PRICE **£5.19.6**
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6-TRANSISTOR POCKET RADIO

Printed Circuit construction. FULL medium and long wave superhet using latest components including 3 transistors, 2½in. moving coil speaker and Ferrite aerial. Cream or coloured plastic case, 5½ x 3½ x 1½in., weight 12 oz. Full assembly instructions supplied.

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£9.19.6 (Plus 3/6 Post)

All components available separately Available assembled ready for use MEDIUM wave only, £9/9/- plus 3/6 post.

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AUDIO P.N.P. Junction Types suitable for high gain and low freq. amplifiers, and for output stages up to 250 milliwatts. **7/6** (Double spot—yellow and green).

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(Double spot—yellow and red.) 3 or 4/-; 6 or 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. T81, T82, T83, 12/6; T84, 14/-; TP1 and TP2, 20/-; T31, T32, T33, 13/6.

EDISWAN MAZDA TRANSISTORS. The very latest types. XB/102, 10/-; XB/103, 14/-; XA/101, 16/-; XA/101, 23/-; XA/102, 26/-.

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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/-.
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A self-contained Portable unit comprising the latest Collaro 4-speed Auto Changer Record Player, incorporating the famous High Fidelity Studio "O" Xtal Pick-up with Turnover Cartridge and fitted with L.P. and 78 Sapphire stylii. An internal 2 valve amplifier of modern design with variable tone and volume controls is fitted. This, together with a quality 6in. P.M. speaker, ensures a high standard of reproduction. The whole is housed in a robust wooden cabinet attractively styled in a maroon contemporary leather cloth with contrasting polka dot relief. A fortunate bulk purchase enables us to offer this commercially styled Player at the following attractive breakdown Unit prices:

- Collaro 4-speed autochanger, £6.19.6 + 4/6 carr.
- 2-valve, 2-stage amplifier, ready wired, complete with speaker, etc., £3. 7.6 + 2/6 carr.
- Cabinet with mounting board, etc. Size 18½in. x 13½in. - Ht. 8½in. £2.12.6 + 3/6 carr.



This is a recommended bargain buy and when present stock is exhausted cannot be repeated. Originally built to be sold at 17 gns.

This complete 3 unit "Do-it-yourself" Record Player Kit offered at amazing bargain price of

£12. 19. 6

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RECORD PLAYER BARGAINS—Latest 4-speed models
 NEW RELEASE by E.M.I.—4 speed Single Player Unit fitted with latest stereo and monaural XAL cartridge and dual sapphire stylii. Auto stop and start. A fidelity unit and bargain buy at only £6.10.0.
SINGLE PLAYERS. BSR (TU9), 90/-; COLLARO (4/564) 6 gns.; GARRARD (48P) £7.10.0. Carr. and Ins. 3/6.
AUTOCHANGERS. BSR (UA9), £6.19.6. COLLARO £7.19.6; GARRARD (RC121 4D Mk II) plug-in head, stereo adapted, 10 gns. Stereo head £2 extra.

RECORD PLAYER CABINETS
 Contemporary styled 18in. x 13in. x 8in., 3gns. Carr. and Ins., 3/6.

2-VALVE 2-WATT AMPLIFIER
 Twin stage ECL82 with vol. and neg. feedback. Tone controls AC. 200/250 v. with double-wound Mains trans. Complete with knobs, etc., ready wired to fit above cabinet.
 £2.17.6 P. & P. 1/-.

6-in. Speaker and matching trans., 22/- P. & P. 1/6.

COSSOR VHF/FM CONSTRUCTORS KIT (Model 701K).

This is a 6-valve (UCC85, 2UF89, UA8C90, UL84, UY85) FM Radio Kit of high quality design and superb reproduction, with pre-aligned coils and printed circuit complete with Power Pack for AC/DC 200/250 v. operation. Kit includes High Performance 10in x 6in. Goodmans Speaker for quality response. Complete in every detail, including calibrated Tuning Dial, Slow Motion Drive and Pilot Lamp and comprehensive instruction details and circuit diagram this Kit is a genuine recommended buy.

BARGAIN OFFER
 Listed at 15gns. Only £8.19.6 Carr. and Ins. 4/6

TRANSISTOR 'ONE WATT' AMPLIFIER

6 v. Battery operated
 Latest Push-Pull, 4 Transistor circuit giving full 1 watt Output into standard 3 ohm speaker. Good sensitivity and improved freq. response. Neg. feedback. Var. Tone and Volume Controls. Chassis Size 8½in. x 3½in. x 1½in. Current consumption 10 mA quiescent—250 mA at 1 watt.
 2 matched GEC GET15 Transistors 42/- pr. 2 GEC GET3 Transistors 21/- pr.
 Driver Trans. 8/6
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 Complete Kit of Parts incl. circuit etc. less speaker, ONLY 99/6 P. & P. 2/6.
 Circuit and instruction booklet 1/6 post free

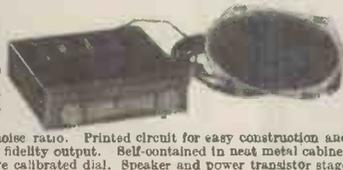
NOW! The THOUrIST Portable
 4 valve, Med. & L.W., 1½watt battery Radio. Size only 8in. x 4½in. x 4in. Weight 3½lb. with battery — P.&P.
 Complete receiver component kit 57/6 1/8
 Set 4 miniature valves (86 series) 35/- 9d.
 5in. Speaker & O/p Trans. 21/- 1/6
 Cabinet, Dial and Knobs, etc. 22/6 2/-
 Latest superhet circuitry, delayed AVC and A.F. Neg. feedback.

Complete kit—BARGAIN—only £6.10.0, post free
 Terrific performance—
 Remarkable size—
 Staggering Value
 Send for Booklet NOW! 1/6 post free

2 WAVEBAND CAR RADIO KIT

12 v. operation Med. & Long Waves

Modern development of the famous Brimar Hybrid vibratorless car radio circuit. Five latest type Brimar low voltage valves and power transistor. R.F. stage and permeability pre-aligned Cydon Tuner Unit provide extremely good sensitivity and signal/noise ratio. Printed circuit for easy construction and 7 x 4in. elliptical speaker for fidelity output. Self-contained in neat metal cabinet 8 x 7 x 2½in. with attractive calibrated dial. Speaker and power transistor stage mounted separately, approx. 8 x 5 x 3in.



Recommended Buy Complete Kit. Bargain Price £12.19.6
 Instruction booklet and parts list available 3/6 post free. P. & P. 3/6

C.R.T. Heater Isolation Transformers

New improved types—mains prim. 200/250 v. tapped

All Isolation Transformers now supplied with alternative no boost, plus 25% and plus 50% boost taps at no extra charge.
 2V 2A type 12/6 (P. & P. 1/6)
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 13V .3A type 12/6 (P. & P. 1/6)
 Size and size and tag terminated for easy fitting. Other voltages available.

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NEW REDUCED PRICES ... and now 12 months guarantee!

All tubes rebuilt with new heater, cathode and gun assembly—reconditioned virtually as new.
 12in. £6, 14in. £7, 17in. £8.10.0, etc.
 10/- part exchange allowance on old tube
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Stand ¼in. diam. Low Loss Semi-Air Spaced Aeraxial.
 Special Reduced Prices
 20 yds. 12/6, p. & p. 1/6; 60 yds. 32/6 p. & p. 3/-; 40 yds. 22/6, p. & p. 2/6;
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 Coax Plugs 1/-, Sockets 1/-, Couplers 1/3, Cable End Sockets 1/6. Outlet Boxes 4/6

JASON FM TUNER UNITS (87-105 Mc/s)

Designer-approved kits of parts for these quality and highly popular tuners available as follows.

STANDARD MODEL (FMT)—as previously extensively advertised. COMPLETE KIT, 5 gns., post free. Set of 4 spec. valves, 30/- post free.

LATEST MODEL (FMT2)—attractively presented shelf mounting unit to enclosed Metal Cabinet with Built-in Power Supply. COMPLETE KIT, 27/6 p. & p. 3/6. Set of 5 spec. valves, 37/6.

NEW JASON COMPREHENSIVE F.M. HANDBOOK, 2/6 post free. 48hr. Alignment Service, 7/6, p. & p. 2/6.

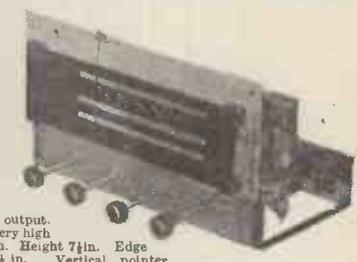
MULLARD "3-3" AMPLIFIER

Quality built to Mullard's specification, with special sectionalised O/P Trans.
 Complete kit with front panel only £9.19.6. P. & P. 3/6.

Manufacturer's Surplus Bargain

7 VALVE AM/FM RADIOGRAM CHASSIS

Valve Line-up: ECC85, ECH81, EF89, EABC80, EL84, EM81, EX80



Three Waveband and Switched Gram positions. Med. 200-500 m., Long 1,000-2,000 m., VHF/FM 88-95 Mc/s. Phillip's Continental Tuning insert with permeability tuning on FM and combined AM/FM IF transformers, 460 Kc/s and 10.7 Mc/s. Dust core tuning all coils. Latest circuitry including AVC and Neg. Feedback. Three watt output. Sensitivity and reproduction of a very high standard. Chassis size 13½ x 6½in. Height 7½in. Edge illuminated glass dial 11½ x 3½in. Vertical pointer. Horizontal station names. Gold on brown background. A.C. 200/250 v. operation.

Aligned and tested ready for use **£13. 10. 0** Carr. & Ins. 5/-
 Complete with 4 Knobs—walnut or ivory to choice.
 Three ohm P.M. speaker only required. Recommended quality speakers.
 5in. Goodmans special cone 21/6
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We design and manufacture MAINS AND O/P TRANSFORMERS to individual spec. Winding capacity available for Prototypes and small production runs.
ONLY A FEW ITEMS ARE LISTED FROM OUR COMPREHENSIVE STOCK. WRITE NOW FOR FULL BARGAIN LISTS, 3d.

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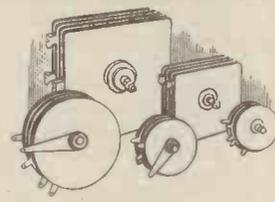
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UL26 3AGT 6/-	IT4 6/-	UL26 3AGT 6/-	IT4 6/-	6F17 12/6	7B8 8/6	20F2 26/6	956 3/6
UL26 3D6 5/-	IT4 6/-	UL26 3D6 5/-	IT4 6/-	6F33 17/6	7C5 8/-	20L1 26/6	5763 11/6
UL26 3B1C 3/6	IT4 6/-	UL26 3B1C 3/6	IT4 6/-	6H6 2/6	7C6 8/-	20P1 26/6	9002 5/6
UL26 3Q5GT 9/6	IT4 6/-	UL26 3Q5GT 9/6	IT4 6/-	6H6GT 2/6	7D6 13/6	20P3 23/3	9004 5/6
UL26 3S4 7/6	IT4 6/-	UL26 3S4 7/6	IT4 6/-	6J5GT 5/-	7H7 9/6	20P4 26/6	9006 5/6

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 B.S.R. UAB, 4-speed Mixer Automatic changer, manual and auto-control, complete with latest B.S.R. "ful-fi" pick-up. Carriage and packing, 3/6. OUR PRICE £6.19.6. The new B.S.R. Model UA12, 4-speed Mixer Automatic record changer, fitted with latest type turnover cartridge. OUR PRICE £8.17.6 Carriage 3/6. The latest Collaro Conquest, 4-speed auto-changer, in cream with Studio "O" insert. Brand new, fully guaranteed, £7.19.6, plus packing and post, 3/6. Collaro, 4-speed single player unit with automatic stop, cream, turn-over crystal cartridge, brand new and guaranteed, £6.19.6

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 4 Heads, twin track operation, 2 motors, tape measuring and calibrating device, finished in cream polystyrene cover plate with maroon controls, 3 speeds 3 1/2, 7 1/2 and 15 in. per sec. Price £16.6.0 plus 10/6 carriage and insurance.

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 Large selection of television aerials at up to 50% discount. Top of the see "V" aerial listed at 42/-, OUR PRICE 29/6. Outdoor array for Band I, II, III, Listed 62/6, OUR PRICE 39/6. Double 6 Element Array Listed 120/-, OUR PRICE 59/6. Loft or Room aerials for Both Bands Listed 29/6, OUR PRICE 19/6. Masts, Cranked Arms and Lashings available, for most types. Outdoor Array H for BBC, 6 elements ITV, Listed 87/6, OUR PRICE 45/-.

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 Types E10H, E38H, E10L. Brand New and Boxed. Complete with Fitting instructions etc. Listed £7.7.0. each. OUR PRICE 55/- or less valves 35/-.

RECTIFIERS FOR BATTERY CHARGERS
 12 v. 1 amp. 4/3
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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 £5.5.0. OUR PRICE, 39/6. With Stand, 47/6. With Floor Stand adapter, 52/6. Postage 1/6.

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 Types TT13S for .1 Heaters and Fitted B8A Plugs, Types TT13S for .3 Heaters and Fitted B9A Plugs; Types TT19P for Parallel heaters. Coils available for Most Channels. Listed £7.7.0. OUR PRICE 55/- each or less valves 35/-.

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 Our 1960 catalogue is now available, please send 1/- stamps for your copy. Trade Catalogue also available. Please attach your business Letter Heading.

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Still by far the finest value

COMPLETE KIT OF PARTS Designed by MULLARD—presented by STERNS strictly to specification.

MULLARD "5-10" MAIN AMPLIFIER

For use with the MULLARD 2 stage preamplifier (described below) with which an undistorted power output of up to 10 Watts is obtained. This combination is thoroughly recommended for "HI-FI, enthusiasts who contemplate a versatile and very high quality home installation. We supply SPECIFIED COMPONENTS AND NEW MULLARD VALVES including PARMEKO MAINS TRANSFORMER (which has extra Power available to drive Radio Tuner) and the choice of the latest Ultra-Linear PARMEKO or the PARTRIDGE Output Transformer. Price: COMPLETE KIT (Parmeko Output Trans.)

£10.00
Alternatively we supply ASSEMBLED AND TESTED **£11.10.0**



ABOVE INCORPORATING PARTRIDGE OUTPUT TRANSFORMER £11/6/0 extra.

MULLARD'S PRE-AMPLIFIER TONE CONTROL UNIT

Employing two EF86 valves, and designed to operate with the Mullard 3-3 and 5-10 MAIN AMPLIFIERS, but also perfectly suitable for other makes.

Our kit is strictly to MULLARD'S SPECIFICATION and incorporates:

- Equalisation for the latest R.I.A.A. characteristics.
- Input for Crystal Pick-ups, and variable reluctance magnetic types.
- Input. (a) Direct from High Imp. Tape Head. (b) From a Tape Amplifier or Pre-Amplifier.
- Sensitive Microphone Channel.
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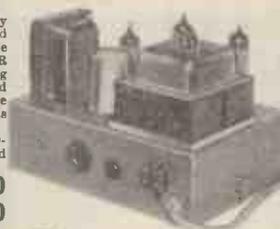
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(Carriage and Insurance 5/- extra).



MULLARD 3-3 MAIN AMPLIFIER

Based entirely on the very popular "3-3" model and designed to operate with the 2-stage PRE-AMPLIFIER (shown here) thus providing all the facilities associated with the more expensive "HI-FI" equipment. We recommend it as the IDEAL SMALL HOME INSTALLATION where very high quality is desired at the lower volume level (up to 3 watts).

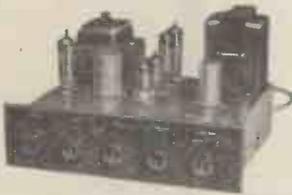
We supply completely to MULLARD'S SPECIFICATION INCLUDING the latest PARMEKO Output Transformer, specified Valves and Components. Has Power available to drive a Radio Tuning Unit. Price for COMPLETE KIT OF PARTS **£7.0.0**
Alternatively we supply ASSEMBLED AND TESTED **£8.0.0**
(Carriage and Insurance 5/- extra).



COMPLETE MULLARD 5-10 AMPLIFIER

The popular and very successful complete "5-10" incorporating Control Unit providing up to 10 Watts high quality reproduction. Input channels for high output pick-ups and all modern Radio Tuning Units, only

Specified Components and new MULLARD VALVES are supplied including PARMEKO MAINS TRANSFORMERS and choice of the latest PARMEKO or PARTRIDGE ULTRA Linear Output Transformer. Has extra power available to drive Radio Tuner. Price: COMPLETE KIT, Parmeko Transformer **£11.10.0**
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THE COMPLETE ASSEMBLY MANUAL AVAILABLE FOR 1/6.

COMPLETE MULLARD 3-3

A VERY HIGH QUALITY AMPLIFIER DEVELOPED FROM THE VERY POPULAR 3-VALVE 3-WATT AMPLIFIER DESIGNED IN THE MULLARD LABORATORIES.

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(Plus 6/6 carriage and insurance).

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H.P. Terms Deposit £2 and 8 monthly payments of £1. Our kit is complete to the MULLARD specification including supply of specified components, valves and PARMEKO OUTPUT TRANSFORMER. We also include switched inputs for 78 and L.P. records plus a Radio position. Extra power to drive a Radio Tuning Unit is also available.

MULLARD—STERN STEREO DESIGNS

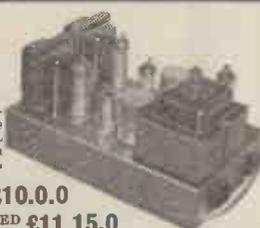
Model 3-3 M/S

DUAL "3-3" MAIN AMPLIFIER

Comprises two "3-3" MAIN AMPLIFIERS (described above) on one chassis and is designed to operate with our DUAL CHANNEL PRE-AMPLIFIER for both STEREO or MONAURAL operation.

Price: COMPLETE KIT OF PARTS **£10.0.0**
Alternatively ASSEMBLED AND TESTED **£11.15.0**

H.P. Terms Deposit £2/7/0, 12 months at 17/4. Its output power is 6 Watts (3 Watts per channel) and together with our PRE-AMPLIFIER provides a very acceptable STEREO installation.



DUAL CHANNEL PRE-AMPLIFIER

STEREOPHONIC or MONAURAL operation. It is designed primarily to operate with our range of MULLARD MAIN AMPLIFIERS but will also operate equally well with any make of Amplifiers requiring an input of 200 m/v.

PRICE COMPLETE KIT OF PARTS **£12.10.0** Alternatively ASSEMBLED AND TESTED **£15.0.0**

H.P. Terms £3 Deposit and 12 months of £1/2/0. Perfectly suitable for MONAURAL Only operation, with one "3/3" or one "5/10" MAIN Amplifier to which the second Main Amplifier can at any time be added thus very easily providing for both STEREO or MONAURAL reproduction.

Recommended combination for STEREO operation. (a) The DUAL CHANNEL PRE-AMPLIFIER together with the Dual "3/3" MAIN AMPLIFIER.

(b) The DUAL CHANNEL PRE-AMPLIFIER together with two "5/10" MAIN AMPLIFIERS. Assembly Manual is available for 2/6 or send S.A.E. for Descriptive Leaflet.



Only New HIGH GRADE Specified Components and MULLARD VALVES are supplied in all these models.

Please enclose S.A.E. if ILLUSTRATED and DESCRIPTIVE LEAFLETS are required . . . alternatively the COMPLETE ASSEMBLY MANUALS containing component Price Lists and practical Drawings, etc., are available at 1/6 each.

COMPLETE STEREO AMPLIFIER

A thoroughly recommended design that very effectively meets the many requests for a low priced but good quality DUAL CHANNEL STEREO AMPLIFIER. PRICE COMPLETE KIT OF PARTS **£8.10.0**
Alternatively ASSEMBLED AND TESTED **£10.10.0**

Two Mullard BCL 82 Triode Pentode Valves are incorporated in the design, they form a "CLASS A" single ended output stage in each channel. The input sensitivity is 300 mV/vo, therefore when used with most STEREO Crystal Pick Ups, or Radio Tuning Units, an output of 2 Watts per channel is achieved, or similarly when switched to MONAURAL Pick-Up position a combined output of 4 Watts is produced.



STERN RADIO LTD. 109 & 115 FLEET ST., LONDON, E.C.4

Telephone: FLEET STREET 5812/3/4

Stern's "fidelity" TAPE RECORDERS

BEFORE YOU BUY — HEAR THESE RECORDERS, THEY ARE COMPARABLE TO THE MUCH HIGHER PRICED MODELS — AND THEN

Take Your Pick

- MODEL CR3/S.** Incorporates the New COLLARO "STUDIO" TWIN TRACK 3-speed Deck..... **£41.0.0**
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H.P. Terms: Deposit £9/18/- and 12 months of £3/12/7.



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.

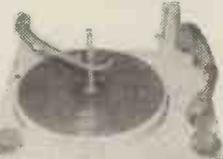
There are no "better value for money" Tape Recorders on the market—if you can't call and hear them—send S.A.E. for fully descriptive leaflets.

MODERNISE YOUR OLD RADIOGRAM

It is **CHEAPER** and **BETTER** TO REPLACE YOUR OLD CHASSIS and GRAM UNIT !! RECORD PLAYERS !!

The **LATEST MODELS** are in Stock. Many at **REDUCED PRICES!!!**
Send S.A.E. for **ILLUSTRATED LEAFLET**

- B.S.R. MONARCH UAS** 4-spd. Mixer Autochanger with Crystal Pick-up..... **£6.12.6**
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- The **NEW COLLARO** model **RP594**, 4-speed Single Record Player, Studio Cartridge..... **£9.18.9**
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- (This high output pick-up is available separately for £1/12/6.)
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HIGH FIDELITY UNITS IN STOCK

- The latest **GARRARD TRANSCRIPTION MOTOR "301"** with Stroboscopically marked turntable..... **£23.18.4**
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HIRE PURCHASE TERMS available on all units £8/10/6 and over.

STERN'S MK II "fidelity" F.M. TUNING UNIT

(Plus 5/- carr. and ins.)
HIRE PURCHASE: Deposit **PRICE £14.5.0**
£8 and 12 months at **£1/0/6**. Incorporates the latest **MULLARD PERMEABILITY TUNING HEAD** and the corresponding **MULLARD VALVE LINE UP** comprising **EC35**, 2 type **EF85a** (or **EF89a**), **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.

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 case, size of each only **7 1/2 x 4 1/2 x 1 1/2** in. high.

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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.
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An AM/FM chassis with nine valves and with push-pull output stage providing 6 watts.
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Provision is made for Stereo and Monaural playback from pick-up or tape. Outputs provided for Stereo or Monaural tape recordings.
- DULCI Model FMT/2**..... **£19.17.6**
A complete self-powered FM Tuner incorporating automatic frequency control.

RADIO TUNING UNITS

- 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.
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- The "STEREO EIGHT" PREAMPLIFIER..... **£23.2.0**
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(Carr. & Ins. 5/- extra.)

SPECIAL CASH ONLY OFFER !!

This very attractive **PORTABLE AMPLIFIER CASE** together with a good quality **GRAM AMPLIFIER** and a detached **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 Resin—WE ALSO **SUPPLY SEPARATELY:**
- (a) The 2-stage (plus Rectifier) **AMPLIFIER**..... **£4 2 6**
 - (b) The **PORTABLE CARRYING CASE**..... **£3 17 6** (Carriage and insurance 4/- extra)
 - (c) 6 1/2 in. **P.M. SPEAKER**..... **18 9**

!! 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.

THE JASON "MERCURY" Switched F.M. TUNER IS IN STOCK
PRICE ASSEMBLED £13.10.0
AND TESTED

CREDIT SALE Deposit **£3/7/6** and monthly payments of **£1/4/10**.
ALTERNATIVELY THE COMPLETE HOME CONSTRUCTORS KIT is available for **£9/10/6** (carr. and ins. in 5/- extra).

CAR BATTERY CHARGER
A COMPLETE KIT OF PARTS FOR ONLY £2.19.6

Will charge 6 or 12 volt batteries at max 2 1/2 amps. The design incorporates Bellant Resistor and Fuse and we supply complete with Metal Box container, **EASY TO-FOLLOW ASSEMBLY INSTRUCTIONS** ARE INCLUDED.

STERN RADIO LTD. 109. & 115 FLEET ST., LONDON, E.C.4
Telephone: FLEET STREET 5812/3/4

Stern's "fidelity" TAPE EQUIPMENT

A SELECTION OF HIGH FIDELITY PORTABLE TAPE PREAMPLIFIERS

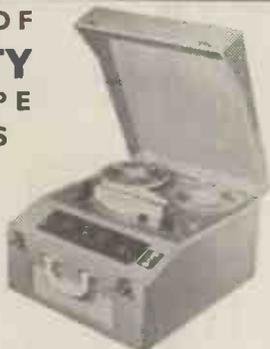
Adds "Hi Fi" Tape Recording to your existing Audio Installation.

IN ALL MODELS WE INCORPORATE THE

TYPE "C" PREAMPLIFIER

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: £8/6/0, 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. **£61.00.0**



STERNS—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 Mk. IV TAPE DECK and the MULLARD TYPE "C" PREAMPLIFIER & Power Unit assembled, tested H.P. Deposit £7 and 12 months £2/11/4. **£35.0.0**
- (b) As in (a) above but the Type "C" supplied as COMPLETE KIT OF PARTS. **£32.0.0**
- (c) The TRUVOX Mk. VI TAPE DECK and the assembled Type "C" Preamplifier and Power Unit. **£40.0.0**
- (d) As above but the Type "C" supplied as complete KIT OF PARTS. H.P. Deposit £8/0/0 and 12 months £2/18/8. **£36.10.0**
- (e) The BRENELL Mk. V DECK and the assembled Type "C" PREAMPLIFIER and POWER UNIT. H.P. Deposit £9/4/- and 12 months £3/7/6. **£46.0.0**
- (f) As above but the Type "C" supplied as complete KIT OF PARTS. **£43.0.0**
- (g) The WEARITE 4A DECK with Type "C" assembled and tested. H.P. Deposit £11/4/0 and 12 months £4/2/1. **£56.0.0**

(Carriage and Insurance on above quotes 10/- extra.)

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

STERN RADIO LTD.

109 & 115 FLEET ST., LONDON, E.C.4

Telephone: FLEET STREET 5812/3/4

THE FINEST RANGE OF TAPE EQUIPMENT FOR THE HOME CONSTRUCTOR

YOU CAN BUILD A COMPLETE HIGH QUALITY RECORDER LIKE THIS FOR **£39.15.0**



WE OFFER THIS SELECTION

- (a) The COLLARO Mk. IV TAPE DECK with the assembled and tested HF/TR3 Amplifier. **£34.10.0**
H.P. Deposit £6/18/- and 12 months £2/10/8.
- (b) As above but the HF/TR3 supplied as KIT OF PARTS. **£30.15.0**
NOTE: Messrs. Collaro when supplying the Mk. IV Deck do not wire up the Deck Switch backs. We will do this for £1 or supply a wiring diagram to the Home constructor.
- (c) The TRUVOX Mk. VI TAPE DECK with the assembled and tested HF/TR3 amplifier. **£39.10.0**
H.P. Deposit £7/18/- and 12 months £2/17/11.
- (d) As above but the HF/TR3 supplied as KIT OF PARTS. **£36.0.0**
- (e) The BRENELL Mk. V DECK with the assembled and tested HF/TR3 amplifier. **£45.0.0**
H.P. Deposit £9 and 12 months £3/6/-.
- (f) As above but the HF/TR3 supplied as KIT OF PARTS. **£41.10.0**
- (g) THE PORTABLE CASE illustrated here (£5), 1,200ft. EMITAPE (35/-), ACOS CRYSTAL MIKE (35/-), ROLA 10 x 6in. LOUDSPEAKER (30/-) ALL FOR **£9.0.0**
Carriage and Insurance on each above 10/- extra.

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.



WE HAVE THE NEW 2 SPEED TWIN TRACK

TRUVOX Mk. VI Tape Deck in stock **£26.5.0** Deposit **£5.5.0** 12 months **£1.18.6** It incorporates PRECISION REV. COUNTER and PAUSE CONTROL and operates at 3½ and 7½ inch/sec. speeds. It fully maintains the general high standard of all Truvox equipment, introducing refinements in appearance and ensures high quality recording, accurate timing and editing. The very popular COLLARO Mk. IV "TRANSCRIPTOR" and the BRENELL Mk. V Decks are also available from stock.

THE NEW B.S.R.

"MONARDECK"

INCORPORATING A CORRECTLY MATCHED PREAMPLIFIER PRICE **£17.17.0** Deposit **£3/12/-**, 12 months **£1/6/2**. (Carr. and Ins. 10/-).

Designed to operate through the Pick-up Sockets of the standard RADIO RECEIVER through which first-class results are obtained. It consists of a single speed Twin Track Tape Deck, incorporating matched Preamplifier, and operates at 3½ in./sec. speed. It uses 5in. Tape Spools thus providing up to 1½ hours' playing time on L.P. Tapes or 1 hour on the standard 5in. Tape Spools. The equipment is supplied fully tested and completely assembled on an attractive wood plinth. It can therefore be "dropped" directly into an existing cabinet and only requires connections to the mains supply and the Pick-up Sockets, for which purposes "floating" leads are incorporated on the Preamplifier.



CLYNE RADIO LTD.



THE
COMPONENT
SPECIALISTS

**UNREPEATABLE
OFFER!**

Our supersensitive "FAMILY FOUR" 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 200/250 v. 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



LEADING THE FIELD —

In equipment for

THE CONSTRUCTOR and HI-FI ENTHUSIAST

SEND STAMP FOR FULL LIST including F.M. Tuners, Receivers, Amplifiers, Stereo Amplifiers, Tape Pre-Amplifiers, Transistor Portables, Crystal Receivers, Battery Charger, Baby Alarm, etc., etc.
NOTE: ALL components supplied, including valves (even if surplus types) are guaranteed to be BRAND NEW !!

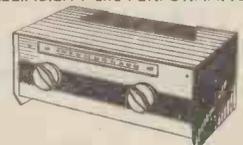
JASON "EVEREST" TRANSISTOR PORTABLES

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 3/6 p. and p. EVEREST-7 (seven transistor), £15/18/9, plus 3/6 p. and p. Fully descriptive booklet with comprehensive assembly instructions available separately if required at 3/6 post free.



THE NEW JASON FM TUNER

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



Incorporates the very latest features in design to ensure simplicity of operation and faultless performance. Housed in smart metal shelf mounting cabinet in pastel green with grey plastic dial. Built-in power supplies enable connection to any amplifier or radio fitted with Pick-up sockets, without complication. 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

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 any of the above cabinets 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.

THE NEW LOOK RAMBLER PORTABLE



This wonderful little Medium and Long wave battery superhet incorporates IR5, IT4, IS5, 3V4 miniature valves, 5in. speaker and frame aerial. Housed in smart two tone Red/Grey cabinet. All required components at only **£7/7/0 plus 2/6 p. & p.** or with the latest low consumption "96 range" valves at **£7/15/6 plus p. & p.** Uses all-dry batteries AD35 (1/6), B126 (9/-). Full descriptive Instruction book with itemised price list, diagrams, etc., available separately at 1/6d. post free.

MAINS UNIT FOR RAMBLER PORTABLE. Fits into battery compartment. A.C. 200/250 v. All required components at **ONLY 47/6 plus 1/6 p. & p.** or assembled and tested at **£3/5/- plus p. & p.** (Also suitable for many other portables.)

GOSSOR BATTERY ELIMINATOR Type MU2

Suitable for converting any All-Dry Battery receiver, employing 1.5 v. L.T. and 90 v. H.T. and modern low consumption valves, to A.C. Mains operation, 200/250 v. Contained in two separate units (L.T. & H.T.) which are identical in size to the AD35 and B126 (or equivalents) batteries. Fully stabilised L.T. supply of 1.5 v. at 125 m.a., H.T. 90 v. at 10 m.a. These units are **BRAND NEW** and packed in manufacturer's original carton. **UNREPEATABLE PRICE OF ONLY 37/6, plus 1/6 p. & p.** (List price 3 gns.) Guaranteed.



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 car piece for above, 12/6.

PRINTED CIRCUIT CAR RADIO (for Home Construction)



We are proud to be able to offer this New type Car Radio employing up to the minute circuitry, special 12 volt valves and transistorised output stage. The highest degree of sensitivity is assured by the incorporation of Permeability Tuning and a tuned R.F. Stage. Covers Medium and Long Wavebands. **NO VIBRATOR PACK IS REQUIRED.** This is a really compact receiver that will fit any car. Comprehensive assembly instructions are provided with all necessary components, including valves and transistor at a Special Inclusive Price of Only **£12/19/6 plus 3/6 p. & p.** Instruction booklet with itemised price list, full description dimensions, etc., available separately at 1/6 post free.

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

CLYNE RADIO LTD.

Open: Tottenham Court Rd : 9 a.m. to 6 p.m. Mon to Fri., Sat. 1 p.m. ● All post orders and correspondence to Holloway Road: 9 a.m. to 6 p.m. daily. Thurs. 1 p.m., Sat. 5.30 p.m.

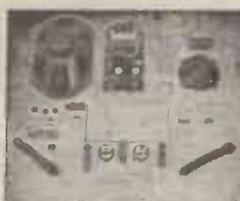
Our advantageous H.P. and Credit Sale terms are available on any single item over £5. Your enquiries invited.

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)

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 feedback incorporated, and the high performance loud-speakers provided, a really high quality output is assured. Suitable for use with radio tuners, microphone, or gramophone units. For A.C. 200/250v. 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 AC or DC 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/-)



RECORDER AMPLIFIER

(Well known manufacturer's surplus.) This is a brand new amplifier designed for use with a famous wire recorder. A simple modification is all that is required to make this unit ideal for use with any Tape Deck. Specifications: Valve line-up 7C5, 2AU7, 6BR7, 6BR7, 6X4. Neon Record Level Indicator. Controls: Volume/Record Level. Tone Control, Record/Playback Switch. High and Low level inputs for Mike and Radio. External Speaker Socket. Built-In Sin. Loudspeaker with High Flux magnet: Separate Power Pack. Dimensions: Amplifier 5 1/2in. H. x 1 1/2in. W. x 2 1/2in. D. Power Pack: 6 1/2in. x 6in. x 5in. High (overall). Full modification details are supplied. Price £6/19/6. P. & P. 3/6.



A SUPERB TABLEGRAM CABINET! (Limited stocks only.) This beautiful cabinet, finished in highly polished dark walnut with gold piping, will accommodate any 4-speed single record unit, amplifier and 7in. x 4in. elliptical loudspeaker. (The motor-board is supplied cut for the Garrard 45P player, but is easily modified for the Collaro Junior, B.S.R. TU9 etc.). Overall dimensions are: 15 1/2in. wide x 13in. x 7 1/2in. high. Clearance above motor-board (inc. lid) 3 1/2in. Clearance below motor-board 3 1/2in. This is a most attractive proposition for anyone who requires small but good quality equipment. Priced at **ONLY 59/6 plus 6/6.** (Do not miss this outstanding bargain!!!) Also available to accommodate auto-changer at 79/6 plus 6/6 P. & P.



DECCA PORTABLE AMPLIFIER. As supplied in famous DECCAMATIC III. Complete with small cream knobs. Full range tone and volume controls. Employs ECL82 valve. Size 3 x 3 1/2 x 8 1/2in. Only 59/6 plus 2/6 P. & P.

SPECIAL CELESTION 8 x 6in. elliptical high flux loud-speaker 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.

EXTRA SPECIAL OFFER!!

A small three-valve **PORTABLE RECORD-PLAYER AMPLIFIER** mounted on baffle 12 x 7in. with High Flux 6 1/2in. Loudspeaker, Valve line-up ECC83, EL84, EZ80. Incorporates separate bass and treble controls. Max. output 3 watts. Will match all types of high impedance pick-up. Ready to use, £5/12/6 plus 3/6 P. & P.



NEW STYLE CABINET finished in two-tone Leatherette. Will accommodate above Amplifier and Baffle without modification, also most types of Ancillary Equipment. Overall size 18 x 13 1/2 x 8 1/2in. Fitted with carrying handle, £3/9/6 plus 5/- P. & P. **NOTE.** If both items purchased together they will be supplied at a special inclusive price of £8/7/6 plus 6/6 P. & P.

RECORD PLAYERS ->

THE LATEST COLLARO "CONQUEST" Stereo 4-speed auto-changer in cream with Stereo insert. Brand new, fully guaranteed. £8/19/6. P. & P. 3/6.

MONAURAL "CONQUEST" with Studio "O" insert, £7/19/6, plus P. & P. 3/6.

B.S.R. UAS MONARCH. 4-speed Mixer Autochanger complete with turnover crystal insert and sapphire styli. Few only, now at £6/19/6 plus 3/6 P. & P. Brand new and fully guaranteed.

GARRARD RC.12ID MK.II STEREO MONAURAL 4-SPEED AUTO-CHANGER. Complete with GC8 plug-in crystal head and sapphire styli for monaural records. Brand new fully guaranteed. Limited stocks. **ONLY £11/0/6, plus 5/- P. & P.** NOTE: Garrard L.P. Stereo plug-in head for above available as optional extra for £2/1/9 inc. P.T. Terms available.

GARRARD RC120/4H. 4-speed auto-changer with GC2 insert. Brand new, fully guaranteed. £9/19/6. P. & P. 3/6.

A QUALITY RECORDER FOR 39 GNS.

Collaro Mark IV Tape Transcriber Deck.....	£17 19 6
Special amplifier.....	£14 14 0
8 x 6in. loudspeaker	£1 10 0
De Luxe Cabinet with gilt fittings.....	£4 10 0
Collaro Mike(orsimilar)	£2 5 0
1,200ft. EMI tape	£1 15 0
TOTAL	£42 13 6



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.

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.

LIMITED SUPPLIES OF THIS FINE AND POPULAR CABINET

Instantly recognised as being of leading High Quality manufacturers' stock, this trolley-type cabinet is finished in polished dark walnut. Can easily be adapted to accommodate tape recorder, amplifier, radiogram, etc., etc. External measurements: 24 1/2in. x 16in. x 29in. The whole is mounted upon "easy run" castors. Subject to being unsold £5/19/6, plus 15/- C. & P.



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.



PORTABLE GRAM AMPLIFIERS RC2A. Small PRINTED CIRCUIT single-valve high-gain amplifier for the smaller type of portable. Employs latest type ECL82 valve. Full details on request. Price 59/6 plus 2/- P. & P.

RC3A. A superior quality 3-valve amplifier employing EZ80, EL84 and ECC83. With separate bass and treble controls. Price £3/19/6 plus 2/6 P. & P. O.P. Transformer available at 4/6 extra.

CABINETS. We carry large stocks of cabinets to suit all types of equipment at prices ranging from 45/-. Suitable for housing all types of turntable, tape deck, amplifier etc. Terms available if required. Send stamp for illustrated leaflets of full range.

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

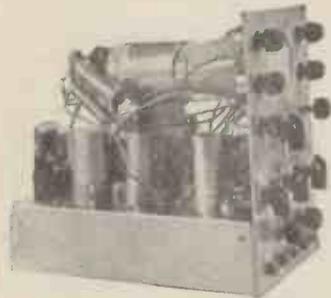
The following equipment of top quality is now available for home construction.



AUDIO GENERATOR AG10. Covers from 10c/s. to 100 Kc/s. in four ranges. Max output 10 volts. Min. output 100 microvolts. Square wave output with excellent rise time makes this generator very useful for checking all Audio equipment. Housed in attractive metal shelf mounting case measuring 1 1/2 in. x 6 1/2 in. x 5 1/2 in. All necessary components available, including valves, at a Special Price of £14/5/-, plus 3/6 p. and 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 20 c/s to 600 Kc/s with a gain of 150. A calibrating voltage of 6.3 v. 50 c/s is provided. Employs ECR30 2 1/2 in. Cathode Ray Tube and 4 valves: 2/ECF80, 1/EF91, 1/EZ35, 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 HIGH QUALITY 4-WAVEBAND AM/FM CHASSIS (By famous manufacturer). BRAND NEW.

A really first-class AM/FM Chassis, which is in great demand by the discerning enthusiast. Brief spec.: 9-valves, ECC85, ECC81, EF89, EABC80, 2/EL84, ECC83, EZ81, EM34. Covers Long, Medium, Short and FM Wavebands. Power pack and output stage (Push-Pull) mounted on separate chassis. Independent Bass and Treble Controls. Volume Control on flying lead. Available with Vertical or Horizontal edge lit dial. Flywheel tuning. Facilities for quality tape recording or playback. Pick-up and extension speaker sockets provided. PRICE WHILST STOCKS LAST ONLY £17/19/6, plus 5/- p. and p. Terms: Deposit 39/6 and 12 monthly payments of 29/4.

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 (1 3/4 in. x 3 1/2 in.) in red, green and gold on black background. Two-speed dial drive. Full range tone control. Output approx. 4 watts to match 3 ohm speaker. For A.C. mains 110/250 v. Overall size 1 3/4 in. x 6 1/2 in. x 6 1/2 in. high. WHILST STOCKS LAST, £7/19/6 ONLY, plus 7/6 P. & P.

VALVES. We have perhaps the most up-to-date valve stocks in the trade. New imported valve types fully guaranteed and P.T. paid and all the usual surplus types at special prices. We also carry a comprehensive stock of all B.V.A. types at current list prices. Send stamp for NEW list now available. Note: Certain other American special purpose types can be supplied. Enquiries Invited.

RE-GUNNED CATHODE RAY TUBES. (As new). Guaranteed 12 months. 12in. 14in. and 15in. £5/10/0; 17in. £6; 21in. £7/19/6. plus 10/- c. and p.

VISIT OUR FULLY EQUIPPED HI-FI SHOWROOM AT TOTTENHAM COURT ROAD FOR DEMONSTRATION OF THE LATEST HI-FI DELIYTY 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.

SPECIAL ANNOUNCEMENT!

The Wonderful New "KORTING" STEREO/MONAUROL 4-TRACK TAPE RECORDER is now being demonstrated at our Tottenham Court Road Branch! This superb instrument will PLAYBACK or RECORD both Stereo or Monaural tapes. The use of FOUR TRACKS enables 8 hours monaural playback time using standard tapes. Tape speed 3 1/2 in. per sec. Frequency response 30-16 Kc/s.p.s. PRICE ONLY 68 Gns., plus 20/- c. & p. or terms available.

A COMPACT TEST METER FOR HOME CONSTRUCTION.

This is a very sensitive multi-range test meter (500 micro-amp basic movement) covering the following ranges: A.C./D.C. voltage: 0-10 v., 0-50 v. and 0-500 v. Current: D.C. 0-10 ma., 0-50 ma. and 0-500 ma. Resistance (on internal battery) 2 K.ohm. to 100K.ohm. Housed in a smart grey stove enamelled case measuring 3 1/2 in. x 7 in. x 1 1/2 in. overall. Brand new best quality components and High Stability resistors are used throughout, resulting in a thoroughly reliable, accurate instrument.

NOTE: Meter is supplied with calibrated scale fitted, and all components, including shunt, are prepared for immediate soldering into position. Comprehensive assembly instructions with practical and theoretical diagrams are supplied together with all necessary components at a SPECIAL INCLUSIVE PRICE OF ONLY 59/6, plus 1/6 P. & P. The instruction envelope is available separately if required at 1/6 post free.

PRECISION TEST METER

(To build yourself) Nineteen ranges, D.C./A.C. Current and resistance. Designed and produced for us by the famous Pullin Company. All necessary components at Special Inclusive Price of only £5/19/6 plus 2/6 P. & P. Illustrated leaflet with full description available on request.

CABY UNIVERSAL TEST METERS

These pocket size multi-range test meters are of excellent quality and cover all the most useful ranges (A.C. Volts, D.C. Volts, resistance and current). Supplied complete with test prods, instruction book and batteries. Model A.10 (2,000 ohms per volt) £4/17/6 Model B.20 (10,000 ohms per volt) £6/10/-

Plus P. & P. 3/6 on each. Fully detailed and illustrated leaflet available on request.

ACOS MIC 39-1. Crystal stick microphone with stand. List price 5gns. Our price 39/6 plus 1/6 P. & P.

EVERSHED AND VIGNOLES BRIDGE MEGERS. Series 2. 250 v. Perfect and complete with leather carrying case. FEW ONLY at £19/19/-, plus 7/6 P. & P.

DEAF AID TYPE EARPIECES. Standard magnetic type complete with lead and plug. As new. ONLY 12/6, plus 1/- P. & P.

CLR LOW IMPEDANCE HEADPHONES. Complete with headband and leads 5/6 pr., plus 1/6 P. & P.

DLRS BALANCED ARMATURE HEADPHONES. Complete with headband and leads, 7/6 pr., plus 1/6 P. & P.

HIGH IMPEDANCE LIGHT-WEIGHT HEADPHONES. Brand new imported type finished in cream. Complete with leads, 15/- pr., plus 1/6 P. & P.

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SURPLUS—P.N.P. RED SPOT (Audio/Experimental Application) 5/- ea.

WHITE SPOT, R.F. up to 2.5 Mc/s. 7/6 ea.

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MULLARD OC16 Power 3 watt 54/- ea.

OC44 18/6 ea.

OC45 R.F. up to 6 Mc/s. 18/6 ea.

OC70 10/- ea.

OC71 10/- ea.

OC72 14/6 ea.

OC72 matched pair ... 27/- pr.

OC73 12/6 ea.

OC77 18/6 ea.

NEWMARKET V6/2R R.F. up to 4 Mc/s. 19/6 ea.

V6/4R R.F. 4-8 Mc/s. 23/- ea.

V6/8R R.F. up to 8 Mc/s. 26/- ea.

Audio V10/15A 12/- ea.

V15/10P (Power) 15/- ea.

MAZDA XA104 R.F. up to 6 Mc/s. 18/- ea.

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XB104 Audio up to 1 Mc/s. 10/- ea.

(Data sheets available) (ALL POST FREE)

METERS. We carry large stocks of Meters from 25 microamps to 1,500 v. A few of the most popular types are:— 25 microamps 2 1/2 in. Flush Round, 65/-; 100 microamps 2 1/2 in. Flush Round Moving Coil @ 45/-; 500 microamps 2 in. Flush Round Moving Coil @ 18/6; 1 mA. 2 in. Flush Square Moving Coil " Elliott " 1954 man., 25/-; 50 mA. 2 in. Flush Square Moving Coil 8/6; 1 mA. 2 1/2 in. Flush Round 35/-.

Send stamp for complete list. We shall be pleased to quote for special meters to your own specification.

No. 17 Mk. II TRANSMITTER/RECEIVER. Built into strong wooden cabinet 15in. x 14in. x 9in. Complete with headphones and microphone. Range 5-8 miles with simple aerial.

Freq. range 44-61 mc/s. (5-7 metres) Uses standard 120 v. H.T. and 2 v. L.T. batteries. Brand new. Complete with full operating instructions, 45/- (Second hand 30/-). Batteries not supplied.)

12in. BAKERS SELHURST LOUDSPEAKERS 15 ohms, 15 watt, 30-14,000 cps. Brand new, £4/10/- P. & P. 3/6.

6 VOLT VIBRATOR PACK. Ex-W.D. Output 140 v. @ 30 ma. Fully smoothed. Size: 6 1/2 in. x 5 in. x 2 1/2 in. As new, ONLY 12/6, plus 2/- P. & P.

12 VOLT VIBRATOR PACK. (Mallory). Output 150 v. @ 40 ma. Complete with synchronous vibrator. Brand new. ONLY 12/6, plus 2/- P. & P.

TRANSFORMER SPECIAL. Superior quality half-shrouded drop thro' type. Ex-equip. but guaranteed O.K. Input 200/250 v. Output 350-0-350 v. @ 80 ma. 6.3 v. @ 3 amps. 5 v. @ 2 amps. ONLY 9/6, plus 2/6 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.
THE COMPONENT SPECIALISTS
SEE ALSO PAGES 156-157

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
10.3 volt 12/6 each
13.3 volt 12/6 each

OUR LATEST SUPERIOR PRODUCT. Type A2. High Quality. Low capacity, 10/15 pi. 16/6

RESISTORS. All preferred values. 20% 10 ohms to 10 meg., 1 w. 4d.; 1 w. 4d.; 1 w., 6d.; 1 w., 8d.; 2 w., 1/-

WIRE-WOUND RESISTORS 1/6
25 ohms-10,000 ohms 2/6
15,000 ohms-50,000 ohms 5 w., 1/8; 10 w. 2/3

WIRE-WOUND POTS, 3 w. Pre-set Min. T.V. type. Knurled Slotted knob. Standard size Pots, long. All values 25 ohms to 25K. Values High Grade. 50K. 3/- ea., 30 K., 50 K., 4/-

MAINS TRANSFORMERS. Heavy Duty 500 mA., 4/6. Multi-ratio push-pull, 7/6. Miniature 3V4, etc., 4/6.

STANDARD 250-0-250, 80 mA., 6.3 v. 3.5 a. tapped 4 v. 4 a. Rectifier 6.3 v. 1 a., tapped, 5/6

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

ALADDIN FORMERS 3 and cores, 1in. 8d.; 1in. 10d. 0.3in. FORMERS 5937 or 8 and Caus TV1 or 2, 1in. sq. x 2 1/2in. or 1in. sq. x 1 1/2in. 2/- with cores.

TYANA. Midget Soldering Iron, 230 v. 40 w., 16/8. REMPLY INSTRUMENT IRON, 230 v. 25 w., 17/-

CRYSTAL MIKE INSERT by Acos 6/6
Precision engineered. Size only 1/2 x 1 1/2in. ACOs CRYSTAL DESK MIKE, Barrain. 35/-

MIKE TRANSF. 50:1, 3/9 ea.; 100:1 Potted, 10/6. LOUDBEAKERS F.M. 3 OHM. 5in., Rola 17/6

I.F. TRANSFORMERS 7/6 pair
465 kc/s. slug tuning miniature can 2 1/2 x 1 x 1 in. High Q and good bandwidth. By Pye Radio. Data sheet supplied.

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, 1 1/2in. x 1 1/2in. 10/-

CRYSTAL DIODE G.E.C. 2/- GEX34, 4/- 40 Circuits, 3/- H.R. HEADPHONES, 4,000 ohms, brand new, 16/6 pair.

VALVE HOLDERS. Pa. int. Oct. 4d. EF50, EA50, 6d. B1A, CRT, 1/3. Eng. and Amer. 4, 5, 6, 7 pin, 1/-

WAVECHANGE SWITCHES. 2 p. 2-way, short spindle 2/6
2 p. 4-way, 2 water, long spindle 6/6
2 p. 4-way, 4 p. 2-way, 4 p. 3-way, long spindle 3/6

EDISWAN TRANSISTORS JUNCTION TYPE P.N.P. AUDIO XB102. for amplifiers, and output stages up to 250 milliwatts in push-pull. PRICE 10/-

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2 p. 4-way, 2 water, long spindle 6/6
2 p. 4-way, 4 p. 2-way, 4 p. 3-way, long spindle 3/6

1959 RADIOGRAM CHASSIS



THREE WAVEBANDS S.W. 16 m.-50 m. M.W. 200m.-450 m. L.W. 800 m.-2,000 m.

FIVE VALVE LATEST MULLARI ECH81, EF89, EBC81 EL84, E281

12 month Guarantee. A.C. 200/250 v., 4-way switch Short-Medium-Long-Grass. A.V.G. and Negative Feedback, 4.2 watts. Chassis 13 1/2in. x 5 1/2in. x 2 1/2in.

BRAND NEW £9.10.0 Carr. 4/6
TERMS: Deposit 25/5 and 5 monthly payments of £. MATCHED SPEAKERS 5in., 17/6; 10in., 25/-; 12in. 30/-

SUPERIOR FM-AM MODEL Six Mullard Valves. ECC85, ECH81, EF89, EA8C90, EL84 E280, V.H.F. 108-87 Mc/s. Med. 190-850 m. Long 1000 1800 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. Leadat 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 18, 33, 45, 78 r.p.m. Records 7in., 10in., 12in. With plug-in NORMAL HEAD.

OUR PRICE £10.10.0 STEREO HEAD 22 extra

LATEST COLLARO AUTOCHANGER £7-19-6



Or With Cabinet, Amplifier and Speaker £11-19-6 Carr. 5/6

B.S.R. MONARCH U8 4-SPEED AUTOMATIC RECORD CHANGERS Brand new and fully guaranteed 12 months.

OUR PRICE £6.19.6 post free STEREO MODELS U8, £7/19/6. UA12, £10/10/-

AUTOCHANGER ACCESSORIES Suitable player cabinets (uncut boards) ... 4/6 Amplifier player cabinets with cut boards 6/3-

GARRARD 4-SPEED SINGLE RECORD PLAYER 45P £7.10s. AUDIO PERFECTION POST FREE

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T.C.C. Printed Circuit, internal Ferrite aerial, Rola loudspeaker, push-pull output. All parts, cabinet 6 x 4 x 1 1/2in. Ediswan transistors.

THE HI-GAIN BAND 3 PRE-AMP Cascade circuit using Valve ECC84, 17db gain. Kit 2/6 less power; or 4/6 with power pack kit. Plans only 6d. Also Band 1 version same Prices.

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VOLUME CONTROLS 80 CABLE COAXIAL

Midget size: Long spindle. Guaranteed 1 year. All values 5 K. ohms up to 2 Meg. No Switch. D.P. 5w. 3/- 4/8 Linear or Log Tracks. Post 1d. per yard. Semi-air spaced, 1in. dia. Ideal Ham 111 6yd. Losses cut 00% P.A. QUALITY AIRSPACED 1/- yd.

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ALUMINIUM CHASSIS. 18 s.w.g. Plain, and dished with 4 sides, riveted corners and lattice fixing holes. with 2 1/2in. sides, 7 x 4in., 4/6; 8 x 7in., 5/9; 11 x 7in., 6/9; 13 x 9in., 8/6; 14 x 11in., 10/6; 15 x 14in., 12/6 and 18 x 16 x 8in., 16/8.

BLACK CRACKLE PAINT. Air drying, 3 tin. P.V.C. CONN. WIRE, 3 colours, single or stranded. 2d. yd. CORED SOLDER RADIOGRADE 4d. yd., 1lb. 2/6. PAULINA 1/15in. 5in. x 10in., 1/6. 10 1/2in. x 10 1/2in., 1/6.

GEVAERT GEVASONOR 50% Extra Long Play Plastic Tape 1,700ft. 7in. Ree 35/-, 850ft. 5in. Ree 21/- SUPERIOR 1,200ft. 7in. Plastic Tape 24/- 300ft. 5in. 15/-. All Spare Reels 3/- each.

INSTANT Bulk Tape Eraser and Hear Jemagnetiser: 200/250 v. A.C. 27/6.

MAINS TYPE. RM1, 125 v., 60 ma., 5/-; RM2, 100 ma. 8/-; 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/-

CONDENSERS. New Stock. 801 mid. 7 kv. T.C.C. 5/6. 25 kv., 9/6. 7 kv. 9/6. 100 pf. to 500 pf. Micas, 6d. TUBE TOLERANCE (+1 pt.) 1.5 pf. to 47 pf. 1/6. DITTO 1% 50 pf. to 815 pf. 1/6; 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 pf. 1/9. Philips, 1/- ea.

NEW ELECTROLYTICS. FAMOUS MAKES TUBULAR CAN TYPES 1/350 v. 2/- 64/350 v. 5/6 8/500 v. 3/-

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Ideal for office, home or workshop. Comprises 2 sound powered telephone handsets and 72ft. of twin connecting flex. No batteries required, just speak and listen. COMPLETE, ONLY 35/-, P/P 3/-. Additional flex 2½d. yd. extra.

BENDIX BC-453 COMMAND RECEIVERS "Q" FIVER



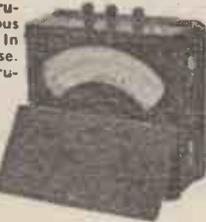
Coverage 190 to 550 kc/s. Complete with 6 valves, 3-12SK7, 12KB, 12SR7, 12A6. 85 kc/s I.F.T. Supplied brand new and boxed, 89/6 each. P/P 3/6

CRYSTAL CALIBRATORS No. 10



An extremely useful instrument providing the following facilities: 1. Xtal controlled osc. giving fixed frequency signals of 500 kc/s and harmonics to 30 Mc/s; 2. An additional switched oscillator (250-500 kc/s) enabling all intermediate frequencies from 500 kc/s to 10 Mc/s to be produced. Compact size, 7 x 7½ x 4in. Utilises 2-1T4 1R5 and CV286 valves and 500 kc/s Xtal. Supplied with instructional hand book. 59/6 each. P/P 3/6.

PORTABLE PRECISION VOLTMETERS



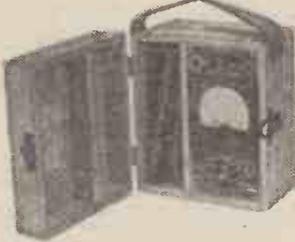
Brand new instruments by famous manufacturer. In polished teak case. Moving iron instrument reading A.C. or D.C. volts on 2 ranges 0-160 v. or 0-320 v., Bin. mirror scale. Accuracy within 2%. £5/19/6 ea. P/P 3/6.

BRAND NEW RCA EXTENSION LOUDSPEAKERS



Bin., 3 ohm Quality Speaker mounted in attractive black crackle case to match AR88 Receivers, etc. 45/- each. P/P 3/6.

AMERICAN 1,000 O.P.V. MULTI-RANGE TESTMETERS



400 microamp basic mov. Seven A.C./D.C. volt ranges 0 to 5,000v. D.C. current 1 mA, 10 mA, 100 mA, 1 amp. Res. 100 ohms, 100 K ohms and 1 meg. Decibels. Supplied brand new with test prods, batteries and instructions. £3/19/6 each. P/P 2/6.

MINE DETECTORS No. 4A

Complete equipment comprises search head, amplifier, headset, control box, telescopic rods for search head, test unit, test measure and haversack. Operation from Std. 67½/1.5 v. battery. Will detect ferrous or non-ferrous metals. Very portable and sensitive. Supplied brand new in original transit cases with circuit and instructions. 99/6 each. Carr. 10/6.

OSCILLOSCOPES TYPE II. Compact little 'Scopes with all standard controls, switched time base, etc. 200/250 volts A.C. operation. Not brand new, but in good condition, fully checked. £9/19/6 each. P/P 7/6.

DON Mk. 5 FIELD TELEPHONES



Ideal for all inter-communication. Buzzer calling. Supplied fully tested, complete with batteries and instructions. 39/6 each. P/P 3/6 ea., 5/- pr.

FURZEHILL BEAT FREQUENCY AUDIO OSCILLATORS. Frequency range 0 to 10,000 cps. Output 10 or 600 ohms. Separate 50-cycle check. Set zero control. 200/250 volt A.C. operation. A real laboratory instrument at a fraction of original cost. Supplied in perfect working order, £9/19/6 each. P/P 10/-.

750 watt AUTO TRANSFORMERS. Tapped from 110 to 230 v. Fine heavy duty type, 69/6 ea. P/P 5/-.

WESTON 772 TESTMETERS. Supplied in perfect working order, with leads and batteries. £7/10/- each. P/P 4/6.



A.C. volts: 2.5 v., 10 v., 50 v., 250 v., 1,000 v. D.C. volts: 2.5 v., 10 v., 50 v., 250 v., 1,000 v. D.C. current: 100 micro/A, 1 mA, 10 mA, 50 mA, 100 mA, 500 mA. Output Meter A.C. Current: 500 mA, 1 amp, 5 amp. Resistance: 100 ohms, 1,000 ohms, 100 k. ohms, 10 megohm.

COSSOR DOUBLE BEAM OSCILLOSCOPES



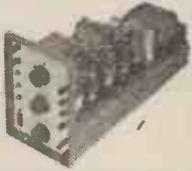
Type 339. 10-position time base, 6 cps. to 250,000 cps. Amplifier 10 cps. to 2 mill. cps. Reconditioned, perfect working order. Complete with handbook. £37/10/- each. Carriage £1.

ROTARY CONVERTERS



12 v. D.C. input. 230 volt A.C. 150 watts 50 cycles output. Housed in wooden case and fitted with voltage control slider resistance switch, plugs and A.C. mains voltage output check meter. Supplied in perfect condition, individually tested £9/19/6 each. P/P 10/-.

VORTEXION PORTABLE AMPLIFIERS



Operation from 200/250 volts A.C. or 12 volts D.C. Separate inputs for microphone or gram. Output matched to 7.5, 15, 250 or 500 ohms. incorporates volume control and full switched tone control. Valve line-up: 6Q7, 6I5, 6V6, 6V6, 5Z4. Size 8½ x 6¼ x 17½in., not brand new but supplied in perfect working order, fully tested. £10/10/- each. P/P 6/-.

UNIVERSAL AVOMINOR TESTMETER



A.C./D.C. volt ranges to 500 v. Current 0 to 500 mA. Resistance 0 to 20K ohms. Supplied in perfect working order complete with batteries, leads and leather carrying case. £3/19/6 each. P/P 2/6.

8-RANGE SUB-STANDARD D.C. AMMETERS



Ranges 1.5, 3, 7, 15, 30, 60, 300 and 450 amps. Bin. mirror scale. Meter housed in polished teak case. Supplied complete with all shunts and leather carrying case. £15 each. P/P 7/6.

RCA PADDED MOVING COIL HEAD- PHONES.

Brand new boxed. Finest tonal quality, low impedance. Fitted with std. jack plug. 19/6 per pr. P/P 1/6.



RCA PLATE TRANSFORMERS.

Input 200/250 volts. Output 2,000/0/2,000 volts 500 mA. Tapped 1,500/0/1,500 volts. Supplied brand new boxed. £6/10/- each. Carriage 10/-.



24 VOLT ROTARY CONVERTORS.

Input 24 volts D.C. Output 230 volts A.C. 50 cycles, 100 watts. Housed in metal carrying case with inlet/outlet plugs. Brand new, 92/6 each. P/P 7/6.



AMERICAN GEARED MOTORS

24 volt D.C. motor fitted with precision gearbox giving twin outputs of 20 and 6 r.p.m. Also operates on 12 volts. 3 in. shafts. Brand new, 19/6 each. P/P 1/6.

FERRANTI TESTMETERS TYPE Q

D.C. VOLTS 3 v. 15 v. 30 v. 150 v. 800 v. A.C. VOLTS 15 v. 30 v. 150 v. 0.08 v. D.C. Current 7.5 ma. 30 ma. 150 ma. 750 ma. Ohms 25,000. 500 ohms per volt on all ranges B.S.S. first-grade accuracy on all self contained ranges. Supplied in perfect working order complete with leads, battery, instructions and rexine covered carrying case. Price 52/6 each. P/P 2/6.



ADMIRALTY POWER UNITS 234A. 200/250 volt A.C. Input. Output 250 volts 150 mA. and 6.3 volts 6 amps. Fully smoothed double choke and paper condensers, fused and fitted with input and output plugs. Sockets are provided on the front panel for meter check. Housed in grey metal case for standard 19 in. rack mounting. Supplied brand new. 59/6 each. P/P 7/6.

CR.100 SPARES KITS. 15 valves, resistors, pots, o/p trans. condensers, all new boxed, 59/6 per set. P/P 3/6.

ADVANCE CONSTANT VOLTAGE TRANSFORMERS. 190 to 260 volt input. Constant 230 volts output. 150 watts. Brand new, £8/10/- each. P/P 5/-.

UNIVERSAL AVOMETERS. Reconditioned, perfect order. Model Z £8/10/-, Model 7 £12/19/6.

FIELD TELEPHONES TYPE L



Generator bell ringing. Light and very portable. Ideal for all installations. Supplied complete with batteries, fully tested. As new, 59/6 each. P/P 3/- 5/- pr.

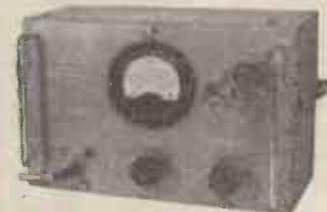
NIFE ALKALINE ACCUMULATORS. 12 volt 45 ampere. £4/19/6 each. P/P 7/6.

PARMEKO TABLE TOP TRANSFORMERS

Input 230 v. 50 c/s. Output 620/550/375/0/375/550/620 volts 250 mA. Also 2-5 v. 3 amp. windings. Size 6 1/2 x 6 1/2 x 5 1/2 in. Brand new only, 45/- each. P/P 5/-.

MUIRHEAD PRECISION STUD SWITCHES

4 pole, 4 bank, 24 position, 17/6 each. P/P 1/3



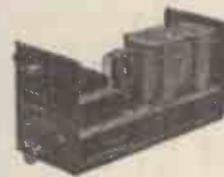
MARCONI TF.428 B/1 VALVE VOLT- METERS. 5 ranges A.C. and D.C. 1.5, 5, 15, 50 and 150 volts. Operation 200/250 volts A.C. Supplied in perfect working order complete with internal H.F. probe. Brand new. £17/10/- each. P/P 10/-.

R.II55 COMMUNICATIONS RECEIVERS.



STANDARD MODEL B. Fitted with improved N type drive, perfect order realigned, etc., £7/19/6 each. Carriage 7/6. **COMBINED POWER PACK AND OUTPUT STAGE,** to suit above, 85/- extra. Illustrated instructor book with 11 receivers.

EDDYSTONE MAIN POWER PACKS



200/250 volt input. Output 75 volts 60 mA and 12 volts .5 amps. Double choke and smoothed 5Z4 rectifier. Supplied as new unused, 22/- each. P/P 0/-.

BATTERY CHARGING OR MODEL RECTIFIERS AND TRANSFORMERS



Rectifiers. All full wave and bridged. 12/18 volt 1.5 amp. 4/3; 12/18 volt 2.5 amp., 6/9; 12/18 volt 4 amp., 9/9; 12/18 volt 6 amp., 18/6; 24/30 volt 1 amp., 12/6; 24/30 volt 4 amp., 22/6; 24/30 volt 15 amp., 62/6.

Transformers. All primaries tapped 200/250 volts. 3.5, 9 or 17 volt 1 amp., 9/9; 3.5, 9 or 17 volt 2 amp., 14/3; 3.5, 9 or 17 volt 4 amp., 16/6; 9 or 17 volt 6 amp., 26/-; 3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30 volt 2 amp., 18/6. Please add postage on all above items.



HALLCRAFTERS S.27 U.H.F. COMMUNICATION RECEIVERS. F.M. or A.M. coverage 27 to 143 mc/s. on 3 bands. Incorporates S meter, variable sel. b.f.o. a.n.s. etc. Output for phone or speaker. Operation 110 or 230 volts A.C. Supplied in good working order. £27/10/- each. P/P 10/-.

FIELD TELEPHONES TYPE

Generator bell ringing. Supplied complete with batteries fully tested and complete with wooden carrying case 59/6 each. P/P 7/6, 10/- pr.



HOURS OF BUSINESS: 9 A.M. TO 6 P.M. THURSDAY 1 P.M. OPEN ALL DAY SATURDAY SEND S.A.E FOR LISTS

G.W. SMITH & CO (RADIO) LIMITED
 Phone: GERRARD 8204/9155
 Cables: SMITHEX LESQUARE
 3-34 LISLE STREET, LONDON, W.C.2

DO-IT-YOURSELF!

All components guaranteed and sold separately

FREE LISTS ON ANY MODEL:
AFTER SALES SERVICE

IDEAL CHRISTMAS PRESENTS:

"THE TRANSISTOR-8"

Combined Portable/Car Radio
Push-Pull Portable Superhet

- ★ Tunable over medium and long wavebands
- ★ 250mW output push-pull
- ★ Internal Ferrite aerial
- ★ Highly sensitive and selective
- ★ 7in. x 4in. high flux speaker
- ★ All components identified and carded
- ★ EDISWAN transistors throughout
- ★ Easy-to-follow layout diagrams

Complete set of parts including cabinet and all components. Now
£10.19.6
P. & P. 2/6
All parts sold separately
FREE BOOKLET



Car radio components 8/-; A.V.C. 4/3;
Size 9in. x 7in. x 3 1/2in. Weight 4lb.

325mW version £11/11/6. P. & P. 2/6.

TRANSISTOR TRANSMITTER

- ★ Top Band 150 metres
 - ★ 3-Transistor
 - ★ Size 4 1/2 x 3 x 1 1/2in.
 - ★ Voice Modulated
 - ★ Low Consumption
 - ★ Ideal for short range communication
- All parts 57/6. P. & P. 1/6
Free List and diagrams
(See "R.C." Jan. 1960)

TRANSISTORS AND MINIATURE COMPONENTS A SPECIALITY

FREE LISTS, DATA AND CIRCUITS ON REQUEST

RED-SPOT TRANSISTORS

5/- EACH

WHITE-SPOT 8/6

250mw. "ADJON" STAGE 2-Transistor Power Amplifier for use with Major-2 or 3 or similar units to give 250mw. push-pull from 3-in. Speaker.
★ 2-XB104
★ 3in. Elac Speaker.
★ Size 5 1/2 x 3 1/2 x 1 1/2in.
All components complete, 59/6 P. & P. 1/6
FREE LIST AND DIAGRAM

MINOP-1

(Transistor Pocket Radio)



- ★ 3 x 2 x 3/4in.
- ★ Medium Wave
- ★ 3-Stage Reflex
- ★ Internal Aerial
- ★ Smallest yet
- ★ Personal phone

All components with case and 'phone 49/6, pp. 1/6

THE SMALLEST WORKING RECEIVER WITH BUILT-IN FERRITE AERIAL EVER OFFERED
All parts sold separately. Diagram and List Free

MAJOR-2

(Two-transistor Pocket Radio)



- ★ 4-stage reflex
- ★ Medium wave; tune-able
- ★ Very sensitive
- ★ No aerial or earth
- ★ Complete layout
- ★ Over 6 months on one battery
- ★ 4 1/2 x 3 x 1 1/2in.
- ★ Weight only 4ozs.
- ★ Personal phone

69/6 COMPLETE POST 1/6

NEW EASY TO FOLLOW BOOKLET
All components sold separately
GOOD RECEPTION ANYWHERE!

MAJOR-3 (3-Transistor Radio)

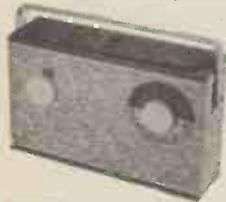


- ★ 5-stage Reflex Circuit
- ★ No Aerial or Earth.
- ★ Min. Volume Control.
- ★ 3 Ediswan Transistors
- ★ Medium Wave Tuning
- ★ Size 4 1/2 x 3 x 1 1/2in.
- ★ Personal phone

(AS DESCRIBED IN "R.C." SEPT., '59)

COMPLETE 87/6 P.P. 1/6
NEW EASY-TO-FOLLOW BOOKLET
RECEPTION GUARANTEED ANYWHERE

"SUPER-SIX" TRANSISTOR PORTABLE SUPERHET



- ★ MEDIUM AND LONG WAVES
- ★ MULLARD TRANSISTORS
- ★ PRINTED CIRCUIT
- ★ SENSITIVE AND SELECTIVE

Complete set of parts including attractive cabinet
£9.10.0
P.P. 2/6
All parts sold separately

- ★ FERRITE ROD AERIAL
- ★ FULLY TUNEABLE
- ★ 3in. 150Ω SPEAKER
- ★ FULL ASSEMBLY INSTRUCTIONS

High sensitivity and selectivity combine to give excellent reception on both medium and long waves and is recommended by us as being the easiest to build transistor printed circuit set ever offered.

AUDIO GENERATOR

Transistor Oscillator, ideal for audio circuit checking or RF modulator. Size 2 1/2 x 1 1/2 x 1in.
All components 25/- P.P. 1/-
FREE LIST AND DIAGRAM

IF AND RF GENERATOR

Transistor Oscillator, for receiver alignment, etc. Harmonic output 450kc/s. to 2Mc/s. Size 2 1/2 x 1 1/2 x 1in.
All components 25/- P.P. 1/-
FREE LIST AND DIAGRAM

SIGNAL TRACER

2-Transistor and Diode: RF, IF and Audio General purpose Signal Tracer for receivers, monitors, etc. Size 4 1/2 x 3 x 1 1/2in.
All parts with phones, etc., 37/6.
P.P. 1/6
FREE LIST AND DIAGRAM

CRYSTAL OSCILLATOR

Transistor Crystal Controlled Test Oscillator.
★ 3 to 12 Mc/s
★ Choice of 400 frequencies
All components including new 20 Mc/s. Transistor.
22/6. P.P. 1/- (Less Crystal).
FREE LIST AND DIAGRAM

VALVES AND TUBES

LARGE RANGE OF SPECIAL PURPOSE AND DOMESTIC TX/RX VALVES IN STOCK

SEND FOR LATEST FREE LIST

VALVE LISTS REDUCTIONS

OZ4	5/-	6AM6	5/-	12AT7	8/-	DK91	7/-	ECL80	10/-
IC5	10/-	6C4	5/-	12AU7	7/6	DL91	7/-	EF22	7/6
1R5	7/-	6F12	5/-	12A8GT	10/-	DK96	9/-	V570	6/-
1S4	7/-	813	65/-	12K8M	10/-	DL33	9/-	EF36	5/-
1S5	6/6	GT1C	15/-	125N7GT10	10/-	DL35	10/-	EF39	5/-
174	6/-	6L6G	8/-	125L7GT	10/-	DL92	7/-	EF40	11/6
3A5	9/-	6L6M	10/-	CV135	5/-	DL94	7/6	EF42	11/-
3Q5	9/-	6Q7G	7/6	CV136	5/-	DL96	9/-	EF89	8/6
354	7/-	6SL7	6/-	CV138	5/-	EB91	5/-	EF91	5/-
3V4	7/6	6SN7	6/-	CV140	5/-	EBC41	9/6	EF92	5/-
5U4	6/-	6V6G	7/6	723A/B	55/-	EBF80	9/6	EL42	10/-
5Y3GT	6/-	6V6GT	6/5	2K25	65/-	EBF89	9/6	EM34	7/6
6A7	9/-	6X4	6/-	DAF91	7/-	ECC81	8/-	EY51	10/-
6ABGT	9/-	6X5GT	5/-	DAF96	9/-	ECC82	7/6	EY86	10/-
6AC7	5/-	7Y4	7/-	DF91	7/-	ECC91	5/-	EZ40	7/6
6AL5	5/-	7Z4	7/-	DF96	9/-	ECF80	12/-	EZ80	7/-

Full List on request

10/-	EZ81	7/-	UBC41	9/-
7/6	KT33C	8/6	UBF89	9/-
6/-	MU14	7/6	UCC85	9/-
5/-	PCC84	9/-	UCH42	10/-
5/-	PCF80	9/-	UCL82	12/-
11/6	PCL82	12/-	UF80	9/6
11/-	PY80	7/6	UF85	9/6
8/6	PY81	8/6	UF89	10/-
5/-	PY82	7/6	UL41	8/-
5/-	VR105/30	6/-	UL84	9/-
10/-	VR150/30	6/-	UY41	7/6
7/6	U50	6/-	UY85	8/-
10/-	U52	6/-	~VR54	2/6
10/-	UABC90	9/-		
7/6	UAF42	9/-		
7/-	UB41	10/-		

HENRY'S RADIO LTD.

5, HARROW ROAD, PADDINGTON, W.2
OPEN MONDAY-SAT. 9-6, THURSDAY 1 O'CLOCK PAD 1008/9



AMERICAN VALVE VOLTMETER

R.C.A. TYPE 165-A (110 to 250 v. A.C. Input)

D.C. ELECTRONIC VOLTMETER.
6-Ranges. 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 3v. 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.

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/-.

V.H.F. TRANS/RECEIVER TYPE TRI920

★ 9.72 MC/S IF ★ 4-CHANNEL CRYSTAL CONTROLLED
★ 40 KC/S BANDWIDTH ★ 100 to 120 MC/S COVERAGE

Unit complete with 21 valves; crystal; 24 volt rotary power unit, etc., in metal case. In new condition with full circuit diagram

£6/10/- carr. 10/6. Circuits separately, 1/9 post free.

V.H.F. TRANS/RECEIVER TYPE 1986

★ 9.72 MC/S IF ★ 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

VACUUM GAUGES

Edwards Type M3 Gauge Heads Complete with individual calibrator. 69/6 P.P. 2/-.

R.C.A. 8in. P.M. SPEAKER

Black crackle case. Brand New. 45/- P.P. 3/6.

BC 906D WAVEMETER

Complete with vernier dial in black crackle case; 500 UA 2½in. meter; 150 to 235 Mc/s Battery operated. Includes circuit. 155 valve. 45/- P.P. 5/6

SMITHS 8-DAY CLOCKS

BARGAIN OFFER !!!!! BRAND NEW SEALED IN SMITHS CARTONS. 6in. dial 8-day clock with detachable adjustable time switch. ONLY 95/- P.P. 5/-

DYNAMOTORS AND CONVERTORS

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.

QUARTZ CRYSTALS

FROM 5/- EACH

From 6 Kc/s-47 Mc/s. FT243, FT241, 10XJ and B7G. Send for list 500 types

ALL TYPES FOR ALL PURPOSES

AIRCRAFT RADAR TYPE AN/APA-1

Complete scope indicator unit with amplifier; aerial switching unit; full scope controls. Includes 3PBI Tube; 6SN7GT; 6K6GT; 6G6GT; 2X2; 6X5GT.

BRAND NEW FULL HANDBOOK 97/6 P.P. 3/6

RF UNITS TYPE 25. Switched Tuning 30 to 40 Mc/s. Includes 3 SP61's. Carriage 2/6 10/-

Type 26. Variable tuning, 50 to 65 Mc/s. Including 2 EF54's and 1 EC52. Carriage 2/6 25/-

(Circuits in stock for both types 9d.)

"372" MINIATURE IF STRIP 9.72 Mc/s



The ideal F.M. conversion unit as described in "P.W." April/May, 1957. Complete with 6 valves, three EF91s, two EF92s and one EB91. I.F.T.'s, etc., in absolutely new condition. With circuit and conversion data.

12/6 (less valves) 37/6 (with valves)

Postage and Packing 2/6 (either type)

SCR522 TRANSMITTER RECEIVER

All complete in new condition less valves. Comprises P.P. BC624A & BC625 15/- 5/-.

SYNCHRONIZER UNIT

VALVES: 3-6C6M; 12-6AC7; 6Q7; 5-717A; 6-6SM7GT; 6H6.

BRAND NEW £4/19/6 P.P. 5/-

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	2in.	M.C. (DC) F.S.	12/6
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) P.	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

AN/ARN-5D GLIDE PATH RECEIVER

3-channel U.H.F. Receiver; uses plug-in crystals (not supplied); operating on 332.6; 333.8; cd 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/-

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

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

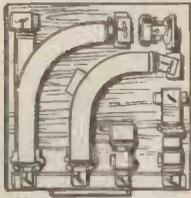
CATHODE-RAY TUBES

2AP1	1in.	25/-
VCR139A	2½in.	35/-
3BP1	3in.	30/-
3FP7	3in.	12/6
3AP1	2½in.	30/-
Mullard DG7/5	2½in.	45/-
5FP7	5in.	20/-
VCR517C	6in.	30/-
VCR97	6in.	40/-
Screens for VCR97		7/6

P.P. 2/- any type.

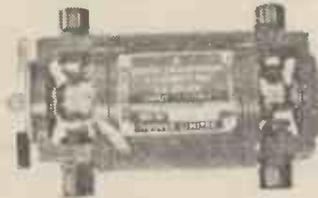
HENRY'S RADIO LTD.

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

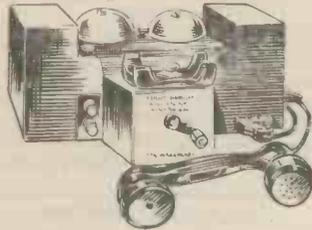


WAVE GUIDE
3 cm, mounted on a carrying board consisting of: (1) directional coupler. (2) 90 degree bend. (3) co-ax to wave guide adaptor type N. (4) British to W.916. (5) Co-ax to wave guide adaptor circular flange. (6)

Circular to American adaptor. Complete in carrying case with coaxial cable. Price 60/-, Carr. 10/-.



MIDGET ROTARY TRANSFORMERS. 2½ in. dia. x 4½ in. Input 11.5 volt. Output 310/365 volts at 30 mA. Brand new. 12/6 each. P. & P. 1/6.



TELEPHONE SETS TYPE F. Portable telephones each in an individual carrying case containing telephone handset, telephone unit, ringer, bells and complete with long-life batteries. Each set perfect, tested, guaranteed working. Has a range of up to 5 miles, ideal for factories, building sites, farms, etc. Price £7/10/- per pair. Carr. England 9/6.

SOUND POWER TELEPHONE HAND-SETS. New, 17/6 each. P. & P. 2/-.

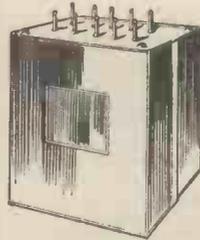
AERIAL AS ILLUSTRATED. Ideal for Car. Overall length 33 in., khaki, with flexible shaft which enables the aerial to be fixed firmly in any position. Price 8/6, plus P. & P. 1/6.

NEW WIRE WOUND RHEOSTAT ON CERAMIC. 58 ohms, 50 watt, complete with instrument knob. Price 8/6. P. & P. 1/6.

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

U.S.A. 27-volt 4-pole CHANGE-OVER RELAYS. Brand new and boxed, 5/6 each. P. & P. 6d.

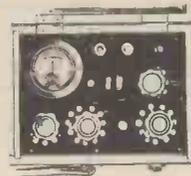
SOLENOID OPERATED MAGNETIC RELAY. Type 5. 5CW/3942 with 4 make, 4 break 25 Amp. contact, D.C. coil resistance 160 ohms, 24 v. operation. Housed in metal screening can 2½ in. x 1 in. x 1½ in. Brand new, 7/6 each. P. & P. 6d.



POTTED TRANSFORMERS. Type 2762 C Core: Input 230 v. 45/65 cycles. Output 350-0-350 at 375 mA. 25 v. at 1 amp., 21 v. at .5 amp., 6.3 v. at 1 amp., 6.3 v. at 5 amp., 5 v. at 4 amp. Price 65/-, Carr. 6/6.

Type 2759 C Core Input 230 v. 45/65 cycles. Output 361-0-361 at 200 mA. 361-0-361 at 65 mA. 5.16 v. at 4 amp., 5.16 v. at 3 amp., 3.25-0-3.25 at 2 amp., 6.5 v. at 5 amp., 3.25-0-3.25 at 5 amp. Price 65/-, Carr. 6/6.

Type 2669 Oil filled Input 230 v. 45/65 cycles. Output 0-70 v. 75 v., 80 v., at 4 amp. Price 42/6. Carr. 3/6.



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

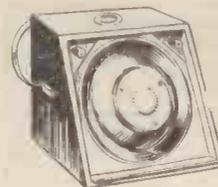
EVERSHED AND VIGNOLES. Circuit testing Ohms Meter, pattern "S" complete with prods, inst. book etc. Two ranges: 0-3 and 0-30 ohms. Brand new, guaranteed perfect, as illus. Offered at fraction of maker's price. £4/17/6 each. P. & P. 2/6.



EVERSHED & VIGNOLES "Vee Megger" 500 v. in leather case. Guaranteed perfect. Price £13/15/-, P. & P. 2/6.

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

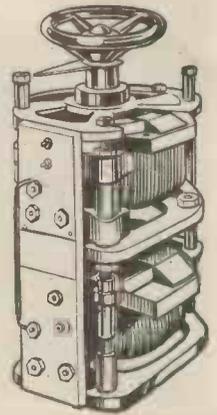
12 v. D.C. AMPLIFIER, as new, for operation on 12 v. car battery, 10 watts undistorted output, with 6L6 valves in push-pull. Mike/Gram input, tapped output 7½, 15, 62, 100, 250 or 500 ohms. £12/10/- each. Carr. 15/-.



TRUVOX LOUD HAILERS, brand new, complete with transformer and condenser. Impedance 7½ ohms. Handling capacity 8 watts. Ideal for speech. Price: 18/6. P. & P. 3/6. Pair 42/- postage paid.

VARIABLE VOLTAGE TRANSFORMER

400 cycles, maximum input 180 v. Output variable from 0 to 180 v. at maximum 15 ampere. Brand new in original manufacturer's cases. Price £10. Carr. 12/6.



METERS BRAND NEW GUARANTEED PERFECT

Charging Types

2½ amp. D.C. M.I. 2½ in. fl. rnd.	7/6
5 amp. D.C. M.I. 2½ in. fl. rnd.	11/6
7½ amp. D.C. M.I. 3½ in. proj. rnd.	12/5
9 amp. D.C. Hot Wire W.R. 2½ in. fl. rnd	6/6

Voltmeters

12 v. D.C. M.C. 2½ in. proj. rnd.	8/6
20 v. D.C. M.C. 2 in. fl. sq.	9/6
25 v. D.C. M.C. 2 in. fl. rnd.	7/6
30 v. M.I. 3 in. proj. rnd.	10/6
40 v. M.C. 2 in. fl. sq.	9/6
150 v. D.C. M.C. fl. rnd. 2½ in.	10/6
250 v. A.C. rectified moving coil linear scale 3½ in. fl. rnd.	35/-
300 v. A.C. M.I. 2½ in. fl. rnd.	22/-
400 v. A.C. M.I. 4½ in. fl. rnd.	35/-

Millimeters

2 mA. M.C. 2½ in. fl. rnd.	14/6
5 mA. M.C. 2 in. fl. square	12/6
10 mA. M.C. 3½ in. fl. rnd.	30/-
30 mA. M.C. 2½ in. fl. rnd.	9/6
40 v. M.C. 2 in. fl. sq.	8/6
200 mA. M.C. 2½ in. fl. rnd.	9/6
500 mA. M.C. 2½ in. fl. rnd.	9/6

Microamp

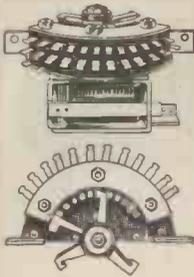
100 microA. M.C. 2½ in. rnd. fl.	42/6
200 microA. M.C. 2½ in. rnd. fl. (calibrated 0-50)	29/6
50 microA. 2½ in. square, sidefitting 3 scales	35/-
500 microA. M.C. 2 in. rnd.	16/6

NEW UNCHARGED UNFILLED 12 VOLT ACCUMULATOR 9 ampere in unspillable plastic cases

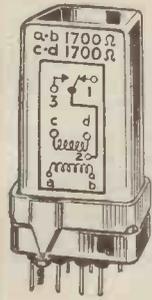
Comprises 6 x 2 v. separate cells connected by terminal strips. 6 x 5½ x 4½ in. over terminals. Price 19/-, plus P. & P. 2/9. Wooden carrying case for same with lid and strap price 3/6.



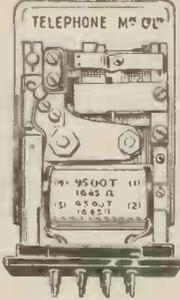
ROTARY TRANSFORMERS made by Delco. Input: dual voltage 12 or 24 v. Output: 265 v. 120 mA., 500 v. 26 mA. Price 27/6 each. P. & P. 3/6.



MINIATURE UNISELECT SWITCH. Two banks of ten plus home contacts on 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 CAR-PENTER'S TYPE POLARISED RELAYS. 2 x 9,500 turns at 1,685 ohms. Price 22/6 each. P. & P. 1/-

MINIATURE MOVING COIL DIFFERENTIAL RELAY. Two coils 350 ohms each. Operating current minimum 140 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 1 1/2 x 1/2 x 3/4 in. Price: 22/6 each.

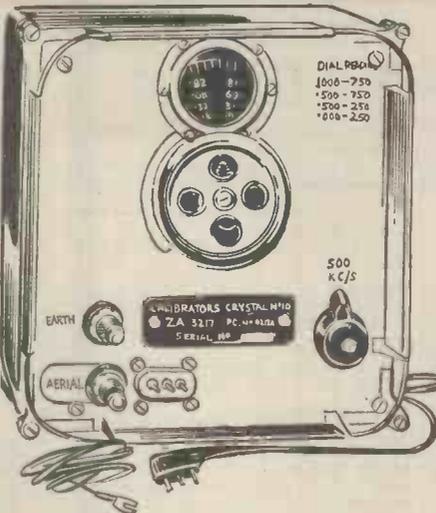
VENNER 8-day clockwork Time Switch. Contacts 1 amp. 230 volt. 24 hour phase, 1/2 hour divisions, allows setting for one make and one break to be made every 24 hours, complete with key. Used but guaranteed perfect. Price 27/6 each. P. & P. 1/6.



MINIATURE P.M. MOTOR. 12/24 volt, reversible. 1 1/2 in. dia. New. Price 9/6 each. P. & P. 1/-.



AIRCRAFT CINE CAMERA G45B Mk. III. Fully modified, fitted with 1/3.5 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.



CRYSTAL CALIBRATOR No. 10 crystal controlled 4-valve high-grade instrument in the same category as the famous B.C.221. Directly calibrated, does not require cross reference or charts—functions as follows:
 (1) A crystal controlled oscillator which provides fixed frequency signals of 500 KC and all harmonics of 500 KC to beyond 10 Meg. and up to 30 Meg.
 (2) A variable oscillator from 250 KC to 500 KC, this enables all intermediate frequencies between 250 Kc/s. and 30 Meg. to be produced and modulated.
 The instrument is supplied complete with 3 spare valves, all leads and maker's instruction book in carrying haversack. The complete outfit is brand new—repeat NEW. Price: £4/19/6. Carr. 3/-.



MUIRHEAD PRECISION, 4 bank, 1 pole, 24 position Stud Switch. Heavy duty contacts, brand new, original boxes. Price 17/6 each. P. & P. 1/-.

CERAMIC PRECISION SWITCH. 2 pole, 6 way, 4 banks. New in manufacturer's boxes. Price 10/6 each. P. & P. 1/6.



20 WAY STRIP containing standard Post Office telephone Jack Sockets, overall size 11 x 3 1/2 x 3/4 in. New. Price 15/- each. P. & P. 1/6.
10 WAY STRIP standard Post Office telephone Jack Sockets, spacing allowing Igranac Jack Plugs. New. Price 10/- each. 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.

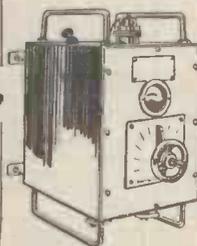


NEW MOVING COIL HEADSETS. Complete with Tannoy carbon hand microphone, with plug suitable for No. 19 set. Price: 12/6 each, plus P. & P. 2/-.

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. Plus P. & P. 2/-.

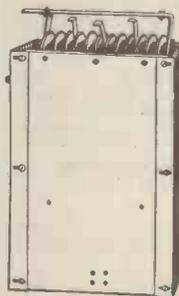
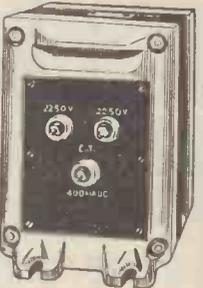
MARCHING COMPASS Mk. 1. Brand new ex W.D. Price 14/6. P. & P. 1/-.

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 150lb. Wound at 800 amps per sq. inch. Brand new. Price: £15. Carr. £1.

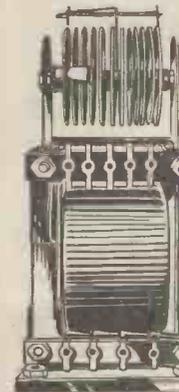
PLATE TRANSFORMER of very best U.S.A. make, brand new, original manufacturer's cases. Input tapped at 190/210/230/250 V. Output 2250-0-2250, centre tapped 400 mA. Nett weight 76lb., size 13in. x 9in. x 6in. Price £6/10/- each, plus carr. 10/-.



BRAND NEW SELENIUM FULL WAVE BRIDGE TYPE RECTIFIERS, in manufacturer's original packing. D.C. output 36 v. 10 amp., made up of 12 x 110 mm. dia. plates. These fitted in cooling funnel (removable). Size 1 1/2 in. x 8 in. x 4 1/2 in. Price 45/- each. 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 manufacturer's original packing. New. 3/6 each. P. & P. 1/6.

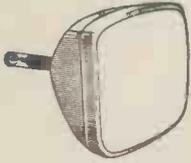
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REPLACEMENT RE-BUILT T/V TUBES



£8'10/-
CASH PRICE
12 MONTHS' FULL GUARANTEE

All sizes except 10in. Completely rebuilt gun assembly, new cathode, heater, etc., giving the high standard required for long picture life, quality and value. Carr. & Ins. 15/6.

OR Yours for 8/6 initial payment (plus carr. & Ins.) and 19 weekly payments of 8/6.

★ EXPRESS DESPATCH SERVICE ★

Please phone to confirm Tube in stock. Send Telegraph Money Order. Tube despatched Passenger Train same day. This service only available with remittance by a Telegraph Money Order and cash sales, not terms.

SUPER SUPERIOR RADIO



89'6
4 waveband. 5-valve superhet radio. 2-tone covered metal cabinet. 4 control knobs. Positions for gram p.u. and extension speaker. A.C. only. Size 24½ x 12 x 10in. deep. Ins. carr. 8/6.

FAMILY RADIO 99/6
5-valve (octal) superhet. A.C. 3 waveband and gram. position. 4 controls. Modern attractive cabinet size 15½ x 18 x 10½in. in cream and brown. Carr. & Ins. 8/6.

POWER PACK and AMPLIFIER 19/6
R.F. E.H.T. Amplifier stage 6V6 with O.P. trans. 3 ohms matching. Smoothed H.T. 350 v. at 5 amp. 6.3 v. at 5 amp. 22 v. at 3 amp. 6.3 v. at 4 amp. and 4 v. centre tapped. Less valves. Drawings free with order. Size 14½ x 8 x 7in. Ins. carr. 5/6.

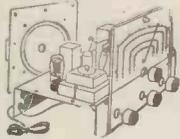
POWER PACK and AMPLIFIER 12/6
Output stage 6V6 with O.P. trans. 3 ohms. Choke smoothed H.T., 350 v. at 250 mA. 6.3 v. at 5 amp. 22 v. at 3 amp. 6.3 v. at 4 amp. and 4 v. centre tapped. Less valves. Ins. carr. 5/6.

COLVERN PRESET POTENTIOMETERS 2/9
Erand new. 200 ohms. 10K. and 20 K. P. & P. 9d.

FOCUS MAGNET 9/9
Brand new. 38mm. Incorporating picture shift control. P. & P. 1/3.

SCANNING COILS 10/6
Low impedance. 38mm. Brand new. P. & P. 1/3.

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



SUPER CHASSIS
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.

SOLO 12/6 SOLDERING TOOL



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 ★

DROP THROUGH TYPE

350-0-350 v. at 250 mA., 12/9
6.3 v. at 4 amp., 6.3 v. at 4 amp., 4 v. at 3 amp., 22 v. at 3 amp., 4 volt centre tapped at 1.5 amp. Primary 200-250 v. 50 cycles. P. & P. 3/9.

350-0-350 v. at 250 mA., 12/9
6.3 v. at 5 amp., 4 v. at 4 amp., 4 v. at 7 amp., 4 v. centre tapped at 1 amp. Primary 200-250 v. 50 cycles. P. & P. 3/9.

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.

T.V. AERIALS 7/9
For all channels. Complete with co-ax cable. For use indoors or in the loft. Postage 1/3.

CAR AERIALS 6/9
Whip antennae. Plated. 50in. long collapsing to 11in. One hole fixing. Post 1/-.

CO-AX CABLE 6d. yd.
Good quality. Cut to any length. 1/6 postage on 20yds.



HOME RADIO
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 x 18½ x 11½in. Ins. carr. 4/6.

CHASSIS 1/-
6 or 8 valve latest type midget valve design for A.M. or F.M. Brand new. Cadmium plated. Size 12½ x 7½ x 2½in. P. & P. 1/9.

GANG CONDENSERS 1/9
Salvage guaranteed. Standard size two gang. .0003 and .0005. All tested and guaranteed. P. & P. 1/3.

INSULATING TAPE 1/6
Finest quality tape 75ft. x ½in. wide in sealed metal container. Post 9d.

T.V. MASKS 1/9
12in. round. Soiled. P. & P. 1/6.

T.V. MASKS 7/9
17in. Brand new. Grey plastic. P. & P. 2/-.

T.V. MASKS 10/9
17in. Brand new. Latest pastel shades. Pink and blue. Post 2/-.

T.V. MASKS 14/9
21in., as above. Post 2/-.

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 4½ x 2in. dia. Base 4 x 4in. Circuit drawings available with order. P. & P. 2/6.

RECTIFIERS 2/9
250 v. 100 mA. Full or half wave. Salvage guaranteed. P. & P. 1/3.

SOUND/VISION and I.F. STRIP 7/9
Plessey. I.F.'s 10.5 Mc/s sound. 14 Mc/s vision. 8 valve holders. Less valves. Size 8½ x 5 x 4½in. Circuit incl. The tuner unit plugs directly into this chassis. P. & P. 2/6.

SOUND/VISION and I.F. STRIP 2/9
Salvaged. Complete sound and vision strip. 8 valve holders. Less valves. I.F.'s 16-19.5 Mc/s. Size 8½ x 4½ x 4½in. Drawings free with order. P. & P. 2/6.

SOUND/VISION and I.F. STRIP 2/9
Salvaged. Superhet. 8 valve holders. Less valves. I.F.'s 7.25 Mc/s sound. 10.75 Mc/s vision. Vision complete from input up to video output. Sound complete from input to A.F. Amplifier. P. & P. 2/6.

TIMEBASE 2/9
Containing scanning coils, line transformer, etc. less valves. Drawings free with order. P. & P. 2/6.

17" T/V 19 GNS.

CASH PRICE



FEATURES

- ★ 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.)

★ LATEST ADDITION TO OUR CHASSIS RANGE

A COMPLETE AND WORKING 17" T/V CHASSIS 24 GNS.

Latest chassis including 17in. tube, permanent magnet speaker, 13 channel Turret-Tuner (any two selected channels fitted). Other channels supplied on request at 7/6 each.

13 valves. Line up as follows: 5-EF80s; 1-ECC84; 1-ECF8; 2-ECL80s; 1-PL81; 2-EB91s; 1-EY51. Chassis and valves guaranteed for 3 months. CRT 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/-.

T/V CHASSIS AT CLEARANCE PRICES

THE POPULAR 12in. PLESSEY CHASSIS 9/6

A bargain for anyone wanting to make up their own T.V. at a very low cost. A chassis in one unit. Less valves and tube. Chassis size 12 x 14½ x 11in. I.F.s. 10.5-14 Mc/s. Can be adapted for a 12 channel Turret tuner and modified to take a larger tube. Carr. & Ins. 10/6.

14in. T.V. CHASSIS, TUBE and 11 Gns. SPEAKER

With 14in. rectangular tube. 12 months guarantee on Tube. 3 months guarantee on chassis and valves. Chassis with Tube and speaker (less valves) 11 Gns. Complete and working with valves and Turret Tuner 15 Gns. Ins. carr. (incl. tube) 25/-.

NODARK OVERLOAD CUT-OUT SWITCH 8/9

This will stop the search for that elusive fuse wire and the annoyance of repairing the fuse. Accidental crossing of wires or faulty connections will automatically throw the switch of the Nodark cutting the current to the fuses. It now only remains to rectify the fault and switch on the No-dark. 200-250 v. maximum load. 2-5 amps. A fraction of the list price. P. & P. 1/6.

13 CHANNEL TURRET TUNER 65/-

Brand new. Well-known manufacturer. 39 Mc/s. Complete with valves PCF80 and PCC84. 3 series line up and channel coils covering channels 1, 2, 3, 4, 5, 8 and 9. Carr. & Ins. 3/6.

DUKE & CO.

RECORD PLAYER CABINETS

R.P.4



79/6 Stylish cabinet by famous manufacturer. Cloth covered in contrasting colours (red and grey). Grilled front controls panel. Size 15 x 19 x 8 1/2 in. deep. Beautifully made—a cabinet of which you can be really proud. Takes 4-speed B.S.R. Autochanger; 6 1/2 in. round of 7 x 4 in. elliptical speaker. Room for any amplifier of your own choice. Carr. & Ins. 4/6.

A delightful looking cabinet 14 1/2 x 17 1/2 x 8 1/2 in. in 2 tone leatherette. Will take a B.S.R. Monarch 4-speed autochanger and 6 1/2 in. round speaker. Carr. & Ins. 4/6.

R.P.3

69/6



A beautifully styled cabinet. Made by a famous manufacturer. In polka dot cloth with clipped lid and carrying handle. Size 16 x 14 1/2 x 8 1/2 in. deep. Will take a B.S.R. Monarch 4-speed Autochanger and 7 x 4 in. elliptical speaker and most of the modern portable amplifiers. Carr. & Ins. 4/6.

R.P.2

69/6



A beautifully styled cabinet. Made by a famous manufacturer. In polka dot cloth with clipped lid and carrying handle. Size 16 x 14 1/2 x 8 1/2 in. deep. Will take a B.S.R. Monarch 4-speed Autochanger and 7 x 4 in. elliptical speaker and most of the modern portable amplifiers. Carr. & Ins. 4/6.

HERE'S UNREPEATABLE VALUE

R.P.6 **29/6**

Elegant cabinet, cloth covered in grey or red with sunken control panel and speaker fret. Size 13 x 17 x 8 in. deep. Takes a B.S.R. Monarch 4-speed Autochanger; 7 x 4 in. elliptical speaker and most of the modern portable amplifiers. Carr. & Ins. 4/6.



★ STEREOPHONIC AMPLIFIER ★

£7/19/6

12 months guarantee

Beautifully made for portable stereophonic record players. Latest design with printed circuit. Dimensions 3 x 5 1/2 x 9 1/2 in. 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. & Ins. 3/6.

STEREOPHONIC CABINET 99/6

Continental style cabinet including extra clip on speaker cabinet. 15 1/2 x 10 1/2 x 24 1/2 in. deep. Takes B.S.R. 4-speed stereo autochanger. Printed circuit amplifier. Two 8 in. speakers. Carr. & Ins. 12/6.

The World's Finest Autochanger



U.A. 8.

B.S.R.

MONARCH

4-SPEED AUTOCHANGER £6/19/6
U.A.12. LATEST B.S.R. MONARCH 4-SPEED MIXER £8/9/6

COLLARO CONQUEST 4-SPEED AUTO-CHANGER £6/19/6

COLLARO CONQUEST STEREO AUTO-CHANGER 11 Gns.

P. & P. on all the above 5/6.

★ AMPLIFIERS ★

12 Months' Guarantee



PORTABLE AMPLIFIER

Mk. D1 **59/6**

Brand new. Latest design with printed circuit. Dimensions 7 x 2 1/2 x 5 in. 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.

PORTABLE AMPLIFIER Mk. D. 2 79/6
Printed circuit. Latest design. Dimensions 7 x 2 1/2 x 5 in. 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.

PORTABLE AMPLIFIER Mk. D. 3 89/6
De luxe model. Printed circuit. Latest design. Dimensions 7 x 2 1/2 x 5 in. 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.

PORTABLE AMPLIFIER Mk. D. 5 39/6
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.

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.

THE NEW CONTINENTAL TYPE RECORD PLAYER CABINETS

in gay two-tone colours as follows:—

P.L.10 CABINET 39/6

Size 14 1/2 x 12 1/2 x 6 in. Takes B.S.R. T.U.9 4-speed record player unit. 8 x 3 in. elliptical speaker. Single control amplifier.

C.H.1 CABINET 69/6

Size 14 1/2 x 16 1/2 x 8 1/2 in. Takes B.S.R. U.A.8 4-speed autochanger. 7 x 4 in. elliptical speaker; most of the modern portable amplifiers. Attractive speaker grille and recessed control panel.

T.W.1 CABINET 79/6

Size 15 1/2 x 19 1/2 x 10 1/2 in. Takes B.S.R. U.A.8 4-speed Autochanger. 8 in. round speaker. 3 control amplifier.

Carr. & Ins. on above 4/6.



PHOTOGRAPHIC SLIDE CASE

(List price £2/10/-) **17/6**

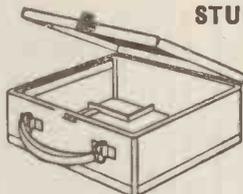
Size 8 x 12 1/2 x 2 1/2 in. deep. Will hold 150 of those expensive coloured transparencies in separated partitions. This is the answer

to that aggravating search for that particular photograph and will, of course, keep them safe from damage. P. & P. 2/6.



BAKELITE CABINETS 5/9

Brand new. Colour brown. Attractive design. Size 12 x 7 x 5 1/2 in. Ideal for small receivers, converters etc. P. & P. 3/9.



STURDY CASE

12/6

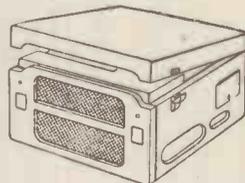
8 1/2 x 7 1/2 x 3 1/2 in. deep. Covered in burgundy and grey washable rexine. Strong clasp, hinges and handle. Ideal

for Portable Radio Chassis or Transistor set. Can be adapted as a Record carrying case to hold 18 seven-inch long-playing records. P. & P. 2/6.

A "must" for the build your own tape recorder enthusiast:—

TAPE RECORDER CABINETS

19/6



Suitable for the Truvox Tape Recording deck. Less front cast speaker panel. Size 13 1/2 x 15 x 8 1/2 in. deep. Detachable lid with compartment for spare tape. Covered in green washable plastic material. P. & P. 4/6.

EXTENSION SPEAKERS

19/9



Polished oak cabinet of attractive appearance. Fitted with 8 in. 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

8 in. P.M. Speakers 8/9. With O.P. transformer fitted 10/-, 6 1/2 in. P.M. Speakers 12/6. Postage 2/6. 7 x 4 in. elliptical speaker 19/6. 9 1/2 x 4 1/2 in. elliptical speaker 22/6. Postage 2/9.

MOTOR BOARDS 2/6

For 4-speed Autochangers. P. & P. 1/3.

3 TRANSISTOR AMPLIFIER 79/6

9 volts. 1 control. P. & P. 3/6.

DUKE & CO.

(Dept. C.11)

621/3 ROMFORD ROAD,
MANOR PARK, E.12

Telephone: ILF 6001/3

CATALOGUE FREE UPON REQUEST

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

Build a high quality recorder in the £70 class for only

29 1/2 GNS (Carr. 17/6)

INCORPORATING THE LATEST MK. IV COLLARO TAPE TRANSCRIPTION. THE LINEAR LT45 HIGH QUALITY TAPE AMPLIFIER. A HIGH FLUX 7x4in. LOUDSPEAKER, 5in. Reel of Best Quality TAPE. Spare Tape Spool, a Portable Cabinet, size approx. 18 x 13 x 9in., finished in Veneered walnut and connection diagram for wiring amplifier to transistor.

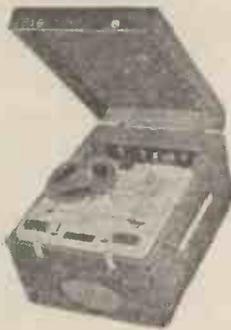
FEATURES INCLUDE

- ★ 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.

H.P. TERMS. Deposit 3 Gns. and 12 monthly payments of 53/9.

Cash price if settled in 3 months.



HI-FI 8 WATT AMPLIFIER

£4-19-6

SPECIAL PURCHASE DUE TO CANCELLED EXPORT ORDER For 200-250 v. A.C. mains.

Carr. 7/6

A REMARKABLE OPPORTUNITY!

Push-pull output. Latest high efficiency B.V.A. valves. Dual separately controlled inputs for mike and gram. Separate bass and treble controls. High sensitivity. Output for 15 ohm loudspeaker. Guaranteed brand new, tested, and in perfect working order.

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

REFANCO CONSTRUCTIONAL ENVELOPES AND COMPONENTS ALWAYS IN STOCK

All parts for: One Transistor Receiver 25/-; Two Transistor Receiver 42/-; 3 Dec 3 Transistor Receiver 43/19/6; Mini 7 Seven Transistor Pocket Portable Receiver 49/19/6; Major 7 Seven Transistor Portable Receiver 15 cas. Only Mullard, Ediswan, or Brimar Transistors supplied for Mini 7 and Major 7 Receivers. Constructional Envelopes. 3 Dec 9d., Mini 3 Pocket Portable 1/3, Mini 7 1/6, 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, 6X4, 6BE6 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 1/8. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite or veneered walnut.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all dry battery eliminator. Size 5 1/2 x 4 1/2 x 2 1/2 in. approx. Completely replaces batteries supply 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s is available. Suitable for all battery portable receivers requiring 1.4 v. and 90 v. This includes latest low consumption types. Complete kit with diagram 39/9 or ready for use 46/9.

Type BM2. Size 8 x 5 1/2 x 2 1/2 in. Supplies 120 v., 90 v. and 60 v., 40 mA. and 2 v. 6.4 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.



COSSOR V.H.F. F.M. RADIO RECEIVER KITS

Brand New Boxed with 6 valves, printed circuit and 10 x 6in. Goodmans Speaker. Normal price 15 Gns. Only 28/19/6

R.S.C. PORTABLE TAPE RECORDER

A completely assembled unit in attractive two-tone rexine covered cabinet. Acos crystal microphone, reel of best quality tape, and empty spool are supplied.

- ★ Single speed 3 1/2 in. per sec.
- ★ Takes up to 5 1/2 in. spools.
- ★ Incorporates high flux 7 x 4 in. speaker.
- ★ Excellent frequency response.
- ★ Output of 3 watts.
- ★ High Sensitivity.
- ★ Inputs for Radio/Gram, or microphone.

19 Carr. 10/6 GNS

Or Deposit 35/- and 12 monthly payments of 34/6

- ★ Fast rewind.
- ★ Automatic erase.
- ★ For 230-250 v. 50 c.p.s. A.C. mains.
- ★ Covered by our usual 12 months' guarantee.

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 200-250 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.	23/9
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.	33/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	33/9
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a.	35/9
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t., 6.3 v. 4 a., c.t. 5 v. 3 a.	40/9

TOP SHROUDED DROP-THROUGH TYPE

250-0-250 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	16/9
350-0-350 v. 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.	22/9
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.	28/9

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. 60 c/s.

6.3 v. 1.5 a.	5/9	6.3 v. 3 a.	8/11
6.3 v. 2 a.	7/6	6.3 v. 6 a.	17/6
0-4-6.3 v. 2 a.	7/9	12 v. 3 a. or 24 v.	8/9
12 v. 1 a.	7/9	1.5 a.	17/6

OUTPUT TRANSFORMERS

Midget Battery Pentode 6B1 for 3S4, 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 5,000 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 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., 7-10 H., 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

PHILCO F.M. RADIO TUNERS

With self-contained power pack. A 6-valve de luxe unit housed in beautiful walnut veneered cabinet. For 110-200-250 v. A.C. mains. Magic eye tuning indicator **12 1/2** GNS. Carr. 5/-

Or Deposit 22/6 and 12 monthly payments of 22/6.

R.S.C. A12 STEREO AMPLIFIER KIT

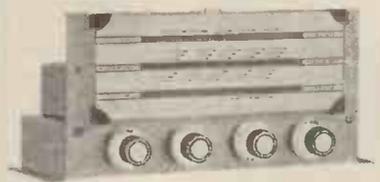
£3-19-6

Carr. & packing 7/6

A complete kit of parts to construct a good quality 3+3 watt (total 6 watt) stereo amplifier providing real 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 200-250v. 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 22/12/-.

E.M.I. 4-Speed Single Players with hi-fi T/O crystal pick-up head for Stereo and Monaural. £7/15/-. Carr. 4/6.

GARRARD 4-SPEED AUTO-CHANGERS Type RC/120E. Limited number at 9 gns. (approx. half price). Carr. 5/6. Brand new.



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 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 (especially suitable for use with any of our Amplifiers). A Triode Heptode F/Changer is used. Pentode I.F. and double Diode Second Detector, delayed A.V.C. is arranged so that A.V.C. distortion is avoided. The W. Ch. Sv. incorporates Gram. position. Controls are Tuning, V. Ch. and Vol. Output will load most Amplifiers requiring 500 mV. input depending on A.C. 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.

LITTLE STAAR 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 23/19/6. Carr. 3/6.

COLLARO JUNIOR 4-SPEED RECORD PLAYER with separate pick-up having dual point sapphire stylus. Brand new, cartoned. For 200-250 v. A.C. mains only. Only £3/15/-. Post 3/6.

B.S.R. MONARCH AUTO-CHANGERS

Type UA8, 4-speed. T/O Pick-up with sapphire stylus £8/19/6. Carr. 4/6.
Collaro AC4/564 4-speed single players with hi-fi turnover crystal pick-up head 28/9/6. Carr. 4/6.

R.S.C. A.10 ULTRA LINEAR 30 WATT AMPLIFIER

HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. EF86, EF86, ECC83, 807, 807, G234. Tone Control Pre-amplifier 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 "micro" and gram, etc., can be simultaneously applied for mixing purposes. **AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 v. 1.5 A. FOR A RADIO FEEDER UNIT.** Price in kit form with easy-to-follow wiring diagrams.



Or Factory built with 12 months' guarantee **£13/19/6. TERMS ON ASSEMBLED UNITS. DEPOSIT 24/6** and 12 monthly payments of 24/6.

Only 11 Gns.
Carr. 10/-
Cover as illustrated
Type 807 output valves are used with High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response ± 3 D.B. 30-20,000 c/c.s. Tone Controls ± 12 D.B. at 50 c/c.s. ± 12 D.B. to -6 D.B. at 12,000 c/c.s., hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue hammer. Overall size 12 x 9 x 9in. approx. Power consumption 150 watts. For A.C. mains 200-250 v. 50 c/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.

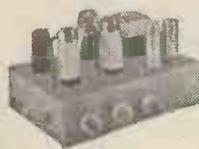
LINEAR 15/5 HIGH QUALITY STEREO AMPLIFIER. Total output 10 watts. Handsome Perspex Facia Plate. All controls gauged. **Only 11 Gns.**

LINEAR 145 MINATURE 4/5 W. QUALITY AMPLIFIER. Suitable for use with any record playing unit and most microphones. Negative feedback 12 D.B. Base 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 x 5 x 5 1/2 in. high. Chassis fully isolated from mains. Guaranteed 12 months. **Only £5/19/6** Or Deposit 22/- and 5 monthly payments of 22/- Send S.A.E. for leaflet.

LG3 MINATURE 3 WATT GRAM AMPLIFIER
For 200-250 v. 50 c.p.s. A.C. mains. Overall size only 6 1/2 x 4 1/2 x 2 1/2 in. Fitted vol. and Tone Control with mains switch. Designed for use with any kind of single player or record changing unit. Output for 2-3 ohm speaker. Guaranteed 12 months. **Only 57/9.**

R.S.C. A7 4-3 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 reproduction. Hum level is negligible being 71 D.B. down. ± 15 D.B. of negative feedback is used. H.P. of 100 v. 26 mA. and 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/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.



TWEETERS. 4in. Plessey, 3 ohms, **18/9.** Rola/Celestion 7.5 ohms, **25/9.**
P.M. SPEAKERS. 2-3 ohm 2 1/2in. Perdio 21/9. 5in. Goodmans 17/9. 7 x 4in. R.A. Elliptical 19/9. 6 1/2in. Rola 19/9. 6in. Rola 19/9. 8in. Goodmans 21/9. 8 x 6in. Elac with high flux magnet 25/9. 10in. R.A. 23/9. 10 x 6in. Elliptical Goodmans 29/9. 12in. R.A. 29/11. 12in. R.A. 3 or 15 ohms, 10 watts, 12,000 lines, **59/6.**

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.
GRAM MOTOR with Turntable and pick-up, standard 78 r.p.m. Brand new. **Only 25/9.**

ACOS Crystal Microphone Inserts. Brand new. Only 5/11 ea. Ex. Equip. 4/11 ea.
ACOS HGP50 Hi-Fi Crystal Cartridges. (Turnover type with sapphire stylus.) Standard replacement for Garrard and Collaro. Only 19/9. B.S.R. Ful-d 17/9. Garrard GC2 19/9.

R.S.C. MANCHESTER, LEEDS & BRADFORD

(LEEDS) LTD.

Open to callers at following branches:—
5-7 County Arcade, Leeds, 1.
54-56 Morley St., (next Majestic Ballroom) Bradford.
8-10 Brown Street, (Market St.) Manchester, 2.

TERMS: C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/9 extra on all orders under £2. 2/9 extra under £5 unless carriage stated. Trade supplied. Post orders to **Mail Order Dept., 29-31 Moorfield Road, Leeds, 12.**

HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PREAMP STAGES

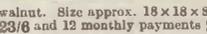


Two input sockets with associated controls allow mixing of "mike" and gram, as in A10. High sensitivity. Includes 5 valves, ECC83, ECC83, EL84, EL84, 6Y3. High Quality sectionally wound output transformer specially designed for Ultra Linear operation, and reliable small condensers of current manufacture. **INDIVIDUAL CONTROLS FOR BASS AND TREBLE "LIFT" and "CUT"** Frequency response ± 3 D.B. 30-30,000 c/c.s. Six negative feedback loops. Hum level 80 D.B. down. **ONLY 22 millivolts INPUT required for FULL OUTPUT.** Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs. **FOR STANDARD or LONG PLAYING RECORDS.** For **MUSICAL INSTRUMENTS** such as **STRING BASS, GUITARS, etc.** **OUTPUT SOCKET** with plug provides 300 v. 30 mA. and 6.3 v. 1.5 A. For supply of a **RADIO FEEDER UNIT.** Size approx. 12-9-7in. For A.C. mains 200-250 v. 60 c/c.s. Output for 3 and 15 ohm 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 lavend metal cover with 2 carrying handles can be supplied for **18/9. TERMS ON ASSEMBLED UNITS. DEPOSIT 18/9.** and 12 monthly payments of **18/9.** Send S.A.E. for illustrated leaflet detailing Ready-to-assemble Cabinets, Speakers, Microphones etc., with cash and credit terms.

R.S.C. PORTABLE GUITAR AMPLIFIERS



JUNIOR 5 WATT. High Quality Output. Separate Bass and Treble "cut" and "boost" controls. Sensitivity 15 m.v. High Flux 6in. 1/speaker. Input sockets for Radio/Tape or Gram Pick-up and Mike /Instrument Pick-up. Handsome strongly made cabinet (Size approx. 14 x 14 x 7ins.). Finished in satin walnut and fitted carrying handle. **£8/19/6** Carr. 7/9. Or Deposit **£1** and nine monthly payments of **£1.** Send S.A.E. for leaflet.

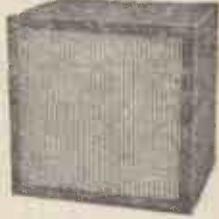


SENIOR 10 WATTS. High Fidelity Push Pull output. Separate Bass and Treble "cut" and "boost" controls. Twin separately controlled high gain inputs so that two instruments such as Guitar and String Bass can be used at the same time. Two Loudspeakers are incorporated, a 12in. P.M. for Bass notes, and a 7 x 4in. elliptical for Treble. Cabinet is well made and finished satin walnut. Size approx. 18 x 18 x 8in. **13 gns.** Plus 10/- carr. **H.P. TERMS. DEPOSIT 23/6** and 12 monthly payments 23/6. Both models for 200-250 v. A.C. mains.

STAAR GALAXY 4-SPEED MIXER AUTO-CHANGERS. Brand New, cartoned. Turnover sapphire stylus. 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. 4/8.

PORTABLE CABINETS

For Record Players or Tape Recorders. Rexine covered. Wide selection of attractive designs and colour combinations **15/9**



12in 10 WATT HIGH QUALITY LOUSPEAKER 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 1/speakers 15 ohms. In Cabinet finished as above. Size 18 x 18 x 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. x 4in. or 5in. speaker. Slightly soiled. **Only 49/6.**

ACOS HIGH FIDELITY PICK-UPS. GP64 with HGP50/52 Cartridge. Turnover sapphire stylus, cream finish. Limited number at approx. half price. **Only 29/11.**

SPECIAL OFFER

Above cabinet Staar Changer, Gram amplifier, and 5in. or 6in. x 4in. speaker **£9/19/6.** Carr. 10/-. Or with B.S.R. changer in lieu of Staar 11 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
BRADFORD and LEEDS
(LEEDS) LTD.,**

For addresses and terms see page 169

ELECTRIC BELLS. 3 in. 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. 1 a. h.w.	120 v. 40 mA.	3/9
6/12 v. 1 a. h.w.	250 v. 60 mA.	3/11
Following F.W. (Bridge)	250 v. 60 mA.	4/11
6/12 v. 1 a.	250 v. 80 mA.	6/11
6/12 v. 2 a.	250 v. 250 mA.	12/9
6/12 v. 3 a.	Contact Cooled.	
6/12 v. 4 a.	250 v. 80 mA.	6/11
6/12 v. 5 a.	250 v. 75 mA.	8/11
6/12 v. 6 a.	F.W. (Bridge).	
6/12 v. 10 a.		
6/12 v. 15 a.		

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 V15/10² 2 watts 17/9. OC71, 10¹-, OC72, 17¹-, XB102, 10¹-, XB104, 10¹-, OC45 17/6. OC44 22/6.

BATTERY CHARGING EQUIPMENT

Trade supplied. Discounts according to quantity.

HEAVY DUTY CHARGER KIT

6/12 v. variable charge rate up to 6 amps. Consisting of Mains Trans., F.W. (Bridge) Selenium Rectifier, 0.7 amp. meter, multi-position switch with knob, fuses, fuseholders, panels, plugs and circuit. Only 59/9. Post 4/6.

ASSEMBLED CHARGERS

6 v. 1 a.	19/9
6 v. 2 a.	29/9
6/12 v. 1 a.	27/9
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. 1 1/2 a.	11/9
0-9-15 v. 2 1/2 a.	14/9
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. 22/9
As above, with ammeter. 32/9
6 v. 2 amps. 25/9
6 v. or 12 v. 2 amps. 31/9
6 v. or 12 v. 2 amps. 42/9
(inclusive of ammeter)

6 v. or 12 v. 4 amps. 53/9
6 v. or 12 v. 4 amp. with variable charge rate selector and ammeter 59/9

CHARGER AMMETERS

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

ASSEMBLED CHARGER

6 v. or 12 v. 2 amps. Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads. Double Fused. Only Carr. 3/9. 49/9

As above, but for 3 amp. charging. Only 69/6. Carr. 3/9



Fitted Ammeter and variable charge selector. Also selector plus for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish. Ready for use with mains and output leads. Carr. 5/- Or Deposit 13/3 and five 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.

TANNOY RE-ENTRANT LOUDSPEAKERS. 8 watt 7.5 ohms 19/6

HIGH FIDELITY 10 watt PUSH-FULL 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. 26/15/- Carr. 7/6.

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

3 v. 16 A.H. EX. GOVT. ACCUMULATORS. New boxed. Only 5/6 each, 3 for 15/-, plus 2/6 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. 2a. 10/11
300-0-300 v. 60 mA., 6.3 v. 2 a. 11/9
280-0-285 v. 100 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. 15/9
350-0-350 v. 100 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. 16 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, 0-215-220-235-240 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 27/9 ea.

D.C. SUPPLY KITS. Suitable for electric trains. Consists of mains trans 200-250 v. 50 c/s, 12 v. lamp selenium rect. (F.W. Bridge); 2 fuseholders, 2 fuses, change direction switch, variable speed regulator, partially drilled steel case, and circuit. Very limited number, 29/9.

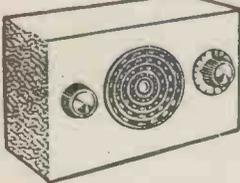
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200 mA., 3-5 H., 50 ohms, Farmeko 8/9; 100 mA., 5 H., 100 ohms 3/11
150 mA., 10 H., 50 ohms 4/9; 80 mA., 20 H., 900 ohms 5/9;
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All for A.C. Mains 200-250 v. 50 s/c Guaranteed 12 months

ASSEMBLED 6 v. or 12 v. 4 amps.

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This Radio is proving to be a real winner equal to many commercial receivers at more than double the price

6 Transistor Plus Diode Pocket Superhet Radio
Easy to build, using 6 Mullard transistors; OC44, OC45(2), OC71, matched pair OC72, OA70. Medium and long wave bands. Printed circuit, Built-in HiQ Ferrite Aerial. Push-pull-output. 150 ohms 3in. loudspeaker. Circuit and layout diagram. Low consumption. Power output 150 M.W. Sensitivity—1MV for 50 MW output. Circuit line up; mixer stage, 2 I.F. stages, Germanium detector, AF driver stage and push-pull output.

ALL COMPONENTS COMPLETE LESS CABINET AND BATTERIES AT THE SPECIAL PRICE OF
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Post and packing 2/6. All parts available separately. Cabinet available in parts to be assembled with tuning knob and scale. 18/6 plus 1/6 post & pkg.

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Plug in ear piece 12/6
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SPECIAL OFFER IN TRANSISTORS

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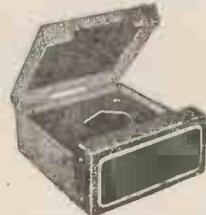
The new Cossor 6 valve FM receiver kit comprising all components including 6 valves, Goodman's 10 X 6 speaker, printed circuit chassis, easy to follow Instructions. Even to nuts and bolts. Manufacturers price 15 gns. Our price £8/19/6 complete. P. & P. 2/6. Cossor 3-watt printed circuit audio amplifier. All components mounted on printed circuit chassis, 3 Cossor valves, 10 X 6 speaker, 4in. tweeter, and all components including easy to follow instructions. Cossor's price £9/15/6. Our price complete £5/19/6. P. & P. 3/6.

Brand new Acos featherweight p/up with t/over crystal H.G. cartridge. Few only 26/6. 1/6 P. & Pkg. with LP and Std. stylus.

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BRAND NEW by famous manufacturer, 10 X 8 elliptical speaker. 3 ohm impedance. Only 17/6. P. & Pkg. 1/6.

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One valve 5W radio, 24-40 metres. All components, 35/-, P. & P. 2/-
Beginners' transistor pocket radio, miniature components, 30/-, complete. P. & Pkg. 2/-
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Acos 73 stereo and monaural t/over cartridge. Our price 42/6 post paid.

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Fully guaranteed for valves and service.

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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 10kV. As used in many TV receivers. Original price £17/15/-.

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Printed circuits made to any wiring diagram. This kit contains all instructions, laminated board and the necessary chemicals for making numerous printed circuits. Additional laminated boards available. All materials of high quality, safe and easy to handle. Complete in perspex case. Our price 19/6. P. & P. 1/6.

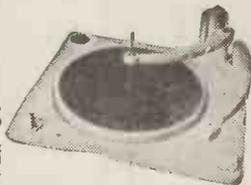
Limited number Acos 73-1A stereo turnover cartridge, suitable for 78, microgroove and stereo records, will fit most modern p/up heads. Mfrs. price 52/10. Our price 42/6. Post free.

Heavy magnet 9 x 5 Elliptical speaker by famous make 18/6. P. & P. 1/6.

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COLLARO 4-SPEED AUTO-CHANGERS

Incorporating auto and manual control. Complete with Studio crystal p.u. and sapphire stylus.



OUR PRICE **£7.9.6** Plus 5/- P. & P.

GARRARD RC121, Mk. 2 Auto-Changer. Wired for stereo with new plug-in head using the popular GC8 turnover cartridge for L.P. & Std. records. OUR PRICE £9/19/6. P. & P. 5/-.

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SPECIAL OFFER

For the Hi-Fi enthusiast—Collaro 4-speed transcription motor and p/up using the new TX88 Stereo cartridge. Brand new. List price £19/10/-.

OUR PRICE £15/19/6. Carr. & Crating 12/6.

JUST ARRIVED—New Garrard 4HF. 4-speed Hi-Fi motor and t/able with new GC8 cartridge. £18/7/6 plus 5/- post and pkg.

As above, using stereo cartridge, £18/17/6, plus 5/- post and pkg.

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Rogers Stereo Control Unit, designed to match RD Junior Units. Price 11 Gns.
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 Armstrong stereo 12 radiogram chassis, 6 w. each channel, FM, p/pull, L. and M. bands, tape record and playback for stereo and monaural. £37/16/-.

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IDEAL FOR ROVING SERVICE MAN.

Resistance ranges: 0-20K ohms, 0-2 Meg ohms
 Voltage ranges: 0-6 v. D.C., 0-12 v. D.C., 0-60 v. D.C., 0-300 v. D.C., 0-1,200 v. D.C., 0-6 v. A.C., 0-12 v. A.C. (23 DB), 0-60 v. A.C. (37 DB), 0-300 v. A.C., 0-1,200 v. A.C.
 Current ranges: 0-300 v. A.-D.C., 0-30 M.A.-D.C., 0-300 M.A.-D.C. complete with test leads £6/19/6 and batts. Post and packing 3/6.



BUILD YOURSELF A HI-FI TAPE RECORDER AT HALF THE NORMAL PRICE

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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. £17/10/0. **WHILE STOCKS LAST.**

The Collaro pre-amp and bias oscillator complete with power pack for the above deck, with instructions. Price £12/19/6. Post and Pkg. 7/6.

The above two items at a special price of £30. Carr. and pkg. 22/6 the two units.

The **Linear Tape Deck Amplifier** with power pack and oscillator incorporated. Switched for 3½, 7½ and 15in. per sec. Suitable for the Mk. 4 Deck. 12 gns. only. Post and pkg. 3/6.

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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/-.

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Special offers in tape by famous maker: 3in. L.P. tape 225ft., 7/- post free. 4in. Std. tape 300ft., 10/6 post free.

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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.

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Bendix Frequency Meters

BC 221 Range 15 kc/s—20 Mc/s.
In perfect condition.
TS 174, 40-250 Mc/s.
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NEW HALLICRAFTERS direct from U.S.A.—All types available, kindly write for details of types and prices.

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MANUALS For the following receivers:—AR88LD-D, AR77E, R107, Hallicrafters, SX24, SX28, S20R, S20, B2 Transmitter-Receiver, HQ120, HRO, Junior and Senior, £1/7/6 each. Others supplied to order from our library.

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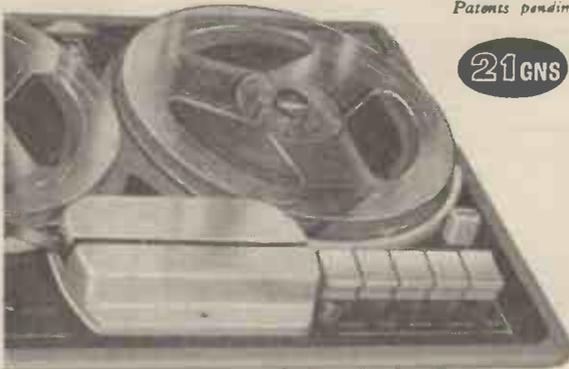
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Now restyled in two tones of grey—you must see the new, attractive Motek K.10.

★ Enlarged drive wheel on the rev. counter ensures accurate tape positioning

★ Non-slip push buttons.

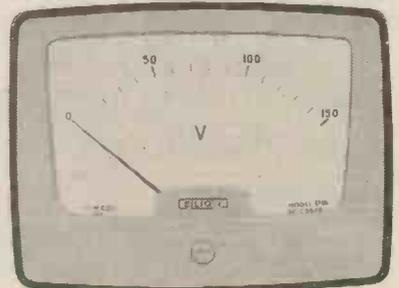
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Model No.	Barrel dia.	Case size	Scale length
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	First Coil	Second Coil	Both coils 50 Volts D.C. Self-contained. Tag boards and resistance boxes extend ranges to 1000 Volts.
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OSCILLOSCOPE No. 11

Made for Anti-Aircraft Command by A. C. Cossor in 1952 this is a First Grade L.F. Oscilloscope incorporating a Hard Valve Time Base, with existing speeds of 1.5-40 milliseconds, but is easily converted at a cost of a few shillings to produce speeds of 3 cycles per second to 30 kc/s. Has High Class Amplifier with Fine and Coarse gain controls, plus Brightness and Focus controls, and X and Y shifts. Conservatively rated Mains Power Pack is for nominal 115 v. and 230 v. input, and is adequately fuse protected in all circuits. Tube employed is 2½in ACR10. Will make up into an ideal workshop or servicing oscilloscope. Has grey and black engraved front panel size 19in. x 7in., depth of unit being 12in. Illustrated in heavy steel transit case in which it can be used, or removed for standard 19in. rack mounting. Complete with leads and suggested modification data. **BRAND NEW, ONLY £12/10/-**, (carriage 15/-).

"Q FIVER" COMMAND RECEIVER. The famous American BC 453 covering 190-550 Kc/s, I.F.s being 85 Kc/s. Complete with all 6 valves and circuit. Size 11 x 5½ x 6ins. **BRAND NEW IN MAKERS' CARTONS. ONLY 89/6** (Post 3/6).

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).

MARCONI SIGNAL GENERATOR TF-517-F/L. Cover 10-18 Mc/s., 33-58 Mc/s. and 150-300 Mc/s. In good, used condition, with charts. Checked before despatch. Complete with power pack for normal A.C. mains. **ONLY £12/10/-** (carriage, etc. 20/-).

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/-**.

12 VOLTS AMERICAN DYNAMOTOR. Delivers 220 volts at 100 milli. Size 6½ 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 a., 2-0-2 v. 2 a. (for VCR 87 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**.

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 Edgcombe, and in perfect order. Brand New and Unused. **ONLY 27/10/0**. Can be supplied modified for 50 cycles, use either 0-150 or 0-300 volts, 20/- extra.

TCS TRANSMITTERS

The renowned American TCS Model designed by the Collins Company for static or mobile use. Covers 1.5-12.0 mc/s. in 3 bands, and is complete with 7 valves, employing 2 of 1625 in P.A. Stage, 1 each of 1625 in Buffer and Modulator Stages, and 3 of 12A6 in Oscillator Stage. Provision for VFO or Crystal Control. 4 Crystal positions. Radio Telephone or Radio Telegraph. Has Plate and Aerial Current Meters. Power Requirements 12 v. LT and 400 v. HT. In black crackle case, size 11 x 13 x 11 in. New condition internally, but externally store soiled. **ONLY 57/19/6** (Carr., etc. 15/-).

We can also supply the **TCS RECEIVER**, which matches the Transmitter in size and appearance, and covers similar frequencies. Complete with 7 valves, 1 each of 12SA7 and 12SQ7, 2 of 12A6 and 3 of 12SK7. Power Requirements 12 v. LT and 225 v. HT. In first class condition. **ONLY £10/10/0** (carriage etc. 15/-).

The double Dynamotor Power Unit, Type 21881B for 12 volts operation, delivering 400 v. for Transmitter and 225 v. for Receiver, is available at **£12/10/-** (carriage, etc. 15/-).

RCA AR 88 RECEIVERS

Re-conditioned and in perfect working order. "L" Model, covers 75-140 kc/s. and 1.2-30 mc/s., **ONLY 45/0**. "D" Model, covers 500 kc/s-1 mcs. **ONLY 45/5** (Carriage etc., 25/-).

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 1T4, 1 or 1R5 and 1 of CV286 (Neon Stabiliser), and Instruction Book. Size 7in. x 7½in. x 4in., weight 5lbs. Used but in first class condition. **ONLY 22/19/6**. Carr. 3/6.

TRIPLETT UNIVERSAL TEST METER. Made by the famous American meter manufacturers. Size 7½ x 6½ x 6½in., and incorporates a unique tilting bakelite container size 5½ x 3½in., 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. 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 £12/10/-** (post, etc. 5/-).

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

CANADIAN MOVING COIL PHONES. Low-resistance, fitted noise excluding chamois car muffs, and leather covered head-band. Lead terminates to jack plug. **BRAND NEW. ONLY 10/6** (Post 1/6).

MAINS ISOLATING TRANSFORMER. Manufactured by Vortexion. Fully shrouded. Will provide true 1:1 Ratio from nominal 230 v. Primary. Rated at 100 watts. **BRAND NEW. ONLY 22/6** (post 2/6).

AIRBORNE TRANSMITTER RECEIVER TYPE 1986. A Mobile 10 Channel Crystal Controlled V.H.F. TX/RX covering 124.4/156 Mc/s. I.F. Bandwidth 23 Kc/s. Complete (less external attachments) in metal case, with all valves and 24 volt Rotary Power Unit. Used, but in first class condition, with circuit. **ONLY 26/19/6**. Carr. etc., 10/6.

HETERODYNE FREQUENCY METERS

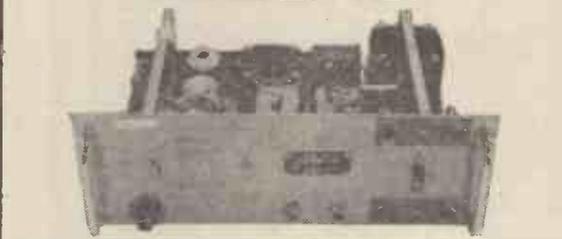
TYPE LM14

Designed and built to United States Navy specification, these Crystal Controlled instruments combine all the advantages of the well known BC.221 Frequency Meter, plus many additional features which increase their usefulness.

- ★ Frequency range 125-20,000 kc/s. in 2 bands.
- ★ Accuracy better than .02% in 125-2,000 kc/s. band, and better than .01% in 2,000-20,000 kc/s. band.
- ★ Voltage stabilisation circuit ensures accuracy not affected by power supply fluctuation.
- ★ Separate power switches allow standby filament operation without HT supply.
- ★ Modulation switch enables instrument to be used as a Signal Generator.
- ★ Has corrector for WWV.
- ★ Supplied with removable shock protection mounting.
- ★ Size only 8½in. x 8in. x 8½in. Weight 11½lb.
- ★ Brand New and Unused. Further details on application.



AMPLIFIER N24



Manufactured for the Admiralty in 1952 by Burndep, this utilises 4 valves, 1 each 5Z4G, 6V6G, 6J7G, 6J5G, and high quality components such as "C" Core Transformers and Block Paper Smoothing Condensers. Has A.C. Mains Pack for nominal 110/230 volts. Provision for 600 ohms or High Impedance Input, and has Output to 600 ohm Line. For normal use only requires changing Output Transformer. Can be used for Speech or Music, giving High Quality Reproduction. Output approximately 4 watts. Enclosed in metal case, and designed for Standard 19in. Rack Mounting, having grey front panel size 19in. x 7in. with Chromium Handles. All connections to rear panel, front having "On/Off" Switch, Gain Control, Indicator Light, Fuses and Valves Inspection Panel. **BRAND NEW IN MAKERS' PACKING. ONLY 24/9/6** (carriage 10/6).

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HEAVY DUTY SLIDING RESISTORS. 26Ω 6s., Double Tube Slider Control, 45/-, 73Ω 1-3a. Completely enclosed. Single Tube Slider, 35/-, 120Ω 1.75-0.9a. Completely Enclosed. Single Tube Slider Control, 20/-, 70Ω 2.8-0.65a. Double Tube Geared Drive Control, 32/6, 1.25Ω, 25a. Geared Drive Control, 27/6, 0.4Ω 25a. Geared Drive Control, 17/6, 11Ω 4.5a., 12/6, 3Ω 10a., 12/6, 1.2Ω 15a., 10/6, 1Ω 12a., 8/6. All Single Tube Slider Control, 12Ω 4a. Horizontal Sweep Control, 12/6, 0.4Ω 24a. Tapped, 8/6, 5.3Ω 8a. Fixed, 10/-, 605Ω 2.8-0.45a. Fixed, 10/-, Carr. on all Resistors, 3/-.

AMERICAN OHMITE RHEOSTATS. 25Ω 2a., 15/-, 15Ω 2.25a., 15/-, 60Ω 1.4a., 12/6, 15Ω 1.3a., 12/6, 10Ω 3.1a., 12/6, Twin Gang, 25Ω 0.75a., each 7/6, 380Ω 25 watt, 3/6. All Types Panel Mounting, 3in. dia. Spindles. Supplied Brand New. P.P. on all types 2/-.

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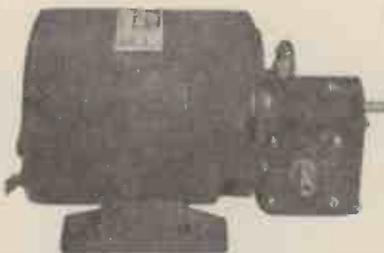
ROLLS-ROYCE COOLANT PUMPS. A heavy-duty turbine pump driven directly from a splined socket, 1,000-1,500 r.p.m., 1½in. bore outlet. Brand new in maker's cartons, 47/6. Carr. 4/-.

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CROYDON ENG. CO. GEARED CAPACITOR INDUCTION MOTORS. A.C. 200-240v. 30 watts, geared right angle, 300 r.p.m., motor shaft 1,400 r.p.m. continuous rating, complete with capacitor. Overall size 7½ x 4½ x 4in. £3/15/-.

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SPECIAL OFFER OF WODEN TRANSFORMERS Brand New. No. 1. Pri. 230v. Sec. 4,100 volts 5 m.a., 2v., 1.85a., 32/6. P.P. 2/6. No. 2. Pri. 230v. Sec. 390-0-390 volts, 150 m.a., 4-6.3 volts, 9 amps., 35/-, P.P. 3/6. No. 3. Pri. 200-250v. Sec. 290-0-290v. 200 m.a., 4v. 2.2a., 4.2-6.3 volts, 6.2 amps., 30/-, P.P. 3/6. No. 4. Pri. 110v.-250v. Sec. 330-0-330 volts, 100 m.a., 4 volts, 6amps., 4 volts, 1.4 amps., 25/-, P.P. 3/6.

A.M. ACCUMULATORS. 2 volt 75 A.H. at 100-hr. rate. Size 6½ x 6½ x 4in., with carrying handle. New 15/-, P.P. 3/6. 4 volt 18.5 A.H. at 12-hr. rate. Size 7 x 4½ x 3½in. New, 8/6. P.P. 3/6. Miniature 2 volt 3 A.H. Size 4 x 1½ x 1½in. Ideal for roadcell, bell circuits, parking lights, etc. Supplied new with charging instructions, 2/6 ea. P.P. 1/6. Three for 6/-, P.P. 2/-, Six for 10/6, P.P. 3/-. Or twelve in strong wooden cases, connected to give 24 volts 3 A.H. Size 12 x 7 x 4½in., 19/6. Carr. 5/-.

NUTS, BOLTS, WASHERS. Special bargains offer 5/- carton of 2, 4, 6 B.A. nuts, bolts and washers. P.P. 1/-, SLEEVING, mixed bundle, 1½-4 mil., various colours. Wonderful offer. 2/6. P.P. 8d

CARBON RESISTORS. 1-3 watt. Carton of 100. Good selection of values. 10/- per carton. P.P. 1/-.

MICA, SILVER MICA, TUBULAR CONDENSERS. Good selection of values. 10/- per carton of 50. P.P. 1/-.

ADMIRALTY VOLTAGE CONTROLLERS 1,000 ohm. 0.59/0.26 amps. Rotary switch type with 32 contacts. Completely enclosed with metal control handle. New in maker's carton at a fraction of manufacturer's price. 10/6. P.P. 3/6.



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

PREPARMENT ELECTRICITY METERS. 1/- in slot. A.C. 200-250v. tariff set to your requirements. 5 amp. 89/6, 10 amp. 80/-, 20 amp. 100/-, Reconditioned and Guaranteed. Carr. 5/-.

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RELAYS (Contactors), two heavy-make contacts; 12v. or 24v. either 3/6. Power Units; Input 200/250v. Outputs 250v. 60mA., D.C. and 6.3v. 2.5A. A.C. 30/-, **AMPLIFIER** V.H.F., with 2/726 A. (Klystrons), 2/717a, 25/-, Bendix MN26C. new, 70/-, RA-10DB, 90/- (Rail 10/-). **INDICATORS**, type 277, with lin. C.R.T., 4/VR91, 2/VR92, 37/6 (p.p. 3/6). Type 101, with VCR530 (6in. Blue, magnetic. Octal base), and 2/EB91, 2/EF91, 2/R10; new cond. 30/-, (Post 3/6). Type 1, with VCRX263, 2/EF52, 5/6/6, 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; BC434A Control boxes, 7/6. **NEW M.C. METERS**, 3½in. round flush, 50µA. 70/-; 100 µA., 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. 40 v. B/6; 300 v. A.C. 2½in., 15/-, **VIBRATORS**, Mallory G634C 12v. 4-pin. 7/6 6v., 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 4½v. battery, 8/6. **DRIVES:** slow-motion Admiralty 200:1 ratio, scaled 0-100, 5/6. **R1155 S.M.** "N" type, new, 10/6. **VIBRAPAK**, 6v. D.C. to 250v. 60mA., smoothed cased, 22/6. 12v. to 250v. 60mA., 18/6 (p.p. 3/6). **DYNAMOTORS** (post 3/6); 12v. to 250v. 10mA. and 6.3v. 2.5A., 11/6; 6v. to 250v. 60mA., 11/6. Type 2A. Input 12v. Outputs 300v. 240mA., 150v. 10mA., 6v. 5A. filtered, cased, 25/-, Potentiometers, miniature wire-wound, 6Ω, 600Ω. 1k or 2k, each 1/-, **CHOKES**, LF 10H 200mA., 8/6; Potted 10H 100mA., 7/6, "C" 5H 400mA., 10/6. **RELAYS**, 12/24v. 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:** 240v. 100mA., 4/-; 240v. 30mA., 3/6; 600v. 30mA., 5/6; 240v. 80mA., 5/6; 1,000v. 30mA., 7/6. Mic inserts, G.P.O. carbon, 2/6, bal. armature type, 2/6. **VALVEHOLDERS**, U.S.A. Octal. doz., 4/-, **ACCUMULATORS**, 2v. 4AH 2½ x 1½ x 3½in. 7/6. **TX. VAR. CONDENSERS**, 3kV. test; 50 or 100 pf., each, 7/6. **MONITOR** Type 56 (2 units-Oscilloscope and power unit), £8/10/- (rail 20/-). **TRANSFORMERS** 240v. input. Outputs: 12.6v., C.T., 1.5A., 7/6. 230v. Input. Output: 0/70/75/80v., 4A., Potted, 45/-. Wafer Switches, miniaturised, 2 role, 4 way, 4 bank, 3/6; Ceramic 3p. 3w. 2b., 3/6; Push switches, small, SPST, 1/-; Slide switches, SPDT, 1/6. **CONDENSERS**, block, paper; 4mfid. 1.5kV. at 140°, 7/6; 4mfid. 800v., 4/6.

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gives a sine wave output of 1 millivolt to 10 volts over the range 20-200,000 c.p.s. This is covered in four ranges, each directly calibrated. Complete with all valves and ready for use from 200/250 volts A.C. mains. £10 plus 4/6 carr./packing.



CR50 BRIDGE measures 10 pF to 100 mF and 1 ohm to 10 Megohms in fourteen ranges. Leakage test for condensers. Designed for bench use, measurements are quick and accurately made. Price complete £8/2/6, plus 4/6 carr./pack.

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Details of these instruments sent on receipt of stamped addressed envelope.

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COLLINS T.C.S. TRANSMITTERS & RECEIVERS

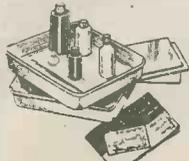


T.C.S. TRANSMITTER. Designed for Mains & Mobile operation covering 1.5-12 Mc/s (160-80-40 metre bands) consists of V.F.O., buffer, doubler, P.A. with internal push/pull modulator, provision for V.F.O. or crystal control on 4 channels. Output 25 watts phone, 50 watts C.W. Complete with aerial current meter scaled 0-3 amps R.F. and plate current meter scaled 0-200 M.A., for phone and C.W. Panel controls: Aerial coupling, plate tuning, aerial selector, aerial loading unit, band selector, oscillator selector emission switch, power switch, geared and calibrated tuning drive, microphone and key inputs. Used in used condition, complete with full details. **£9.10.0** carr. 15/-.

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, 12SK7-1 F.S. The 12A6 final puts 1.4 watts into 500 ohms with an input modulated only 30%. Panel controls: R.F. Gain, A.F. Gain, C.W. Pitch, band-switch, mod-C.W. switch, power switch, ground and aerial posts, M.O. or crystal frequency switch, speaker jack, card holder to log 30 stations, hand vernier tuning knob turning a large etched calibrated plate behind hair lined window, anti-backlash gear used. Used condition, Note.—If both items purchased together, **£17. Carr. 25/-.**

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You can now make your own printed circuits in the comfort of your own home. Etch-your-own kits do not require any skill or additional equipment, errors can be corrected at any stage, and can be completed within 1 hour. Each kit contains more than 60 square inches of laminated board and sufficient chemicals to make dozens of printed

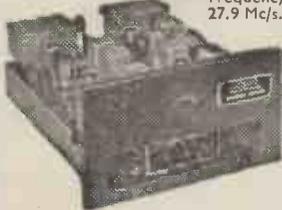


circuits. Highest quality materials and completely safe to handle. Absolutely any schematic can be made to printed circuit. This kit opens a whole new field for the radio constructor, hobbyist, etc., no matter how limited his skill. Complete kit, with comprehensive manual containing advice and illustrated examples on translating schematics into printed layouts, etc. Fully guaranteed. **ONLY 19/6.** P. & P. 1/6.

SPECIALLY DESIGNED MIN'ATURE KITS FOR OUR ETCH-YOUR-OWN PRINTED CIRCUIT KIT
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 All kits supplied entirely complete with full wiring and assembly details. Fully guaranteed.

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.



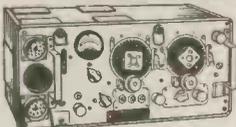
alignment meter, volume control, mike and phone inputs. 6 and 12 volt supply unit and dry battery case. **Complete Station only £8/10/-.** Carr. 20/- U.S.A. hand set 20/- extra.

POCKET MULTI-METER

2,500 o.p.v. Multi range. 6/30/120/300/1200 v. A.C., ditto D.C. 0-1k., 0-1 megohm; 400 micro-A., 12 M.A., 300 M.A.; -00 to +64-DB, 5 ranges 3x4 1/2 x 1 1/2 in. Large clear dial. Leads supplied. (List price £6/19/6.) **OUR PRICE £4/7/6.** P. & P. 2/6.



WIRELESS SET No. 19 Mk. II



This famous Transmitter-Receiver incorporates "A" Set —TX/RX covering 2-8 Mc/s. (37.5-15.0 metres). Set—VHF TX/RX covering 230-240 Mc/s. (1.2-1.3 metres) and intercom. amplifier. Complete with 15 valves 500 micro-amp check and tuning meter, circuits and instruction book (American manufacture). In used condition. **65/-.** Carr. 10/-.

COMMUNICATION RECEIVER R107

This magnificent 9-valve 3-wave band receiver gives world-wide reception over 1.2-17 Mc/s (18-250 metres). The sensitivity is 1 microvolt on C.W., and 2-6 microvolts on R.T. Panel controls include Bandwidth switch ("Wide" or "Narrow"), choice of AVC and BFO, Audio Filter, R.F. Gain, Aerial Trimmer. Has built-in Output stage with internal speaker. Headphones sockets. Incorporates internal A.C. mains power unit (100-250 v. A.C.) and 12 volts D.C. Vibrator pack. Size 24x13x17ins. These sets are extensively tested prior to despatch.

Supplied Complete and Ready for Immediate Use

Model 1, slightly used appearance, **£8/10/-.** Model 2, very good appearance, **£10/10/-.** Carr. 20/- (England and Wales), rest of U.K. extra.

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

U.S.A. TRANSMITTER B.C.625. Covering 100 to 156 Mc/s. 4-channel crystal controlled, using 6G6 osc., 12A6 harm. ampl., 832 harm. ampl. and driver and 832 R.F. output plate—modulated by P-P 12A6s which are transformer coupled to 6S17 speed amp. Supplied with circuits and operating gen. **ONLY 25/-.** P.P. 5/-.

D.M.34. America's finest little dynamotor offering 12 v. in with 220 v. out at 80 mA. With suppression and smoothing mounting base. Size 4 1/2 x 2 1/2 x 2 1/2 in. Original packing. **ONLY 35/-.** P. & P. 3/6.

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/-.

V.H.F. MOBILE AERIAL and Base, as used by Taxis, Police, etc., 7/6. P. & P. 2/6.

VERDIK HI-FI AMPLIFIER. 10-watt push-pull ultra-linear feedback. Beautifully styled in green stove enamel. Provision for tuner, bass and treble. 5-position selector for radio, tape, mike, tape, L.P. and std. records. List price 20 gns. **OUR PRICE £13/19/6.** P. & P. 7/6.

PORTABLE 10 LINE SWITCH-BOARDS. S.A.E. for details.

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Pocket-size battery operated gives INSTANT CHECK OF:

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

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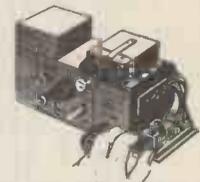
BUILD AN F.M. TUNER

With this miniature 9.72 Mc/s I.F. Strip. Has 6 modern miniature valves, I. F.T.'s etc. supplied with full F.M. Tuner conversion details. Hailed by all our previous purchasers as a wonderful F.M. Tuner. Brand new, only **40/-.** P. & P. 3/6.



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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.



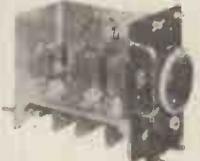
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12in. Co-axial Speaker. The woofer uses 6.8 oz. Alnico 5 magnet. Has 3in. tweeter and an electronic crossover network to separate the speaker functions. Frequency response: 40-17,000 cycles. Output 12 watts, impedance 8 ohms. **ONLY 120/-.** 8in., 2 1/2 in. tweeter, 10 watts, etc., **90/-.** P. & P. 4/- on each.



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.



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They're High and Low Impedance! These H.5.30 phones are the smallest used by the U.S. Air Force. 250 Ω 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 4,000 Ω. **ONLY 15/-** P. & P. 2/6.



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1/2in., 3/4in. or 1in. flanges (inside or outside) 6d. extra or each bend.

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48 sq. in.	4/-	176 sq. in.	8/-	304 sq. in.	12/-
80 sq. in.	5/-	208 sq. in.	9/-	336 sq. in.	13/-
112 sq. in.	6/-	240 sq. in.	10/-	368 sq. in.	14/-
144 sq. in.	7/-	272 sq. in.	11/-	and pro rata	
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Discount for quantities. Trade enquiries invited. Spray finished arranged for quantities of 25 or over.

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The same material can be supplied for panels, screens, etc. Any size up to 3ft. at 4/6 sq. ft. (sq. in. x 1/2) Post, up to 72 sq. in. 9d., 108 sq. in. 1/3, 144 sq. in. 1/6, 432 sq. in. 1/9, 576 sq. in. 2/-.

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Telephone: PAD 5891/7595



COMMUNICATIONS RECEIVER B28 (MARCONI CR100)

PRICE—ONLY £21

Later Model with Noise Suppressor £25

Carriage England and Wales 30/-. Send S.A.E. for further details.

COMMUNICATIONS RECEIVERS R-1155B

A first class 10 valve Communication and D/F receiver, covering 75 Kc/s. to 18 Mc/s. (16.2-4,000 m.) in 5 bands. The large scale and superior dual ratio slow-motion drive make tuning easy, and the R.F. stage and 2 I.F. stages ensure world-wide reception. ALL the receivers we sell have been thoroughly overhauled and completely re-aligned, and are in first class order. ONLY £7/19/6.

ALSO available, R-1155-N as above, but has 1.5 to 3 Mc/s. (100-200 m.) in place of the 75-200 Kc/s. band. ONLY £12/19/6.

A.C. MAINS POWER PACK OUTPUT STAGE

In handsome black-cracked steel cabinet to match the R-1155. Fitted with Bin. speaker. Just PLUG IN and switch on! Only the finest quality components are used, and we guarantee OUR power packs for 6 months. ONLY £6/10/-. Deduct 10/- when purchasing receiver and power unit together. Send S.A.E. for further details, or 1/3 for 14 page illustrated booklet giving technical data and circuits etc. (FREE with each receiver.) Add 10/6 carriage for receiver, 5/- for power unit.

HALLICRAFTER SX-24 RECEIVERS

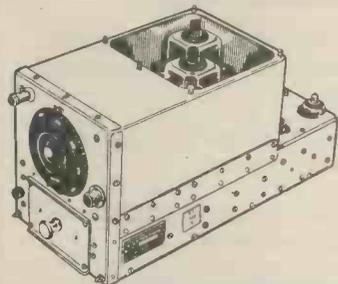
Covers from 540 Kc/s. to 44 Mc/s. in 5 bands. With separate bandspread tuning, variable selectivity crystal filter, B.F.O., "S" meter, noise limiter etc. For 117-230v. A.C. mains. In perfect working order and first class condition. £25. Carr. 10/-.

RCA AR-88 SPEAKERS

A high quality 3 ohm unit fitted into heavy gauge black cracked steel cabinet, size 10½ x 11½ x 6in. Fitted with rubber feet and 6ft. lead. Ideal for extension speaker, CR100, etc. In original cartons. BRAND NEW. 45/-. 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. Carriage 30/-.



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.

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. 24/19/6. CARRIAGE 25/6.

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No. 10. Consists of 500 Kc/s. crystal oscillator and a variable 250-500 Kc/s. heterodyne oscillator. This enables all intermediate frequencies between 500 Kc/s. and 10 Mc/s. to be produced. These frequencies are indicated on the calibrated scale. The calibrator may actually be used up to 30 Mc/s. The unit uses a CV-286 neon modulator, 1T4 crystal osc., 1T4 het. osc., and IR5 mixer. Operates from 300 v. 15 m/a., and 12 v. 0.3 A., but can be easily modified for 120 v. and 1.4 v. working. Size 7x7½x4in. In first class condition, complete with valves, crystal, instruction manual and circuit. One of our "best buys" at ONLY 59/6. Post 3/6.



RCA HF SWEEP GENERATORS



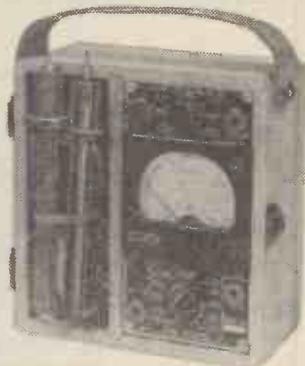
Laboratory type equipment designed for alignment of wide band RF and IF amplifiers. Comprises generator and regulated power supply unit each housed in grey cracked steel case 17 x 10 x 12in. Centre Frequency 5-65 Mc/s. Sweep width 0.2-20 Mc/s. Marker oscillator frequency 5-70 Mc/s. Operates from 105-125/210-230 v. A.C. Mains. Complete condition.

with 13 valves and Technical handbook. BRAND NEW condition. £39/10/-. Carr. 10/-.

RCP 20 RANGE TESTMETERS

1,000 ohms per volt, 400 micro-amp basic movement.

D.C. VOLTS	A.C. VOLTS
2.5 v.	2.5 v.
10 v.	10 v.
50 v.	50 v.
250 v.	250 v.
1,000 v.	1,000 v.
5,000 v.	5,000 v.
D.C. CURRENT	RESISTANCE
1 am.	500 ohms
10 ma.	100k. ohms
100 ma.	1 megohm
1 amp.	DECIBELS
	-10 to +69



In light oak case 6½ x 6 x 4½in., including lid. Complete with test leads and prods, internal battery, and instructions manual. ALL BRAND NEW and tested. LIMITED NUMBER 79/6. Post 2/6

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G.E.C. sealed, wire ends, 670 ohms.	2 H/D makes,	M1099	15/-
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S.T.C. size 1¼ x ¾ x ½in. 250 ohms.	2 C/overs, double contacts ...		7/6
Siemens High Speed, 1K + 1K ohms.	1 C/over.....		10/6

FURZEHILL BEAT FREQUENCY OSCILLATOR No. 5
 Push-pull output 0-10,000 c/s. of 0.5 v. at 10 ohms, or 0.50 v. at 600 ohms, monitored by 2½in. M/C meter. Incorporates set-zero control and 50 c/s. check. Operates from 100-250 v. 50 c/s. mains. In handsome instrument case, 17½ x 9 x 11in. Despatched in transit case, in perfect condition, tested, complete with 7 valves, circuit and instructions. A laboratory instrument for ONLY £12/10/-. Carr. 10/-.



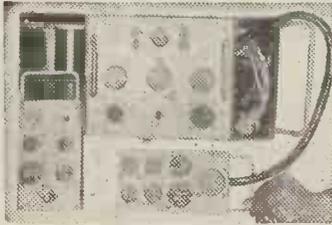
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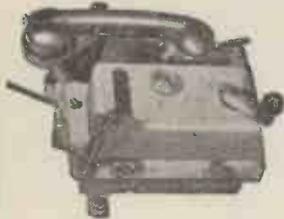
SURPLUS BARGAINS



Cable Tester Type 209

Mains operated with magic eye indicator. This tests insulation of complete cable assemblies of up to 18 cores. Also tests breeze plugs etc., £9.10.0 complete but not tested.

EX-ROYAL NAVY SOUND-POWERED TELEPHONE



These require no batteries and will go for long periods without attention. Complete with generator and sounder which gives a high-pitched note easily heard above any other noise. Also fitted with an indicator lamp which in quiet situations can be used instead of the sounder, or, where several telephones are used together, will indicate which one is being called. Size 7 1/2 x 9 x 7 1/2 in., wall mounting, designed for ships' use but equally suitable for home, office, warehouse, factory, garage, etc. Price 39/6 each, plus 4/6 carriage.

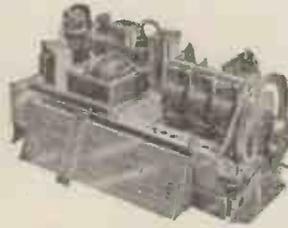
10 Valve 1 1/2 Metre Superhet

Ideal for Commercial T.V. These contain 6 valves type 8P61, and one each RL7, RL16, and EA50. Six I.F. transformers, 12 Mc/s band and hundreds of other useful components. Price 29/6, plus carriage and packing, 7/6. These receivers are unused.

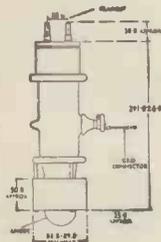


For the Serious Short-Wave Listener

This is undoubtedly a super receiver—5 wavebands, viz.: medium wave 560Kc-1.6 Mc., short wave 1.3 Mc-8 Mc., short wave 2.8 Mc-14 Mc., short wave 3.14 Mc-20 Mc. short wave 4.20 Mc-27 Mc. These use 7 valves and have H.F. stage and tuning indicator. Valves EF39, ECB35, EF39, EBC33, EL33, EM34, AZ31 (or their American equivalents 6Q7 etc.). Available less valves dial and cursor only £7.19.6. Actually the coil pack and tuner unit is worth more than this. A few less power pack £8.19.6. Circuit diagram available separately 1/6.

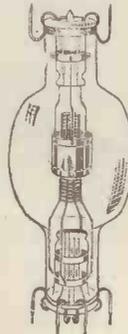


SPECIAL PURPOSE VALVES



Triode Type CV 1098, this is a high-powered air-cooled triode. Specification of which is as follows: Filament voltage 8.2 v., filament current 35 amps., anode dissipation 750 watts. Anode volts 25 kv. This valve is very suitable for R.F. heating at high frequencies and two of these in push-pull under Class C conditions would have an output of approximately 2 kilowatts. Brand new, still in original shockproof packing, price £5 each. Carriage and insurance 10/-.

MAGNETRON 725 A American make and type. Brand new, unused, few only, £5/10/-. Others available, state your requirements.



TETRODE TYPE VT31

This is a high-powered air-cooled tetrode. Specification of which is as follows—heater volts 11.25, heater current 8 amps., maximum anode voltage 5 kv., anode dissipation 250 watts, size approximately 1 1/2 in. long and 6 in. across the bulb.

Limited quantity only at £4 each, still in original packing. Carriage and insurance, 10/-.

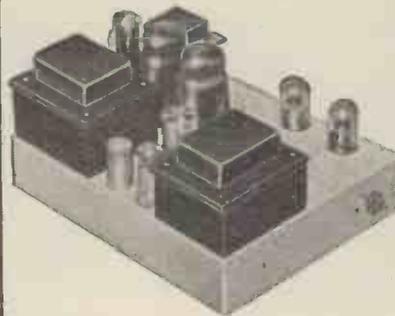
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25-watt High-Fidelity Amplifiers by world-famous manufacturers listed at 28 gns. Special Offer:—In sealed cartons at 15 gns. each—with guarantee and instruction book, carriage 5/- extra.

Suitable for use with all types of stereo and monaural pre-amplifiers. Brief specification—flat frequency response from 2 to 160,000 kc/s per sec. Distortion less than .1 at 15 watts, less than .3 at 25 watts. Gramophone test report on application. Pamphonic 1004 Hi-Fi 10-watt shelf-mounting amplifiers. Listed at 25gns. Offered at 15 gns.

Both the above items can be demonstrated at our Edgware Showrooms.

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SPECIAL THIS MONTH

Battery Charger Rectifier—selenium 12-15 v., 5 amp, 9/6.

Blank Metal Chassis—all 2 1/2 in. deep from 18 gauge aluminum. Sizes: 6 in. x 2 1/2 in. 4/6; 7 1/2 in. x 6 in. 6/6; 13 1/2 in. x 9 in., 10 in. x 7 1/2 in., 7/-; 11 1/2 in. x 7 1/2 in., 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, 2/9/6.

Waterproof Heater Wire—suitable electric carpets, electric blankets, heat 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

0-500 microamp	2 1/2 in. flush	17/6
250-0-250 microamp	2 1/2 in. surface	27/6
750 microamp	2 1/2 in. surface	17/6
0-0-5 microamp	2 1/2 in. flush	17/6
0-30 milliamp	2 1/2 in. flush	17/6
0-100 milliamp	2 1/2 in. flush	15/-
0-300 milliamp	2 1/2 in. flush	15/-
0-500 milliamp	2 1/2 in. flush	15/-
0-1 milliamp	2 1/2 in. flush	25/-

Luminous Switch, double pole designed for electric blankets, neon indicators glow when appliance is switched on, 10/-.

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 equivalent RM5, 12/6

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

Flament Transformer, 6.3 v., 1 1/2 amps, 6/6.

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

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

Bi-metal Strip with heavy duty contact—ideal for thermostat, fire, lamp, etc., 2/6.

Neon Lamp—midget wire led, ideal mains tester, etc., 2/-, ex Gort., 1/6.

Phillips Trimmers—0-30pF, 1/- each, 9d. doz.

Set of 8 Allen Keys, 3/6.

Heavy Duty Test Prods—red and black with plug-in lead attachments, 3/6.

Install these 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, post 1/-.

Ditto, unbranded, 6/6, post 1/-.

Cold Cathode Valve CV413. Voltage regulator or trigger switch—unused but ex-equipment, 2/- each.

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

Slidylok Panel Mounting Fuses with carrier, 5 amp, 2/- each, 15 amp, 2/6 each. Belling Lec 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 1/2 and 1 watt, 5/- for 50.

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

Mains Transformer. Standard 230 v. input 250-0-250 at 80 mA., 6.3 v. at 5 A., 12/6.

Toggle Switch. Standard metal body, type with round dolly, fixing ring and on/off indicating plate, 1/3 or 12/- doz.

Metal Rectifier. 250 v. 60-80 milli-amps. Ideal for mains set or instrument or to replace that expensive valve, 4/6.

Screened Cable. Rubber covered flexible with metal braiding, ideal for microphone or gramophone extensions, 4d. per yd., 30/- per 100 yds.

Install 2-Way Switches. Our outfit comprises: 30 yd. multicore cable, two 2-way switches, two wood blocks. Full instructions, 9/6 each, post and insurance, 2/6.

Long, Medium and Short Wave Coil Pack. An exceptionally well made coil pack which covers the standard long, medium and short wavebands for 485 k/c. L.F., complete with diagram of connections, 14/6, plus 1/6 postage and insurance—limited quantity only.

Car Battery Charger, 12 v. 4 a. variable charge, fitted meter, 55/- plus 3/6 post.

Amplion A224 Tape Recorder



Product of one of the oldest names in the radio industry. This excellent tape recorder represents the best value available today. Suitable for normal A.C. mains uses Mullard E. range of valves and has power output of 3 watts with excellent frequency response. Tape speeds 3 1/2 in. per sec. gives playing time of 1 1/2 hours from standard 5 in. reels (two tracks). Uses 7 in. x 4 in. high flux speaker and has all the normal controls inputs and outputs including extension speaker socket. Special features include mixing from microphone and gram., super impose button for adding second recording to existing tape and automatic device for preventing accidental erasing. Price 25/6 gns. H.P. terms and full technical details on request.

Thermostats



1 1/2 amp	3/6
2 amp G.M.B.	5/6
5 amp	8/6
16 amp	15/-
16 amp—wall mounting	27/6

Note all are skeleton type similar to illustration except the wall mounting type which is encased in metal box with scale and pointer.

Yaxley Switches

1 Pole 3 Way	1/6
1 Pole 5 Way	2/-
1 Pole 11 Way	2/6
2 Pole 2 Way Ceramic	2/6
2 Pole 4 Way	2/-
2 Pole 6 Way	2/6
2 Pole 8 Way	3/6
2 Pole 11 Way	3/6
2 Pole 12 Way	4/6
3 Pole 3 Way	1/6
3 Pole 6 Way	3/6
4 Pole 4 Way	3/-
6 Position Shorting	2/-
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6 Pole 3 Way Ceramic	3/6
8 Pole 2 Way	2/6
9 Pole 3 Way	2/6
12 Pole 2 Way	2/-

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Our 1960 catalogue now ready gives constructional hints and circuits for the following items:

- Moisture operated switch
- Simple but clever signal tracer
- Versatile power pack costing only 10/-
- Instantaneous heater for workshop or den
- Six transistor pocket superhet
- Simple bed warmer
- Photo-flood controller

Send for this catalogue today—price 2/6, refundable from purchases.

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 whitell case 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/- carriage and ins.
Inductor 40 for 4ft. 40-watt lamp	32/6+4/6 " " "
The Three-Forty: for 3ft. 40-watt lamp	31/6+3/6 " " "
Inductor 20 for 2ft. 20-watt lamp	29/6+3/6 " " "
Circle Light for 40-watt circular lamp	49/6+3/- " " "

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 carriage and ins.
Three Forty complete with tube ready to work... 39/6+4/6

The Dulci F.M. T/2 Hi-Fidelity F.M. Tuner



The Tuner which includes every feature and refinement for perfect reception! reliability and simplicity of operation. An exclusive feature Automatic frequency control makes this the finest tuner available. Uses 7 valves and metal rectifier has its own internal power supply and sockets for audio output and aerial input. Limiting on two stages provides constant output free from interference and is therefore ideal for tape recording. Engraved copper bronze fascia and modern styling complete—a perfect tuner. Size approx. 2 1/2 in. x 3 1/2 in. x 9 1/2 in. Highly suitable for working with DPA10 amplifier. Price £19.17.6. H.P. terms and full technical specification on request.

Unique Opportunity to build Fine Transistor Set

Constructor's parcel: to build Pocket 8 Transistor Set as currently being sold at £17/17/-. Parcel comprises modified two-tone cabinet as illustrated, tuning dial, two gang tuning condenser, combined bakelite chassis/printed circuit and easy-to-follow circuit. Costing value 87/6—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.



Crystal Mike by Acos



Model 39/1 this is ideal for tape or general amplifiers complete with screened lead 39/6 plus 1/- post.

A.C./D.C. Multimeter Kit

Ranges: D.C. volts 0-5, 0-50, 0-100, 0-500, 0-1,000. A.C. volts 0-5, 0-50, 0-100, 0-500, 0-1,000. D.C. milli-amps. 0-5, 0-100 0-500. Ohms 0-60,000, with internal batteries 0-500,000 with external batteries. Measures A.C./D.C. volts, D.C. current and ohms. All the essential parts including metal case, 2 1/2 in. moving coil meter, selected resistors, wire for shunts, range selector switches, calibrated scale and full instructions, price 19/6, plus 2/6 post and insurance.



Beginner's Superhet

As supplied to many schools and colleges. A simple basic superhet—easy to understand and which can be progressively extended—ideal for students—components include—valves—metal rectifier tuning condenser—1 F transformers, etc. In fact complete superhet except speaker. Price £3 plus 3/- post and insurance. Data included free or sep. 1/6.



Band III Converters

Suitable Wales, London, Midlands, North, Scotland, etc. All the parts including 2 EF80 valves, coils, fine tuner, contrast control, condensers and resistors. (Metal case available as an extra). Price only 19/6, plus 2/6 post and insurance. Data free with parts or available separately, 1/6. Please send two more kits, the one you sent last week is performing magnificently. We receive this sort of letter every day of the week, so if you have hesitated because you thought our kits too cheap you need hesitate no longer.



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Manor Park, E.12.

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266 London Road,
Croydon.
Phone: CRO 6558.
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Wilkinsons EST. 1921

METERS GUARANTEED

F.S.D.	Size	Type	Price
50 Microamps	2½ in.	MC/FR	70/-
100 Microamps	3½ in.	MC/FR	70/-
500 Microamps	2 in.	MC/FR	25/-
500 Microamps	2½ in.	MC/FR	37/6
1 Milliamp	2 in.	MC/FS	27/6
1 Milliamp	2½ in.	MC/FR	35/-
30 Milliamps	2½ in.	MC/FR	12/6
100 Milliamps	2½ in.	MC/FR	12/6
200 Milliamps	2½ in.	MC/FR	12/6
500 Milliamps	3½ in.	MI/FR	30/-
5 Amperes	2 in.	MC/FS	27/6
15 Amperes	2 in.	MC/FR	10/6
25 Amperes D.C.	2½ in.	MI/FR	7/6
0-0-50 Amp.	2 in.	MC/FS	12/6
30-0-30 Amp.	2 in.	MC/FR	15/6
20 Volts	2 in.	MC/FS	10/6
40 Volts	2 in.	MC/FS	10/6
300 Volts	2½ in.	MI/FR	25/-

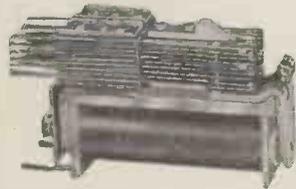


GROSS POINTER METERS. 2 separate 100 microamp movements, 22/6. **MICROAMMETER.** 250 F.S.D. 3½ in. F.R. Sangamo Mod. S.37. Scaled for valve voltmeter. Circuit available free. 55/-.

Postage 1/6 extra for above meters.

CATHODE RAY TUBES. 2AP1, 25/-, 139A 35/-, 5BP1 55/-, Post 3/-. **TEST PRODS.** Retracting points, fused, flex and terminals, 5/6. Post 6d.

RELAYS P.O. TYPE 3000.



Built to your own specification
Keen Prices
Quick Delivery
Contacts up to 8-Changeover

SPECIAL OFFER. YOKES for Type 3000 Relays 30/- doz. Armatures 9/- doz. Armatures (adjustable) 18/- doz.

MINIATURE RELAYS:

Siemens High Speed Sealed.		S.T.C. and G.E.C. Sealed.	
2.2Ω + 2.2Ω H96A	15/6	2Ω	2 C O 4184GA 18/6
145Ω + 145Ω H96C	19/6	700Ω	2 C O 418GD 19/6
500Ω + 500Ω H96D	22/6	2500Ω	1 make HD 4186EE 22/6
1700Ω + 1700Ω H96E	25/-	2700Ω	2 C O 4184GE 21/6
Siemens High Speed Open.		180Ω	2 m 2 b M1087 19/6
100Ω + 100Ω H85N	15/-	670Ω	4 C O M1092 21/6
1000Ω + 1000Ω H95A	17/6	2500Ω	1 C O M1022 22/6
1700Ω + 1700Ω H85L	17/6	5000Ω	2 C O M1052 25/-

Comprehensive range available from stock.

SWITCHES. 1 hole fixing, 3 amp. 250 volt.

1/6 each, 12/- doz.

RACKS—POST OFFICE STANDARD. 6ft. high with U-channel sides drilled for 19in. panels, heavy angle base, 4ft. 10in. in stock.

ROTARY CONVERTERS. Input 12 D.C. Output 230 A.C. 50 cy. 135 watts. In fitted case with variable resistance, 0/300 voltmeter. The ideal job for television where A.C. mains are not available. £10, carr. 15/-. Special connectors, one fitted with 6ft. heavy duty flex and clips for D.C. side. 10/- set, post 1/-. **CONVERTERS ONLY.** 12 volt or 24 volt. 28/10/-. Cge. 7/6.

SOLENOIDS. 12 volt D.C. with 3½ in. lever. Ideal for remote control, model railways. 5/- ea., post 1/6. Unit of 26. £4/6/8. Cge. 15/-.

NIFE BATTERY. Nickel cadmium. 6 volts 75 amp., crated and connected. Alkaline filled. Brand new, £7/10/-. Carr. 15/-.

LOUDSPEAKERS. P.M. Elac 5in. round 15/6, post 1/6. Axiom 150 dual cone 12in. 15 watts 15 ohms, fully dustproof, £7/19/6, post 7/6. Pye 10in. portable 3 ohms 50/-, carr. 7/6.

JACK PLUGS. Cylindrical bakelite screw-on cover, 2 contact 2/6, post 6d.

SOCKETS. One hole fixing for above, 3/6. Post 6d.

TELEPHONE PLUGS TYPE 201 with headphone cord. 3/- each, post 1/-. Large quantities available from stock.

VARIAC TRANSFORMER. Input 230 volts. Output infinitely variable 0-230 volts and 0-270 volts. 9 amp., bench or panel mounting. £15, cge. 12/6.

TERMINAL BLOCKS. 2-way 4/- doz. or box of 50 for 15/-, 3-way 6/- doz., 50 for 22/6. Post 1/6.

AIR BLOWER. 230 volt A.C. 15in. fan. Volume of free air at max. r.p.m. is 1,250 cu. ft. per min. At maximum efficiency 900 cu. ft. per min. Brand new £25. Carr. 20/-.

XPELAIR EXTRACTION FANS. 7½ in. blades, Baffle outlet 190/-, Cge. 5/-

HEADPHONES. Balanced armature type DLR5. 10/6 pr., post 1/6.

HEADPHONES. High resistance 4000 type CHR, 12/6 pr., post 1/6.

HEADPHONES. Balanced armature type DHR, 17/6 pr., post 1/6.

LOUDHAILERS RE-ENTRANT TYPE all-metal 15in. diameter with mounting bracket £6/10/0, carr. 10/-.

AVO TEST BRIDGES. 220/240 volt A.C. Measure capacities from 5 pf. to 50 mfd. and resistances from 5 ohms to 50 megohms. Valve voltmeter range 0.1 to 15 volts and condenser leakage test. BRAND NEW. Full working instructions supplied with instrument. £9/19/6. Post 3/-.

A LARGE AND COMPREHENSIVE STOCK OF WIRELESS AND ELECTRONIC COMPONENTS



TELEPHONES Easy to Fix

TELEPHONE SET TYPE "A" Ringing and speaking both ways on a 4-core cable. Very loud and clear over any distance. The handsets are as illus. and the set is complete except wire. 4-core at 8d. per yard or 2-core at 3d. per yard extra. Price 75/- set, post 3/6.

SET B. Two headphones connected to breast microphones, with leads, plugs and fitted carrying cases. Join instruments together with two wires and 1½ volt battery for a super Intercom., 25/-, post 3/6.

SET "C" Similar to set "A". Instead of P.O. Type handsets, two P.O. Desk Type Instruments are supplied with usual drawer in base. Complete ready for use. Price 150/-, post 7/-.



10 AMP BATTERY CHARGER

HERE IS YOUR CHANCE TO PURCHASE A BRAND NEW UNIT WORTH £40! FOR OUR SPECIAL PRICE **£17.10.0**
Carriage 20/-.

Input 200/250 v. A.C. 50 cy. Output 10 amps., 22 volts D.C. Controlled by two 4-position switches for fine and coarse control which enables 6 to 24 volt batts. to be charged. Brand new with 0/12 ammeter. Fused A.C./D.C.

BATTERIES. Portable Lead Acid type, 6 volts 125 ampere hours. In metal case 16in x 8in. x 1½ in. (Two will make an ideal power supply for our 12 volt Rotary Converters). Uncharged 88/10/- each, carriage 15/-, 24 volt 85 ampere £15/- each, carriage 15/-.

UNI-PIVOT GALVANOMETER by Cambridge Instruments, 50-0-50 microamps., dia. 4 in. Knife pointer, mirror scale. Complete with leather carrying case. Ideal for laboratory use. £10, carriage 3/-.

FLIGHT TO GROUND SWITCHES. 5C/2828 as used on aircraft. Very robust, will carry a very heavy current 25/- each; or in pairs with auxiliary switch 50/-, post 3/-.

OSCILLOSCOPE. Type 43. With 3½ in. C.R.T. 138A, 4 — 617, 3—VR54, 574, VU120. Brand New with usual controls, power-pack and leads. Suitable for 230 volts, £10/10/-, carr. 12/6.

SIGNAL GENERATOR TYPE 52A. Input 230 volt 50 cycles; complete with leads, dummy antenna. Brand new in transit case. 6 to 52 Mc/s. inclusive in 4 bands with calibration charts. Coarse and fine attenuators. Int. and ext. mod. Output 0.5 volt to 100mv. impedance 70 and 100 Ω. £10. Carriage 10/-.

MOTORS. 12 volts D.C. Reversible. 2 in. x 1½ in. Spindle ½ in. x ½ in., 10/6 each, post 1/6.

SYNCHRONOUS MOTOR. 200/250 volts A.C. 60 r.p.m., suitable for electric clocks, etc., 25/-, post 2/6.

MAINS MOTORS. Capacitor 230 v. A.C. 1/40th hp 1,400 r.p.m. 55/-, post 3/-.

GEARED MOTOR for model maker, small but powerful, 12/24 volts A.C./D.C. 4/8 r.p.m., 35/-, post 2/6.

GEARED MOTOR 220/240v AC 175r.p.m. torque 15lb.in. Klaxon, £10, cge 15/-.

MAINS TRANSFORMER WITH RECTIFIER mounted on top. Giving a D.C. output of approx. 30 to 40 volts 1 amp. Price 27/6 each, post 2/6.

SELENIUM METAL RECTIFIERS.

Charging Rectifiers Full Wave Bridge

12 Volts 1 Amp 8/6 each 24 Volts 1 Amp 13/- each
12 Volts 2 Amps 13/6 each 24 Volts 2 Amps 24/- each
12 Volts 3 Amps 16/6 each 24 Volts 3 Amps 28/- each
12 Volts 4 Amps 20/- each 24 Volts 4 Amps 36/- each

Discounts for quantities of above charging rectifiers.

MAINS TRANSFORMERS to suit above rectifiers.

12 Volts 1 Amp 12/6 each 12 Volts 4 Amps MT5 25/- each
12 Volts 2 Amps 24/- each CT109 12 Volts 4 Amps CT107 29/6 each
12 Volts 2.5 Amps 22/- each MT5B 24 Volts 3 Amps 25/- each

RESISTORS EX STOCK IN QUANTITY WIRE WOUND, HIGH STABILITY CARBON ETC., BEST MAKES AT LOWEST PRICE.

ELECTRO-MAGNETIC COUNTERS

COUNTING UP TO 9999

Type 16A
2,300 ohms 75/230 v. C.D.,
15/- each. Post 1/6.

Type 17A
3 ohms 2/6 v. D.C., 15/- each.
Post 1/6.

VEEDER-ROOT MAGNETIC COUNTER. General purpose type with zero re-set. 800 counts per minute up to 999999. 48 volt D.C. 55/-, post 2/6.

MAP READING LAMPS, EX-R.A.F. NAVIGATOR'S CHART MAGNIFIERS 3in. lens complete with batteries, bulb and dimming switch 12in long. 37/6, post 2/6.

THERMOSTAT SATCHWELL, 12in. stem 0/250 volt A.C./D.C. 15 amps A.C. 10 to 90 degrees cent. 25/-, post 2/6.

ROOM THERMOSTAT. Adjustable between 45 and 75 deg. Fahr., 250 v. 10 amp. A.C. Ideal for greenhouses etc., 35/-, post 2/-.

THERMOSTAT. For frost protection, on at 34 deg. F., off at 49 deg. F., 1½ amps. at 250 volts, adjustable, 4/6, post 1/-.

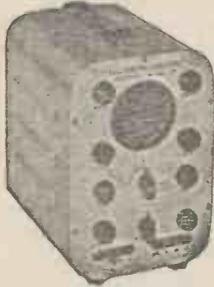
SIMMERSTAT by SUNVIC Plug-in type with knob control, 15 amps 3-pin, 200/250 volts. 35/-, post 2/-.

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D.C. OSCILLOSCOPE



A.C. MAINS 200-250 VOLTS

SIMPLIFIED SERVICING
PROBLEMS WHEN USING
THE
'TESTGEAR' SCOPE
3in. D.C. OSCILLOSCOPE

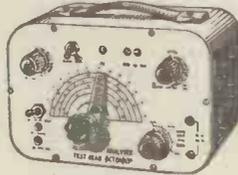
Engineered to precision standards, this high-grade instrument is made available at the lowest possible price, incorporating the essential features usually associated with luxury instruments. This "SCOPE" will appeal particularly to Service Engineers and Amateurs. A high gain, extremely stable differential Y-Amplifier (30 mV/C.M.).

Provides simple sensitivity with A.C. or D.C. 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, 6in wide, 9in deep. Wgt. 11lbs. £15.15.0 plus P. & P. 7/6, or 30/- deposit, plus P. & P. 7/6 and 12 monthly payments of 2/6/6.

FULL 12 MONTHS' GUARANTEE INCLUDING VALVES AND TUBE

ALIGNMENT ANALYSER TYPE MC12

A.C. MAINS, 200/250 volts. Provides—"WOBBULATOR" (SWEEP 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—30 pf and 0—120 pf. SPECIAL FACILITY enables true resonant frequency of any tuned ckt. I.F. transformer etc. to be rapidly determined. Cash price £6.19.6 and 5/- P. & P. H.F. terms, 25/- deposit and 5/- P. & P. and 6 monthly payments of 21/6.



B.S.R. MONARCH U48 with STEREO HEAD



4-speed plays 10 records 12in., 10in., or 7in. at 33, 45 or 78 r.p.m. Intermixes 7in. 10in. and 12in. records of the same speed. Has manual play position; colour brown. Dimensions: 12in. x 10in. Space required above baseboard 4in., below baseboard 2in. Fitted with Full-FI turnover crystal head. £7.19.6 Plus 5/- P. & P. (Standard Head £6.19.6 Plus 5/- P. & P.)



PLAYER CABINET

Finished in 2-tone leatherette, will take B.S.R. U48, with room for amplifier and 7in x 4in speaker. Overall size 15in. x 13in. x 9in. Similar to the above in POLISHED WALNUT, will take Coltara.

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

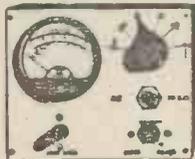
13 CHANNEL TUNER

INCREMENTAL TYPE

34 to 38 Mc/s. complete with PCF80 and POC84. Tested and guaranteed. Complete with fitting instructions and knobs.

39/6 Plus 3/6 P. & P.

AC/DC POCKET MULTI-METER KIT



Comprising 2in. moving coil meter, scale calibrated in A.C./D.C. volts, ohms and milliamperes. Voltage range A.C./D.C. 0-50, 0-100, 0-250, 0-500. Milliamperes. 0-10, 0-100. Ohms range, 0-10,000. Front panel, range switch, wire-wound pot (for ohms zero setting), toggle switch, resistors and rectifier. Basic movement, 2 mA. In grey hammer finish case.

196 Plus Built and tested P. & P. 1/6. 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. 200-0-200 v. 75 ma., 6.3 v., 2.5 amp., 5 v., 2 amp., 10/8. 280-0-280, 40 ma., 6.3 v., 2 amp., 6.3 v., 1 amp., 10/6. Postage and packing on the above 3/-.

SIGNAL GENERATOR



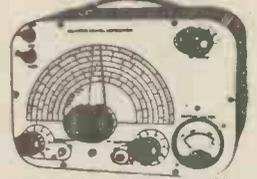
Coverage 100 Kc/s.-100 Mc/s. on fundamentals and 100 Mc/s. to 200 Mc/s. on harmonics. Metal case 10in. x 6in. x 5in. grey hammer finish. Incorporating three miniature valves and Metal Rectifier. A.C. Mains 200/250 v. Internal Modulation of 400 c.p.s. to a depth of 30%. Modulated or unmodulated R.F., output continuously variable 100 millivolts O.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 Mc/s., 2.75 Mc/s.—8.5 Mc/s., 8 Mc/s.—28 Mc/s., 16 Mc/s.—55 Mc/s., 24 Mc/s.—84 Mc/s. Metal case 10in. x 6in. x 4in. Size of scale 6in. x 3in. 2 valves and rectifier A.C. mains 230-250 v. Internal modulation of 400 c.p.s. to a depth of 30 per cent. modulated or unmodulated R.F.. Output continuously variable 100 millivolts O.W. and mod-switch variable A.F. output and moving coil output meter. Grey hammer finish case and white panel. £4/19/6 Accuracy plus or minus 2%.



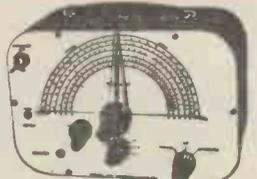
Or 25/- deposit and 4 monthly payments 21/6. P. & P. 5/- extra.

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. x 2in. x 2in.

25/-

Plus P. & P. 1/6

Circuit diagram free with unit.

1/-

8 WATT PUSH-PULL AMPLIFIER

COMPLETE WITH CRYSTAL MIKE AND 8in. LOUDSPEAKER



A.C. mains 200/250 v Size 10in. x 6in. x 2in. Incorporating 6 valves, H.F. pen., 2 triodes, 2 output pens, and rectifier. For use with all makes and types of pick-up and mikes. 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 30 Kc/s. Output 8 watts at 8% total distortion. Noise level 40 db. down, all hum. Output transformer tapped for 8 and 15 ohm speech coils. For use with 8td. 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/-.

6 watt PUSH-PULL AMPLIFIER

A.C. mains 200/250 v. Incorporating 4 valves and metal rectifier, 2 inputs, high and low, and controls for same. Separate controls for Bass and Treble lift. Size of chassis 11in. x 4in. x 2in.

59/6

Plus P & P. 5/-.

2-TRANSISTOR POCKET RADIO

Plus Germanium diode, fully tuneable over medium and long waves. Size 3in. x 4in. x 1in. Complete set of components including case, 2 transistors and earpiece (less batteries). Point to point wiring diagram 1/6. (Free with kit.)

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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.

**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. Wgt. 5 lbs. Size 7 in. x 7½ in. x 4 in. A miniature B.C.221 in every respect. A must for every laboratory, etc. **ONLY £4/19/6. P. & P. 2/6.**

AVO MODEL 40



Admiralty Pattern No. 47A. Supplying 40 ranges of current, voltage and resistance tests. Complete in specially made wooden carrying case with leads and batteries, ready for use. Perfect cond. **£10/19/6. Carr. 5/-.**

ACCUMULATORS



12v. 25A.H. New and unused. Housed in strong wooden case for extra protection, 45/- Carr. 7/6. 2 v. 100. A.H. 75 actual. Ex Govt. New and unused. Complete with carrying handle. Size 6½ x 6½ x 3½ in., 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/-.

**EVERSHED & VIGNOLES
MEGGER CIRCUIT TESTER (low reading ohm meter)**

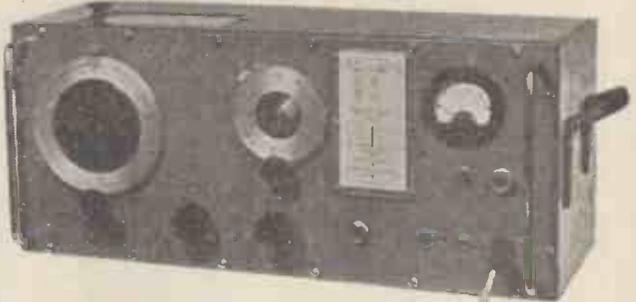
2 ranges. 0-3, 0-30 ohms. The perfect meter for continuity and polarity testing. Complete with test leads and ready to use. Brand new. Only **£4/17/6. P. & P. 3/-.**



GEE ^{ros} RADIO ^{ltd.}

15, LITTLE NEWPORT STREET, LONDON, W.C.2. GER 6794/1453
ADJOINING LEICESTER SQUARE TUBE STATION — Open 9-6 Weekdays 9-1 Sat.

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/-.**



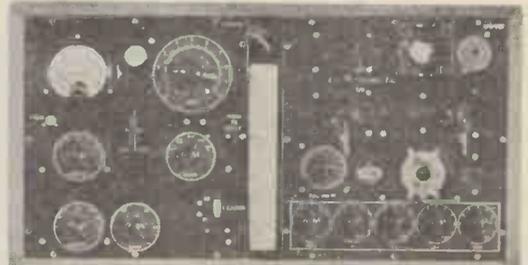
ALSO MARCONI SIGNAL GENERATOR TYPE TF390G for 200-250 v. A.C. mains input. Freq. range 4-16 Mc/s. and 32-100 Mc/s. indirect calibration. Output 1 uv to 100M/V. 400 c/s internal modulation. In good order **Only £12/10/- Carr. 20/-.**

BRIDGE MEGGERS



Evershed and Vignoles Series 2 in perfect condition. 250v. £22 carr. paid. Leather case available at 20/- extra.

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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/-.**

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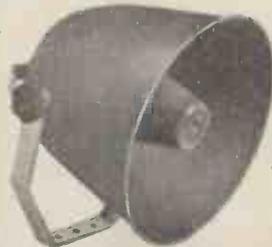
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ROTARY CONVERTER. 24 v. D.C. to 230 v. A.C. 50 cycles, 150 watts. Brand new and unused **£8/10/- Carr. 7/6.** Ditto, 100 watts, **£6/9/6 Carr. 7/6**
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Heavy duty 20 watts all-metal. 15 ohms. Diameter 15 in., length 15 in. (approx.). Good condition. **£6/10/- Carr. 10/-.** Ditto, Brand new **£8 Carr. 10/-.**

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12 in. P.M. 15 ohms 15 watts, 30-14,000 c.p.s. **Our price £4/10/-.**
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**HEAVY DUTY — ALL STEEL
TRIPOD STANDS**

Adjustable every 6 in. to approx. 9ft. 6 in. when fully extended. (Folds up to only 4ft. 6 in. for storage). Suitable for outdoor speakers, public address systems, floodlighting, etc., etc.

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WITH OR WITHOUT HIGH-GRADE TRANSFORMER TO SUIT. These are new goods, best makes, not reconstructed Government surplus. Popular types, 6 v. 1 a., 4/-, 2 a., 7/6, 12 v. 2 a., 8/6, 12 v. 1 a., 7/6, 12 v. 3 a., 15/-, 6 a. alloy-finned type, 27/6, 24 v. 0.3 a., 9/-, 0.6 a., 12/6, 24 v. 1 a., 13/6, 2 a., 15/6, 24 v. 3 a., 21/-, 50 v. 1 a., 24/-, 50 v. 2 a., 42/-, 130 v. 300 ma. h. wave, 38/-, 250 v. 300 ma. do., 65/-, 110 v. 1 a. bidge., 48/-, 130 v. 80 ma. bidge., 21/- Postage 9d. extra each.

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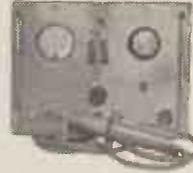
No. 1, a kit for 2 v., 6 v., 12 v., 3 amp. transformer, rectifier, ammeter, all high-grade new parts, not rubbish, 52/6, unique convector housing for same, as illust., 12/6, p.p. 3/-, ditto, but 2 amp., 43/-, case 12/6, p.p. 3/-.

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Voltage indication by Magic Eye.

Power supply 200-250 A.C.

Dimensions 18 x 18 x 13in.

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Made for flash testing and for the measurement of the breakdown voltage of electrical components and insulation. A spring-loaded switch is fitted in the test prod which keeps the 200/250 v. supply switched off. Original cost £75

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(M/L or M/S Waves.) Size 4 1/2in. x 3 1/2in. x 1 1/2in. Variable sensitivity control Vari Q ferrite rod aerial. "Sonotone" min. dynamic earpiece with insert. Months of listening pleasure from pencil battery. Complete kit with Ediswan transistor and easy build diagrams 37/6. P.P. 2/-.

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(M/L Waves & Trawler Band. (size: 6 1/2in x 4 1/2in x 1 1/2in)

As the Transigen Three but with Push-Pull output stage. Uses five transistors including MULLARD OC45 and EDISWAN Transistors. New improved 3in speaker. Complete kit 58/7/6. P.P. 2/6. Easy build practical wiring diagrams free with kit.



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Entirely self contained (no external aerial required), B.F. stage with MULLARD OC45 and two EDISWAN transistors. Combined volume and sensitivity control.

On test (50 miles from London) tuned in the Home, Light, Third and in the evening Radio Luxembourg, A.F.N. and many others. Attractive pale blue polystyrene case with red grille. This receiver will operate a speaker in wood recreation areas. Complete kit with easy build diagrams, battery and B.A. Hand Speaker-Phone, 75/- P.P. 2/6.

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Parts price list and circuits for the above kits 2/6 set of four.

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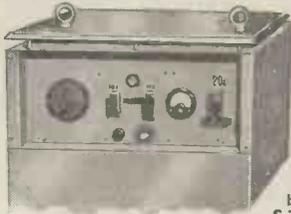
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Available in Grey Cabinet.

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(Circ. diag. and instr. loaned for 10/- deposit)

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OUTPUT: 24 volts, 10 amps. D.C.
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IN ATTRACTIVE CASE

The best portable telephone ever made. With a range of up to 5 miles ideal for

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2 perfect sets in individual carrying cases, complete with long life batteries, bells, magneto and 100ft. telephone cable.

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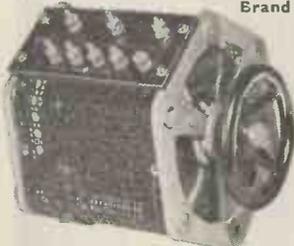
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Brand New



OUTPUT (2KVA) Completely Variable 0 to 270 volts. 9 amps.
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A SHROUDED FULLY VARIABLE TRANSFORMER FOR BENCH OR PANEL MOUNTING
SIZE:—Approximately 8½ Cube.
WEIGHT:—Approximately 30 lb.
PRICE:—RIDICULOUS, ONLY £15.0.0
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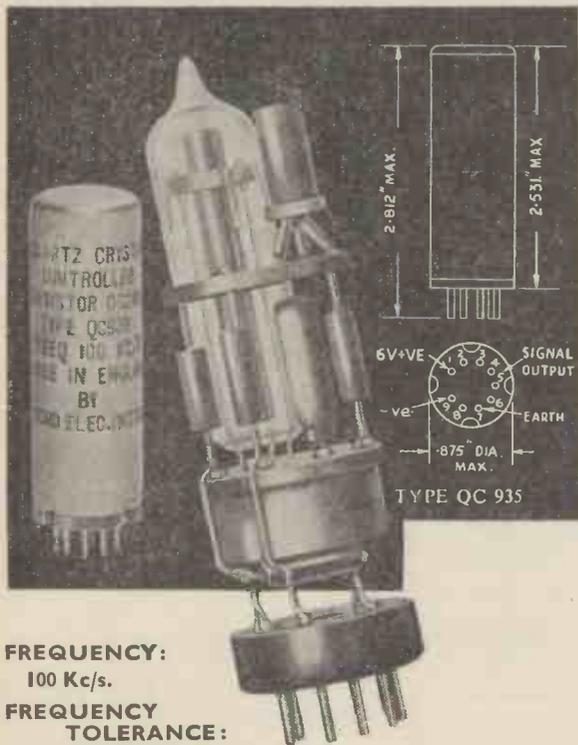
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FREQUENCY STABILITY: Less than 5 parts in 2 million change with a 10% change in supply voltage.

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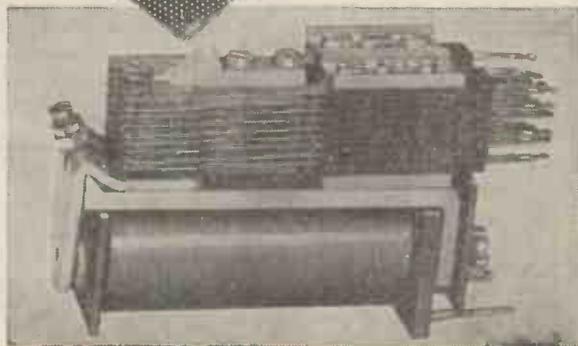
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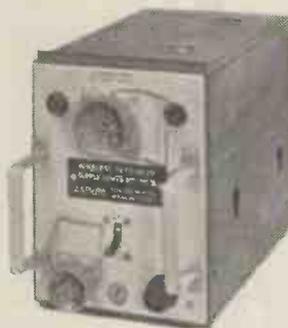
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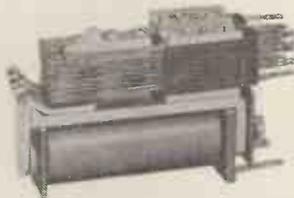
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Z.530006	40	2C	6	15 0
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Z.530010	40	2C 2K	6	17 6
Z.530011	180	2C 2K	12	£1 2 6
Z.530014	2	1C	1.3	10 6
Z.530015	40	1C	6	12 6
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Z.530018	2,500	1C	48	£1 2 6
Z.530019	2	2C 2K	1.3	14 6
Z.530020	2	4C	1.3	16 6
Z.530022	2	M.B.	1.3	12 6
Z.530023	2	2B 2M	1.3	12 6
Z.530024	40	2M	6	12 6
Z.530025	40	M.B.	6	12 6
Z.530027	180	2M	12	17 6
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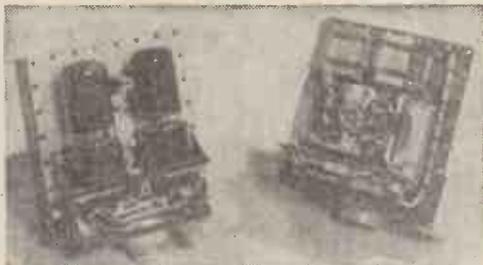
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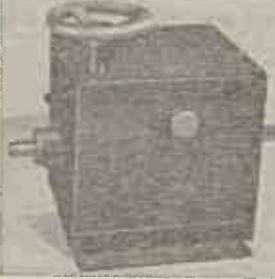
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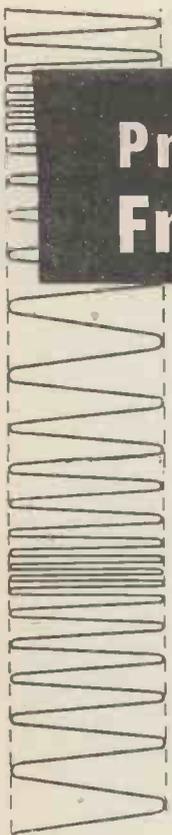
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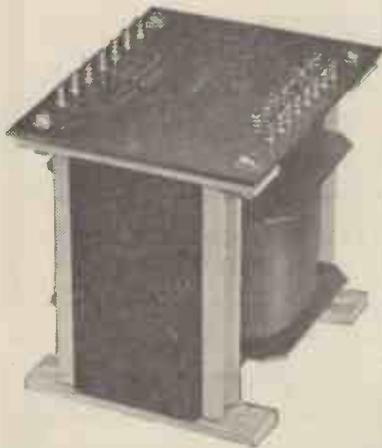
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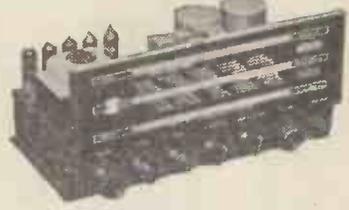
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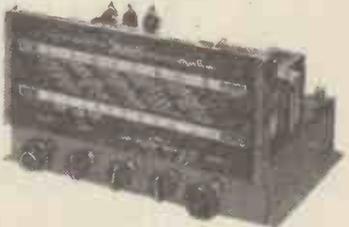


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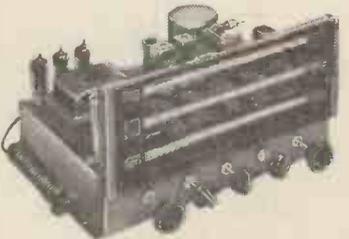
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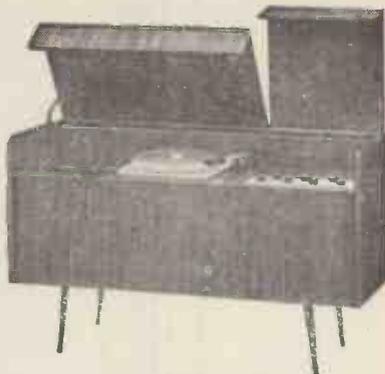
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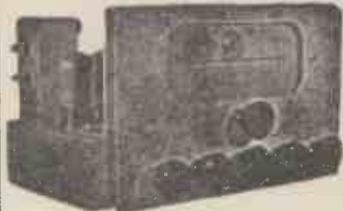
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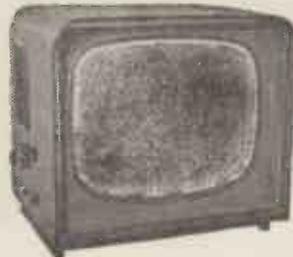
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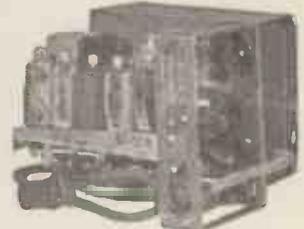
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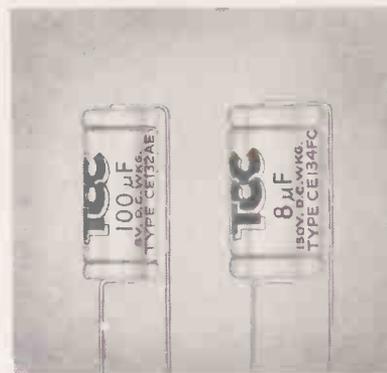
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Illustrated actual size

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SPECIALISTS
SINCE 1906**



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				Length	Diameter	
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50	-20 +100	12	15	1.5 1.6	0.8	CE132BE
50	-20 +100	25	35	1.5 1.6	1.2	CE134CE
25	-20 +100	25	15	1.5 1.6	0.8	CE132CE
25	-20 +100	50	35	1.5 1.6	1.2	CE134DE
12	-20 +100	50	15	1.5 1.6	0.8	CE132DE
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4	-20 +50	150	15	1.5 1.6	0.8	CE132FC
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