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Wireless World

ELECTRONICS, RADIO, TELEVISION

NOVEMBER 1959

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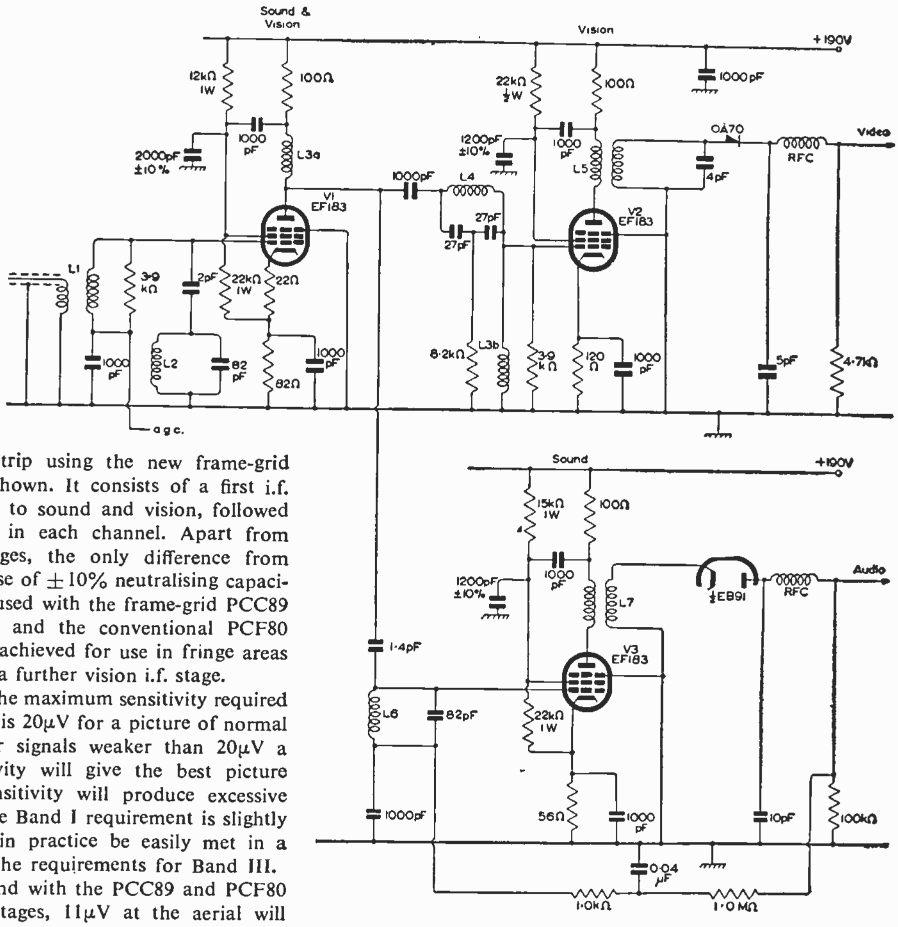
FRAME GRID VALVES FOR TELEVISION

2

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 20μV for a picture of normal contrast level. Even for signals weaker than 20μV 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, 11μV 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 63μV. 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 9μV on Band III and 5μV 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.

Mullard MULLARD HOUSE, TORRINGTON PLACE, LONDON, W.C.1

MVM 473

NOVEMBER 1959
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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. 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 λ_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

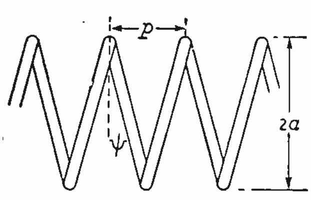


Fig. 1. Helix dimensions.

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 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).

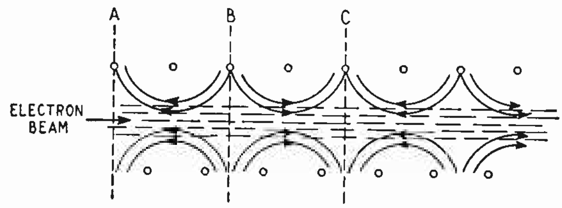


Fig. 2. R.F. fields inside helix.

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 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.

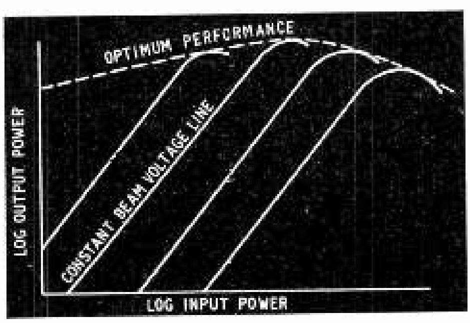


Fig. 3. Gain characteristics of helix type tubes.

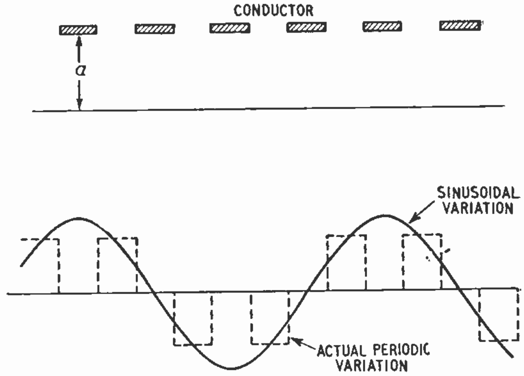


Fig. 4. R.F. fields in a periodic circuit.

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

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

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 nth 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

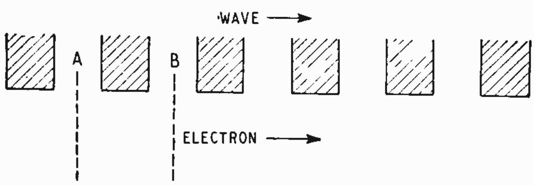


Fig. 5. Space-harmonic interaction.

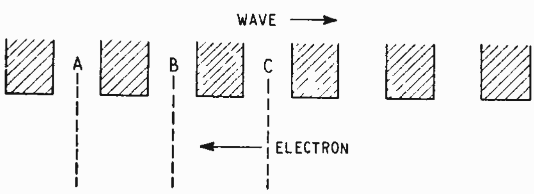


Fig. 6. Backward-wave interaction.

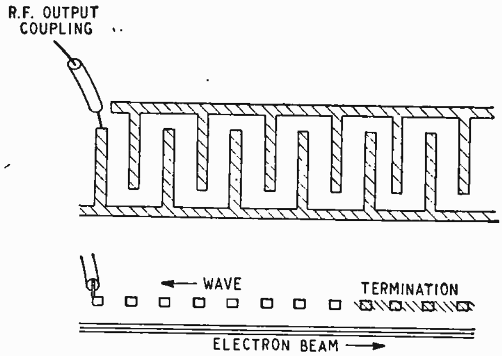


Fig. 7. Interdigital line backward-wave oscillator.

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 $t_o + n$T 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 $= \frac{\omega}{u_n} = \frac{\omega}{p}\left(\frac{p}{u_o} + \frac{2\pi n}{\omega}\right)$

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

This describes interaction between the nth 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

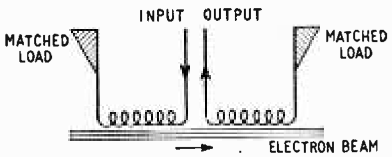


Fig. 8. Cascade backward-wave amplifier.

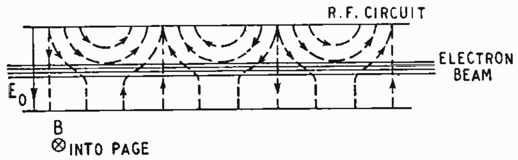


Fig. 9. Crossed-field interaction.

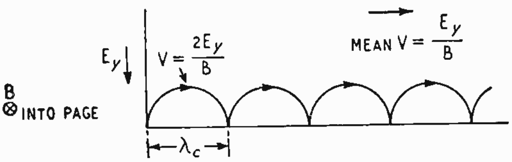


Fig. 10. Electron motion in crossed fields.

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 $V = E_o/B$ where E_o 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, $\lambda_g = V\frac{2\pi}{\omega}$

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

They are in the ratio

$$\frac{\lambda_c}{\lambda_g} = \frac{E\sim}{E_o} \cdot \frac{\omega}{\omega_c}$$

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_o. 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 displace-

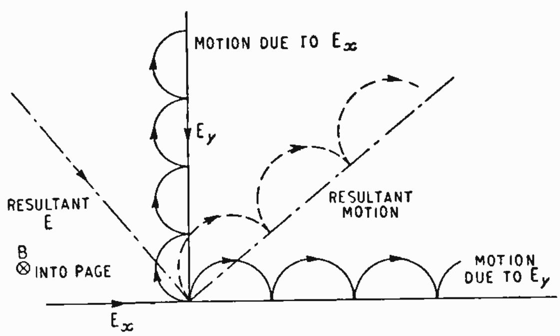


Fig. 11. Electron motion in combined crossed fields.

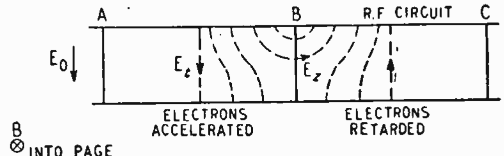


Fig. 12. Bunching mechanism in crossed-field valves.

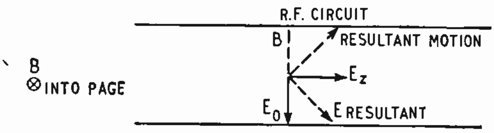


Fig. 13. Effect of axial fields in crossed-field valves.

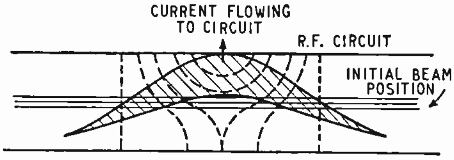


Fig. 14. Displacement of beam in crossed-field interaction.

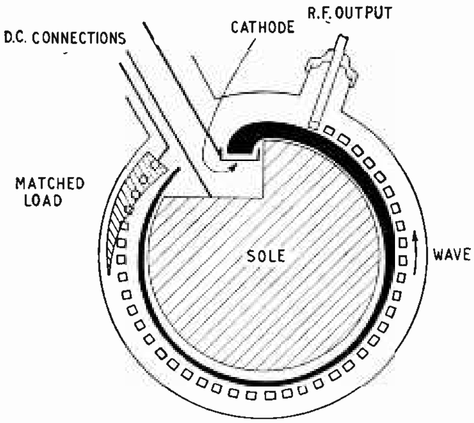


Fig. 15. Crossed-field backward-wave oscillator.

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_x/B. These motions will of course add vectorially to produce net motion at right angles to the total field $\bar{E}_x+\bar{E}_y$ and the resultant motion will be as shown in Fig. 11.

The electron has, however, fallen through the additional potential $E_y.y$ and hence an additional amount of work $e\,E_y.y$ has been done on it by E_y. It has also moved a distance x against the force eE_x, and has therefore given an amount of energy $eE_x.x$ 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 $e(E_y.y-E_x.x)=O$, 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_o (Fig. 12).

The mean axial electron velocity is always $E/B=(E_o+E_t)/B$. 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_o, 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 $u_o=E_o/B$ is changed in both magnitude and direction to $u=(\bar{E}_o+\bar{E}_z)/B$. The electrons again absorb energy from one component of the total field, E_o, 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.

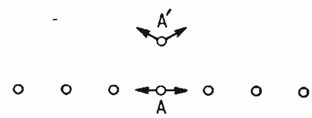
Crossed-field Backward-wave Oscillator.— This valve is the best known of linear-injection (parallel-beam) crossed-field valves. Like its O-type counterpart it has a beam which interacts with a wave having a phase velocity in the opposite direction to its group velocity, and is therefore a voltage-tuned 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.



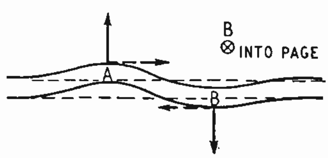
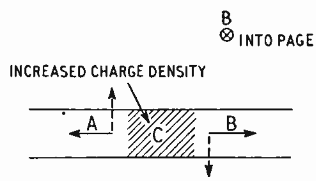


Fig. 17. Effect of r.f. disturbance on a sheet beam in crossed fields.

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

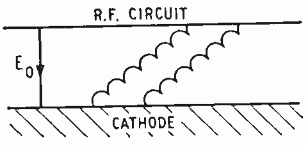


be forces as shown by the full arrows acting on the electrons at A and B, and this will result as previously in motion as shown by the dotted arrows, giving the situation shown in Fig. 17.

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.

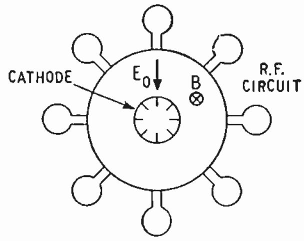
Continuous-injection Crossed-field Valves.—Perhaps the most severe limitation of linear-injection (parallel-beam) valves is the difficulty of designing electron guns with large cathode areas. The maximum current and therefore the maximum r.f. power obtainable is thus limited. However, it is possible 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 with a forward or a backward wave.



Left: Fig. 19. Continuous-injection cathode.

Below: Fig. 20. Magnetron.



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 8μsec/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 Ediswan Mazda transistors and a germanium diode, delivering an output of over 200mW, with a mean sensitivity of 90μV/m for 5mW output. A ferrite rod aerial is used, and the total weight, excluding cabinet, is 3¾lb. 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 10^6 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 economy 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 50Ω 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 40kΩ and 500kΩ. 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, Honywood 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 abusage 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 ϵ, 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 opporunity 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 jehad (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 thyratron 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, idealogue, 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.

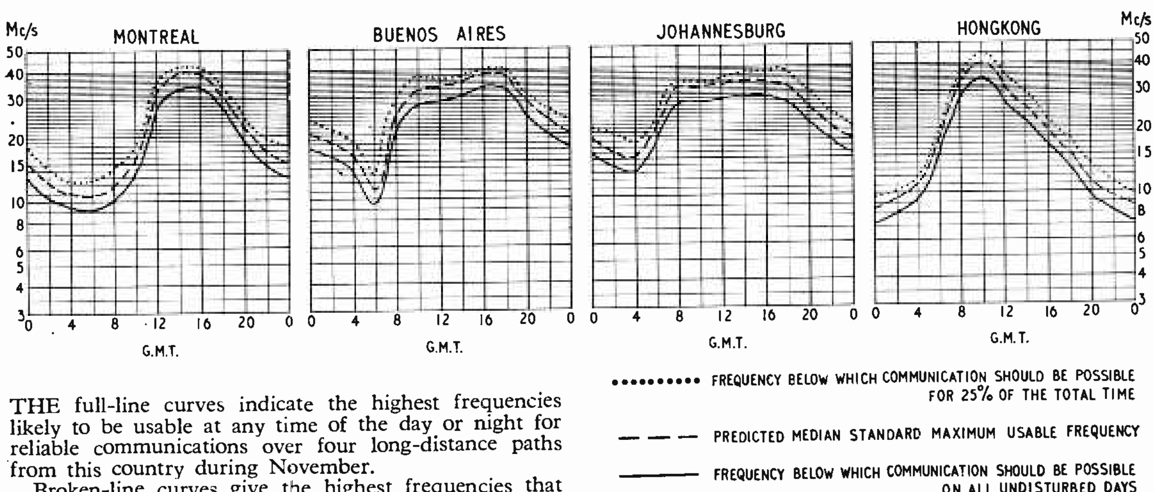
My objection to the original, apart from its sneer at those who "often adduce" a reason for saying what is in fact true, is that it combines tautology with pretentiousness; we do know the relationship between resistance and the voltage/current ratio and generally speaking there is no need to talk down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

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 ±2kc/s for the base station and ±3kc/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.

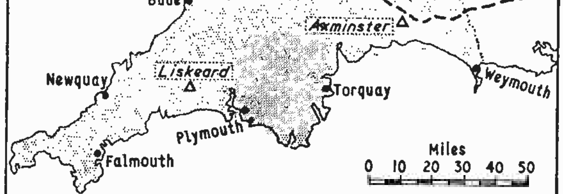
Of the £7.29M expenditure under "engineering" for the national sound and television services £4.62M was for television—an increase of £0.75M during the year.

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 Electronic 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.

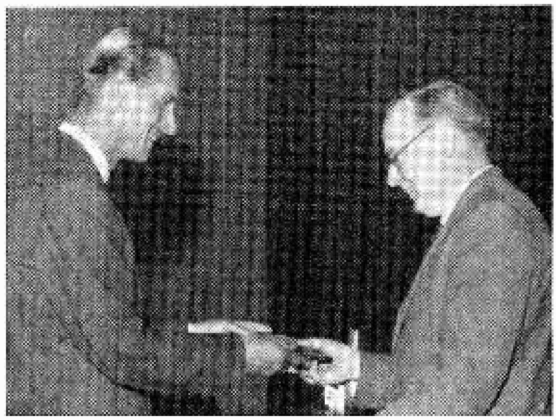
Receiving Licences.—Combined television and sound licences in the U.K. increased by 90,815 during September, bringing the total to 9,718,472. Sound-only licences totalled 5,199,421, including 405,732 for car radio.

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 coloquium 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 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.

R. J. Halsey

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. Prenn, 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 "Kybernetes" 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.

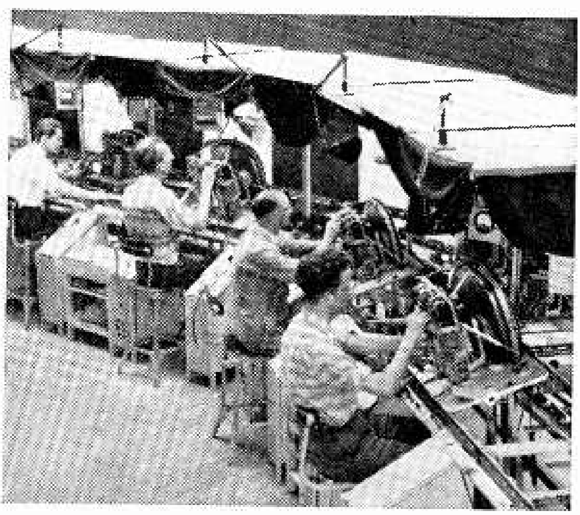
Beam-Echo International Ltd., with offices at 820 Greenwich Street, New York 14, has been formed by H. M. Rahmer, managing director and founder of Beam-Echo Ltd. Mr. Rahmer is vice-president of the American company, of which Michael Muckley, a Canadian, is president. New showrooms for demonstrating Beam-Echo 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 "Glidewheels" 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 communications services at Yugoslavian airports, has been placed with Redifon.

CLUB NEWS

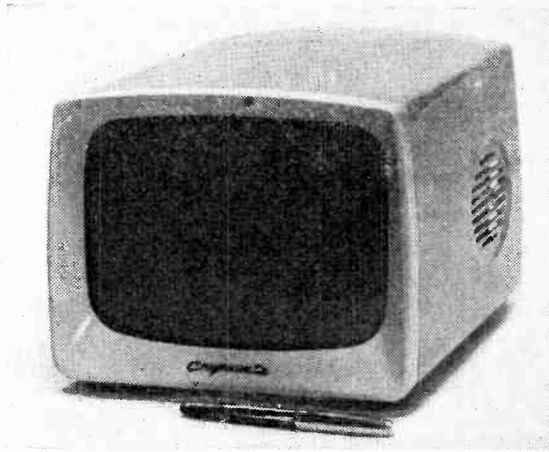
Bexleyheath.—The history, development and manufacturing techniques of the Avometer will be described by J. A. Thomas (Avo) at the meeting of the North Kent Radio Society on November 12th. A fortnight later A. O. Milne (G2MI) will deal with the work of the International Amateur Radio Union. Meetings are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



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

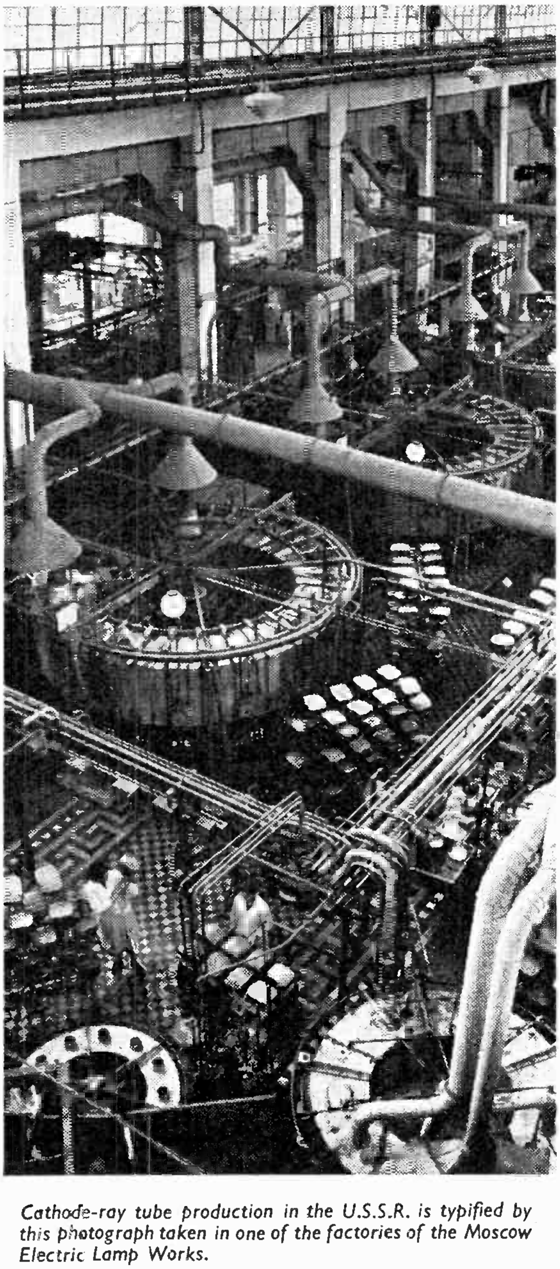
TRANSISTOR television sets are planned for mass production in the U.S.S.R. in 1961-62. For this purpose a 17-inch model has been developed which can be powered from batteries or the a.c. mains. The picture above shows a 10-inch model with 30 transistors, the "Sputnik-2," which was developed last year.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



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.

F.M. Receiver Using New

LOW-COST LIMITER/DISCRIMINATOR GIVING GOOD A.M. REJECTION

In an ideal f.m. receiver, changes of amplitude of the input signal should produce no response at the output; while this condition cannot be achieved in practice, adequate suppression of amplitude modulation is essential if the performance of the receiver is to be satisfactory. In particular, a signal received in conditions of multipath propagation contains both a.m. and f.m. components of distortion; if the former is adequately suppressed the total distortion is considerably reduced[1] and for this purpose an a.m. suppression ratio of some 35 dB is required.†

The simpler types of domestic f.m. receivers usually rely for their a.m. suppression on a ratio detector unassisted, at least over the lower range of input levels, by any other form of limiting. The a.m. suppression ratio achieved is seldom as high as 35 dB and is often considerably lower, with the result that their performance, while satisfactory under most conditions, can be poor in the presence of multipath propagation.

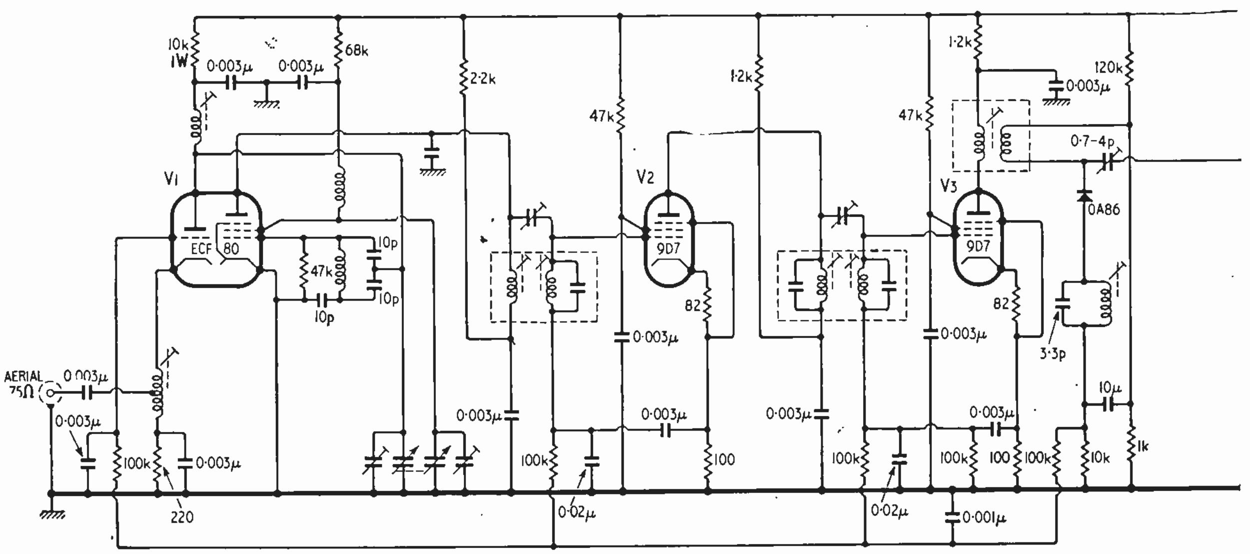
The receiver here described incorporates a recently-developed limiter and discriminator circuit[2,3] and, while it is comparable in cost and complexity with the simpler types of ratio-detector receiver, it achieves better a.m. suppression characteristics without either requiring increased i.f. amplifier gain or sacrificing sensitivity.

The circuit diagram of the receiver is shown in Fig. 1. Apart from the limiter and discriminator the design differs little from established practice; V1 is an ECF80 triode-pentode, the triode section operating as a grounded-grid r.f. amplifier and the pentode section as a self-oscillating mixer. V2 and V3 are two 9D7 i.f. amplifiers; part of the cathode bias resistor of each stage is undecoupled to compensate for changes of input capacitance with variations of a.g.c. bias voltage. The intermediate frequency is 10.7 Mc/s and the local oscillator frequency is below that of the signal. Three germanium diodes, one Type OA86 and two Type OA91, are used in the limiter and discriminator circuit; V4, an ECL82 triode-pentode, is the audio-frequency amplifier and output stage.

Limiter and Discriminator.—The theory of the limiter and discriminator used has been dealt with fully elsewhere,[2] but can be summarized as follows. Amplitude-limiting devices are generally voltage operated and require input levels of one volt or so for satisfactory operation. Such levels do not normally occur in stages before the discriminator unless extra amplification is introduced specifically to drive a limiter. However, the required voltage is normally available at the discriminator transformer itself and, if limiting can be performed there, the extra amplification is not needed. In the design of the Foster-Seeley discriminator it is assumed that it is fed from a high impedance source, i.e., one approximating to a constant-current generator, and the amplitude/frequency response of the transformer is utilized to control the linearity of the transfer characteristic. Thus, a limiting of either the primary or secondary voltage or of a combination thereof would be unsatisfactory. The circuit proposed to overcome these limitations is shown in Fig. 2. In this circuit L_2C_2 and L_3C_3 are the primary and secondary circuits respectively of a conventional

† The a.m. suppression ratio of a receiver is defined for the purpose of this article, as the ratio of the output due to f.m. to that due to a.m. when the input carrier is simultaneously frequency modulated ± 30 kc/s and amplitude modulated to a depth of 40%.

Fig. 1. Theoretical circuit diagram of receiver incorporating new limiter.



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 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.

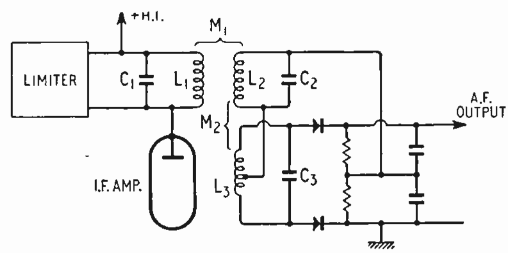


Fig. 2. Basic circuit of limiter and discriminator.

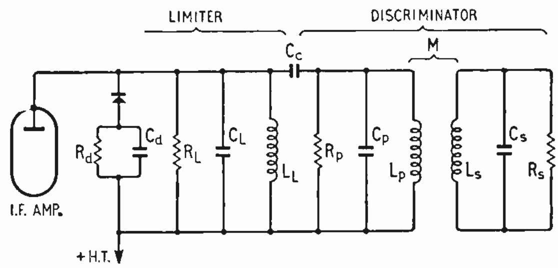
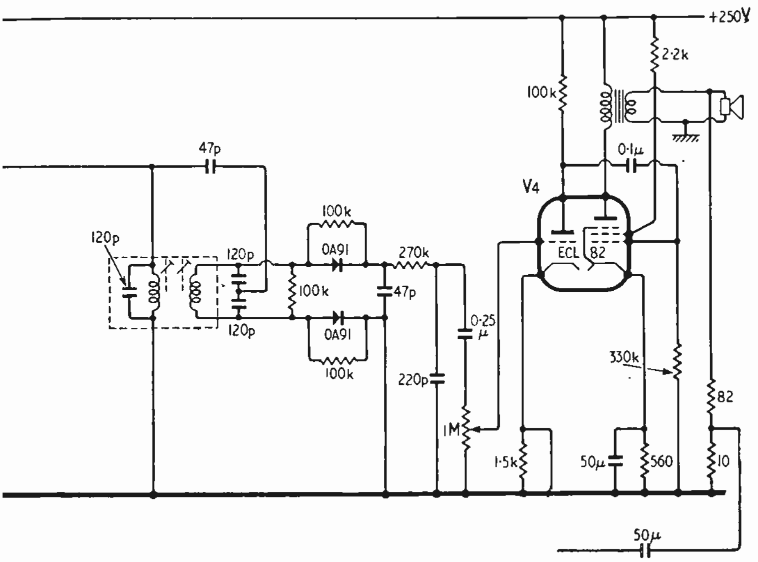


Fig. 3. Equivalent circuit of limiter and discriminator.



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.

$$Q_p = \frac{R_p}{\omega_0 L_p} \qquad k = \frac{M}{\sqrt{(L_p L_s)}}$$

$$Q_s = \frac{R_s}{\omega_0 L_s} \qquad Q = \sqrt{(Q_p Q_s)}$$

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 $\omega_0 = 2\pi f_0$ where f_0 is the intermediate frequency.

*B.B.C. Research Department.

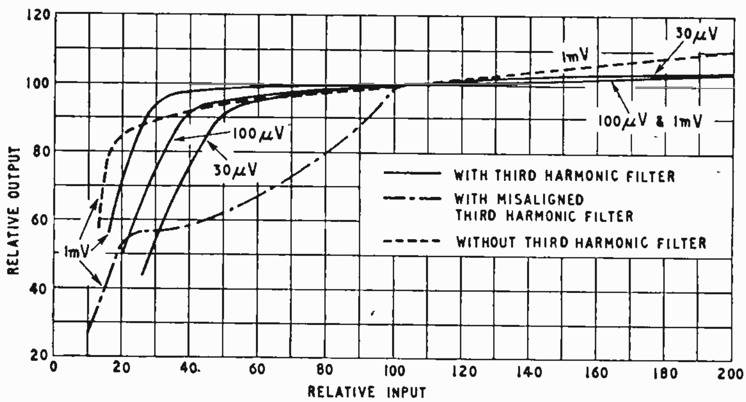


Fig. 4. Correct dynamic-limiter characteristics for various input levels and effect of mis-tuned harmonic filter (two-kneed curve) and absence of filter (dotted curve).

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

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

where $X_c = 1/\omega_o C_c$. 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 $R1_L$ and $R_d/2$. In order to deal with a fractional depth of modulation m, we require that

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

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 $R_d = 10$ kΩ, $R_L = 50$ kΩ, $R'_p = 2$ kΩ, $f_o = 10.7$ 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 1.8pF. The impedance reflected across the discriminator primary from the limiter circuit is X_c^2/R_x where R_x is the effective dynamic impedance of the limiter and its load. Measurements indicate that R_x is about 500Ω, so that with the conditions specified $X_c^2/R_x \approx 130$ kΩ. 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 6×1×12.

Limiter Transformer: Neosid Type 5000A/6E former

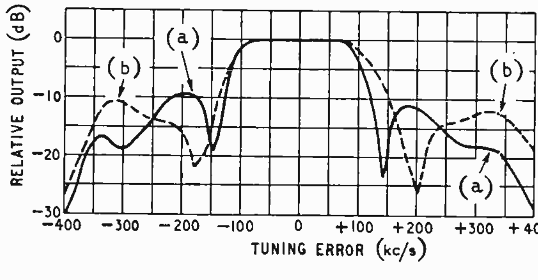


Fig. 5. Tuning characteristic with (a) narrow-band discriminator, (b) wide-band discriminator.

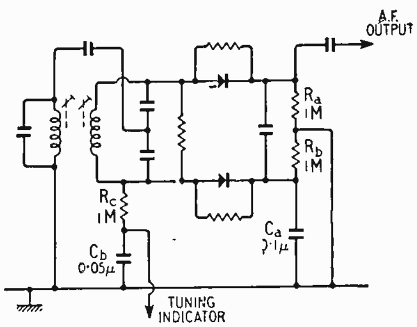


Fig. 6. Circuit modifications to obtain tuning indicator drive from discriminator.

(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

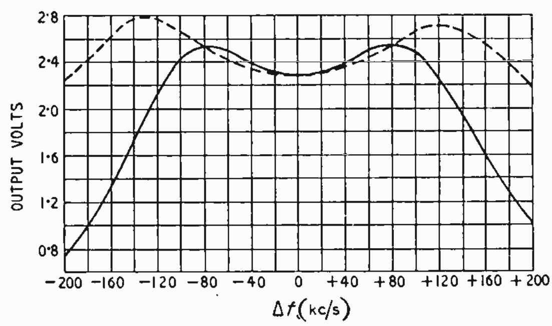


Fig. 7. Potential derived from discriminator to feed tuning indicator (solid line); 1mV constant input to receiver. Dotted line shows response of discriminator alone.

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,

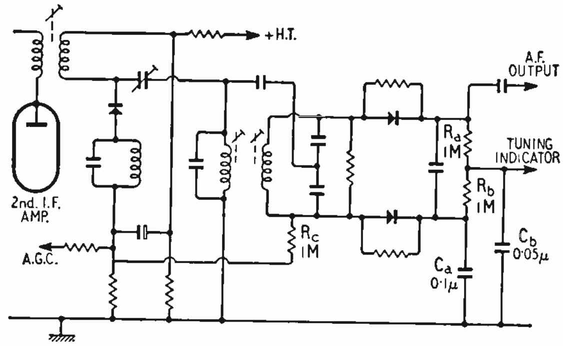


Fig. 8. Circuit modifications to obtain tuning-indicator drive from combination of a.g.c. and discriminator voltages.

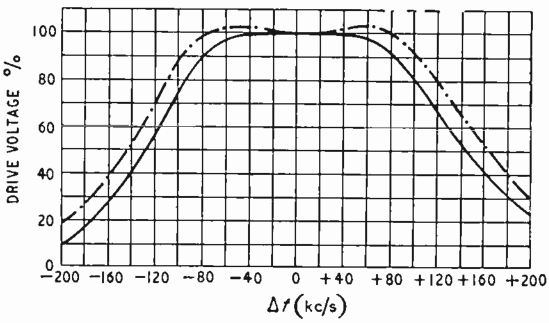


Fig. 9. Potential derived for tuning indicator from combined a.g.c. and discriminator action (solid line). The broken line represents a.g.c. voltage. Indicator drive voltage is relative to that at midband frequency.

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

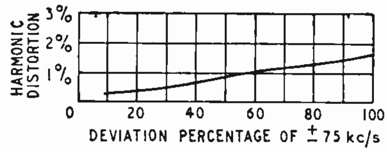


Fig. 10. Variation of harmonic distortion with deviation.

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 8μV.

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 8μV 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 10μV.

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 50μsec pre-emphasis time-constant, the response relative to that at 400 c/s was within the limits ± 1dB 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.

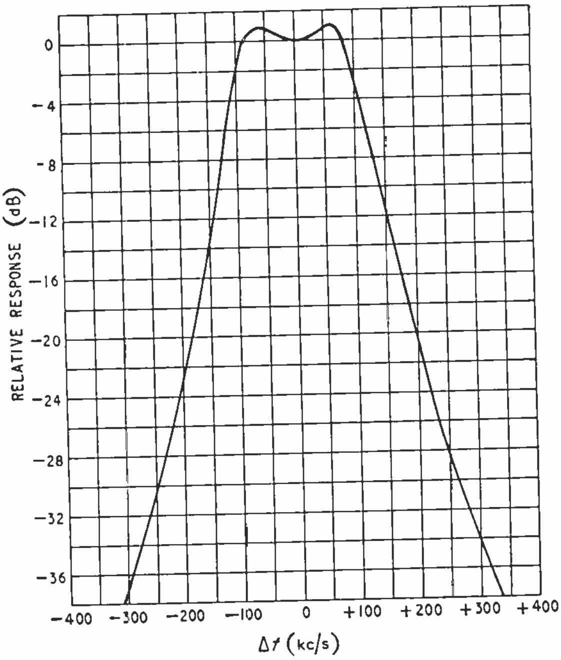


Fig. 11. I.F. amplifier frequency response.

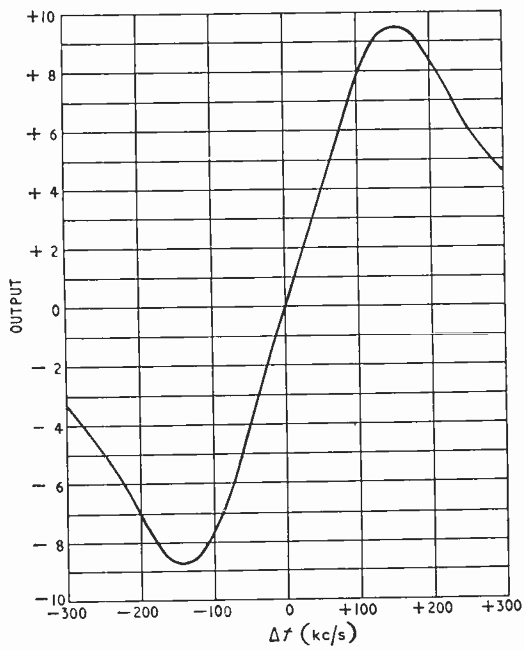


Fig. 12. Discriminator frequency response. Output is in arbitrary units.

TABLE 2

Input Signal Level	A.M. Suppression Ratio
30 μV	35 dB
100 μV	38 dB
300 μV	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

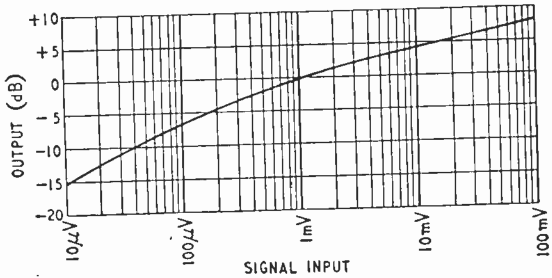


Fig. 13. Variation of a.f. output with input level. Output is referred to 1mV and input level is open-circuit voltage from 75-Ω source.

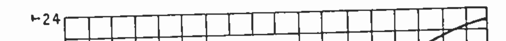


Fig. 14. Input/output characteristic for impulsive interference. Input carrier level 500μV, impulse p.r.f. 2,500/sec; relative output is referred to output with ±35kc/s deviation at 2kc/s and impulse input amplitude is referred to 1μV peak per kc/s bandwidth.

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 μV, 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 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.

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

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 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 μV. 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.

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.

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*RPOOL, 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

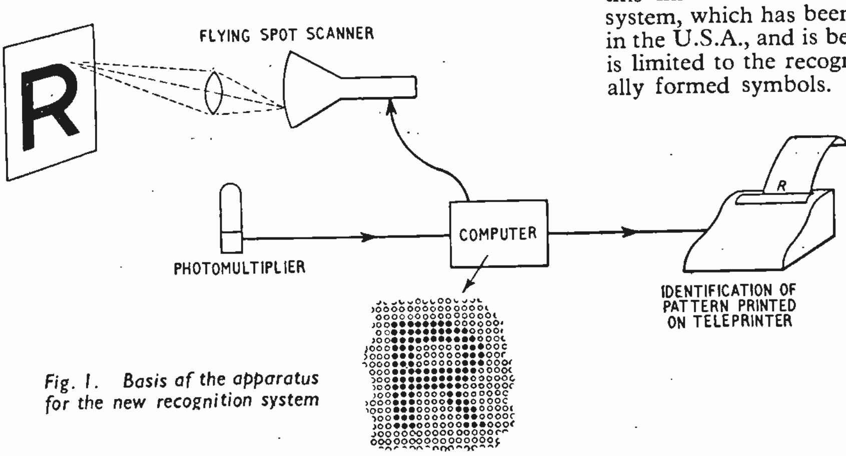


Fig. 1. Basis of the apparatus for the new recognition system

*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-

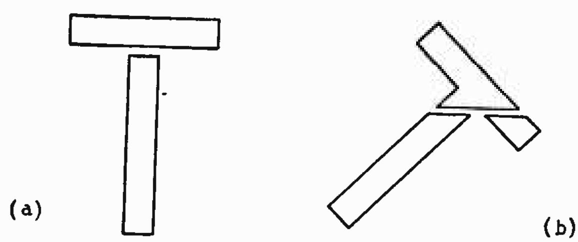


Fig. 2. Pattern divisions produced during examination; (a) with normal orientation, (b) when presented at a different angle to the scanner.

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

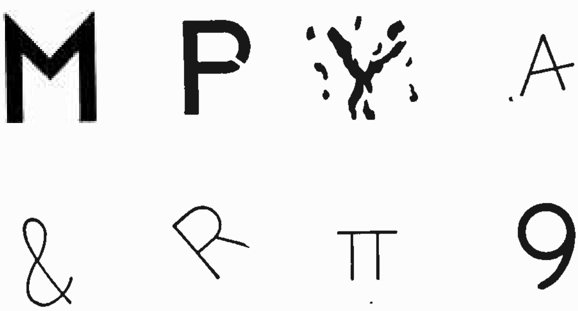


Fig. 3. Example of patterns which the system has shown itself capable of recognizing.

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 TE_{10} 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 formulæ 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

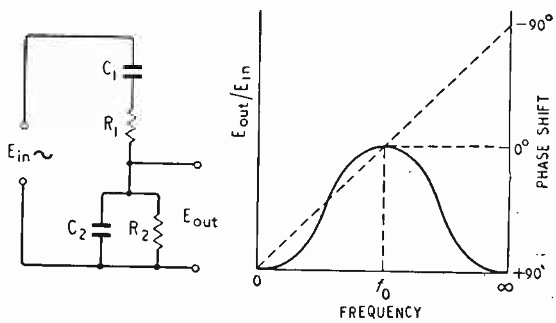
THE oscillator to be described in this article is an R-C oscillator of the "Wien bridge" variety. This makes use of the frequency-selective properties of the network shown in Fig. 1. When connected as shown, the output is a maximum, and the phase shift is zero, at one frequency f_0 given by $1/2\pi\sqrt{(R_1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

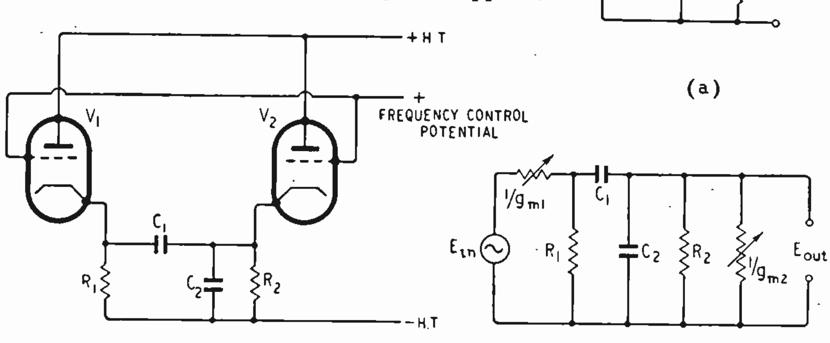
By using valve internal resistance for R_1 and R_2 (Fig. 1.) it is possible to achieve electronically-controlled variation of frequency. The most suitable internal resistance is that ooking into the cathode of a cathode-follower or an earthed-grid amplifier, since this comes in convenient sizes and varies 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 1kΩ when the valve slopes are maximum, but when they are low a much greater load .s 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 multivibrator. 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 10kΩ 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 $1/g_m$.

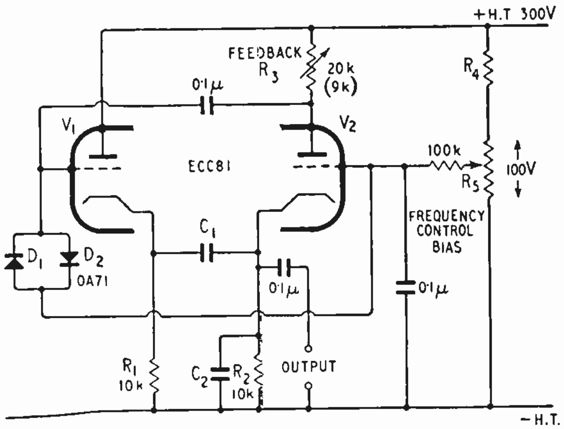


Fig. 3. Complete oscillator circuit. The diodes D_1 and D_2 form a limiter to prevent multivibrator action.

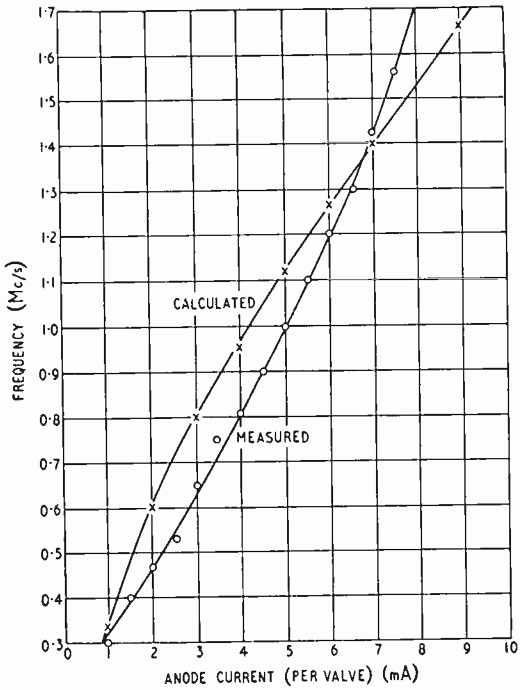


Fig. 4. Measured and calculated frequency/anode-current curves with $C_1 = C_2 = 500pF$.

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

An oscillator was constructed using the circuit of Fig. 3 with $C_1 = C_2 = 500$pF. The theoretical frequency (neglecting the effects of $R_{1,2}$ and the anode load of V2) now becomes g_m/πMc/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 4.7kΩ, 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 $C_1 = 50$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_{out}/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_{max}/f_{min} is then reduced to $\sqrt{(C_{max}/C_{min})}$, which is typically a little over 3. A suitable value for the fixed capacitor C_1 is $\sqrt{(C_{max}/C_{min})}$ which is about 160pF when an ordinary variable capacitor (C_{max}=500pF) is used.

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 1kΩ 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 100kΩ filter resistor and 0.1uF 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.

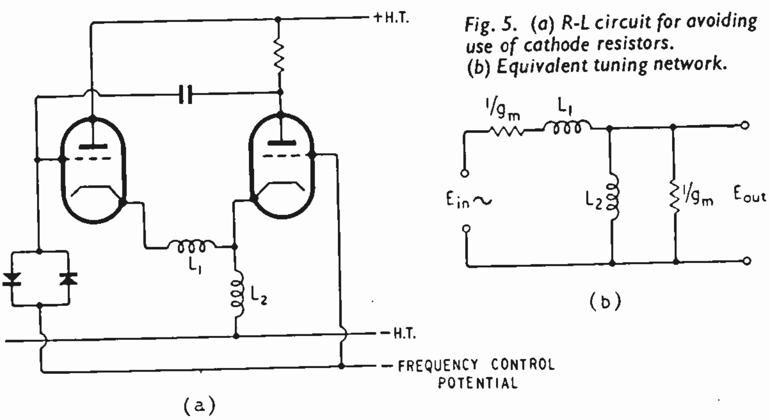


Fig. 5. (a) R-L circuit for avoiding use of cathode resistors.
(b) Equivalent tuning network.

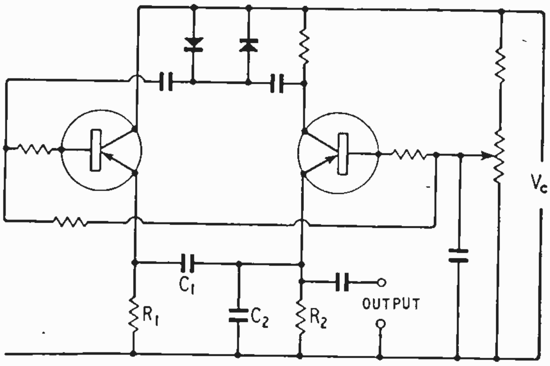


Fig. 6. Transistor-oscillator circuit (equivalent to Fig. 3).

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_k, where V_g is the external bias voltage. The accurate expression is, of course $(AV_g + v_g)/R_k$, 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_5. 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 V2 on the cathode input impedance of V2. The effects on frequency can easily be allowed for. Referring to the equivalen circuit shown in Fig. 7, where r_k stands for the impedan

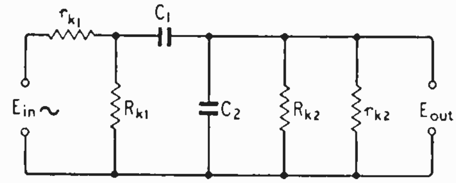


Fig. 7. Equivalent R-C oscillator network.

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 $(R_a + r_a)/(1 + \mu)$ instead of just $r_a/(1 + \mu) \approx 1/g_m$. 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.

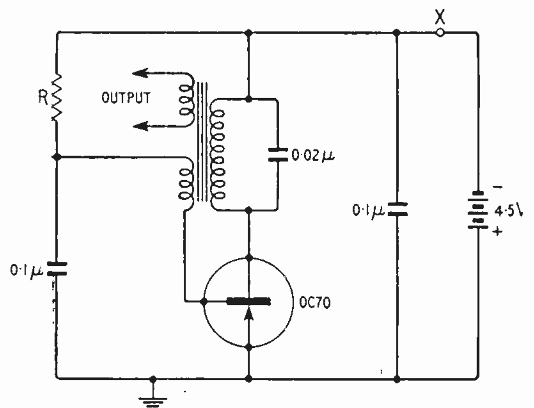


Fig. 1. Transistor oscillator circuit using triple-wound transformer.

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 current measured by the meter is the collector current (I_c). The information gained from the curve is interesting as with R of 100kΩ 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 150kΩ with a nominal collector voltage of 4.5V. Preferably it should be nearer 220kΩ, under which conditions the collector current is about 150μA. 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

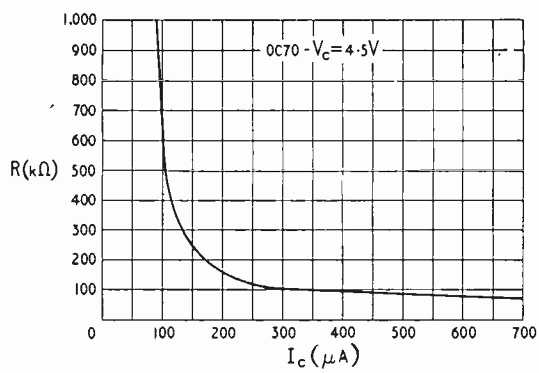


Fig. 2. Collector current with different values of resistor R.

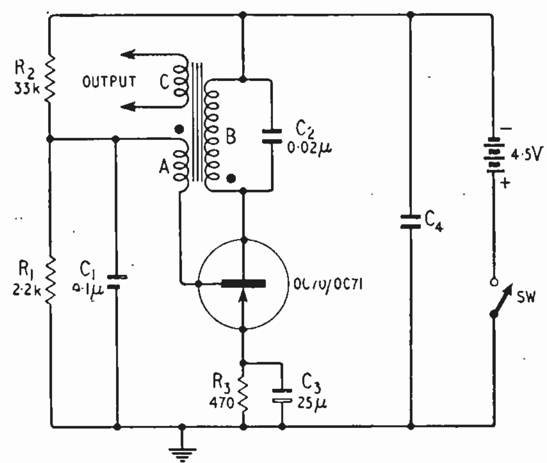


Fig. 3. Oscillator circuit with base current stabilized.

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

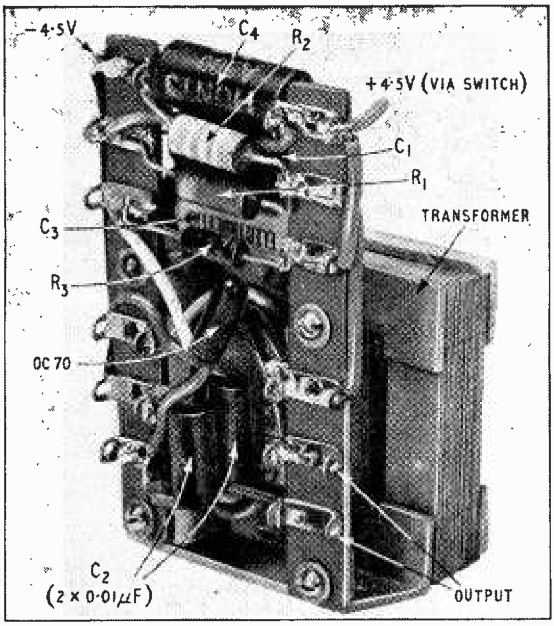


Fig. 4. A convenient form of construction for the transistor oscillator. Components can be identified from Fig. 3.

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 10μA so that the potential divider R_1 and R_2 need not consume more than about 100μA leaving about 400μA 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 2.2kΩ and 33kΩ respectively. R_1 was bypassed by a 0.1-μF capacitor and R_3, which is included as a further safeguard for d.c. stability, by a 25μF capacitor.

With the particular OC70 transistor employed the total current through R_2 was 115μA and the collector current was 260μA, making a total battery drain of 375μA. 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 0.1μF to 10μF 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 0.1μF. 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 ($1\frac{23}{32} \times 2\frac{1}{16} \times 0.4$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.

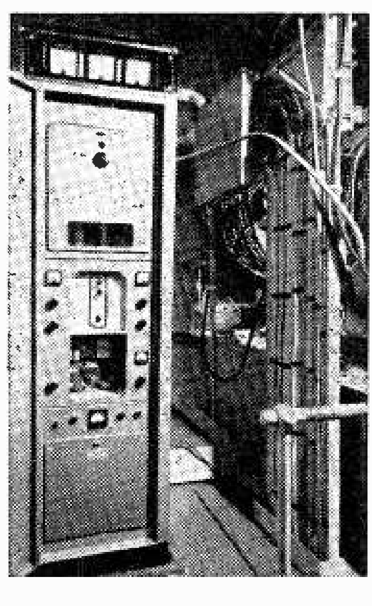
The base winding A was put on first and consists of 50 turns of No. 38 s.w.g. enamelled copper wire. Winding B, with 1,000 turns of the same wire, followed and finally winding C with 200 turns. The black dots adjacent to one end of A and B windings (Fig. 3) indicate the beginning (or inner) of each, 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_4 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 ¼W 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 2½ to 15 kc/s. The 250-ft aerial has a gain of 40 dB and a beam width of 1¼° at 200Mc/s (angle subtended by the moon is ½°).



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 ± 2½, 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, "Alsoarbeitsitzundweytz—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:

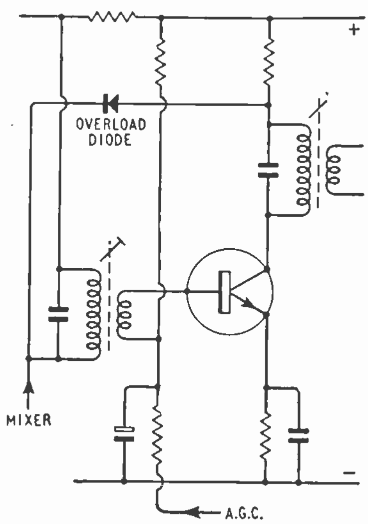
I never had a piece of toast
Particularly long and wide,
But fell upon the sanded floor,
And *always* on the buttered side.

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."

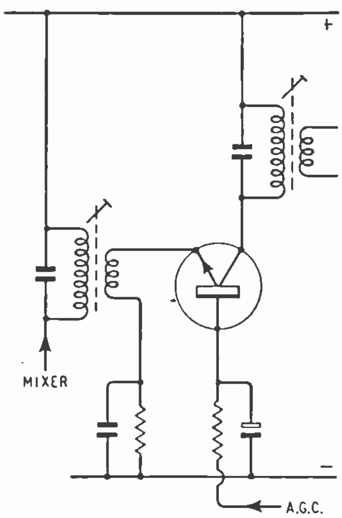
Chelmsford. W. R. MASEFIELD.

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



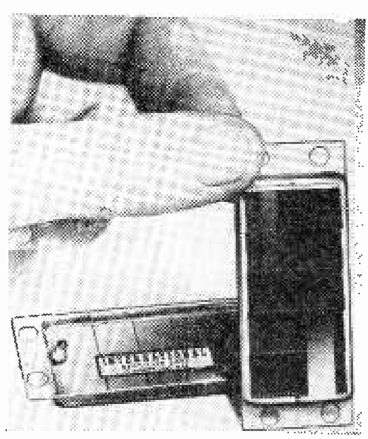
resistor holds the diode cut-off until a certain signal level is reached. When the voltage drop is reduced by the action of the simple a.g.c. on the i.f. amplifier the diode conducts, shunting the mixer o.p.; but this point depends on the d.c. amplification of the transistor, so an individual adjustment 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 sawtooth sweep waveform from a Miller transitron 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 phantastron 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

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

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

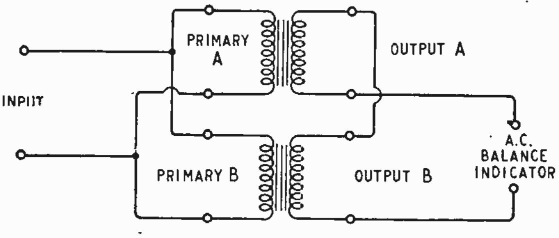


Fig. 2 Basis of testing procedure described in the text. Transformer A is a standard, transformer B the one under test.

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

* Radford Electronics, Ltd.

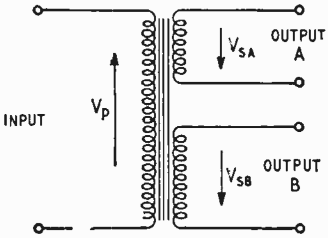


Fig. 1 Relative instantaneous voltages in a transformer is shown by arrows.

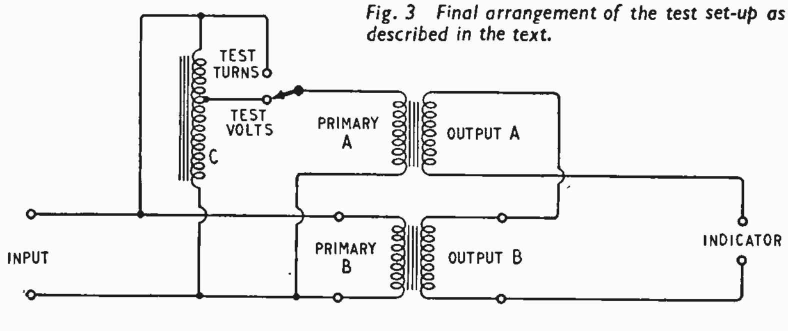


Fig. 3 Final arrangement of the test set-up as described in the text.

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 ±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.

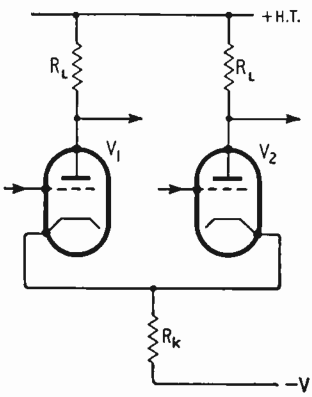


Fig. 1

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} will increase to $I_{a1} + g_m v$
I_{a2} 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 expressed 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-

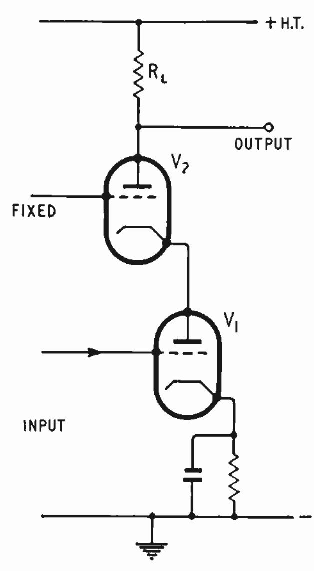


Fig. 2

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 $= \mu$ 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 $= \mu^2$.

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 potential. 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.

* See *Wireless World*, Vol 65, p. 126 (March, 1959).
† "Masers" by "Cathode Ray," *Wireless World*, Vol. 65, p. 197 (April, 1959).

"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.

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-

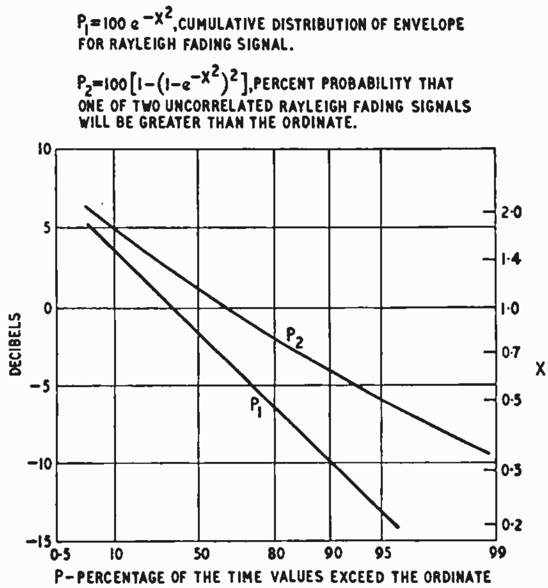


Fig. 1. Theoretical distribution of signal envelope.

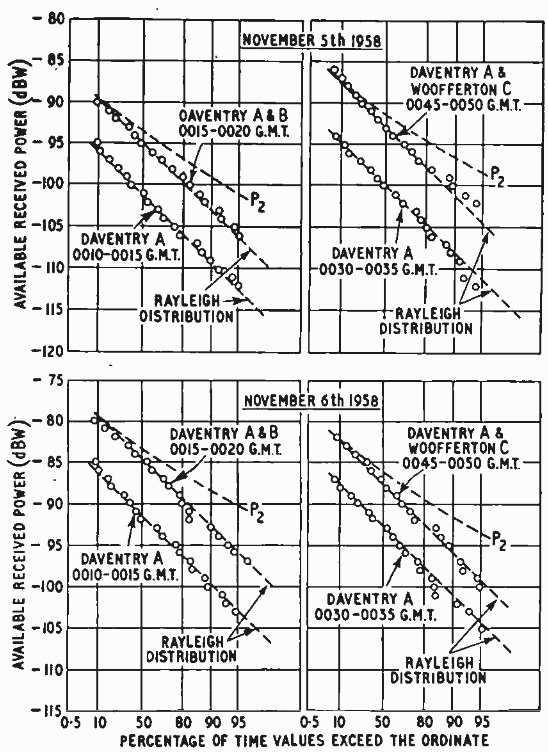


Fig. 2. Distribution of signal envelope amplitude.

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 time[1]. 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 P_1 in Fig. 1. The curve labelled P_2 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 P_2.

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.

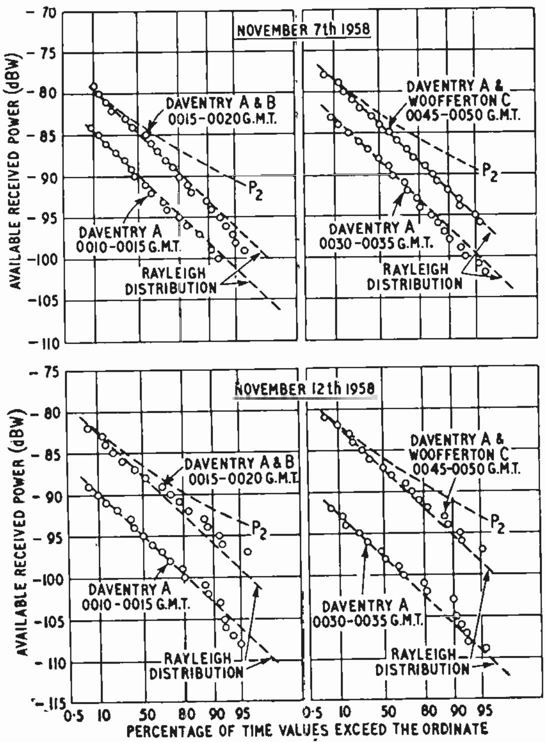


Fig. 3. Distribution of signal envelope amplitude.

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
	c/s	c/s	c/s	c/s
0010–0015	0.943	2.11	1.08	1.66
0015–0020	0.806	1.33	0.98	1.61
0030–0035	0.905	1.19	1.40	2.08
0045–0050	0.714	1.38	1.26	1.66

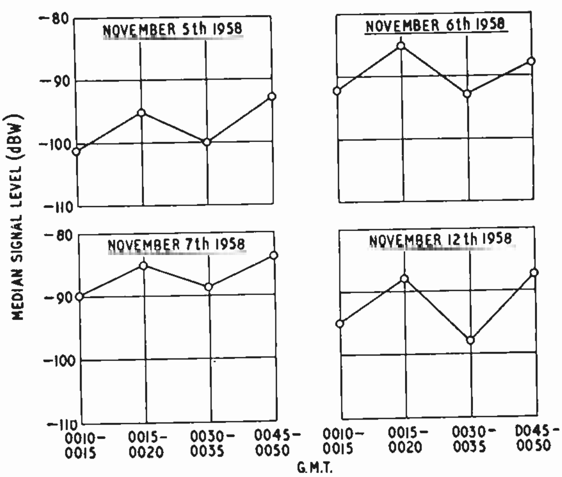


Fig. 4. Median signal level variations.

* 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

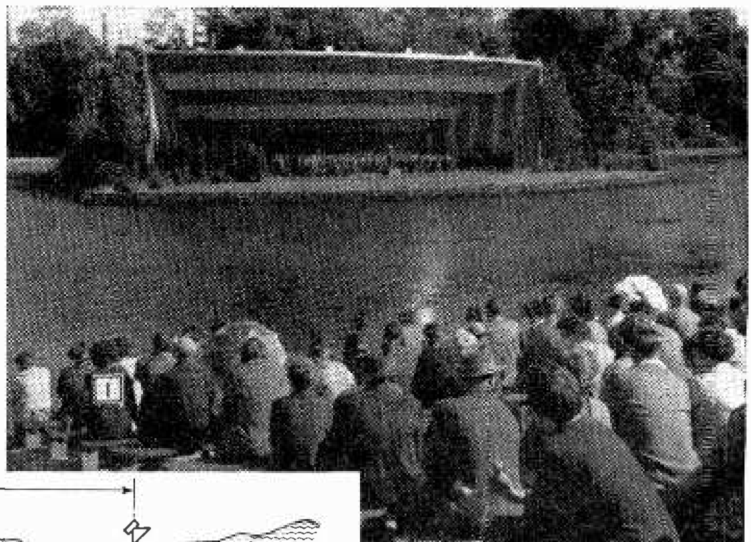
[1] "Ionospheric Radio Propagation," National Bureau of Standards Circular 462, p. 108, June, 1948.

Stereophony in the Open Air

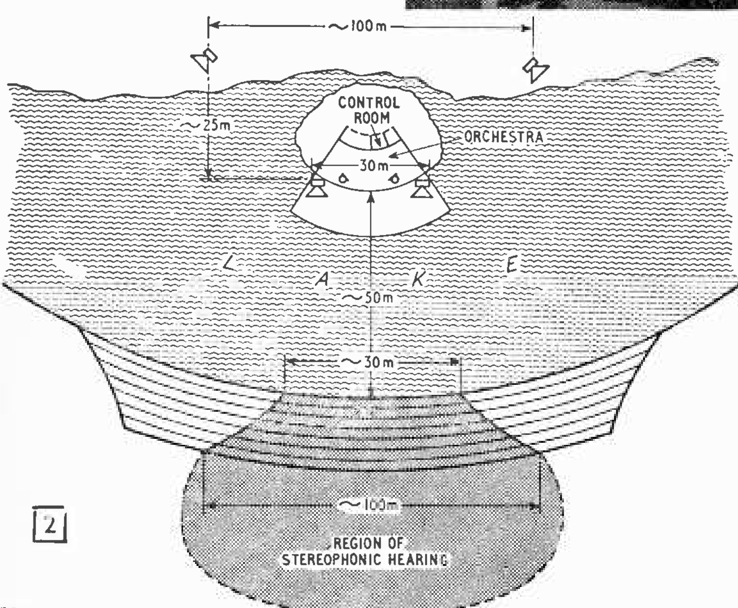
A SUCCESSFUL sound-reproducing system was installed by Telefunken at the Federal Horticultural Show held this year in Dortmund.

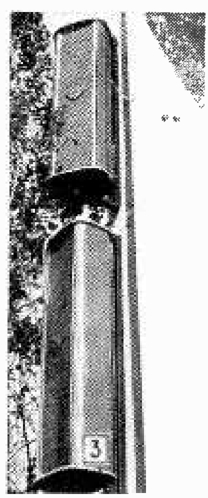
In view of the limited knowledge available of open-air stereophony, tests were first made on a building site in Hannover and the results obtained from these series of trials were used as the basis for the design of the Dortmund installation.

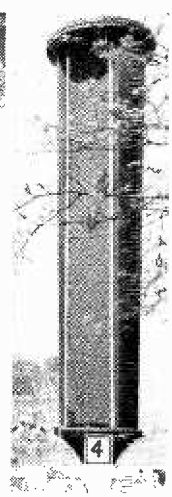
A power of 300 watts is provided for each stereophonic channel. Sound columns, which comprise a total of 48 units are used as loudspeakers. These sound columns are distributed over a base of 100 metres and permit stereophonic sound reproduction over an area with space for about 6,000 persons. The installation 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 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.

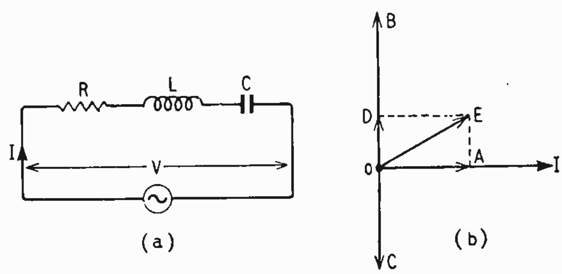


Fig. 1. A typical a.c. circuit diagram and corresponding vector diagram. What are all the arrow-heads for?

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

*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.

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 if 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

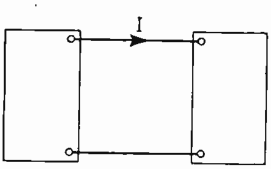


Fig. 2. Which connecting wire is positive when the current is positive ?

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

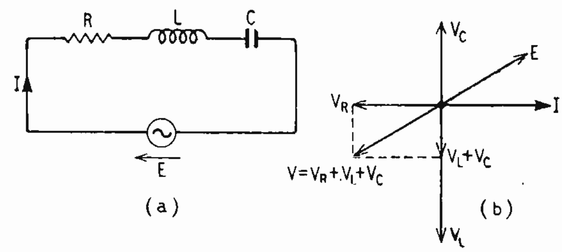


Fig. 3. Alternative and more helpful version of Fig. 1.

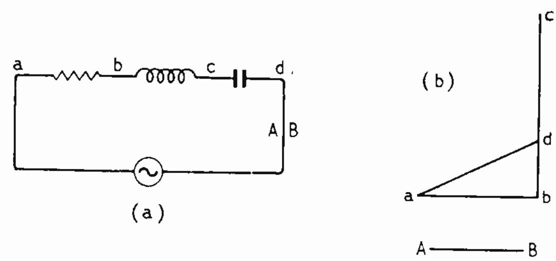


Fig. 4. Another and still more helpful version, if you know the conventions.

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

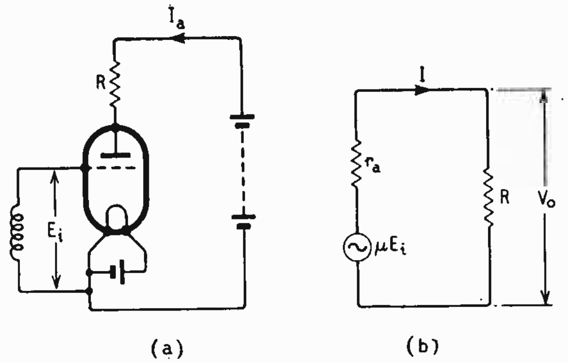


Fig. 5. Simple valve circuit and its "equivalent." In this form, does it really help?

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 reradiated 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 "Microwave 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

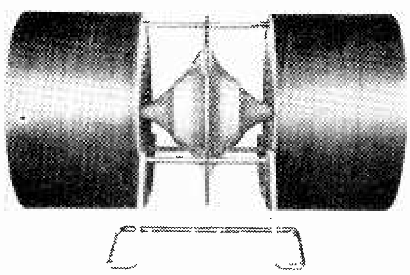
NEW ELECTRONIC EQUIPMENT AND ACCESSORIES

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 photograph).



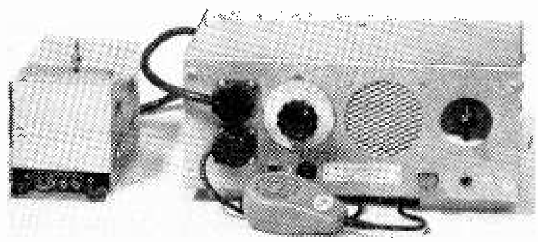
Burne-Jones "Treble Twin" tweeter.

Moreover, the sound is beamed within a few tens of degrees (±20° 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 Twin 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 × 5½in × 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 receiver, and output impedance of the transmitter, is 75Ω.



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

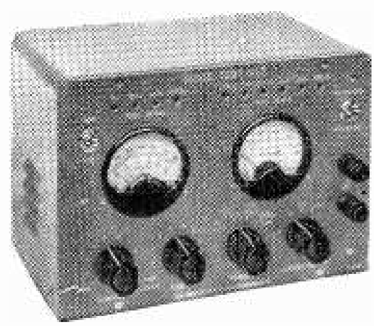
A press-to-talk switch on the hand microphone actuates relays in the equipment which make the necessary circuit changes for send and receive.

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

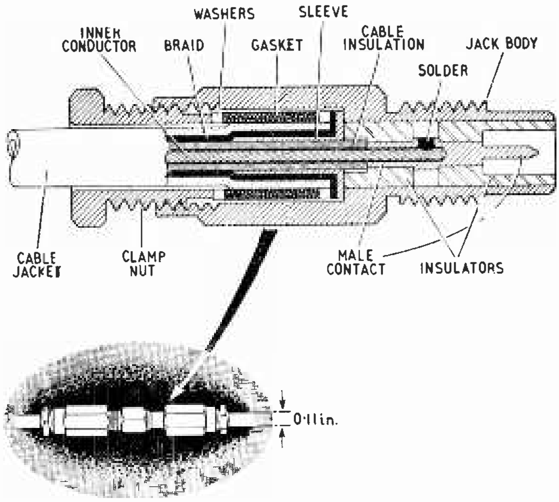
RANGES from 50μA to 5A and 3 to 1200V for a full-scale meter deflection are provided in the Thompson (Instruments) Type ED8 diode tester for simultaneous current and test voltage measurements at dissipations up to 15W. A polarity reversal switch is provided so that both forward and reverse characteristics 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.



Thompson diode test meter.

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.

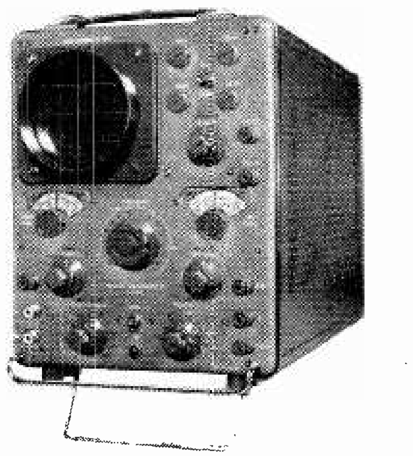
The connectors are available for cables of 50, 75 or 95Ω characteristic impedance and the matching is such that over the frequency range 1 to 9.3 Gc/s the voltage-standing-wave ratio is claimed to be within 1.1 and 1.3. Insulation resistance is better than 10^6MΩ.

The sample illustrated comprises a Type 3000 plug and Type 3001 socket and is a cable-to-cable connector measuring only $1\frac{7}{16}$in long overall and $\frac{7}{32}$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, Hersham 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.

10^7cm/sec in 15 ranges and can be increased up to 5×10^7cm/sec using the X-expansion control. Both times and voltages can be measured to within ±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.

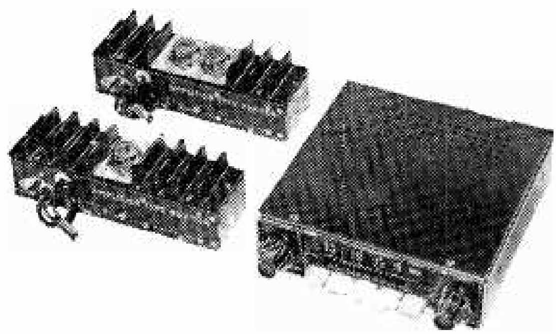
Transistorized Car Radio

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 7in × 7in × 2in while the associated amplifier (A or B) Measures $2\frac{5}{16}$in × 7in × 2in. The overall size of the model 50T is $7\frac{1}{8}$in × 7in × 2in. Six-volt versions are also available.

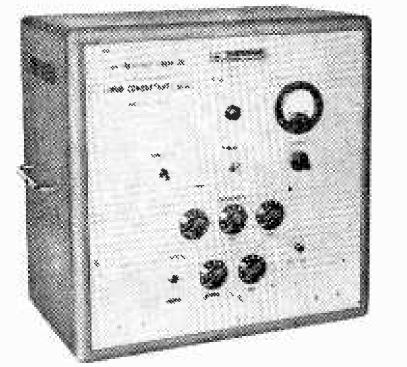


Smith's Radiomobile 500T series car receiver with alternative transistor power amplifiers alongside.

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^{-3}c/s can be obtained from the Servo Consultants Model 111 or 110 generators respectively. In both



Servo Consultants very low frequency generator.

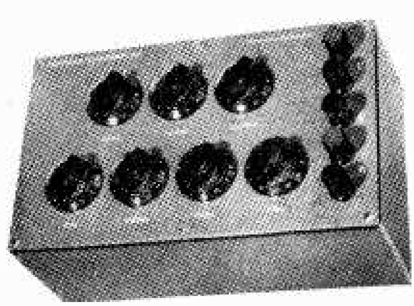
these generators the distortion is 1% at the maximum output of 30V and 10mA; the output impedance is 250Ω. The main part of both generators consists of a resolver whose rate of rotation is the signal frequency, f say, and whose stator is supplied with a 30V carrier signal at 2400c/s. The rotor output at a time t is then proportional to $30 \sin 4800\pi t \sin 2\pi f t$. 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

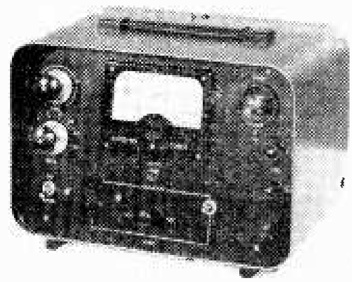


A combined capacitance and resistance decade box made by R. E. Thompson and Co

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.

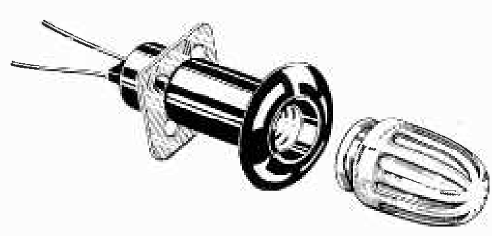
The equipment is a.c. operated and mains voltage is normally used for coil heating, but provision is made for applying, if necessary, bonding voltages of lower value from an external source.

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 $\frac{5}{16}$in in



Bulgin miniature moulded panel-mounting signal lamp.

diameter and it fits panels up to $\frac{3}{16}$in 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.

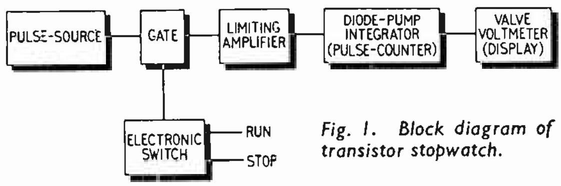


Fig. 1. Block diagram of transistor stopwatch.

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_2 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

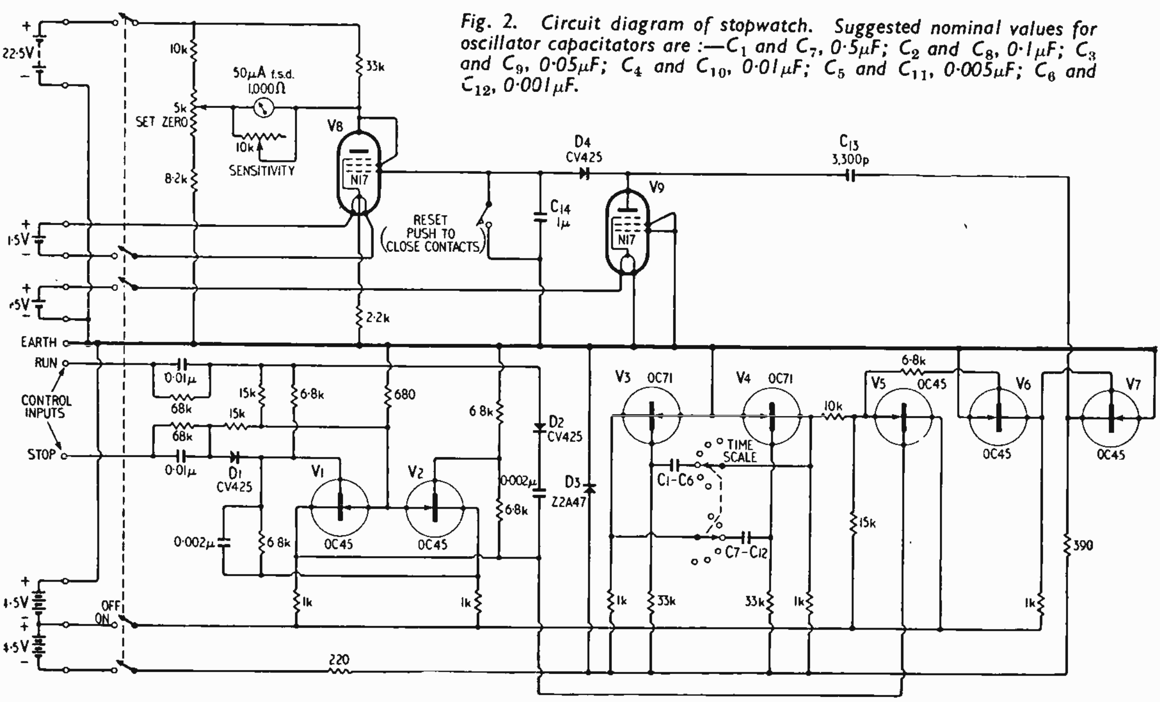


Fig. 2. Circuit diagram of stopwatch. Suggested nominal values for oscillator capacitators are :—C_1 and C_7, 0·5μF; C_2 and C_8, 0·1μF; C_3 and C_9, 0·05μF; C_4 and C_{10}, 0·01μF; C_5 and C_{11}, 0·005μF; C_6 and C_{12}, 0·001μF.

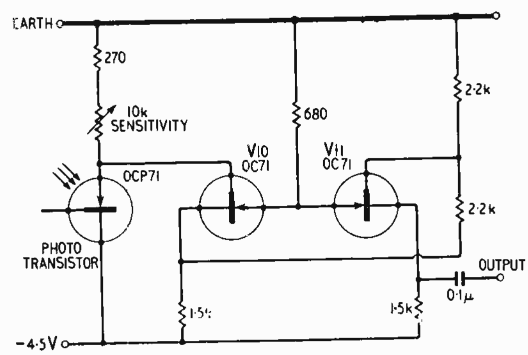


Fig. 3. Photoelectric trigger unit circuit. Note that OCP71 phototransistor is used as photodiode, i.e. base connection is left "floating."

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-μF 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.

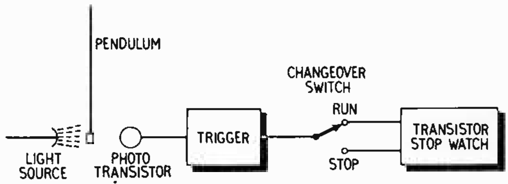


Fig. 4. Arrangement of apparatus for setting up time scale. Pendulum interrupts light beam when in the position occupied when at rest.

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 $2\frac{1}{4}$ 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 reproduction, 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.

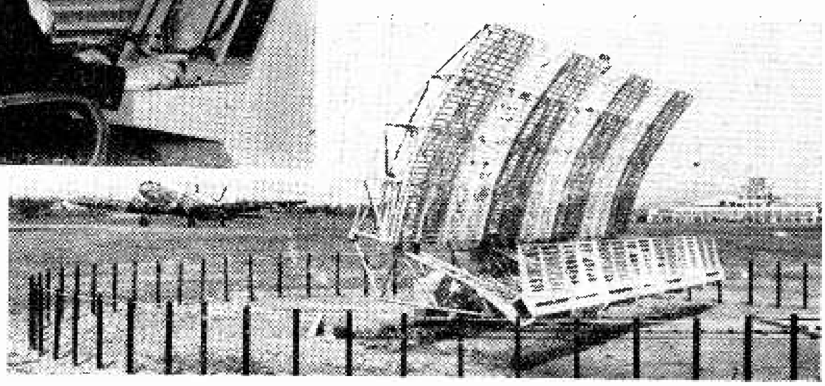
Mr. Briggs is once again to be congratulated on a very successful and enjoyable concert, and for his unsparing efforts to find the best in sound reproduction—this time, as it happened, in two-channel stereo.

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 equipment" 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.

UNBIASED

By FREE GRID

לְפִי־חָרֶב

THE Editor, wearied of etymological alarums 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) φουή cannot, as every Greek scholar knows, be derived from a verb with an α stem like φάω, for the α and the ο would contract into ω (as they do in φωνή) 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 φουή and φωνή are in no way connected.

(c) φουή 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 φουή 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, 'ἐν' means 'in' not 'on'; secondly, in no other passage does φουή mean 'edge.' No Greek scholar worth his salt would hesitate to translate this phrase 'in a slaughter wrought by the sword.' Clearly, 'Free Grid's' translation of φουή 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 φουή 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."

Readers' etymological excursions.

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 ἐν 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 ἐν 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 φουή 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 φουή 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 unhellenistic 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 φωνήσυριγγων 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*.

"φονή 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.

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 "phoney" 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!

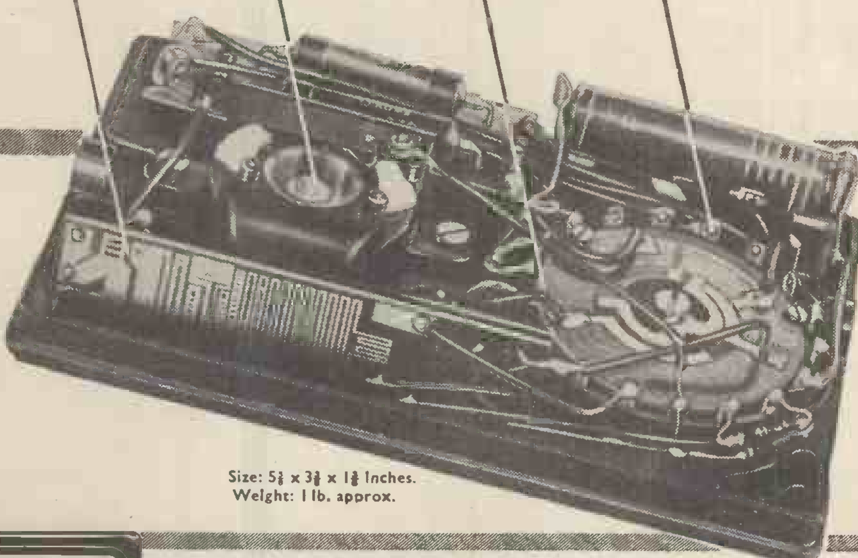
This sturdy multi-range test meter is remarkable for the wide range of test facilities which have been so neatly incorporated. Full advantage has been taken of printed resistor techniques to produce a compact instrument of low weight.

Printed resistance panel for universal meter shunt.

Composite printed resistors and auxiliary switch.

Meter movement is enclosed to give protection against the infiltration of dust.

Robust range switch similar to that used in the famous Avo-Meter. Eighteen fixed silver-plated contacts embedded in a ring of high-grade moulding material are swept by a double contact rotor arm.



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Size: 5¾ x 3⅝ x 1⅝ Inches.
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7 D.C. Voltage Ranges: 0-1,000 V.

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List Price:
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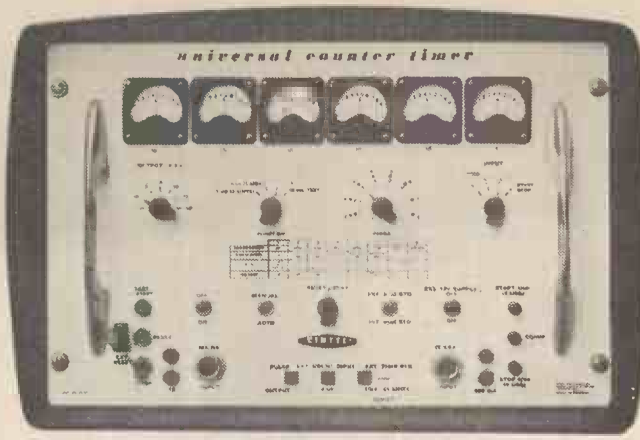

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Random Counting

Frequency Division

Time Measurement

Frequency Standard

This fully transistorized portable equipment provides for a wide range of time and frequency measurement as well as facilities for counting, frequency division and the provision of standard frequencies. The facilities available are briefly listed below:

TIME/UNIT EVENT (1 LINE): For the measurement of the time interval between two occurrences in a continuously varying electrical function in the range 3μsec to 1sec. The time for 1, 10 or 100 such events can be measured.

TIME/UNIT EVENT (2 LINE): For time measurement in range 1μsec to 2777hrs. of any interval defined by a positive or negative going pulse in any combination.

EVENTS/UNIT TIME: For frequency measurement in range 30c/s to 1Mc/s over period of 0·001, 0·01, 0·1, 1 or 10secs. Crystal accuracy $\pm$2 parts in 10^6/week. For mains or 12Vd.c. operation.

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is ideal for long-distance ground-air links, marine shore stations, meteorological stations, fixed and semi-mobile military uses, national security networks and medium-distance R/T circuits—indeed for nearly all radio links. It gives a power amplification of at least 10 times with an R.F. output of 5 kW P.E.P. from an R.F. input of 500 W or 3 kW R.M.S. Its simplicity of operation and tuning accuracy demand little or no skilled attention in the transmitting station. It is designed to comply fully with Joint-Services Specification K.114 (Protected Ground Equipment), soundly constructed and fit for the most adverse climatic and operating conditions. Full specifications and details on request.

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

CATHODE-RAY TUBE

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

Y1 AMPLIFIER

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

Y2 AMPLIFIER

Identical with Y1 amplifier.

SIGNAL DELAY

200 mμsec approximately. Not more than 10 mμsec differential between channels.

PRE-AMPLIFIER (2)

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

PROBES (OPTIONAL EXTRA)

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

TIME-BASE

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

X AMPLIFIER

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

CALIBRATION

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

POWER SUPPLY

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

SIZE AND WEIGHT

Height	17½ in.	(43.2 cm).
Width	12 in.	(30.5 cm).
Depth	24¾ in.	(62.9 cm).
Weight	80 lb.	(36.3 kg).

ACCESSORY

Camera Model 1428.

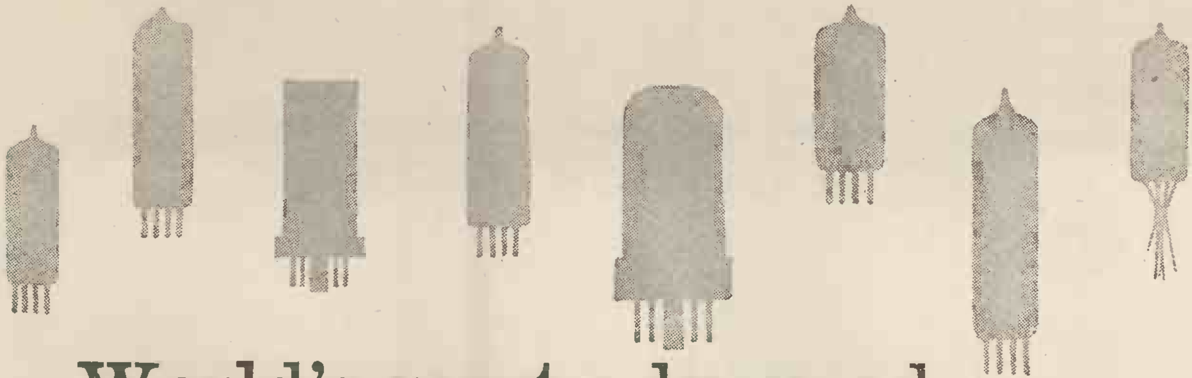
COSSOR INSTRUMENTS LTD

The Instrument Company of the Cossor Group

COSSOR HOUSE, P.O. BOX 64, HIGHBURY GROVE, LONDON, N.5.

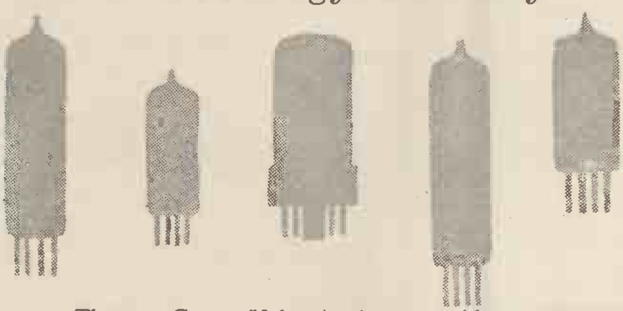
Telephone: CANonbury 1234 (33 lines). Telegrams: Cossor, Norphone, London. Cables: Cossor, London. Code: Bentley's Second.

TAS/CI.11



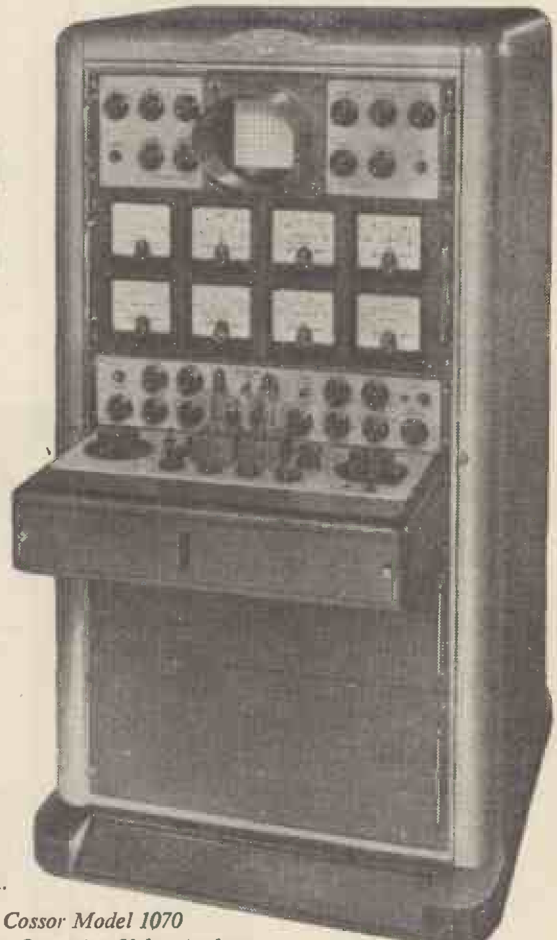
World's most advanced Valve Performance Analyser

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″×4″×3″ £1 9 6

1470B 6″×4″×5″ £1 13 6

1480A 8″×5″×5″ £2 4 6

1480B 8″×5″×7″ £2 7 6

1490A 12″×7″×5″ £2 11 6

1490B 12″×7″×7″ £2 15 6

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

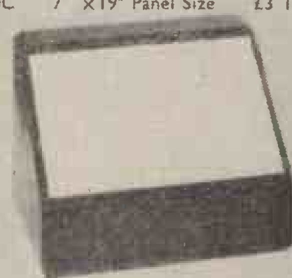
15 new Imhof standard cases with panel sizes from 6″×4″ to 24″×10½″ Just look at these examples . . . compare the new low prices. Here's real value for money! Whatever the size—whatever the quantity—all these new cases are built to the same, robust specification and high finish as the existing Imhof 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

Fully Radiused Sloping Panel Cases

1450B 10½″×19″ Panel Size £5 4 0

1410C 7″ ×19″ Panel Size £3 12 8



1450A 10½″×12″ Panel Size £3 18 10

1410B 7″ ×12″ Panel Size £2 18 6

1410A 7″ × 6″ Panel Size £2 5 3

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″×1⅝″×2⅛″ to 17″×4″×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 WC1 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 Reijsen, Delft
NEW ZEALAND: Imarex Ltd, Auckland C3
NORWAY: Birger Christensen, Oslo
PORTUGAL: Projectos e Construcoes Lda, Lisbon
SWEDEN: Elektronlund AB, Malmo C
SWITZERLAND: Walter Blum, Zurich 2/39
U.S.A.: Bud Radio Inc, Cleveland 3, Ohio
BRIT. GUIANA: Davsons Carribbean Agencies Ltd, Georgetown

No. 19

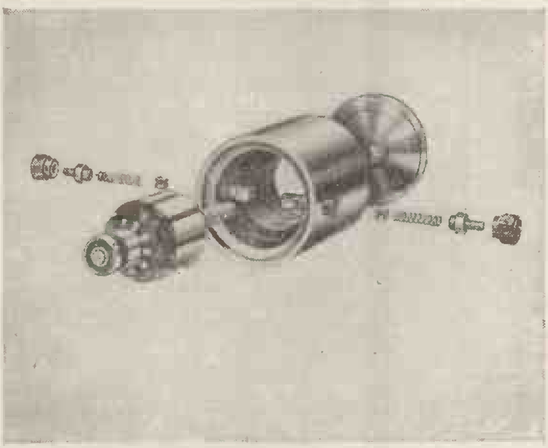
Permanent Magnets

Design Advisory Service

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.

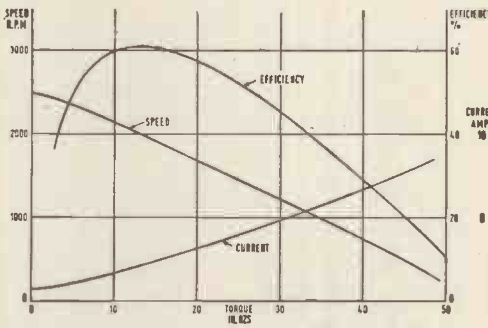
The introduction of Mullard "Magnadur" magnets has resulted in the development of quite revolutionary designs in many types of apparatus, amongst which the design of permanent magnet motors is an outstanding example.



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

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

MC282

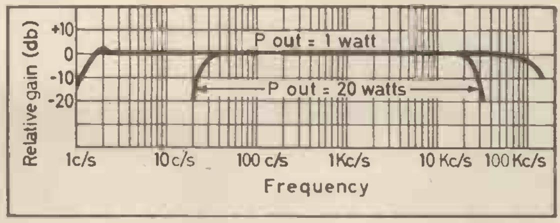
Avantic

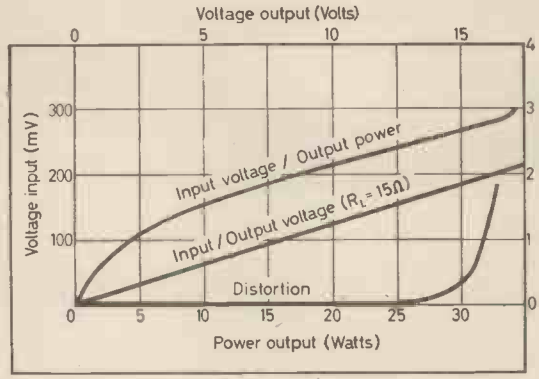
AUDIO AMPLIFIER STANDARD

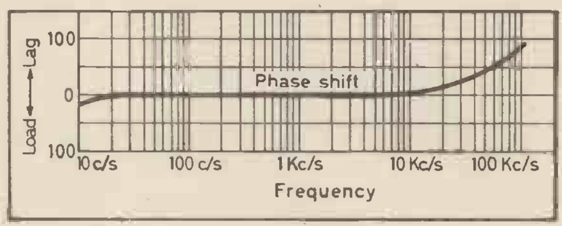
Suitable for use as:

- ✱ *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.
440V. at 30mA. d.c.

Price: 30 gns.

✱ *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

16a

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

16b

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 x 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 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 radioactivity studies we offer a fully integrated range including scalers, ratemeters, automatic sample changers and print-out timers.

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 multichannel 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.

16c

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.

★

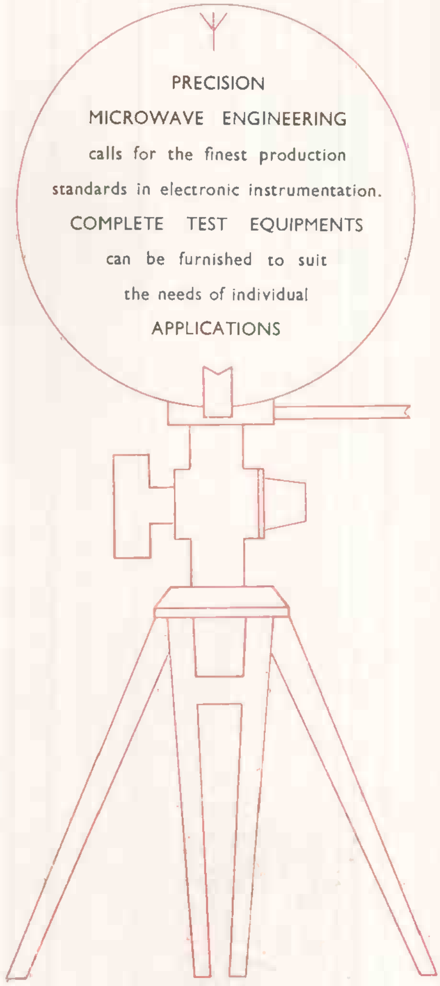
SPECTRUM ANALYSERS

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.



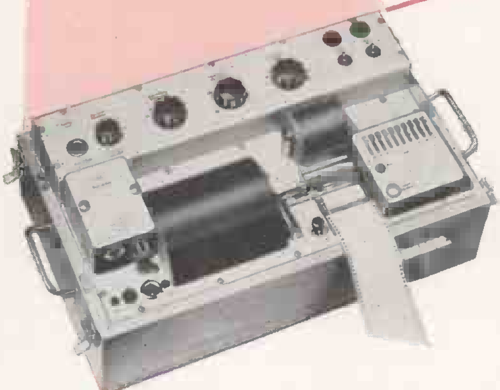
The SL range of waveguide test equipment comprises automatic standing wave indicators, direct-reading frequency meters, motorised waveguide switches, sliding screw tuners, adjustable shorts, rotating joints, double stub tuners, mixers, attenuators, etc., for frequencies from 2,450 to 18,000 Mc/s.

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 Preamplifier 1606 for readings of acceleration, velocity and displacement.

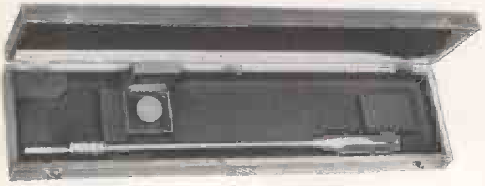


Level Recorder 2304 will automatically record spectra from test pieces, Measuring Microphones, Accelerometers, Strain Gauges, etc., by means of electrically synchronised Octave / **Third - Octave Spectrometer** 2111, containing 16c/s-35Kc/s filters and special v.t.v.m. Self-contained **Audio Frequency 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.

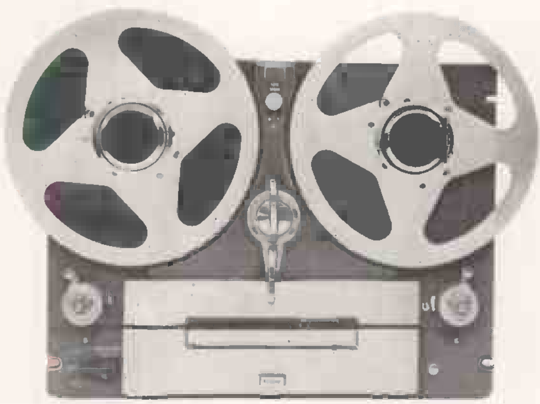
16a

TAPE
INSTRUMENTATION

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 magnistors.

For basic instrumentation applications, various models are available for direct record/reproduce applications using $\frac{1}{4}$″ tape with various tape speeds. Frequency Response $\pm$ 2dB 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.

16F

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 30,000µ 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, megohmeters 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).

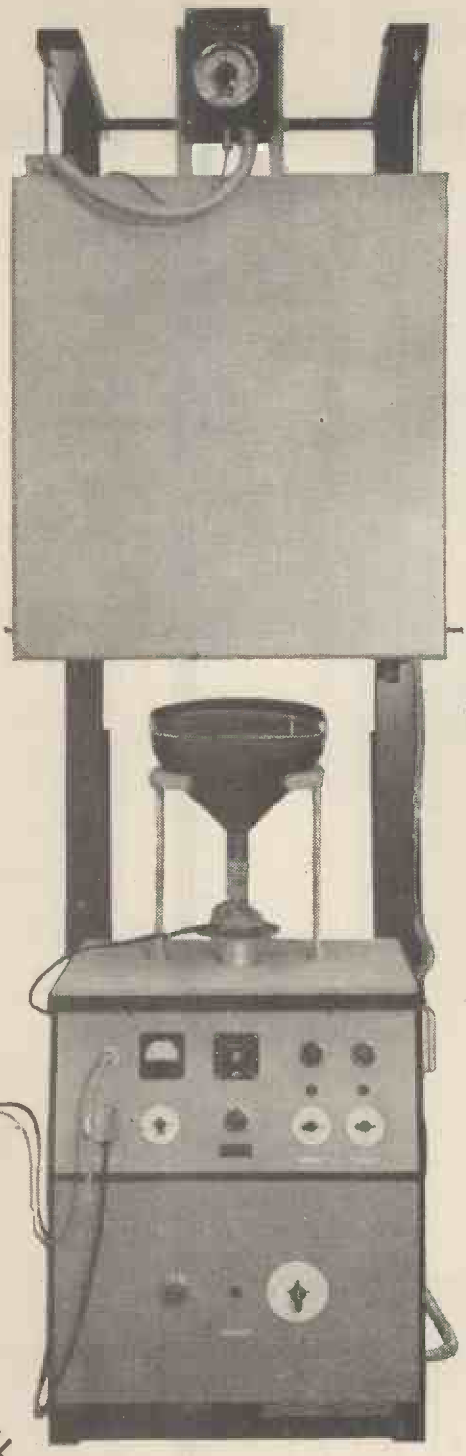
FIRST STAGE RECONDITIONING OF C.R.T.s

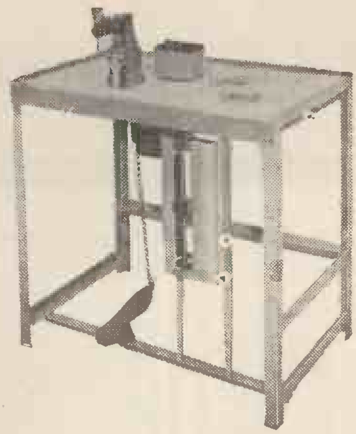
For the reconditioning of C.R.T.s we supply the complete outfit as an additional service to our customers. This Equipment can only be purchased with our Pumping Units and is not available for sale on its own.

Additional items obtainable: Heater Box for Gun Assembly; Assembly Jigs. All spares for Pumping and Auxiliary Equipment.

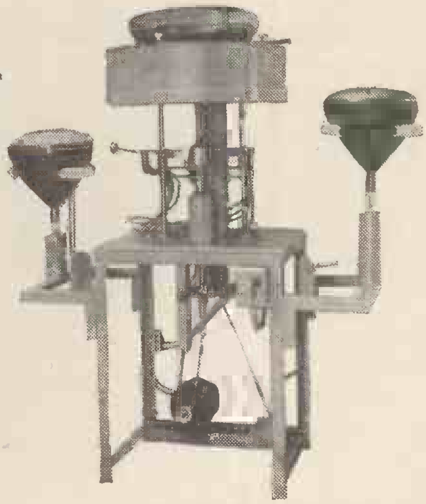
Our Engineers are available to help you, to lay out and to install the required machinery, and our Technical Dept. will assist you in any problems you might encounter in this field.

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.

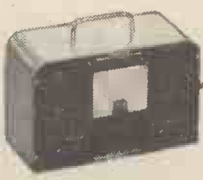


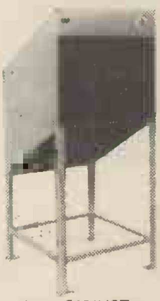


SPOT WELDER with Automatic Timer and Resistance



GLASS SEAL MACHINE for neck sealing, drop sealing and stretch sealing

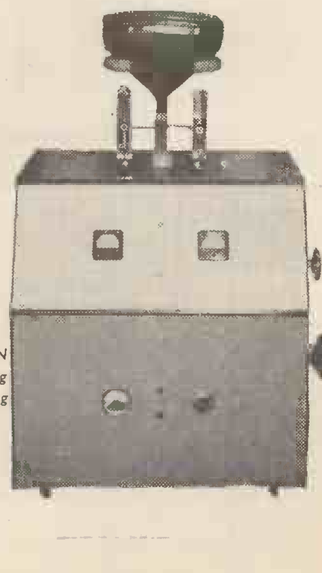




U.V. CABINET For Screen Inspection.

VACWELL ENG. CO. LTD.

Single Position Pumping Unit complete with Automatic press-button electric seal-off and pre-selected cathode forming



H.F. INDUCTION UNIT for De-gassing and Getter Firing

VACWELL ENGINEERING Co LTD

WILLOW LANE · MITCHAM · SURREY *Phone: MITcham 8211 (3 lines)*

So easy to build — Heathkit DAYSTROM — **so easy to use**

Good news!

Recent relaxation of import regulations enables us to supply certain American Heathkit models. If there is one you want please drop us a line and we shall be glad to send you prices.

5in. OSCILLOSCOPE KIT

Model O-12U

Laboratory quality at utility osci'loscope price and ease of assembly make this kit of outstanding value. Vertical frequency response 3c/s to 5 Mc/s., + 1.5 dB. — 5 dB., sensitivity 10 mV. per cm. at 1 kc. Horizontal frequency 1 c/s. to over 400 k/c. (± 1 dB. up to 200 kc). The Heath patented sweep circuit functions from 10 c/s. to over 500 kc. in five steps giving five times the usual sweep of other scopes. In addition it has exceedingly short re-trace and rise times and electronically stabilised power supply. Included is a 40-page Instruction Manual.............................. **£34.15.0**

VALVE VOLTMETER KIT

Model V-7A

The world's most popular valve voltmeter, with printed circuit and 1 per cent. precision resistors to ensure consistent laboratory performance. It has 7 voltage ranges measuring d.c. volts to 1,500 and a.c. to 1,500 r.m.s. and 4,000 peak to peak. Resistance measurements from 0.1 ohm to 1,000 M ohms with internal battery. Input impedance is 11 Megohms and dB measurement has a centre-zero scale. Complete with test prods, leads and battery...... **£13.0.0**

RESISTANCE-CAPACITANCE BRIDGE

KIT Model C-3U

Polarised 5-450 V. D.C. Measures power factor. Capacity 10 pF. to 1,000 mfd., and resistance 100 Ω to 5 Megohms. Safety switch provided. **£7.19.6**

TRANSISTOR PORTABLE KIT

Model UXR-1

Presented in elegant real hide case with tasteful gold relief. Can be assembled in 4 to 6 hours and you have a set in the top flight of the 25-30 guinea class. Prealigned I.F. transformers, printed circuit and a 7in. high-flux speaker......... **£15.18.6**

HI-FI STEREO AMPLIFIER KIT

Model S-88

Gives 16w. output (8 per channel with 0.1 per cent. distortion at 6w. per channel). It has ganged controls, STEREO/MONAURAL gram, radio and tape recorder inputs and push-button selection as well as many other first class features well above its price range. In two-tone grey metal cabinet with a golden surround and fittings. Also u'tra-linear push-pull output **£25.5.6**

VARIABLE FREQUENCY OSCILLATOR KIT

Model VF-1U

For all Amateur Bands, 160-10 metres. Ideal for Heathkit DX-40U and similar transmitters **£10.12.0**

Price less valves £8/19/6

DUAL-WAVE TRANSISTOR RADIO KIT Model UJR-1

This sensitive headphone set is a fine introduction to electronics for any youngster. (Not illustrated) **£2.16.6**

● Deferred Terms available on all orders above £10.

DAYSTROM LTD.

DEPT. W.W.11, GLOUCESTER, ENGLAND

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

thoroughly Heathkit DAYSTROM **dependable**

COTSWOLD SPEAKER SYSTEM KIT

This acoustically designed enclosure measures 26 x 25 x 13in. and houses a special 12in. bass speaker with 2in. speech coil, elliptical middle speaker together with a pressure unit to cover the full frequency range of 30-20,000 c/s. Its polar distribution makes it ideal for really Hi-Fi Stereo. Delivered complete with speakers, cross-over unit, level control, Tygan grille cloth, etc. Left "in the white" for finish to personal taste, all parts are pre-cut and drilled for ease of assembly. **£19.18.6**

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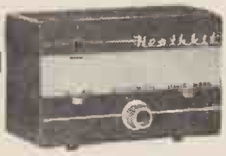

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	V-7A	Valve Voltmeter Kit		RP-U1	Transcription Record Player
	SSU-1	Hi-Fi Speaker System Kit		—	Gloucester Stereo Cabinet Kit
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Grid Voltage	*600 V*
Pulse Anode Current	*16 A*
Peak Anode Current	*18 A*
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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

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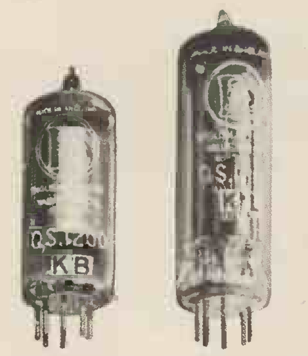

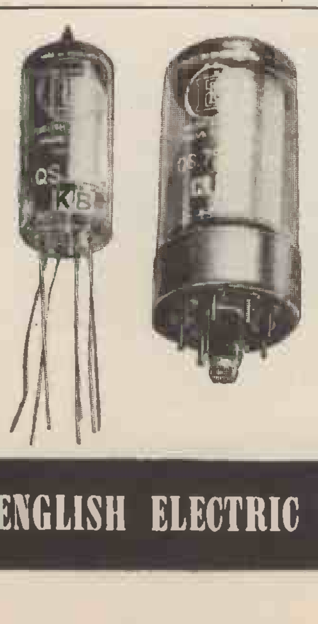

E.E.V. type	Previously known as	American equivalent	Service type	Striking voltage (V) ○	Striking voltage (V) ●	Operating voltage max. (V)	Ignition electrode voltage (V)	Ignition electrode series resistance (megohms)	Tube current max. (mA)	Tube current min. (mA)	Regulation max. (V)	Base
OA2	QS1207	OA2	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. ○ 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

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AP 131

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GD 81

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Special Quality Beam Tetrode

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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

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.

CRC 16/9

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The famous H.F.1016 at £7.12.3.

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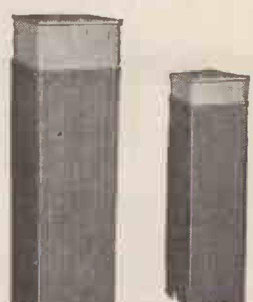

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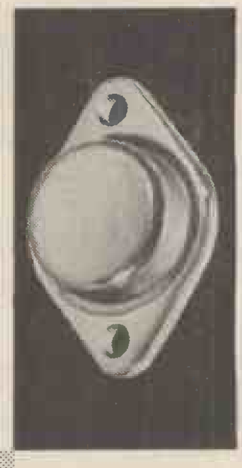

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Characteristics (at $T_{junction}$ = 25°C) for OC22, OC23 and OC24.

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Collector Leakage Current		*Typical*	*Max.*
(at V_c=–10V, I_e=0)	$I_{c(o)}$	30µA	100µA
Emitter Leakage Current			
(at V_e=–10V, I_c=0)	$I_{e(o)}$	20µA	100µA
GROUNDED EMITTER			
Collector Bottoming Voltage			
(at I_c=1.0A, I_b=30mA)	V_{ce}	–400mV*	—
Current Amplification Factor		*Typical*	*Min*
(at V_c=–2V, I_c=100mA)	$\bar{\alpha}'$	200	—
(at V_c=–2V, I_c=1.0A)	$\bar{\alpha}'$	150	50

* –400mV for OC23 and OC24 only. OC22=–600mV.

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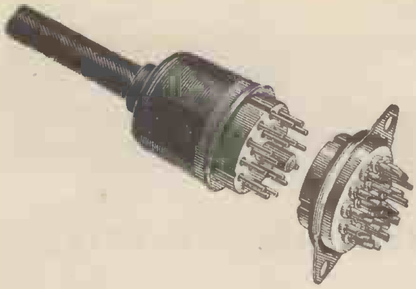

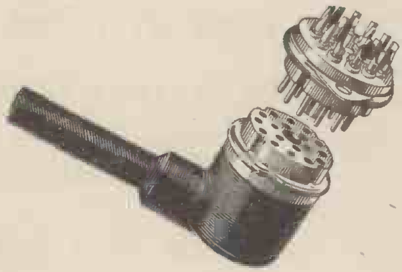

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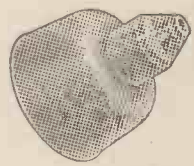
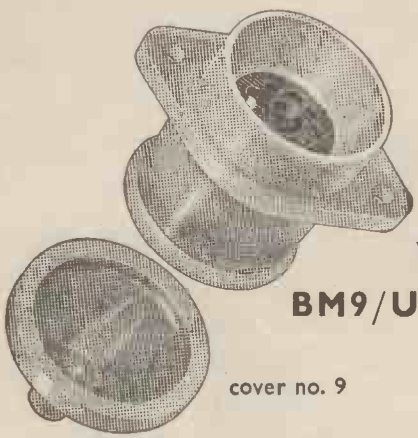


TC2



B9A E.H.T. VALVEHOLDERS

BM9/UV

cover no. 9

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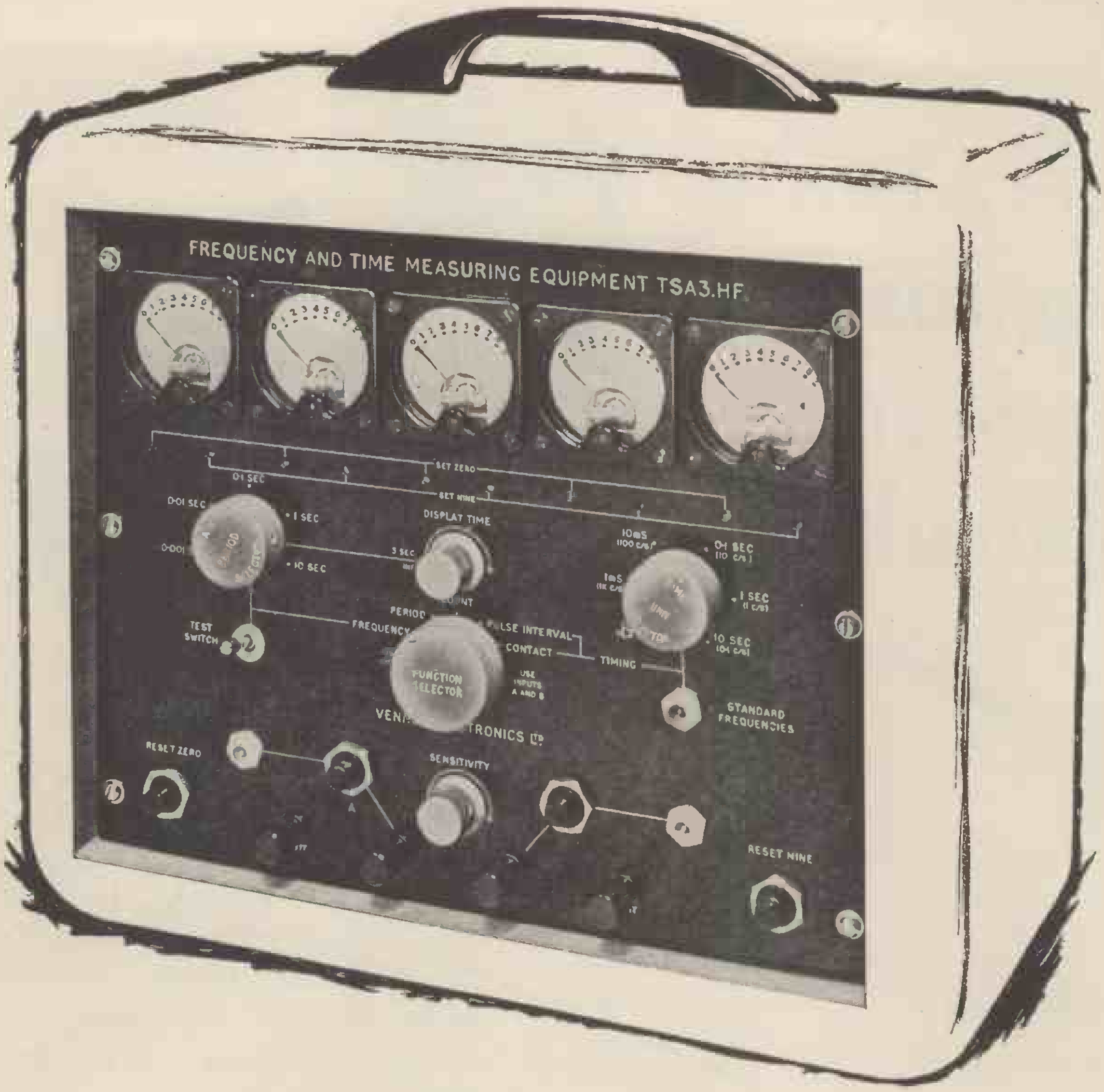

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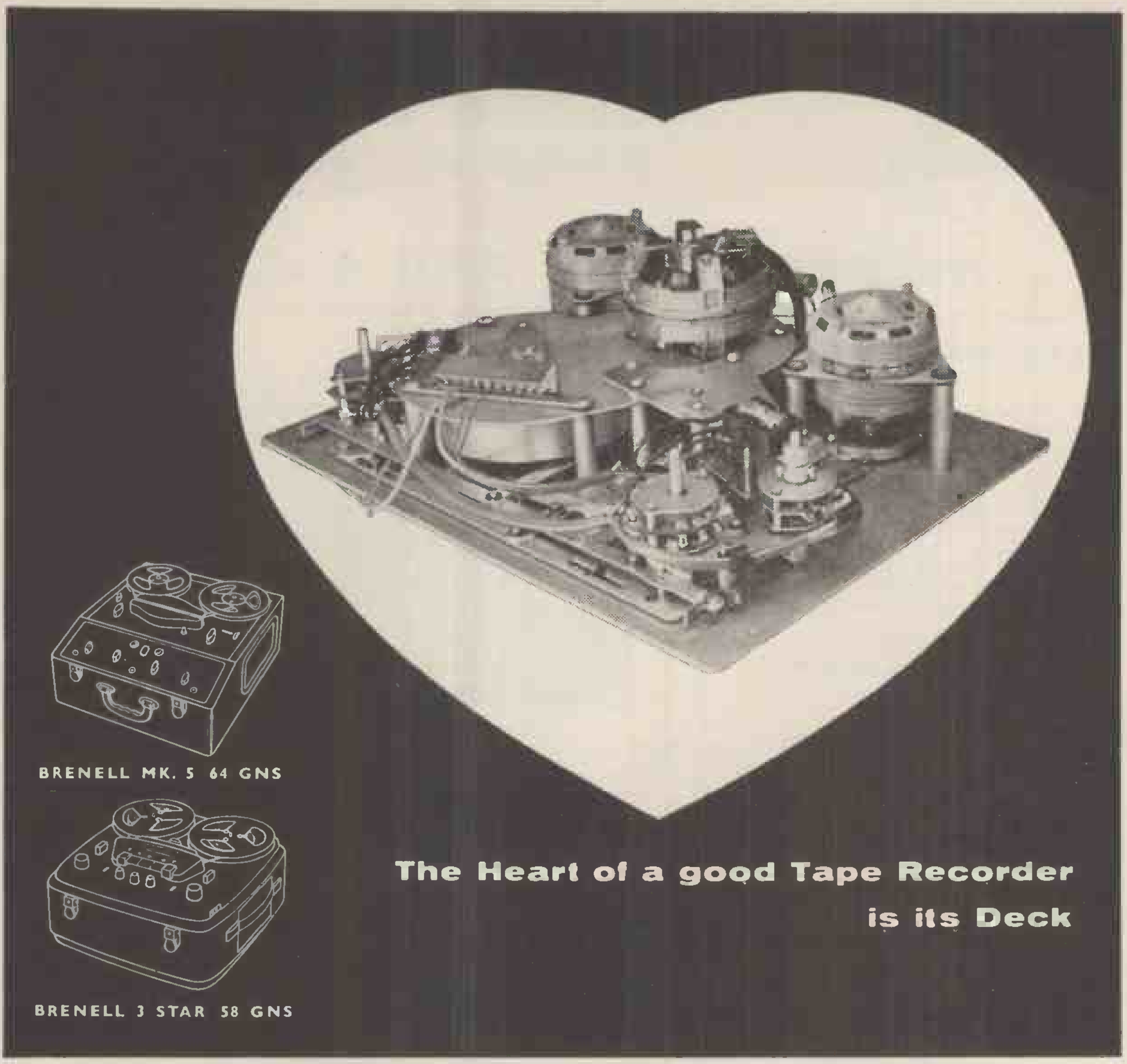

For the enthusiast who loves to experiment—who wishes to build up his own tape recording unit —to construct into his own furniture or to add to existing hi-fi equipment, the Brenell Mk. 5 Deck presents truly remarkable value. Its versatility of application has firmly established the Brenell in the hi-fi market as a general purpose deck with immense advantages. Superbly made, it is conclusive evidence of the skilful design for which Brenell are noted.

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GD23

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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.
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Dipole and all leads supplied.
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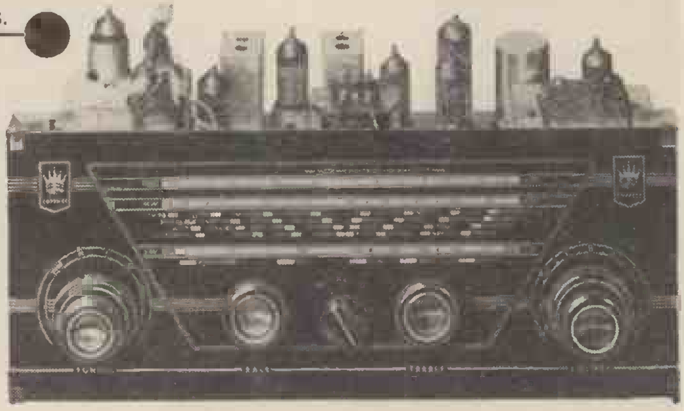
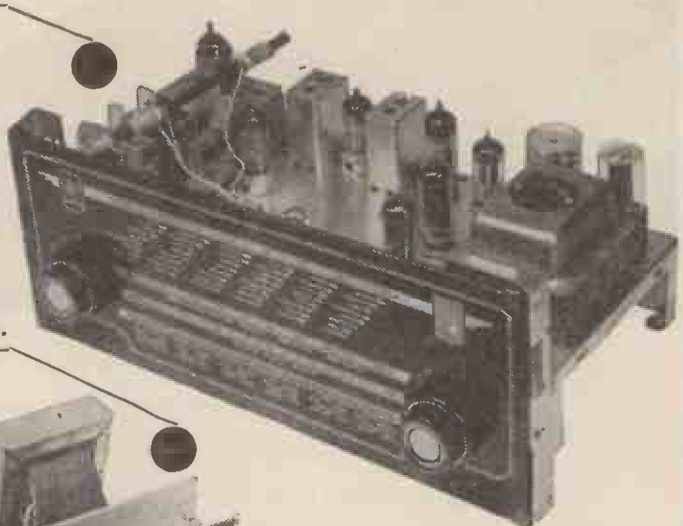


R.G.9 A.M./F.M. CHASSIS 25 Gns.

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.



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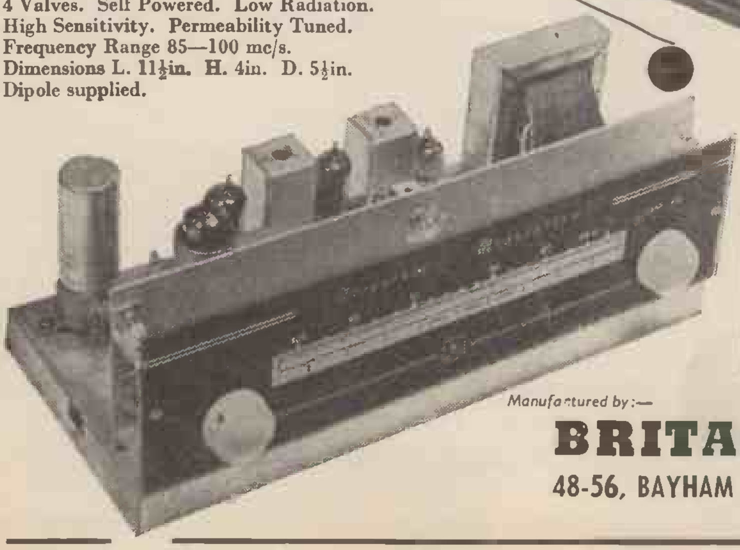
4 Valves. Self Powered. Low Radiation.
High Sensitivity. Permeability Tuned.
Frequency Range 85—100 mc/s.
Dimensions L. 11½in. H. 4in. D. 5½in.
Dipole supplied.



OTHER MODELS

RG6. 6v. A.M./F.M. Radiogram Chassis—21 Gns.
FMT5.5v. A.M./F.M. Tuner Chassis—19 Gns.
SA4. 4 Valve Stereo Amplifier—£8.0.0d.

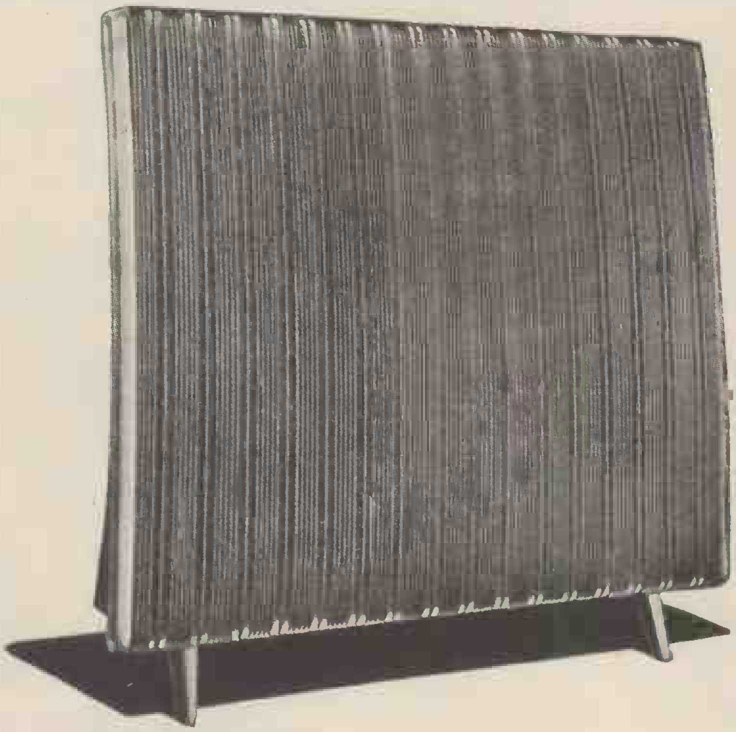
Manufactured by:—

BRITAMER LIMITED

48-56, BAYHAM PLACE, LONDON, N.W.1.

Telephone No. EUSton 7841-3

A higher standard of listening enjoyment and satisfaction in the home



QUAD

ELECTROSTATIC LOUDSPEAKER

'For the closest approach to the original sound'

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.

**Increasingly used in studios, monitor rooms and wherever standards have to be set—and maintained.*

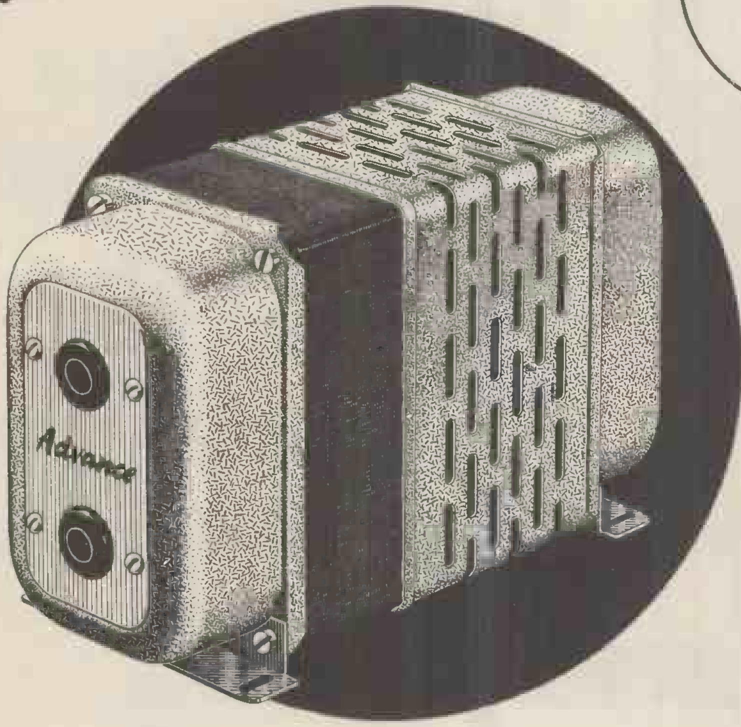
Send a postcard marked W.W. for illustrated booklet.

ACOUSTICAL MANUFACTURING COMPANY LTD., HUNTINGDON, HUNTS. *Huntingdon 361*

More WATTS PER lb / £

with the New

CV SERIES



Take the best in Constant Voltage Transformer design and practice . . . maintain all those features proven by years "in the field" . . . . add still greater efficiency . . . . reduce size and weight . . . . and then drastically cut the cost — and you have the NEW CV Series.

Models now available with output capacities of 25, 50, 75 and 100 watts and range of outputs from 6 to 240 volts — all providing assured output voltage regulation within ±1% for input variations of up to ±15%

- **WEIGHT REDUCED** by over 25%
- **SIZE REDUCED** by over 40%
- **STRAY FIELD REDUCED** by over 75%
- **OPERATE AT ANY LOAD** from 'NO LOAD' to 'FULL LOAD'
- **WILL OPERATE CONTINUOUSLY AT AMBIENT TEMPERATURES** from −10 to +50°C.

CONSTANT VOLTAGE TRANSFORMERS

They are **SMALLER - LIGHTER** *and* **COST LESS!**

Here's a typical example-

	MODEL CV.25/E	MODEL MT.281/E
Input Voltage	190-260V	190-260V
Output Voltage	6V	6V
Output Capacity	25W	25W
Dimensions	$5\frac{1}{4}$"x $3\frac{3}{16}$"x $4\frac{7}{8}$"	7"x $5\frac{1}{8}$"x $4\frac{1}{8}$"
Weight	5lb	7lb
	PRICE £6. 5. 0	PRICE £8. 0. 0

Full details in Folder W-63 available on request

by **Advance** – to be sure!

Advance COMPONENTS LIMITED

MAINS STABILIZATION DIVISION

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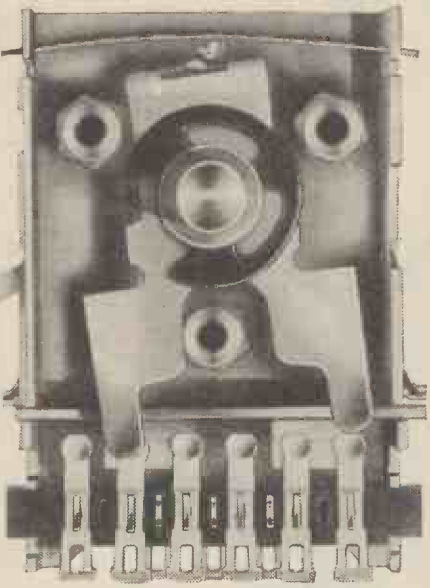

Patent Applied For

take a careful look–

it's the first you've ever seen

Yes, it's an 'S' Type variable capacitor—but with a difference! It provides full tuning over two complete wavebands—in one variable capacitor—with no separate switches—no messy linkages—and at minimum cost.

It incorporates an integral switch that permits wave change and tuning to be carried out with one control knob only on any two-band radio.

Available as 'S', 'W' or 'V' Types fitted with two-pole changeover switches but a third pole can be fitted for dial lamp switching or similar purposes. Also available with split-reduction gear.

Designers and engineers are invited to write for Publication No. 169.

A new break in Radio Receiver Design

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New Lane · Havant · Hants
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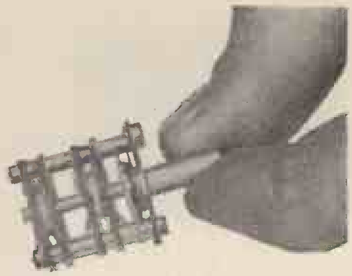
Plessey

CRT 1a

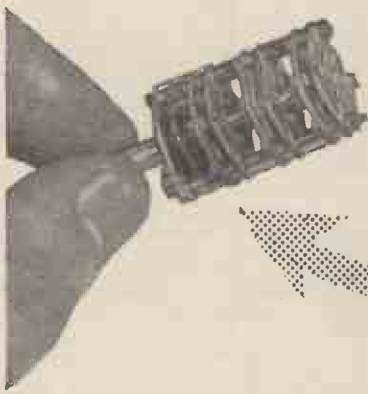


New

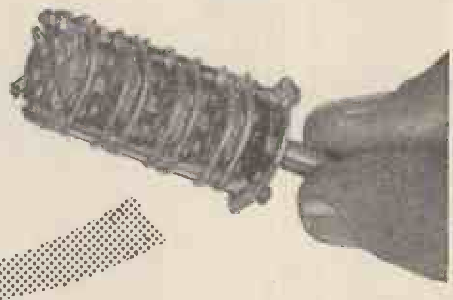
miniature

ROTARY SWITCH

by ARDENTE



* *full technical data upon request*



ARDENTE

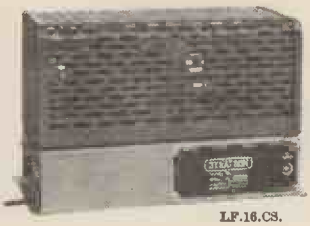
ARDENTE ACOUSTIC LABORATORIES LTD

8-12 MINERVA ROAD, LONDON, N.W.10 *Phone: ELGAR 3923 (6 lines)* *Telegrams: HAILER, LONDON.*

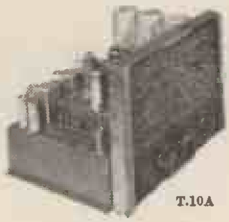
LF.15.CS.

A GUIDE TO BRITAIN'S BEST
HI-FI EQUIPMENT

Dynatron offers you, among many other advantages: advanced design. Conservative ratings. Scrupulous attention to detail. Ruthless testing. And the narrowest tolerances in the industry. Dynatron can never be cheapest, it is always best.



LF.16.CS.



T.10A

LF.20.CS.

FM.2.LV.

CLS.15.

LOUDSPEAKERS

Panorama Console Loudspeakers. Bass reflex chamber with acoustic resistance unit.

CLS.15. 15 watts max. 12" + one 5" High Flux speakers. **£35.5.0.**

CLS.20. 20 watts max. 12" + Trebax Unit. **£46.10.0.**

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.**

LF.20.CS. 5 valve Push-Pull LF Amplifier. 20 watts output. 8 volt R.M.S. input for full output. Auxiliary power supplies. Operates with tone control unit TC.20.CS. **£29.15.0.**

TUNERS

T.10A. The 'Ether Pathfinder' 9 valve AM/FM Tuner. Four wavebands AM 13-2000 metres, one waveband FM 88-108 Mc/s. Variable selectivity 4 positions. R.F. Stage. Tuning indicator. Large fully illuminated tuning dial. High sensitivity, and signal to noise ratio. **£63.10.0.**

FM.2.LV. V.H.F. Tuner Pretuned. 7 valves. 4 Pre-tuned FM Stations. Range 88-108 Mc/s. Single shaft operation. Universal mounting. Ideal for FM conversion purposes. As used by BBC. **£24.5.0.**

FM.2.HV. (8 valves) **£28.5.0.**

SC1. A three-way console designed to store a comprehensive range of sound reproduction equipment. **£49.16.0.**

TONE CONTROL UNITS (PRE-AMPLIFIERS)

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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DYNATRON RADIO LIMITED, DEPT. 4, ST. PETER'S ROAD, FURZE PLATT, MAIDENHEAD, BERKS. TELEPHONE: MAIDENHEAD 5151/2.

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IN BOTH GREAT BRITAIN AND OVERSEAS

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HIGH VACUUM

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NEW TOOL FOR HIGH VACUUM SPECIALISTS
Introducing a whole new series of ion pumps that will develop absolutely clean vacuum, better than 10-9 mm Hg. They are available in pumping capacities of 100 and 250 litres/second. Larger sizes can be supplied on special order. They offer tremendous advantages in such applications as particle accelerators, space research chambers, fusion processes, mass spectrometers, electron microscopes, vacuum tube processing—whenever uncontaminated ultra-high vacuums are required.

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In the field of instrumentation, Livingston Laboratories offer a unique service in the form of expert advice in the choosing of test equipment to meet your needs.

The relevant factors are not who makes it or where it is made, but will it do the job? At Retcar Street you can discuss the technical problems of instrumentation and the new techniques developed both in this country and abroad. If it is impossible to call—write or telephone about your particular problem or requirement and our representatives will supply you with full information.

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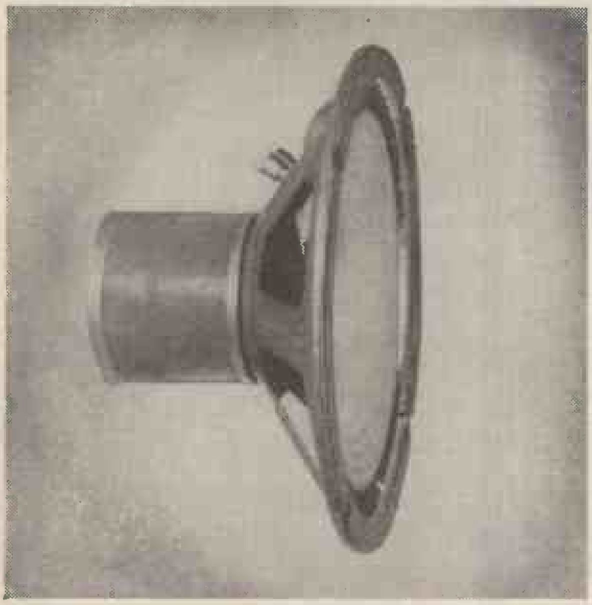
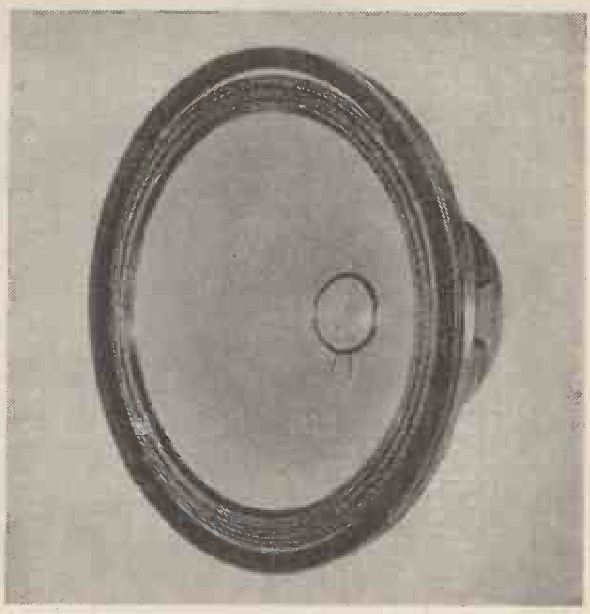
Choose from 2 superb Full-Range Loudspeakers





These features outclass all competition

8" AXIETTE

- Smooth response 40–15,000 c/s.
- Hyperbolic plastic terminated diaphragm.
- Precision wound long throw aluminium voice coil.
- Anisotropic high efficiency ring magnet. Gap flux 15,000 gauss.
- Full 6 watts power handling capacity.

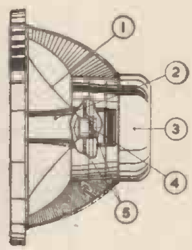
Price £6.12.1 (Inc. P.T.)

10" AXIOM 110

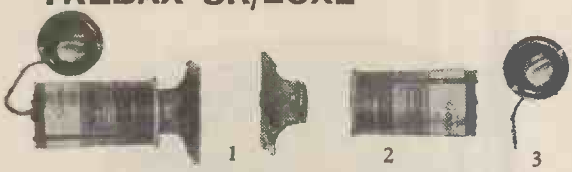
1. Vacuum formed controlled edge hyperbolic diaphragm giving smooth response 40–15,000 c/s.
2. Rigid die-cast chassis of slender silhouette.
3. Closed circuit slug type magnet system 12,000 gauss.
4. Individually precision wound and terminated extra-long aluminium voice coil.
5. Heat formed, impregnated corrugated centre suspension. Linear force/deflection characteristic with maximum radial centering action.

FULL 10 WATTS POWER HANDLING CAPACITY

Price £5.0.0 (Inc. P.T.)



TREBAX 5K/20XL



ADD THIS UNIT TO IMPROVE ANY LOUDSPEAKER SYSTEM

1. Wide high frequency dispersion from die-cast horn.
2. Built-in L/C crossover network.
3. Constant impedance variable L-pad attenuator ready wired to unit.

In one step give your system smooth undistorted performance up to 20,000 c/s.

Price £7.0.0

Why you should choose GOODMANS LOUDSPEAKERS ! Because when you buy a Goodmans Loudspeaker you obtain the results of a long and excellent tradition of uncompromising research, giving you reliability and years of pleasurable listening. You also obtain the technical advice services of the laboratory who by constant research and rigid self criticism, have enabled Goodmans Industries to lead in World Markets.

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G13WW

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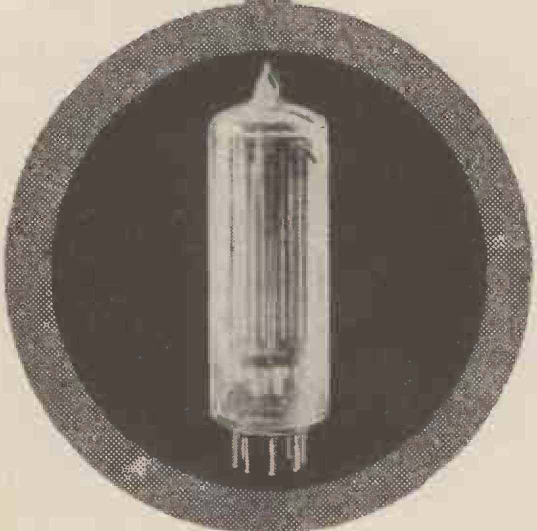
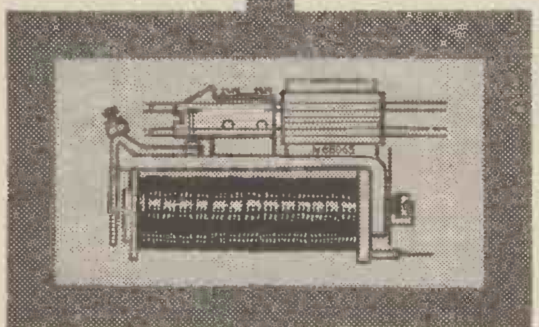
Europe's largest manufacturers and the World's largest exporters of High Fidelity Loudspeakers.

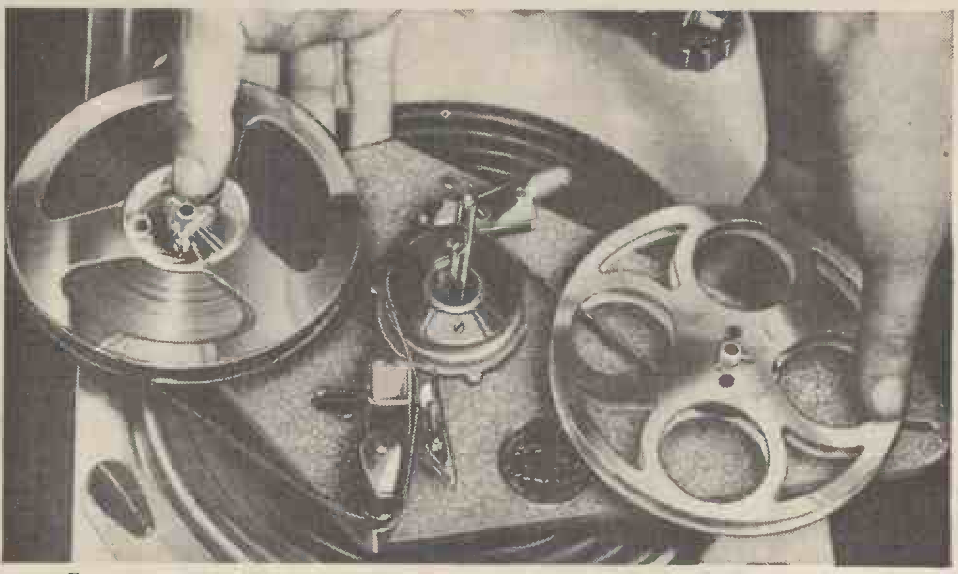




A REVOLUTIONARY NEW BRITISH INVENTION!

★ Uses standard tapes
★ Plays at $7\frac{1}{2}''$ per. sec. or 3 other speeds
★ Records direct from radio or microphone
★ Erase and fast rewind

FULLY GUARANTEED



Instantly turns any gramophone into a first-class Tape-Recorder

and back into a record-player in a moment!

Gramdeck is completely *new* . . . a revolutionary and ingenious invention that instantly turns your gramophone into a tape-recorder and back into a gramophone at will! Slip the Gramdeck on to your turntable and you have the finest tape-recorder you've ever heard! Lift it off . . . your gramophone is ready to play records again. There are no motors or valves to go wrong—and *you get a quality of reproduction that has to be heard to be believed!*

Everyone is praising the Gramdeck. "*The quality is at least equal to that obtained from a good microgroove disc,*" says a leading professional journal.

WORKS FROM ANY RECORD PLAYER OR RADIOGRAM

Gramdeck records and reproduces with a wonderful depth and breadth of tone. Because it uses equipment that is already in your gramophone it only costs a fraction of the high-quality tape-recorder you would normally require. Full details, specifications, photographs, easy terms, etc., are given in the Gramdeck Book. Send for your FREE copy, today.

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Special moving-coil microphone and tape extra.

Free!

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"Ingenious—simple . . . why on earth did no one think of it before!"—THE TAPE RECORDER.
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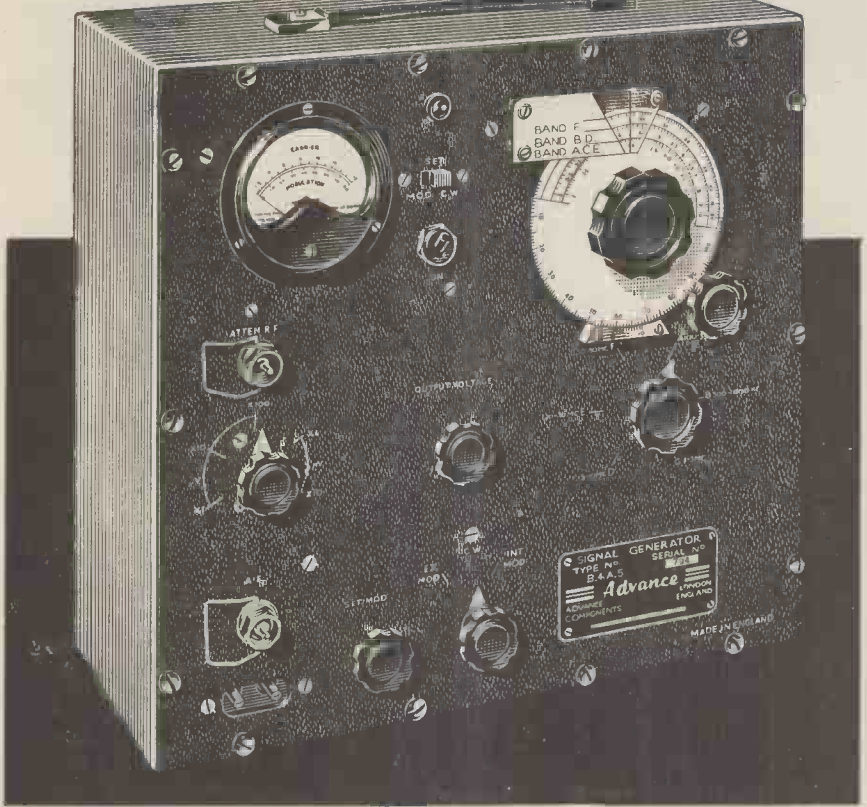
GRAMOPHONE TAPE RECORDER

HIGH QUALITY TAPE-RECORDING FOR EVERY HOME

GRAMDECK TURNS A TURNTABLE INTO A TAPE-RECORDER

The R.F. SIGNAL GENERATOR...



TYPE B4

MODEL A
100 kc/s to 80 Mc/s
in 6 bands

MODEL B
30 kc/s to 30 Mc/s
in 6 bands

Calibration accuracy of both models is ± 1%

by **Advance** to be sure!

NETT PRICE IN U.K.

£68

Full technical details in Leaflet W38 available on request.

The " Advance " B4 Signal Generator is a well tried and proven instrument which incorporates special features consisting of a monitored R.F output and variable modulation depth (which is also monitored); an 80 dB attenuator of special design provides exceptional accuracy of attenuation throughout the frequency range and an unusually low leakage factor is achieved by triple screening of the R.F. oscillator, and by mounting the calibrated dial on the outside of the case.

OUTPUT IMPEDANCE: 75 ohm unterminated; termination pad supplied to provide output impedances of 37 and 10 ohms and a dummy aerial facility.
INTERNAL MODULATION: 400 c/s ±10%. Modulation depth 0 to 80% ±10%.
EXTERNAL MODULATION: Model A: 10 c/s to 30 kc/s; modulation depth 0 to 80%.
Mode B: 10 c/s to 10 kc/s; modulation depth 0 to 80%
AUDIO OUTPUT: 0 to 10 volts into 600 ohms at 400 c/s.
R.F. LEAKAGE: Less than 1 microvolt.

Advance COMPONENTS LIMITED
INSTRUMENTS DIVISION
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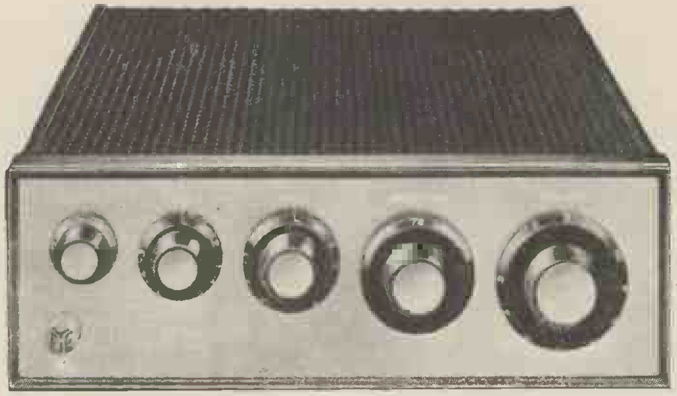
Today's best looking listening

Cabinet in walnut or mahogany veneers. Dennis & Robinson, Old Portslade, Sussex. Price £21.9.0.

The outstanding PYE MOZART STEREO AMPLIFIER*

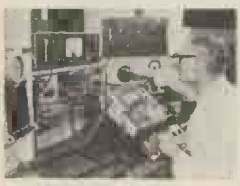


Model HFS20M (Cased)—Price 35 gns.

*with two very special features

1. *DC Heated Preamplifier*—means extremely low hum levels.
2. The cased version *can be split* for cabinet installation if desired later and the chassis model may be cased.

CRAFTSMAN BUILT

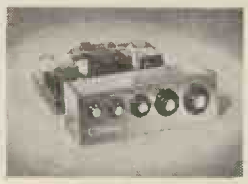


This newest addition to the High Fidelity range is the result of the most intensive development by this specialist Division of Pye Ltd.

BRIEF SPECIFICATION

Pre-amplifier	
Sensitivities:	P.U. 7mV, Tape 100mV, Radio 100mV.
Hum & Noise:	P.U. —58db. Tape and Radio —65db.
Frequency Response:	Tape and Radio 20 to 20000 cps ±1½db. P.U. within 1½ db of published replay curves.
Channel Separation:	Between —40 and —50 db overall.
Controls:	Selector. (Tape, Radio, 78 L.P.O. L.P.N. RIAA). Bass: —15 db to +10db. Treble: —15 db to +10 db. Balance: 6 db per channel. Volume: Continuously variable.
Main Amplifier	
Output:	10 watts per channel
Distortion:	0.3% at 9 watts
L.F. Power Output:	8 watts at 40 cps.
Speaker Imp.:	4, 8, and 15 ohms (with phase reverse switch)
Mains Voltage:	200 to 250v. 110 to 120v (Export Model)

Scientific Research



Model HFS20 (Chassis) —Price £35.0.0
Supplied complete with 3 ft. of linking cable. Optional extras include casing and extra 3ft. leads.

PYE HIGH FIDELITY DIVISION

65 Fairview Road, Norbury, London, S.W.16.

2-3 kW channelised transmitter

The versatility and reliability of this new, tropicalised Mullard transmitter make it eminently suitable for h.f. en-route, ground-to-air services and point-to-point communication networks. 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. There are ancillary units available that permit remote control of the transmitter over telephone circuits.

Mullard

Frequency Range 1.5 to 30 Mc/s.
Frequency Stability to Atlantic City 1947 standards.
Power Output 3kW. c.w., 2kW m.c.w. or r/t.
Types of Emission c.w., m.c.w., telephony, frequency shift (with external keying unit), A1, A2, A3, F1.
Output Impedance 600 ohms balanced.
Power Supply 400V, 50-60c/s 3-phase.

A PRODUCT OF
MULLARD EQUIPMENT LIMITED
A COMPANY OF THE MULLARD GROUP

MULLARD LIMITED
Equipment Division
Mullard House, Torrington Place,
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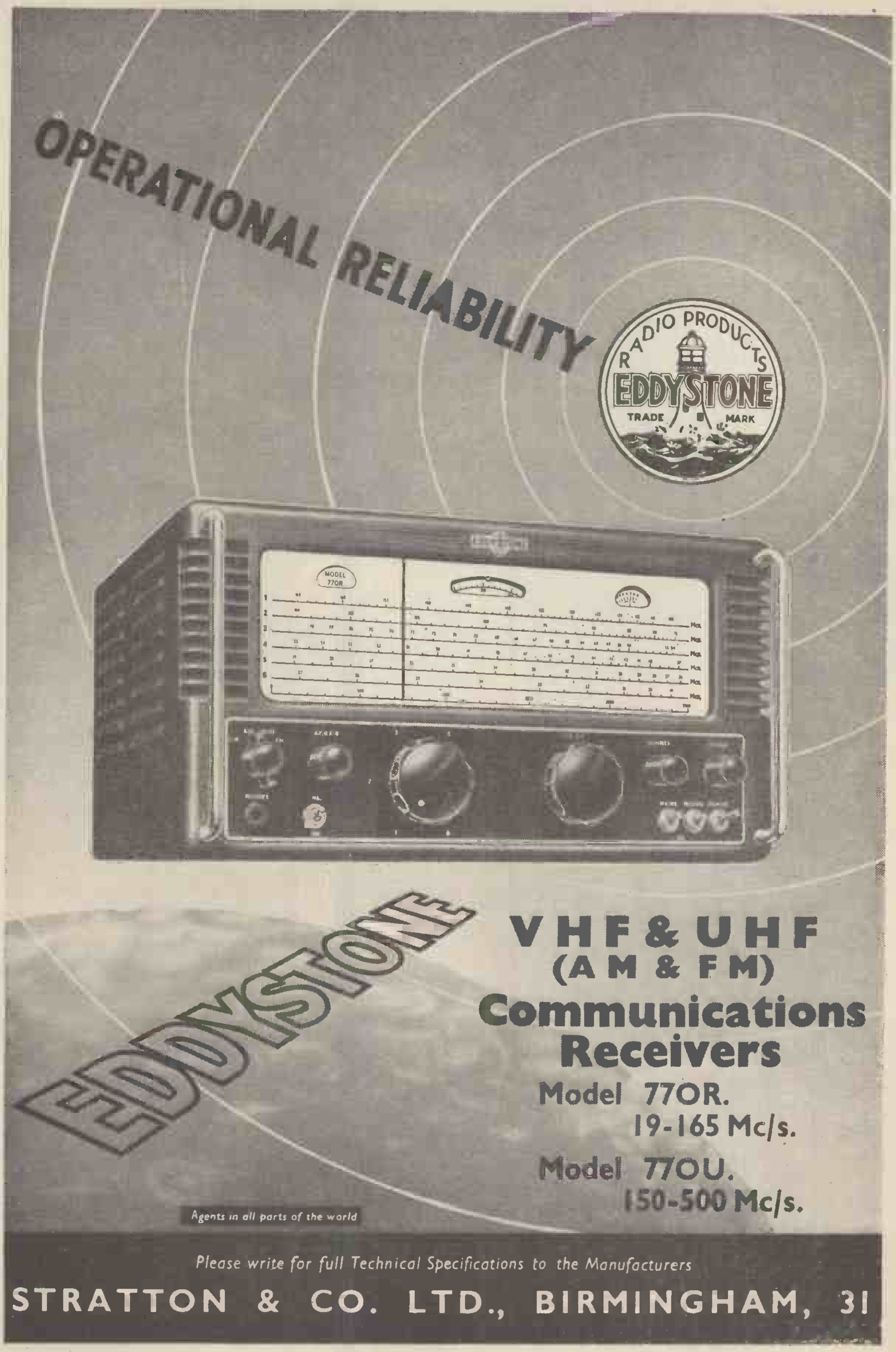

OPERATIONAL RELIABILITY
RADIO PRODUCTS
EDDYSTONE
TRADE MARK
EDDYSTONE
VHF & UHF
(AM & FM)
Communications
Receivers
Model 770R.
19-165 Mc/s.
Model 770U.
150-500 Mc/s.
Agents in all parts of the world
Please write for full Technical Specifications to the Manufacturers
STRATTON & CO. LTD., BIRMINGHAM, 31

Tough &

Tiny!

Plessey

"MP"

Miniature Preset

Potentiometers

General Specification

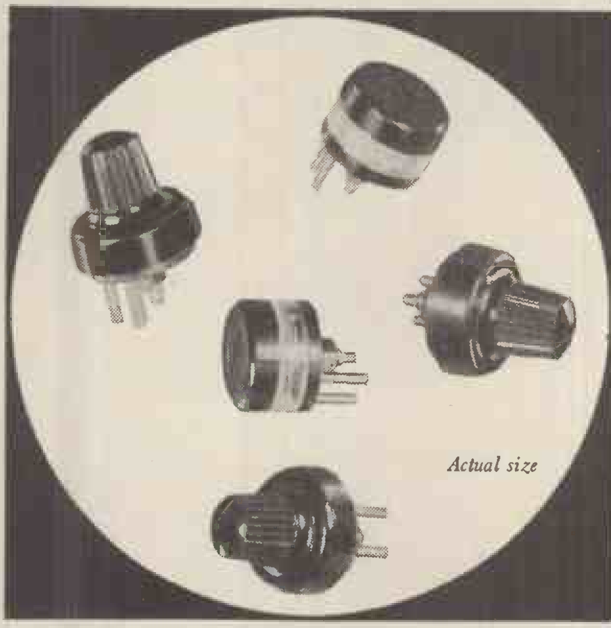
Standard resistance values
1 kΩ 2.2 MΩ (in preferred values)
Tolerance .... ±20%
Law .... Linear
Rating (total track .... ¼ *watt at 55° C*
(subject to max. voltage not being exceeded)
Maximum voltage .... 500 V
Terminal resistance .... 50 Ω *max.*
Total rotation .... 290° *min.*
Max. resistance change
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.



Actual size

The Plessey Miniature Preset Potentiometers are rugged controls with moulded carbon tracks—and they are, in fact, the smallest available today.

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.

Two forms are at present available: one, having a minimum of height from the mounting panel, is designed for screwdriver adjustment by engineers or servicemen, while the second has a knob for finger or screwdriver operation by the listener or viewer. Securing is by means of a 6BA nut.

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'.*

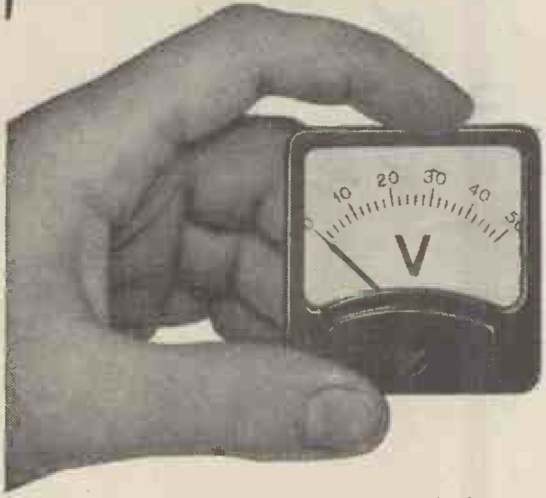
Overseas Sales Organisation:
Plessey International Limited, Ilford, Essex · Tel: Ilford 3040

Plessey

THE PLESSEY COMPANY LIMITED
CAPACITORS AND RESISTORS DIVISION
KEMBREY STREET · SWINDON · TEL. SWINDON 6211

CR2A

A COMPREHENSIVE RANGE OF
"Miniature" Instruments



Above: 2″ square moving coil voltmeter

★ **DESIGNED TO HARMONISE WITH ALL MODERN ELECTRONIC EQUIPMENT**

★ **FIXINGS CONFORM TO ACCEPTED PRACTICE**

★ **PRICES ARE HIGHLY COMPETITIVE**

For utmost reliability all 'ENGLISH ELECTRIC' miniature instruments have been designed with a higher-than-normal torque/weight ratio in combination with lower power consumption. All types have been successfully subjected to the following tests:

RESISTANCE TO IMPACT SHOCK OF 200g in any plane.

VIBRATION FATIGUE TEST—two million cycles at peak resonant frequency.

OSCILLATORY TEST—up to one million operations.

SPECIFICATIONS B.S. 89–1954 and other International Specifications.

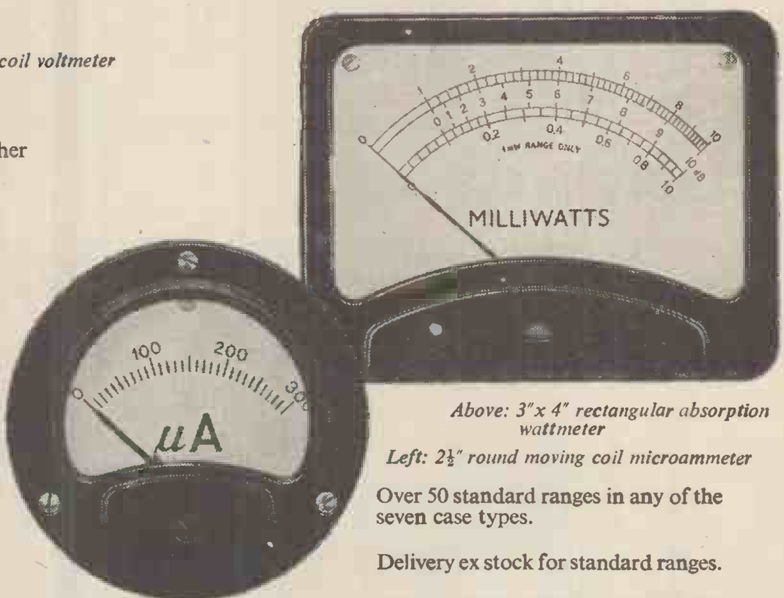
TYPES

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.

Non-standard ranges to customer's specification within 21 days.

Literature available on request to The ENGLISH ELECTRIC Co. Ltd., Instrument Department, Stafford.

'ENGLISH ELECTRIC'

THE ENGLISH ELECTRIC COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2

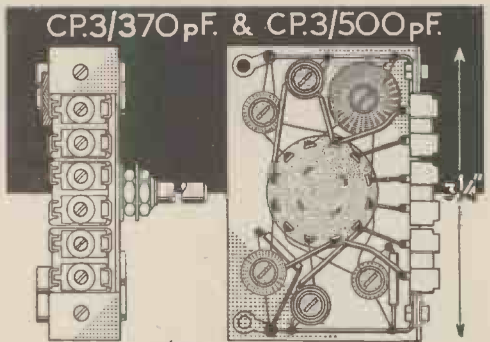
Meter, Relay and Instrument Division, Stafford

WORKS: STAFFORD · PRESTON · RUGBY · BRADFORD · LIVERPOOL · ACCRINGTON

INS.43A

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.

GENERAL CATALOGUE covering full range of components, send 1/4 in stamps or P.O. PLEASE SEND S.A.E. WITH ALL OTHER ENQUIRIES.

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STOP PRESS.—WF.1428 Treble Lift Inductor for the "Mullard 3-valve Pre-Amplifier", **23/9** each.

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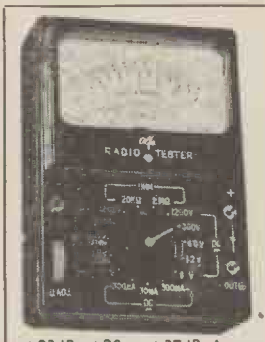
Build your own Hi-Fidelity Tape Equipment using this exclusive product of Tele-Radio (1943) Ltd., suitable for use with Wearite, Brenell & Collaro Decks. C.C.I.R. characteristic. Complete with external Power Pack. Full wiring instructions with each unit. Please advise type of deck when ordering. **27 gns.** plus P. & P. 4/-. *Free Leaflet on request.*



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6/12/60/300/1,200 v. A.C., ditto D.C., 0-20k, 0-2 megohm, 300 microA, 30mA, 300 mA — 20 to +23dB, +20 to +37dB. Accuracy ± 3% D.C. ±4% A.C. Multi-range, 5½in x 3⅝in. x 1⅜in. Large clear dial, Leads **£5/19/6.** (P. & P. 2/-).

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			Each
4 x 4 x 4in. Sloping Front		9	5
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6 x 6 x 12in. Sloping Front		24	9
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6 x 4 x 3in. Rectangular		8	10
8 x 6 x 3in. Rectangular		11	0
10 x 6 x 2½in. Rectangular		13	3
10 x 7 x 7in. with Alum. Panel	£1	4	9
12 x 7 x 7in. with Alum. Panel	£1	11	5
14 x 7 x 7in. with Alum. Panel	£1	15	9
14 x 9 x 8in. with Alum. Panel	£2	5	8
16 x 9 x 8in. with Alum. Panel	£2	9	6
16 x 11 x 8in. with Alum. Panel	£2	16	8
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ALSO FULL RANGE OF CHASSIS

Chassis and Case List Free on request.

10 SPECIAL OFFERS!

1. Mains Transformer 550-0-550 v. 150 mA. 6 v. 3 A., 4 v. 3 A., 110 v. Primary **£1.**
2. Mains Transformer (Potted) 350-310-0-310-350 v. 220 mA. 6.7 v. 5 A., 6.3 v. 3 A., 6.3 v. 1 A., 5 v. 3 A., 6 v. 3 A., 6.3 v. 1 A., 230 v. Primary **£2/10/-.**
3. Mains and Output Transformers for Modern Version of Mullard 510. Shrouded of first class quality, **£2/15/-** per pair.
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5. Choke 10H 250 mA. Potted "C" Core, **25/-.**
6. Choke 20H 50 mA. Potted, 15/-.
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8. Choke 5H 100 mA. Potted, **5/6.**
9. Choke 5H 300 mA. Potted, 12/6.
10. Rectifier 300 v. 300 mA., 13/6.

Immediate despatch of goods available from stock. Carriage charged extra at cost.

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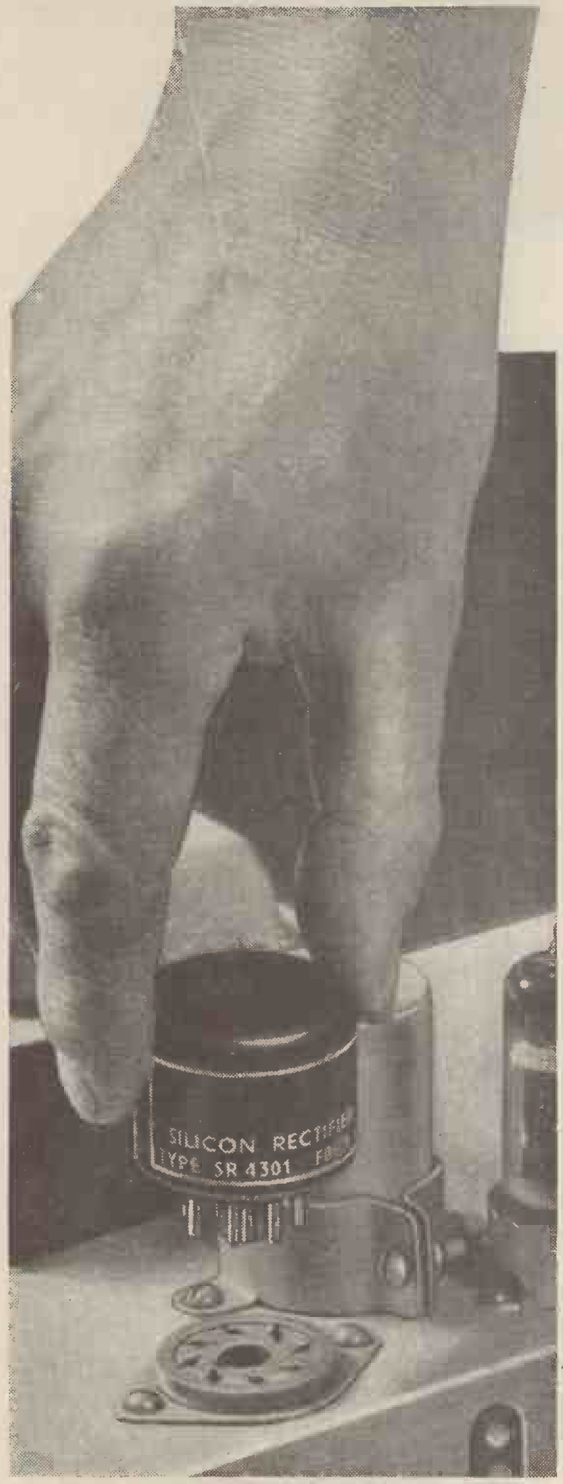
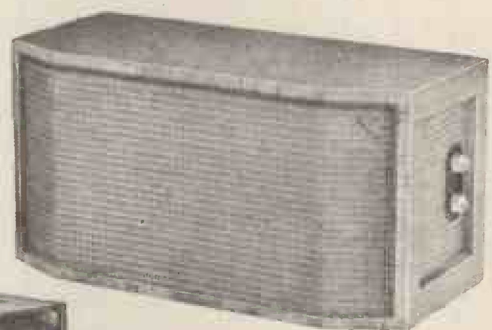
Our only address ● Few mins. from Marble Arch ● Open all day Sat.
Well-equipped demonstration room ● *Phone: PAD 4455/6*



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.

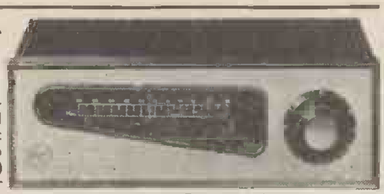
Price **£49.10.0** complete, tax free.

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: 'Wharfdel,' Idle, Bradford.



Chapman

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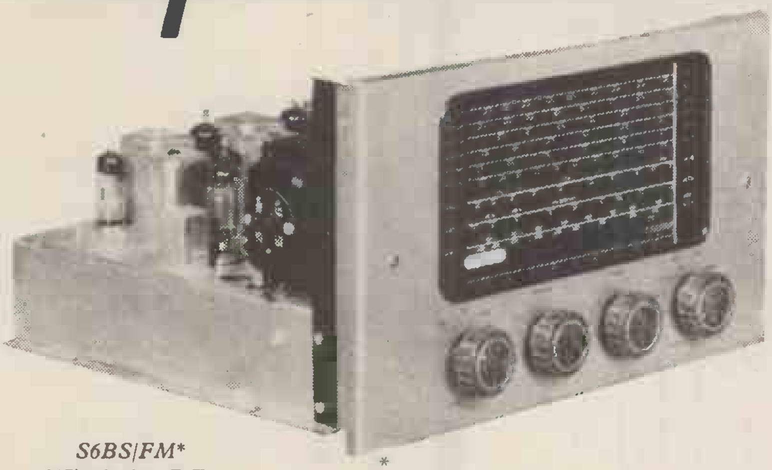

*S6BS/FM**
£67/10/0 inc. P.T.

The S6BS/FM is a worthy addition to our fine range of High Fidelity Equipment

- **AM & FM 2 micro-volts**
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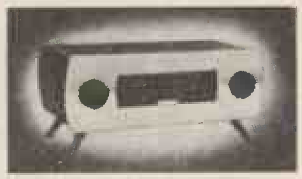
- **6 Band Spread Ranges 11-31m**
- **FM 88-108 mcs.**
- **12-Valve Self-Powered Tuner**
- **Stereo Multiplex Output**
- **Fully Tropicalised**

Standard S6BS AM only still available

S5/FM AM/FM TUNER
£34 inc. P.T.



FM 95 AM/FM TUNER
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£29/18/0

FM91 VHF/FM TUNER
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£34

305 *Stereo Control Unit*
£18/18/0

STEREO 10*W*+10*W.*
£21

Catalogue giving full technical details of the above models available free on request

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THE GROSVENOR
Price £19.19.0

This elegant cabinet is available in veneered figured walnut and polished to a high gloss in a medium shade. Gold embellishments are an attractive feature of the design. 9in black legs are normally fitted. A three sliding door system provides ample storage room for tapes etc.

We can offer a very wide range of hi-fi and stereophonic equipment to fit this cabinet and any equipment purchased from us will be fitted and wired free of charge.

THE SERENADE
Price £13.19.6

Veneered with finest selected walnut, beautifully polished to a medium shade; this attractive cabinet has generous storage space, with board sliding out smoothly on metal rollers. This cabinet can be fitted with any of the latest Hi-Fi units.

THE CONTEMPORARY
Price £11.15.0

This beautifully designed Contemporary Cabinet can be supplied in Oak, Walnut, or Mahogany Veneer and has a waxed semi-matt finish.

This cabinet can be fitted with any of the latest Hi-Fi units.

THE CONTINENTAL
Price £29.10.0

This elegant Cabinet is the finest in our range designed in the continental style. Solidly constructed and finished in oak, walnut or mahogany veneers. (Dark, medium or light, high gloss or satin finish available.)

THE SAVOY
Price £10.19.6

The Savoy is available in Walnut Veneer in medium colour with a high gloss finish. It has a silk covered baffle large enough to accommodate a 12in speaker and tweeter. The left hand compartment has a generous sized motor-board with a shelf above, both being covered by a sliding glass door.

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120 GREEN LANES, PALMERS GREEN, LONDON, N.13
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The Cabinet Catalogue
The Equipment Comparator Catalogue

(Designed to assist your choice of cabinet and equipment.)
Please send me details of your two new catalogues.

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There's nothing so good as building it with a Jasonkit

AUDIO-GENERATOR AG.10

Jason offer a number of test-equipment designs in Kit form or ready built including Audio-Attenuator, Wobbulator, Oscilloscope, Crystal Calibrator, Stabilised Power Pack.

All are designed to high standards of efficiency. Details gladly sent on request.

Capacity-tuned Wien Bridge gives excellent stability with low distortion. Output held constant over entire band. Model AG.10 covers from 10 to 100,000 c/s in four ranges. A maximum of 10V is available from cathode follower output stage. The attenuator gives a minimum calibrated output of 100 microvolts. Square wave output with an excellent rise-time makes the instrument valuable for checking all audio equipment. Output, level within 1dB over whole range, available as sine or square wave as required. Square wave rise-time less than 2 microseconds at all frequencies.
This instrument is designed in conformity with other test instruments in the Jasonkit range, and is complete with case.

Kit complete with building and operating manual

£12 - 10 - 0

Kit built and ready for use **£15.2.6**

● *ALSO AVAILABLE—AUDIO AND TUNER KIT DESIGNS*

BRITISH DESIGNED TO HIGH TECHNICAL STANDARDS

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Watch that WOW!

Gaumont-Kalee Fluttermeter Type 1740

with the Gaumont-Kalee FLUTTER METER

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 10¼″ 26.04 cm. Width 12¼″ 31.12 cm. Depth 14⅜″ 36.47 cm.

Nett weight 29 lb. 13.15 Kilos

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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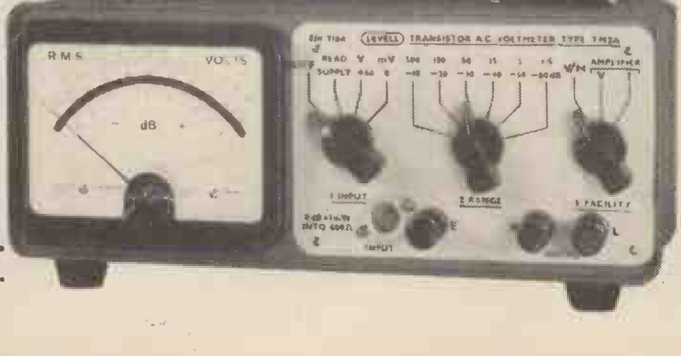
TRANSISTOR TESTER
TYPE TM5

Measures the current gains of PNP and NPN transistors, the values of resistances, and the leakage currents of diodes, transistors and low voltage electrolytic condensers.

Collector Current Ranges: 0.5, 5, 50, 500 mA.
Current Gain Ranges: 100, 250, 500.
Resistance Ranges: 0-50KΩ, 0-500KΩ.

Price with batteries **£17.0.0**

A.C. MILLIVOLTMETER
TYPE TM2A



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

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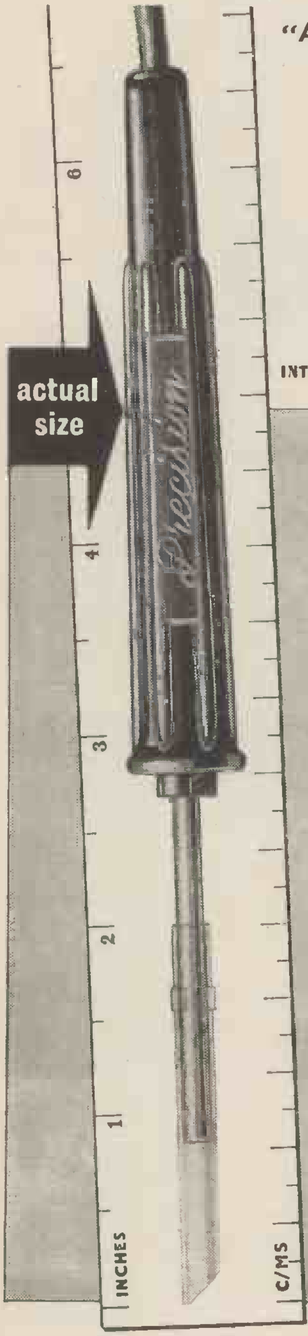
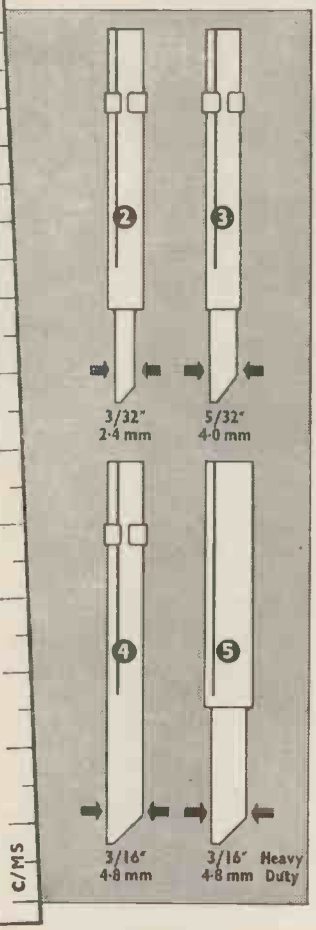
Transistors · Printed Circuits · Miniaturized Equipment

"AS LIGHT AS A PEN"

MODEL	VOLTAGE
C.240	230/240
C.220	220/230
C.125	120/130
C.115	110/120
C.50	48/52
A or B.6	6
A or B.12	12/13
A or B.24	22/26
A or B.28	26/28



INTERCHANGEABLE SPARE BITS



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SUPPLY METERS (kilowatt hour). 200/250 v. 50 c. Usual 5-index dial reading from 1/100th unit. Loading 5 amps. L.R. (suitable for 10 amp. load). These are brand new, at zero reading, simple to install. We offer a few only at only **39/6** each (despatch 3/6).

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SYNCHRONOUS TIMERS (by well-known British maker—brand new). Operating on 200/250 v. 50 c. Providing any "on" period between 5 min. and 8 hours, switching "off" at the end of the set period. Made for electric cookers but suitable for many other purposes—tape recorders, immersion heaters, etc. Capacity 25 amps., fitted neon indicator. Housing 6in. sq. by 3½in. Most remarkable offer. **£4/12/6** (despatch 3/-).

SYNCHRONOUS TIME SWITCHES (Sangamo) for accurate pre-set switching operations on 200/250 v. 50 c. Providing up to 3 on-off operations per 24 hours at any chosen times, with day-omitting device (use optional). Capacity 20 amps. Compactly housed 4in. dia., 3¼in. deep. With full instructions. **£5/8/6** (despatch 2/6).

SHORT INTERVAL TIME SWITCHES (Smith's). Spring driven. Closed circuit period continuously adjustable from 1 to 15 minutes. 15 amp. (230 v. A.C.) switching. 2in. dia. by 2¼in. long. Not calibrated. **17/6** (despatch 1/6).

OPERATION COUNTERS (mechanical). Brand new units with continuous rotary action, counting up to 6,000. One rev. per digit, with 1/10th indicator, will also count motor speeds. Counting forwards and backwards, suitable for tape recorder and film work. Size 3⅜in. by 1¼in. sq. **29/6** (despatch 1/6).

HIGH SPEED MOTORS (Delco). 1/10th H.P., 200/250 v. A.C./D.C., 10,000 r.p.m. Body 4½in. by 3in. with ¼in. shaft proj. 1¼in. Made for spin driers and ideal for drills, sanders, mixers, etc., new, **47/6** (despatch 2/-).

AIR THERMOSTATS (Kieft-Pullin). Adjustable range 30/90 deg. F. Switching capacity up to 15 amps A.C. In smart ivorine housing 4¾ × 2 × 2in. Easily installed instructions with each. Right for greenhouses, rooms, labs., etc. **45/6** (despatch 2/-).

EXTRACTOR FANS. A very popular line. Well-made units at much lower than normal prices. 200/250 v. A.C. induction motor, silent running, no interference. With mounting frame and back grille, ready for easy installation. With 8in. impeller (10in. overall dia.), 200 C.F.M., **£5/5/-**. 10in. impeller (12in. overall), 240 C.F.M., **£5/12/6**. Also minor model, 6in. overall dia., 75 C.F.M., **£4/12/6** (despatch any one 3/-).

COOLING OR EXTRACTOR FANS with open type S.P. induction motor, 200/250 v. A.C., 2½in. by 2⅞in. by 1⅞in., with 6in. plastic 3-blade impeller. Also suitable for proj. lamp cooling and convector heaters. Selling very fast at only **22/6** (despatch 2/9).

COMPLETE SEWING MACHINE MOTOR OUTFITS. No better job obtainable at any price. 200/250 v. A.C./D.C. Fitted latest radio/T.V. suppressors. Comprising motor with fixing bracket, foot control and switch, needle light with switch, belt, etc., and instructions for easy fixing to ANY machine. The complete outfit, still **£6/15/-** (despatch 3/-).

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Model 840A illustrated

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Model No.	Cash Price	Deposit	12 Monthly Payments	24 Monthly Payments
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840A	£55	£5	£4/9/7	£2/9/2
888A	£110	£10	£8/19/2	£4/18/4
680X	£120	£10	£9/17/1	£5/8/1

Carriage paid per passenger train.

These sets are the choice of the discerning professional and amateur users. Descriptive literature gladly forwarded.

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The Eddystone Specialists

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MAGAZINE LOADED TAPE DECK

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★ NO TAPE THREADING

★ NO SPILLING

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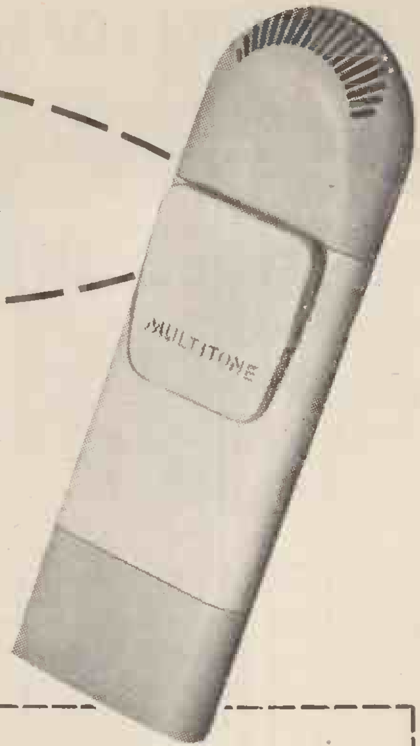
from AIRPORTS

to ZYMURGISTS



Multitone
leads in pocket staff location

By far the largest number of hospital and industrial installations of the pocket receiver type in this country, and overseas, are Multitone. Our selective induction system " Personal Call " is saving time, money and worry in well over 100 different types of industrial concerns from airports to zymurgists. (We are looking for a Quill Manufacturer to complete the alphabet.)
The new MULTI-CHANNEL equipment provides over 400 individual channels using the new flat Receiver (as illustrated).

Additional Facilities

ELECTRONIC TRUNCHEON

The Electronic Truncheon is no bigger than standard equipment carried by guards and serves the same purpose, but inside there is a transmitter which, when the button is pressed, sends out a signal. This is picked up by the loop of wire around the area to be protected. The pulse is used to operate a small receiver, which automatically switches on any form of electrical alarm. It can be operated from any point in the area.

INTERNAL TRANSPORT COMMUNICATION

The Multitone " Personal Call " loudspeaker-receiver has been designed to solve the problem of conveying verbal instructions to transport vehicles used for handling loads inside a given area. Messages can be conveyed to all or selected vehicles from the central transmitter.

MULTITONE INDUCTION SYSTEMS CAN SOLVE YOUR STAFF LOCATION PROBLEMS

★ Equally suitable for large and small areas or concerns
★ Low rental terms
★ Virtually no internal wiring

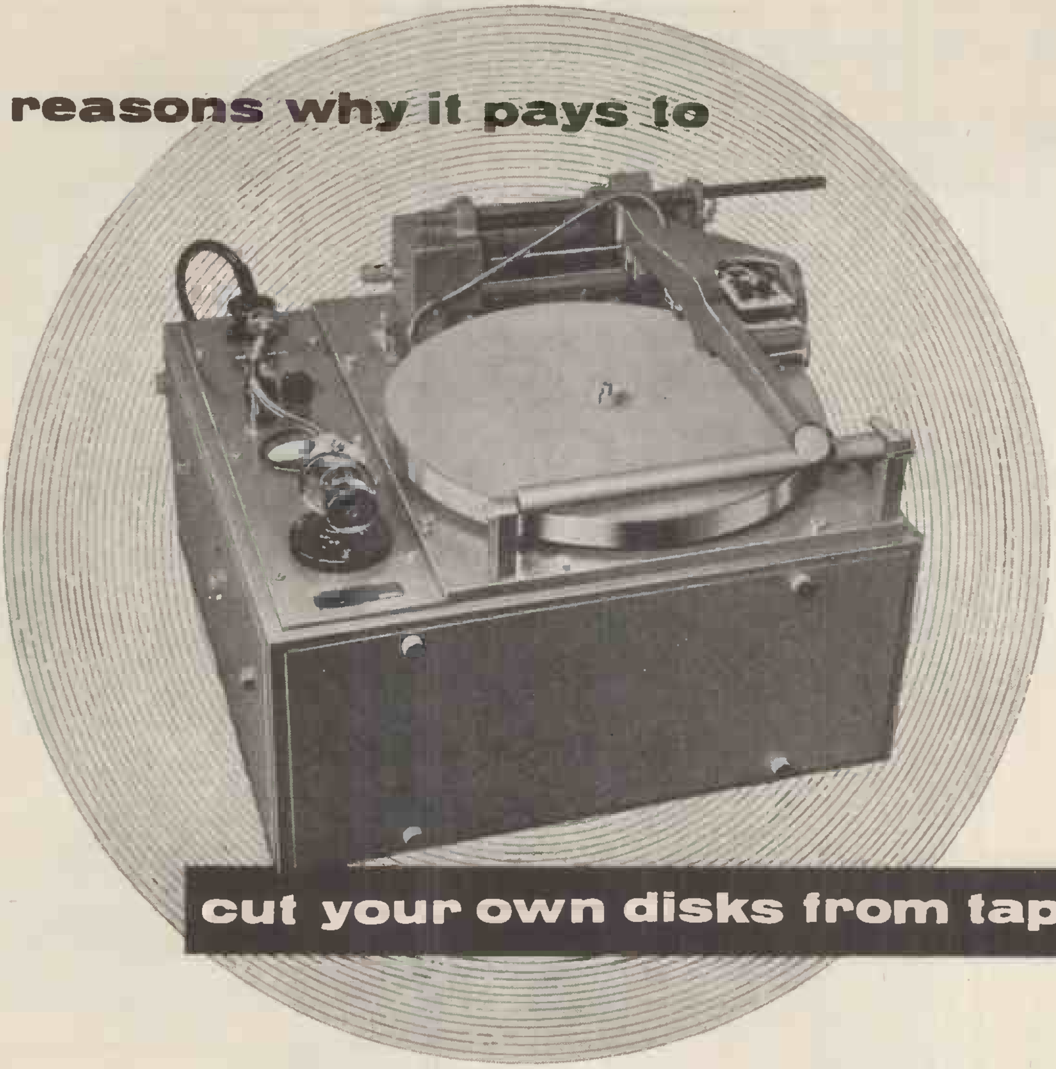
THE MULTITONE
personal call
system of staff location

(the 'peep-peep' in the pocket), the only staff location system worth installing.

Write or 'phone for further particulars. We can be found in 10 seconds.

MULTITONE ELECTRIC COMPANY LTD., 12/20 Underwood St., LONDON, N.1. (CLErkenwell 8022)

3 reasons why it pays to



cut your own disks from tape

- Disks are permanent and cannot easily be erased or mutilated
- Disks can be played on any record player at any one of three speeds
- Disks are cheap to produce and simple to despatch

A disk cutter is an indispensable item of equipment for the more thoroughgoing tape user. But it must be conveniently priced, easy to operate and economical to maintain.

These are leading features of the MSS machine, and they make it the only logical choice for professional and non-professional alike. But other more technical features contribute to make it quite unique in its field; three speeds, recordings made live or from tape and the possibility of comparing the sound quality of the original tape with that of the new disk *while the disk is being cut**. The price is £187.

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

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

MSS DISK CUTTER AND BLANK DISKS

*Other MSS disk cutter features include modulation indicator, radius compensator, press-button scrolling, cutter head muting switch, accurate cutter location in the recording head.

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

TOP OF THE BILL

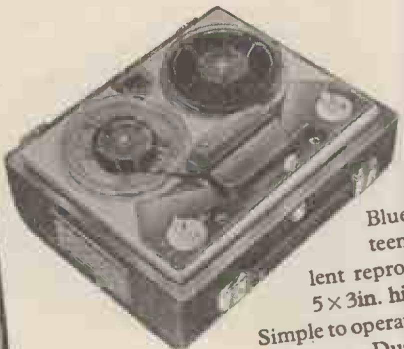
FOR EVERY PERFORMANCE

TRUVOX

ALL THAT THE NAME IMPLIES

Music or speech, "Pop" or classic . . . they're all on a good thing when they're Truvox taped. The young and gay will delight in the "Melody," the enthusiast will revel in the "Harmony" . . . whichever you choose, every programme will "top the bill" for you *and* your friends.

MELODY



Has the size and elegance of a lady's vanity bag, finshed in Summer Blue. Ideal for teenagers. Excellent reproduction from 5×3in. hi-flux speaker. Simple to operate. Tape speed $3\frac{3}{4}$in. p.s. Dual track. 4in. spools. Dimensions $11 \times 9 \times 5$in.

£36 *Complete*

HARMONY

Designed for the enthusiast Reproduction far in excess of that normally expected from an instrument of its size. Handsome, light tan leatherette case with gilt trim. Tape speed $3\frac{3}{4}$in. p.s. Dual track. 6×4in. hi-flux speaker. 5in. spools. Dimensions $12 \times 9 \times 5\frac{3}{4}$in.

£44 *Complete*

Supplied with spool L.P. Tape and empty reel, crystal microphone and radio lead. For 110-240 v. A.C. mains.

MARK VI TAPE DECK

A worthy newcomer to the range of Truvox tape recording equipment, introducing refinements in appearance and facilities for higher quality recording with accurate timing and editing. Fully controlled by push buttons. Electrical and mechanical braking. Speed change knob. Pause control. Reels "locked" in "Off" position. Precision revolution counter. Contemporary colour scheme to harmonise with any cabinet finish.

TAPE DECK Mk. VI
Fitted with Monaural Head, 25 gns.
Fitted with Stereophonic Head, 37 gns.

TRUVOX LIMITED NEASDEN LANE, LONDON, N.W.10, ENGLAND

iia 113

Wireless World

ELECTRONICS, RADIO, TELEVISION

NOVEMBER 1959

VOLUME 65 NO. 10

PRICE: TWO SHILLINGS

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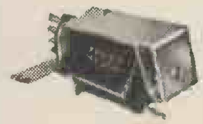
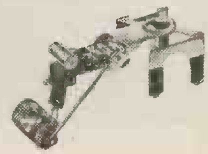
Acos products for better listening:



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



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

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

Swan Lake in the sitting room

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.

'Swan Lake in the sitting room?'

'ACOStereo in the sitting room!'

* ACOStereo Type 71 is now fitted with a diamond stylus at no increase in price.

acos ARE DOING THINGS IN STYLI

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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.

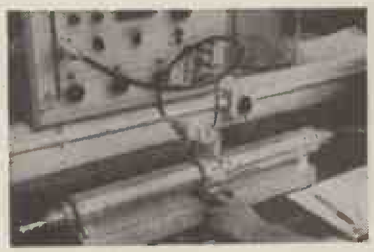
Components in missiles must have a long "shelf-life." We hope they will never be used, but if, in ten years they go into action, they must not fail. Reliability over a long period is of prime importance. This means that contact surfaces must not tarnish, springs must not tire and seals must remain seals.

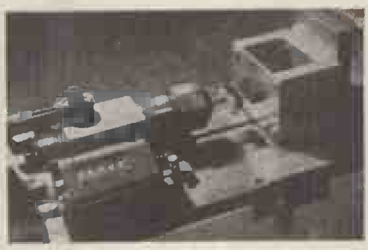
Components for use in atomic reactors may have to withstand intense radiation as well as intense heat—and they may not be accessible. Generally components come into two classes, those for professional use and those for domestic use. The greatest hazard to which domestic plugs have to stand up to is the sweeper.

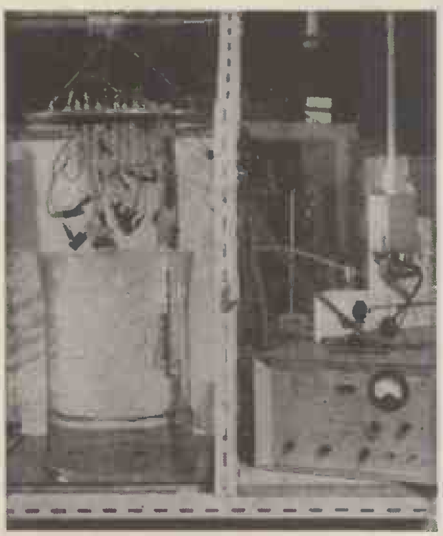
Below we show photographs of some of the test equipment in constant use in our laboratories.

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.





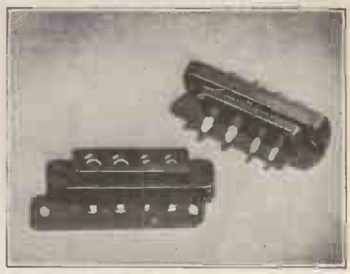


(Above left). In the foreground is a slotted line used for voltage standing wave ratio (V.S.W.R.) measurements up to 3000 Mc/s.

(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

BELLING & LEE LTD
GREAT CAMBRIDGE ROAD, ENFIELD, MIDDX., ENGLAND

Telephone: Enfield 3322 · Telegrams: Radiobel, Enfield

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) ..	$p_{g2(max)}$	0.5
Anode Voltage (volts)	$V_{a(max)}$	250
Screen Voltage (volts)	$V_{g2(max)}$	250
Heater to Cathode Voltage (volts r.m.s.)	$V_{h\text{-}k(max)r.m.s}$	150

INTER-ELECTRODE CAPACITANCES (pF)

Grid 1 to Anode (with external can) ..	$c_{g1\text{-}a}$	0.0017
Grid 1 to Anode (without external can)	$c_{g1\text{-}a}$	0.0019
Anode to Earth (without external can)	$c_{a\text{-}E}$	4.3
Grid 1 to Earth (without external can)	$c_{g1\text{-}E}$	5.0

Inter-electrode capacitances measured in fully shielded socket.

TYPICAL OPERATION

Anode Voltage (volts)	V_a	175	175
Screen Voltage (volts)	V_{g2}	100	175
Grid Bias Voltage (volts) ..	V_{g1}	−1.3	
Anode Current (mA)	I_a	12	
Screen Current (mA)	I_{g2}	3.5	
Mutual Conductance (mA/V) ..	g_m	4.4	
Bias to give Mutual Conductance 100μA/V (volts)	V_{g1}		−19.5
Valve Anode Resistance ($\delta v_a/\delta i_a$)(kΩ)	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) ..	Δc_{in}	1.7*	
Input Loss at 38 Mc/s with cathode pins strapped (kΩ)		16	

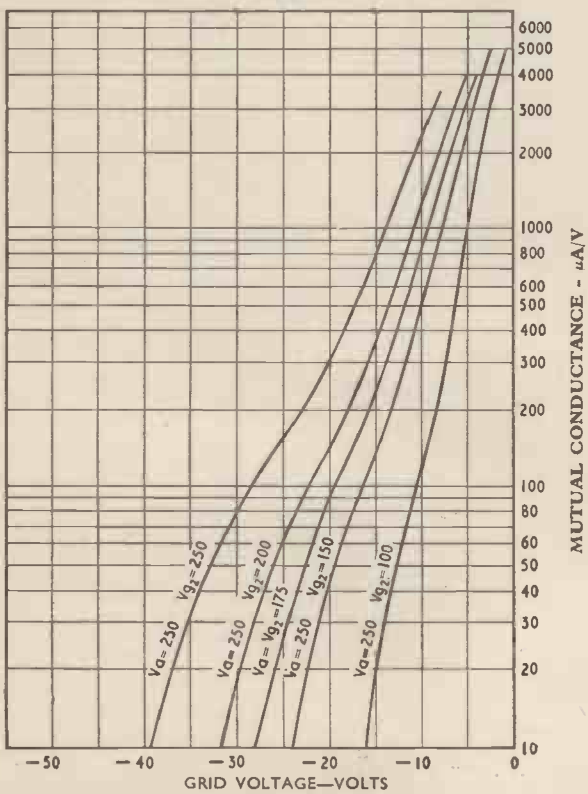
Note: If only one cathode pin is required it is recommended that pin 3 be used.

* *Inter-electrode capacitance with holder capacitance balanced out.*

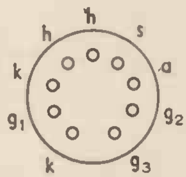
MAXIMUM DIMENSIONS (mm)

Overall Length	56
Seated Height	49
Diameter	22.2

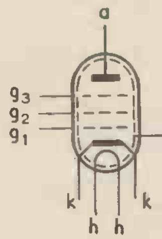
Characteristic Curves of Average Ediswan Mazda Valve Type 10F18

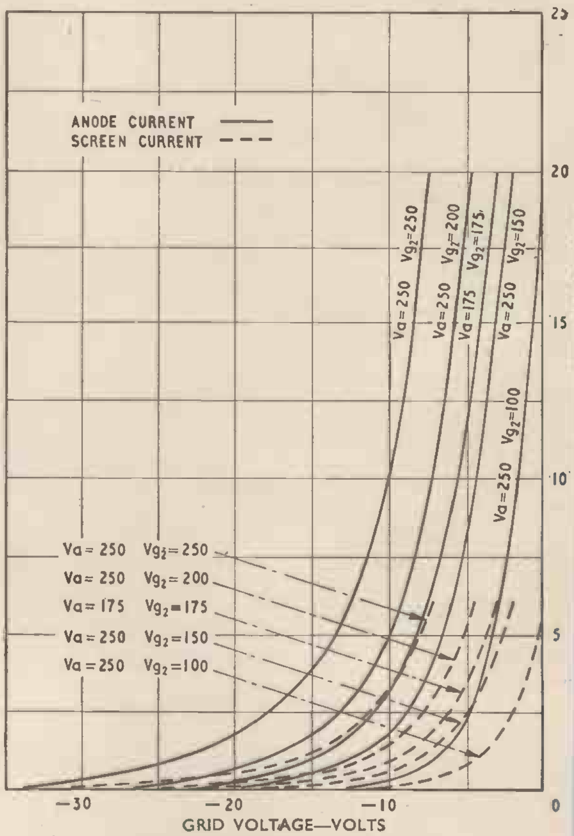


BASE
B9A
(NOVAL)



VIEW OF FREE END





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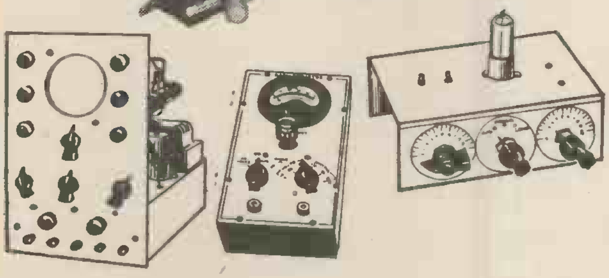

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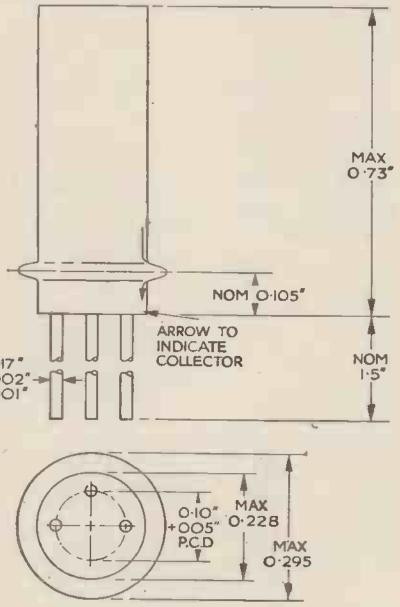
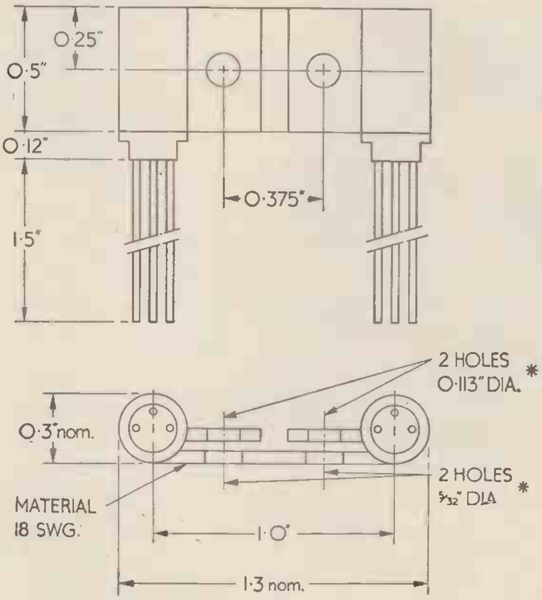
EDISWAN MAZDA SEMICONDUCTOR **NEWS**

NEW AUDIO OUTPUT TRANSISTORS

These new Ediswan Mazda transistors will be of special interest to designers and engineers concerned with audio output circuits of portable radios, amplifiers, and similar equipment. They offer low thermal resistance and high and level d.c.β. Full particulars of Ediswan Mazda Semiconductors will be sent gladly on request. If you wish to keep up to date with the latest developments in this field, please ask us to add your name to our semiconductor mailing list.





GERMANIUM PNP JUNCTION TYPE XC 121

Maximum Peak or Mean Collector/Emitter Voltage (Common Emitter Circuit)	(volts)	—16
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 $R_{b\text{-}e} < 500\ \Omega$	(volts)	—35
Maximum Peak or Mean Emitter/Base Voltage	(volts)	—12
Minimum d.c. β at I_c=—200mA, V_c=—1v		40
Minimum d.c. β at I_c=—50mA, V_c=—1v		48
Maximum Junction Temperature	(°C)	75
Thermal Resistance in Free Air	(°C/mW)	0.2

GERMANIUM PNP JUNCTION TYPE XC 131

(Matched pair of XC121's complete with heat sink for Class B Push-Pull Output Stage)

Maximum Peak or Mean Collector/Emitter Voltage (Common Emitter Circuit)	(volts)	—16
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 $R_{b\text{-}e} < 500\ \Omega$	(volts)	—35
Maximum Peak or Mean Emitter/Base Voltage	(volts)	—12
Minimum d.c. β at I_c=—200mA, V_c=—1v		40
Minimum d.c. β at I_c=—50 mA, V_c=—1v		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

EDISWAN SEMICONDUCTORS
MAZDA

SIEMENS EDISON SWAN LIMITED *An A.E.I. Company.* VALVE CRT & SEMICONDUCTOR DIVISION
155 CHARING CROSS ROAD, LONDON, W.C.2 Tel: GERrard 8660 'Grams: Sieswan, Westcent, London

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we can get you out of a rectifier problem

We, that's the M-O Valve Co. Ltd., have spent over 40 years bottling up hard valves, soft valves, tough going-aloft valves, standard valves, valves to government specs . . . so we know how you feel in there. But we're used to it, because now we've acquired a rare collective know-how that can beat most valve problems. And of course, it's backed by the brilliant research, progressive development and flexible production you'd expect us to have. Next time you're enveloped in a valve problem, let us know—if we haven't a ready-made type for you, we'll see if we can make you one to measure.

XENON FILLED TYPE. *The G.E.C. range will keep going a long time—and has better PIV safety ratings too.*

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Let us know what types you're interested in and we'll send you full details.

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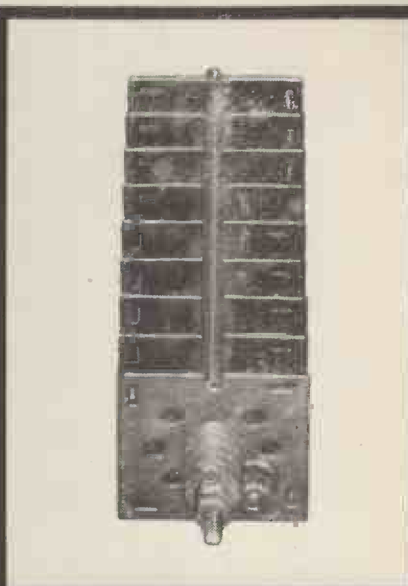
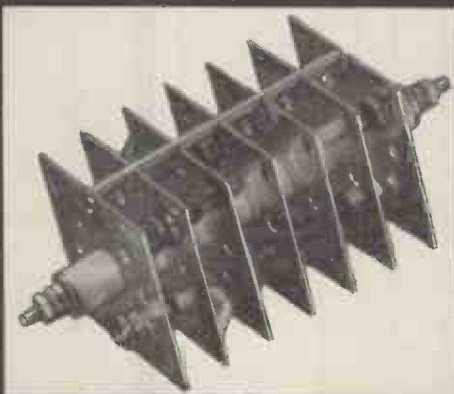
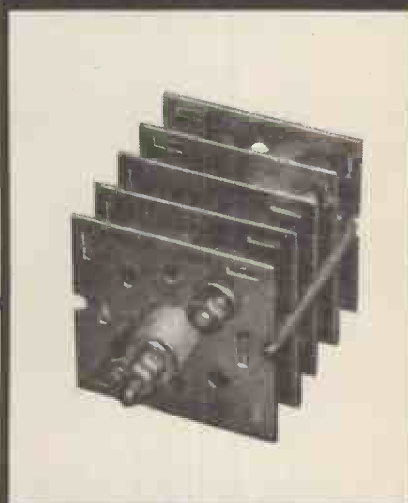
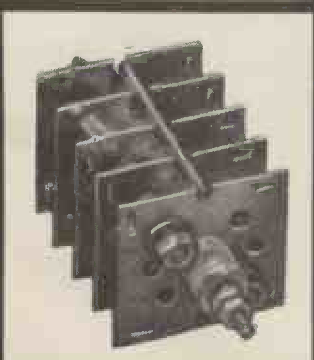
incorporating RS.3 & RS.5 series

Silicon Junction Power Rectifiers









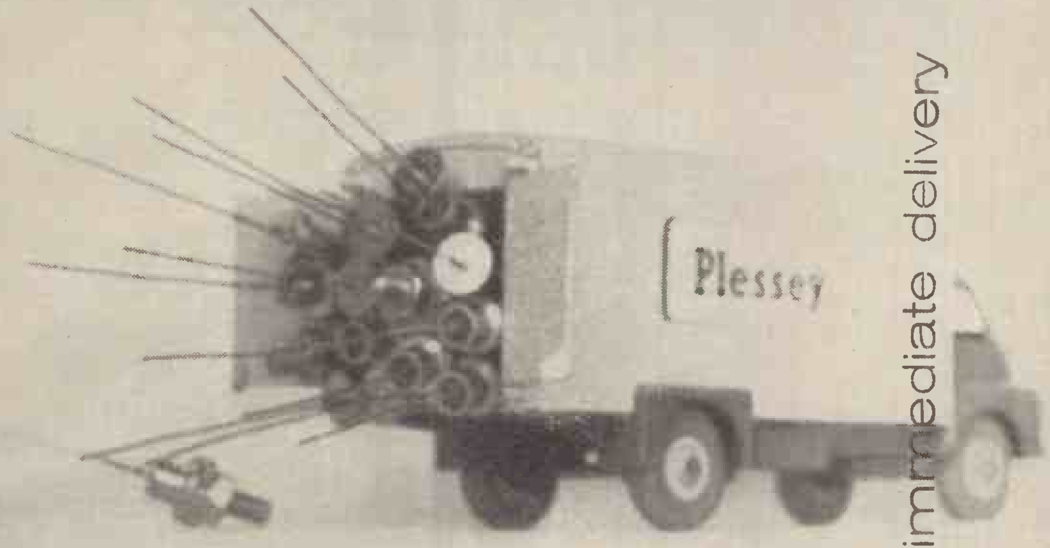
The design of these *SenTerCel* Silicon Rectifier Stacks offers many advantages including small size, low weight and higher ambient operating temperatures (up to 100°C). At present, silicon stacks are supplied with half-wave, bridge or push-pull connections for either single-phase or three phase inputs. The great variety of possible series and parallel connections between diodes provides an extensive range of voltage and current outputs. These ratings are listed in Information Leaflet No. MF/105 Ed.1. which will be sent on request.

STC COMPONENTS GROUP

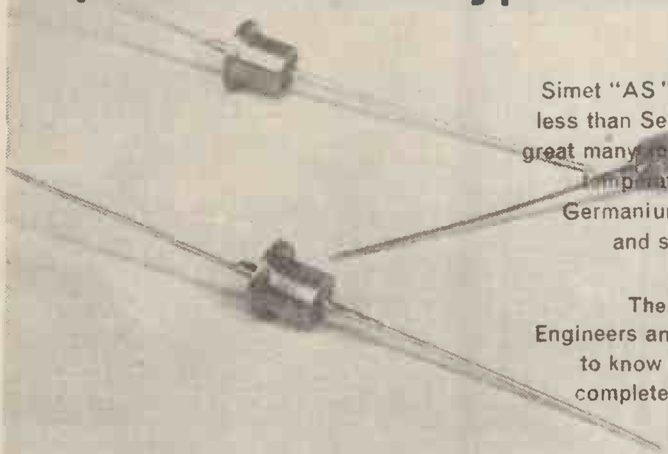
Standard Telephones and Cables Limited

Registered Office: Connaught House, Aldwych, London, W.C.2

RECTIFIER DIVISION: EDINBURGH WAY · HARLOW · ESSEX



✱ Simet "AS" type Silicon Rectifiers



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

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

SIMET

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Chemical & Metallurgical Division
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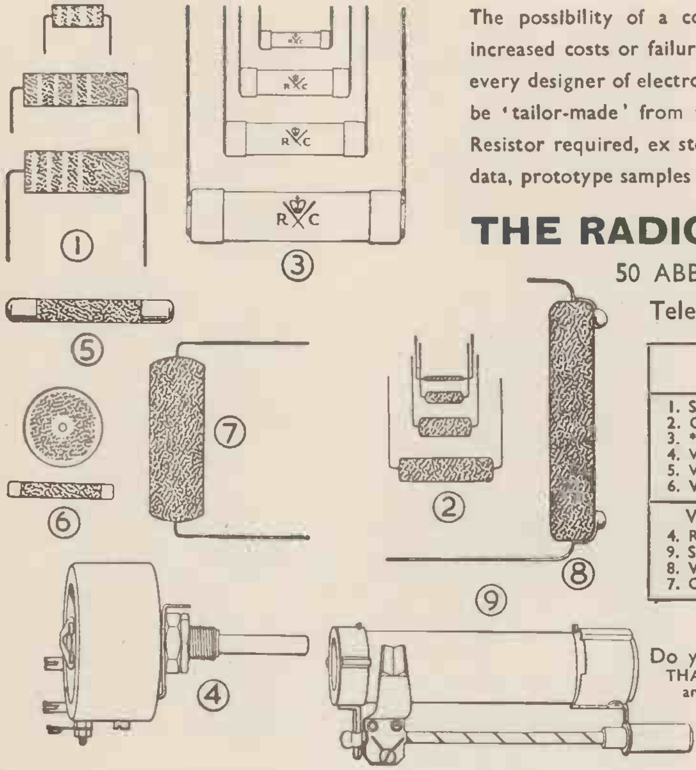

The possibility of a component change—due to shortage of supplies, increased costs or failure to meet specific conditions—is a problem facing every designer of electronic equipment. However, one basic component can be 'tailor-made' from the start, for LAB will supply the precise type of Resistor required, ex stock *and* at the right price. Write for full technical data, prototype samples and price schedules to:—

THE RADIO RESISTOR CO. LTD.,

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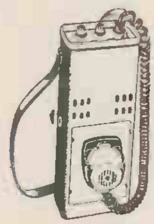

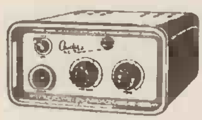

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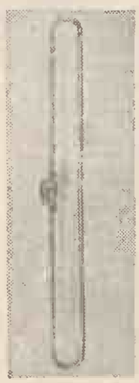

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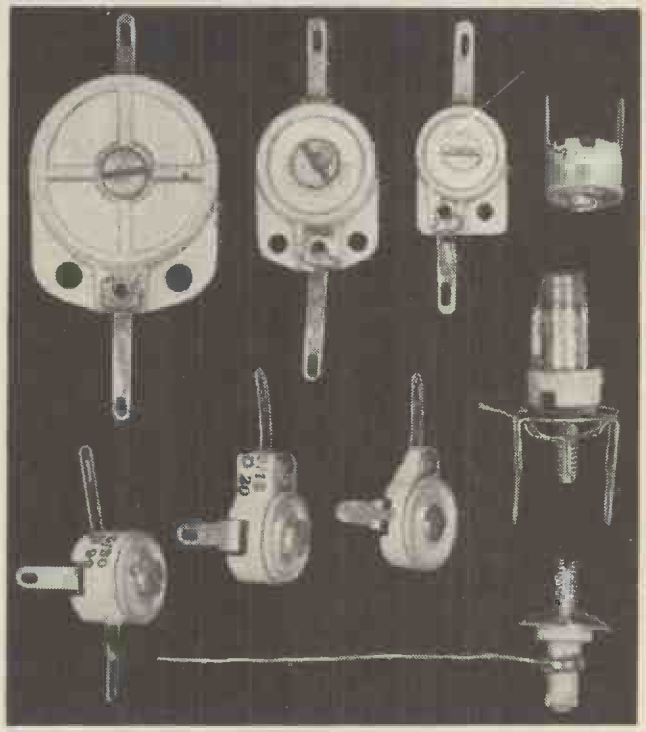

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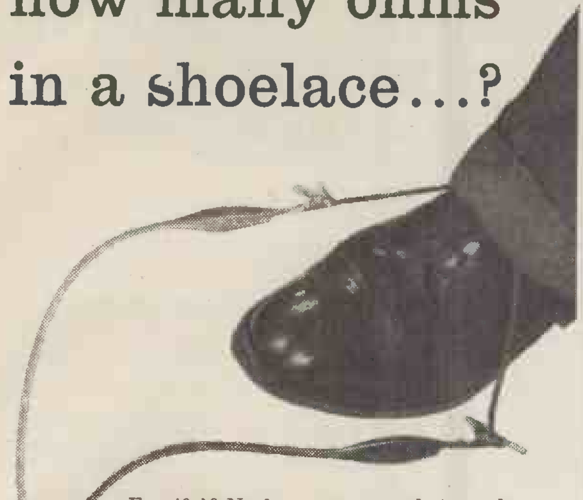

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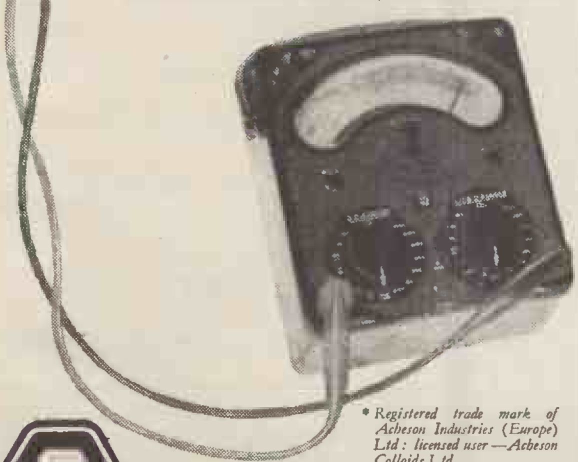

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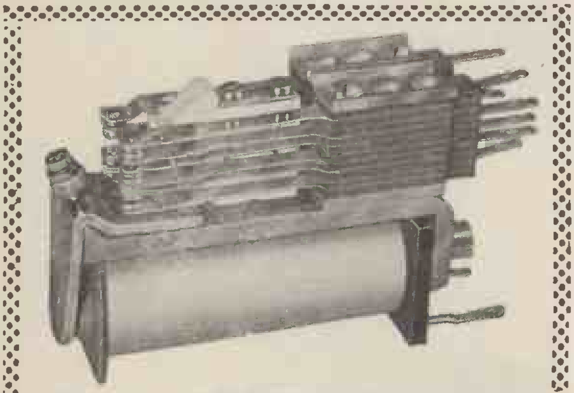

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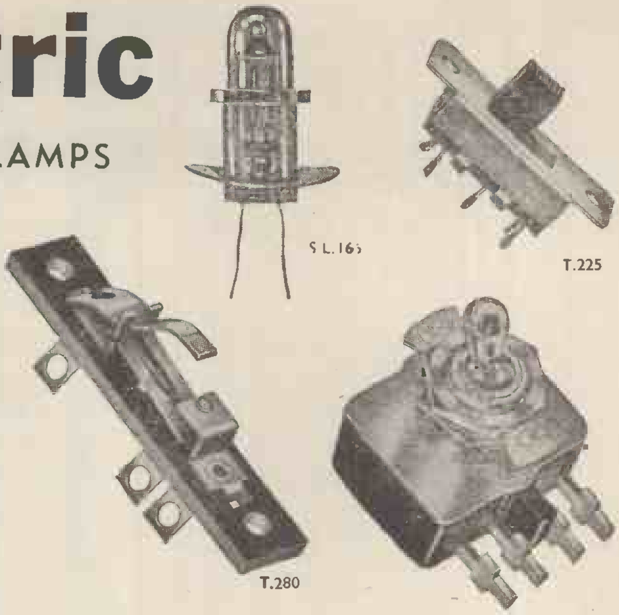

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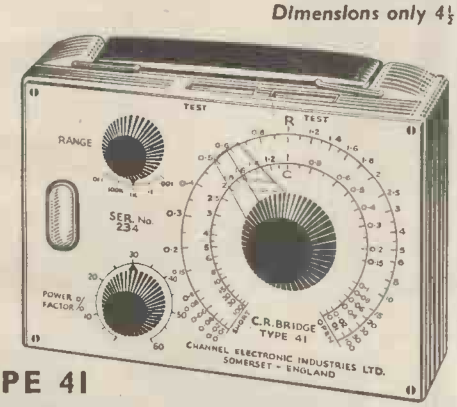

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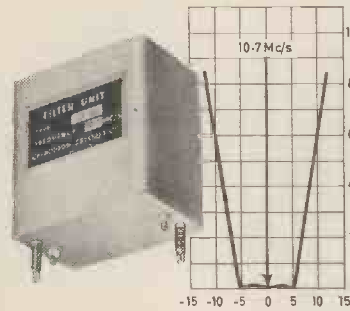

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for playing 45/45 records. Miniature ceramic type with replaceable diamond stylus Constant velocity output approximately 20mV from each channel. Frequency range 20 to 16,000 cycles. Channel separation 20/25 dbs.

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

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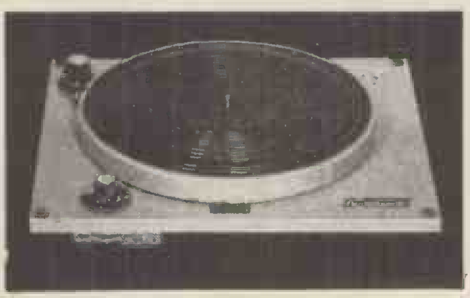

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★ High Q frame aerials.
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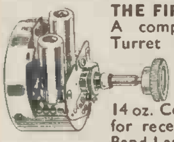

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A truly High-Fidelity Ultralinear Amplifier with a push-pull output of 10 watts and incorporating negative feedback. Provision for Tuner, also bass and treble control and 5-position selector switch for Microphone, Radio Tape and L.P. & Standard Recordings. Finished in an attractive grey/green stove enamel.
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ORIGINAL PRICE £9/15/0
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ORIGINAL PRICE 15 Gns.
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This Eliminator is completely assembled and supplied with 4ft. of Mains Lead and Torpedo Type of On/off Switch. It is housed in 2 Metal Containers approximately the same size as the AD35 and B126 Batteries, and suitable for such Receivers as the Cossor 543, 551 and 552 or Receivers operating on 1.4 volt L.T. and 90 volt H.T., for use on 200/250 v. A.C. mains. Size: L.T. Unit 3in. x 2½in. x 1⅜in., H.T. Unit 4in. x 2¾in. x 2in. Original Price 3 gns. OUR PRICE for a limited period only, 37/6 plus 2/- p. & p.

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Transistorised miniature battery-operated TAPE RECORDER

★ Completely transistorised circuit.
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★ Remarkable reproduction on both speech and music.

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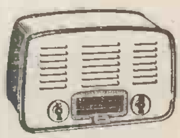

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For **99/6** plus 5/- P. & P. or £1/0/0 Deposit and 5 monthly repayments of 19/-

This receiver is ideally suitable for use in the home or where normal electricity supply is not available, remarkable reception on both medium and short wavebands, incorporating the following latest-type miniature Battery Valves; DK92, DF96, DAF96, DL96 and operates on an external B.103 Battery or equivalent. The receiver is housed in an attractive two-tone metal case. Size 11½ x 7½ x 5¾in.
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"INSTANT" BULK TAPE ERASER
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3 channels. For use with all tape recorders and audio amplifiers. Size 4¼ × 3¾ × 3½in.
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21 Gns.

Carr. & Ins. 12/6.

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LASKY'S PRICE

21 in. **39 GNS.** 17 in. **29 GNS.** *WORTH DOUBLE*

Also a few chassis less valves and C.R. Tube at various prices for callers.

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12-CHANNEL TURRET TUNERS

Complete with PCC84 and PCF80 valves. I.F. 33-38 Mc/s. Complete with 8 sets of coils: 5 Band I channels and channels 8, 9, 10 Band III. New and unused. Today's value over £7.
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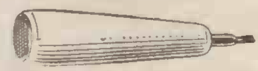

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Desk Stand 2/6 extra.

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Post 3/6. **£7.19.6**

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3in.	5in.	5¾in.	7in.	8¼in.

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7×4	9×6	10×2½	10×6	10×7
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Carr. & Pkg. 5/-. **£6.19.6**

Ditto, wired for Stereo and with Stereo cartridge, **£7/19/6.**

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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 7¾ x 3¼in., max. height 4½in. Controls mounted separately. **LASKY'S PRICE** complete with knobs **55/-**
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MATCHED PAIR FOR STEREO .... **5 Gns.**
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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.
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COLLARO 4/564 or GARRARD 4SP 4-spd. single player, auto. stop, T.O. crystal,
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E.M.I. 4-speed with auto start and stop, wired for Stereo and fitted with Acos Stereo t.o. cartridge.
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BELOW HALF PRICE!

B.S.R. "ful-fi" **TC8,** turnover crystal cartridge with L.P. and standard styli. 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
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★ Independent Bass and Treble Control.
★ Pick-up Matching Device and Switch positions for LP and 78
★ Tape Record and Replay facilities
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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, 11½in. x 5¼in., fine readings and 'LOG' scale. Length 12in., depth 9in. from dial front (10in. including knobs and spindles), height 7in.

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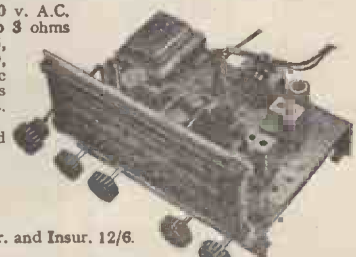

Famous make. For 200-250 v. A.C. Output 4 watts matched to 3 ohms speaker. 7 valves: ECC85, ECH81, EF89, EABC80, EL84, EZ80, EM81, magic eye tuning indicator. Covers medium, long and FM bands. Length 12in., height 7¾in. front to back 8¾in. Limited number only.

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LASKY'S RADIO

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Circuit Diagram and Building Instructions, 1/6 each, post free.	COMPLETE PARCEL
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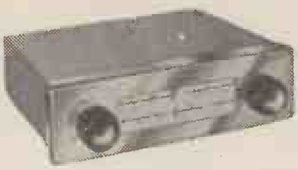
ALL JASON KITS IN STOCK. Send for Brochures



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★ New Hybrid circuit
★ Transistor output
★ New type Brimar valves
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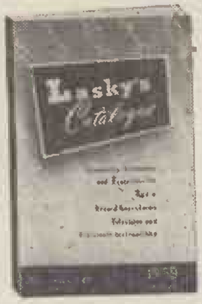
★ Tuned R.F. stage
★ Medium and long waves
★ Permeability tuning
★ Small size. Will fit any car

Send 1/6 for Instruction Booklet giving full details, illustrations, dimensions, circuit diagram and shopping list.



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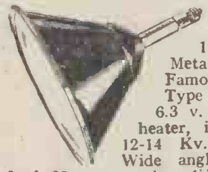

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FERRANTI 9in. type T9/3. 4 v. heater, triode, octal base, standard deflection LIST 9 GNS.
LASKY'S PRICE **50/-** Carr. & Insur., 12/6.

FERRANTI 12in., types T12/44 and T12/54.
LIST £12. LASKY'S PRICE **84/-** Carr. & Insur., 12/6.
Many others. List on request.

RE-GUNNED C.R. TUBES

Guaranteed for 12 months.

Type	Price	Carr. & Ins.
12in. round	£6 10 0	12/6
14in. rect.	£6 10 0	12/6
15in. round	£6 19 6	21/-
17in. rect.	£6 19 6	21/-
21in. rect.	£7 19 6	25/-

MINIATURE INSTRUMENT SOLDERING IRONS

Famous make, 230/250 v., 25 watts with pencil bit and 3-core flex. Warning light in handle. LIST 22/6.
LASKY'S PRICE **16/6** Post 1/3.

SPECIAL OFFER OF SOLDER

1lb. reels of Ersin 5-core "Savbit" SOLDER. List 15/-. LASKY'S PRICE **10/-** Post 1/6.

20,000 VALVES IN STOCK

Mullard, Brimar, G.E.C., Mazda, Cossor, E.M.I., Philips, Pinnacle, Telefunken, etc.

Send for our New List of manufacturers' surplus, ex-Govt. and imported Valves at lowest prices. We save you money.

5-milliamp **METER RECTIFIERS.** Special offer of limited number at only **8/6** Post 9d.

SPEAKER COVERINGS

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

MULTI TEST METER BARGAIN

Limited number only.

SEND TODAY

AN/20. Pocket size Microtester. An accurate 18-RANGE Test Meter for all purposes. 5,000 ohms per volt A.C. and D.C. In black leatherette-covered case, 3¾ × 3¾ × 1⅝in. deep. LIST 9 GNS.
LASKY'S PRICE **£5.19.6** Post 3/6. Leads 3/9 extra

6-TRANSISTOR POCKET RADIO

Printed Circuit construction. FULL medium and long wave superhet using latest components including 6 transistors, 2½in. moving coil speaker and Ferrite aerial. Cream or coloured plastic case, 5¾ × 3½ × 1½in., weight 12 oz. Full assembly instructions supplied.

CAN BE BUILT FOR £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.

TRANSISTORS

AUDIO P.N.P. Junction Types suitable for high gain and low freq. amplifiers, and for output stages up to 250 milliwatts. (Double spot—yellow and green). **7/6**
3 for 20/-; 6 or 37/6 post free.

R.F. P.N.P. Junction Type suitable for medium and low freq. oscillators, freq. changers and I.F. amplifiers (1.5 to 8 Mc/s.) **15/-**
(Double spot—yellow and red.)
3 or 40/-; 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. TS1, TS2, TS3, 12/6; TS4, 14/-; TP1 and TP2, 20/-; TJ1, TJ2, TJ3, 13/6.

EDISWAN MAZDA TRANSISTORS. The very latest types. XB/102, 10/-; XB/103, 14/-; XC/101, 16/-; XA/101, 23/-; XA/102, 26/-.

SPECIAL OFFER. Set of 7 Ediswan Transistors: XA/101, XA/102, 2 XB/102 XB/103, 2 matched XC/101. Price 79/6

CRYSTAL DIODES. General Purpose GEX00, each 1/-. Per doz. 9/-. All other types in stock.

"GOLDTOP" POWER TRANSISTORS

All types in stock. Example:—
V15/10P. Ideal for output stage of car radio, will give approx. 3 watts operating from 12 v. Each 15/- post free.
Suitable Output Transformer for above, correct ratio, matched to 3 ohms, 9/6. Post 1/-.
Driver Transformer, 9/6. Post 1/-.

PLEASE NOTE 2 ADDRESSES FOR PERSONAL SHOPPERS

42 TOTTENHAM COURT ROAD, W.1
Nearest Station Goodge Street. MUSeum 2605

207 EDGWARE RD., W.2
Opposite Edgware Road Tube Station
Few yards from Praed Street
PADdington 3271/2

OPEN ALL DAY SATURDAY
Early Closing Thurs., 1 p.m.
(Both addresses)

Please address Mail Orders to Lasky's (Harrow Rd.) Ltd., Dept. W, 207 Edgware Rd., London W.2

SEE OVERLEAF FOR MORE NEWS FROM LASKY'S RADIO

RECORD PLAYER BARGAIN OFFER

A self-contained Portable unit comprising the latest Collaro 4-speed Auto Changer Record Player, incorporating the famous High Fidelity Studio "O" Xtal Pick-up with Turnover Cartridge and fitted with L.P. and 78 Sapphire 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 18¼in. – 13¾in. – 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

carriage free

RECORD PLAYER BARGAINS—Latest 4-speed models

NEW RELEASE by E.M.I.—4-speed Single Player Unit fitted with latest stereo and monaural Xtal 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 (4SP) £7.10.0.. Carr. and ins. 3/6.

AUTOCHANGERS. BSR (UA8), £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. × 13in. × 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, UABC80, 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 × 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 6¾in. × 3¾in. × 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
Output Trans. (to 3 ohms)........... 10/6
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 TOURIST Portable

4 valve, Med. & L.W., l'tweight battery Radio. Size only 8in. × 5½in. × 4in. Weight 3½lb. with battery :—

		P.&P.
Complete receiver component kit	57/6	1/6
Set 4 miniature valves (96 series)	35/-	9d.
5in. Speaker & O/put 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

NEW BOXED VALVES ALL GUARANTEED

IR5, IT4	7/6	EABC80	9/6	EZ81	7/6
IS5	7/6	ECC84	10/6	MU14	9/6
S34,3V4	8/-	ECF80	11/6	PCC84	10/6
5Z4	9/6	ECH42	10/6	PCF80	10/6
6K7	5/6	ECL80	10/6	PCL83	12/6
6K8	8/6	EF80	9/6	PL81	12/6
6Q7	8/6	EF86	13/6	PL82	9/6
6V6	7/6	EF91	8/6	PL83	11/6
DAF96	9/-	EL41	10/6	PY80	7/6
DF96	9/-	EL84	9/6	PY81	9/6
DK96	9/-	EY51	10/-	PY82	7/6
DL96	9/-	EY86	10/-	U25	12/6

SPECIAL PRICE PER SET
IR5, IT4, IS5, or 3S4 or 3V4, 27/6.
DK96, DF96, DAF96, DL96, 35/-.
6K8, 6K7, 6Q7, 6V6, 5Z4 or 6X5, 35/-.

COAX 80 OHM CABLE.

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; All other lengths 8d. per yard.

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, £7, p. & p. 3/6. Set of 5 spec. valves, 39/6.

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 £6.19.6. 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)
6.3V. .6A type...... 12/6 (P. & P. 1/6)
10.5V. .3A type ... 12/6 (P. & P. 1/6)
13V. .3A type ...... 12/6 (P. & P. 1/6)

Small size and tag terminated for easy fitting. Other voltages available.

RE-GUNNED TV TUBES
NEW REDUCED PRICES

... and now 12 months guarantee!

All tubes rebuilt with new heater, cathode and gun assembly—reconditioned virtually as new.

12in. £6, 14in. £7, 17in. £8.10.0, etc.

10/- part exchange allowance on old tube

Carr. and ins. 10/-. Comprehensive stocks—quick delivery.

CONDENSERS—Silver Mica. All pref. values, 2 pf. to 1,000 pf., 6d. each. Ditto, ceramics 9d. each. Tubulars 450 v. T.C.C. etc., .001 mfd.-01 and .1/350 v., 9d. each, .02-1/500 v., 1/- each. .25 Hunts 1/6, .5 T.C.C. 1/9, .001 6 kv., 5/6, .001 20 kv., 9/6.

RESISTORS—FULL RANGE 10 ohms—10 megohms 20% ¼ w. and ½w., 3d., ¾ w., 5d., (Midget type modern rating), 1 w., 6d., 2 w. 9d., 10% Hi-Stab, ¼ w., 5d., ½ w., 7d., 5% ½ w., 9d., 1% HI-STAB. ½ w., 1/6 (10-100 ohms 2/-).

PRE-SET W/W POTS. T/V Type, 25 ohms—50 K ohms, 3/-. 50K—2 Meg. (Carbon, 3/-).

SPEAKER FRET—Expanded Bronze anodised metal 8 × 8in., 2/3; 12 × 8in., 3/-; 12 × 12in., 4/6; 12 × 16in., 6/-; 24 × 12in., 9/-; 36 × 12in., 13/6, etc., etc.

TYGAN FRET (Contemporary pat.), 12 × 12in., 2/-; 12 × 18in., 3/-; 12 × 24in., 4/-, etc.

LOUDSPEAKERS P.M. 3 ohms, 2½in. Elac., 17/6. 3½in. Goodmans, 18/6; 5in. Rola, 17/6. 6in. Elac 18/6; 7 × 4in. Goodmans Elliptical, 18/6; 8in. Rola, 20/-; 10in. R. and A., 25/-; 10in. WB-HF1012, 99/9; 12in. Plessey 15 ohms with 6/4in. Tweeter and Cross Over Filter, 97/6.

Electrolytics All Types New Stock

TUBULAR		CAN TYPES	
25/25 v. 50/12 v.	1/9	8+8/450 v.	4/6
50/50 v. 100/25v.	2/-	32+32/275 v.	4/6
8/450 v.	2/3	50+50/350 v.	6/6
16+16/450 v.	5/6	60+250/275 v.	12/6
32+32/450 v.	6/6	100+200/275 v.	12/6

Comprehensive range in stock

VOLUME CONTROLS—10K—2 Megohms, ALL LONG SPINDLES, MOCCANITE MIDGET TYPE, 1½in. diam. Guar. 1 yr. LOG or LIN Ratios less Sw. 3/-. D.P. Sw. 4/6. Twin gang controls ¼ Meg. ½ Meg. 1 Meg. less Sw., each 8/9.

Manufacturer's Surplus Bargain
7 VALVE AM/FM RADIOGRAM CHASSIS

Valve Line-up: ECC85, ECH81, EF89, EABC80, EL84, EM81, EX80

Three Waveband and Switched Gram positions. Med. 200-500 m., Long 1,000-2,000 m., VHF/FM 88-95 Mc/s. Philip's Continental Tuning insert with permeability tuning on FM and combined AM/FM 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 × 6½in. Height 7½in. Edge Illuminated glass dial 11½ × 3½ in. Vertical pointer. Horizontal station names. Gold on brown background. A.C. 200/250 v. operation.

Aligned and tested ready for use **£13 . 10 . 0** *Carr. & Ins. 5/-*

Complete with 4 Knobs—walnut or ivory to choice.
Three ohm P.M. speaker only required. Recommended quality speakers.
8in. Goodmans special cone 21/6
10in. Rola (Heavy Duty) 30/-
Post & Pkg. 1/6

We design and manufacture MAINS AND O/P TRANSFORMERS to individual spec. Winding capacity available for Prototypes and small production runs.

ONLY A FEW ITEMS ARE LISTED FROM OUR COMPREHENSIVE STOCK. WRITE NOW FOR FULL BARGAIN LISTS, 3d.

Terms: C.W.O. or C.O.D. post and packing up to ½lb. 7d.: 1lb. 1/1; 3lb. 1/6; 5lb. 2/- 10lb. 2/9.

2 WAVEBAND CAR RADIO KIT

12 v. operation Med. & Long Waves

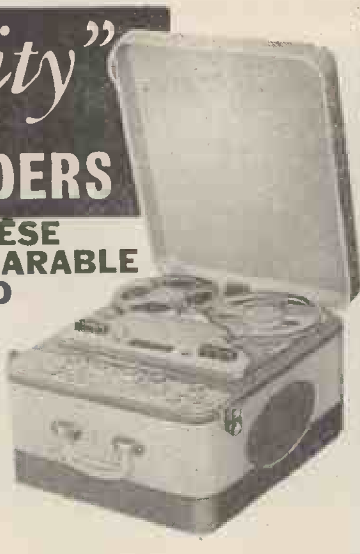
Modern development of the famous Brimar Hybrid vibratorless car radio circuit. Five latest type Brimar low voltage valves and power transistor. R.F. stage and permeability pre-aligned Cyldon Tuner Unit provide extremely good sensitivity and signal/noise ratio. Printed circuit for easy construction and 7 × 4in. elliptical speaker for fidelity output. Self-contained in neat metal cabinet 8 × 7 × 2½in. with attractive calibrated dial. Speaker and power transistor stage mounted separately, approx. 8 × 5 × 3in.

Recommended Buy *Complete Kit. Bargain Price* **£12.19.6** *P. & P. 3/6*

Instruction booklet and parts list available 3/6 post free.

TRS RADIO COMPONENT SPECIALISTS
70 BRIGSTOCK RD., THORNTON HEATH, SURREY
Established 1946. Tel: THO 2188 Hours: 9 a.m.—6 p.m. 1 p.m. Wednesday

Stern's "fidelity" TAPE RECORDERS



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.

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

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

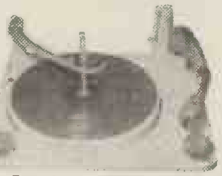
MODEL TR3/Mk. VI. Incorporates the New TRUVOX Mk. VI TWIN TRACK 2-speed Tape Deck...... **£49.10.0**
H.P. Terms: Deposit £9/18/- and 12 months of £3/12/7.

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 UA8 4-spd. Mixer Autochanger with Crystal Pick-up. **£6.12.6**

The COLLARO "CONQUEST" 4-speed autochanger Studio "O" Pick-up. **£7.10.0**

The latest COLLARO "CONTINENTAL" 4-speed MIXER Autochanger, Studio "C" Pick-up **£8.10.0**

The NEW COLLARO model RP594, 4-speed Single Record Player, Studio Cartridge .... **£9 . 18 . 9**

The COLLARO model 4 564 4-speed Single Record Player, Studio Pick-up .... **£6 . 6 . 0**

THE NEW B.S.R. model UA12 is in stock. A 4 "SPEED" MIXER AUTOCHANGER .... **£8 . 7 . 6**

UA12 is also available incorporating the B.S.R. STEREO Pick-up plays L.P. and 78 records .... **£10 . 10 . 0**

GARRARD RC121/4 4-speed Autochanger fitted with latest Crystal Pick-up .... **£10 . 0 . 0**

B.S.R. Model TU9 4-speed single record player, complete with separate crystal pick-up .... **£4 . 4 . 0**

(This high output pick-up is available separately for £1/12/6.)
Carriage and insurance on each above 5/- extra.

HIGH FIDELITY UNITS IN STOCK

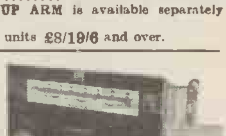
The latest GARRARD TRANSCRIPTION MOTOR "301" with Stroboscopically marked turntable .... **£23 . 18 . 4**

The new GARRARD Model 4HF High Quality Single Record Player fitted with the latest T.P.A. 12 pick-up arm and G.C.8 Crystal Cartridge .... **£18 . 7 . 6**

GARRARD Model TA/MK. II Single Record Player fitted with high output Crystal Pick-up, detachable head .... **£8 . 10 . 0**

The GARRARD T.P.A. 12 TRANSCRIPTION PICK-UP ARM is available separately or with Crystal or Moving Coil Pick-up Heads.
HIRE PURCHASE TERMS available on all units £8/19/6 and over.

STERN'S MK II "*fidelity*" F.M. TUNING UNIT



(Plus 5/- carr. and ins.)
HIRE PURCHASE: Deposit PRICE **£14.5.0**
£2 and 12 months at £1/0/9. Incorporates the latest MULLARD PERMEABILITY TUNING HEART and the corresponding MULLARD VALVE LINE UP comprising ECC85, 2 type EF85s (or EF89s), EM84, Tuning Indicator, plus 2 type O.A. 79s Germanium Diodes. A really first-class Tuner very attractively presented and comparable to many offered at much higher prices Power consumption is only 1.5 amps at 6.3 volts and 25 m a at 250 volts.

HOME CONSTRUCTORS!

YOU CAN BUILD THIS TUNING UNIT FOR ONLY **£10.10.0**
(Plus 5/- carr. and ins.)
Please send S.A.E. for fully descriptive leaflet, or the Assembly Manual is available for 1/6.

SPECIAL CASH ONLY BARGAIN

A bulk purchase enables us to offer this very useful **INTERCOM SET or BABY ALARM** *For only* **£5.5.0**

Consists of MASTER UNIT (illustrated) and one EXTENSION, providing 2-way TALK-LISTEN facility. Complete in polished wood cases, size of each only 7¼ × 4¾ × 6in. high.

! ! RADIOGRAM CHASSIS ! !

ARMSTRONG "STEREO TWELVE" - - - - - - - - - **£37.16.0**
The most complete A.M./F.M. unit yet produced. For Stereo, giving 6 watts high fidelity push-pull output on each channel, 12 watts for Monaural.

ARMSTRONG "JUBILEE" - - - - - - - - - - - - - **£29.8.0**
An AM/FM chassis with nine valves and with push-pull output stage providing 6 watts.

ARMSTRONG AM/FM "STEREO 44" - - - - - - - - **£28.7.0**
Provision is made for Stereo and Monaural playback from pick-up or tape. Outputs provided for Stereo or Monaural tape 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.

THE DULCI CHANNEL STEREO PREAMPLIFIERS
The "STEREO EIGHT" PREAMPLIFIER £23.2.0
The "STEREO TWO" PREAMPLIFIER £9.9.0
(Carr. & Ins. 5/- extra.)

SPECIAL CASH ONLY OFFER !!

This very attractive PORTABLE AMPLIFIER CASE together with a good quality GRAM AMPLIFIER and a matched P.M. SPEAKER. ALL FOR ONLY **£8.7.6** (plus 7/6 carr. and ins.). The Amplifier consists of a 2-stage design incorporating the 3 modern BVA valves and has separate BASS and TREBLE CONTROLS. The Portable Case will also accommodate almost any make of Autochanger and is attractively finished in Grey colour Rexine—WE ALSO SUPPLY SEPARATELY:—

(a) The 2-stage (plus Rectifier) AMPLIFIER £4 2 6
(b) The PORTABLE CARRYING CASE £3 17 6
(c) 6½in. P.M. SPEAKER 18 9
(Carriage and insurance 4/- extra)

! ! 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 AND TESTED **£13.10.0**
CREDIT SALE Deposit £3/7/6 and monthly payments of £1/4/10.
ALTERNATIVELY THE COMPLETE HOME CONSTRUCTORS KIT IS available for £9/19/6 (carr. and ins. is 5/- extra).

CAR BATTERY CHARGER
A COMPLETE KIT OF PARTS FOR ONLY **£2.19.6**
Will charge 6 or 12 volt batteries at max 2½ amps The design incorporates Reliant Resistor and Fuse and we supply complete with Metal Box container. EASY TO-FOLLOW ASSEMBLY INSTRUCTIONS ARE INCLUDED.

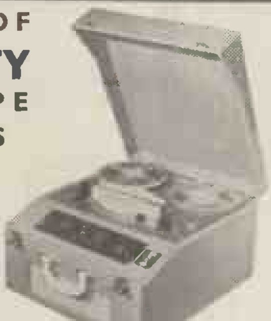
STERN RADIO LTD. 109. & 115 FLEET ST., LONDON, E.C.4
Telephone: FLEET STREET 5812/3/4

Stern's "fidelity" TAPE EQUIPMENT

THE FINEST RANGE OF TAPE EQUIPMENT FOR THE HOME CONSTRUCTOR

A SELECTION OF

HIGH FIDELITY PORTABLE TAPE 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 .... **£61.0.0**

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 **£35.0.0**
H.P. Deposit £7 and 12 months £2/11/4
(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**
H.P. Deposit £8/0/0 and 12 months £2/18/8.
(d) As above but the Type "C" supplied as complete KIT OF PARTS **£36.10.0**
(e) The BRENELL Mk. V DECK and the assembled Type "C" PREAMPLIFIER and POWER UNIT **£46.0.0**
H.P. Deposit £9/4/- and 12 months £3/7/6.
(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 **£56.0.0**
H.P. Deposit £11/4/0 and 12 months £4/2/1.
(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

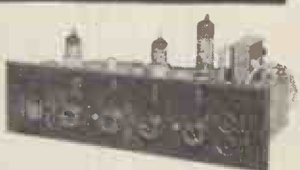
YOU CAN BUILD A COMPLETE HIGH QUALITY RECORDER ◄ LIKE THIS FOR £39.15.0

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 concorporates PRECISION REV. COUNTER and PAUSE CONTROL and operates at 3¾ 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/-).

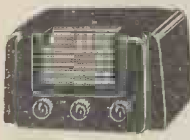
Designed to operate through the Pick-up Sockets of the standard RADIO RECEIVER through which first-class results are obtained. It consists of a single speed Twin Track Tape Deck, incorporating matched Preamplifier, and operates at 3¾ in./sec. speed. It uses 5in. Tape Spools thus providing up to 1½ hours' 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

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 1R5, 1T4, 1S5, 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.)

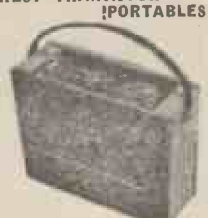
LEADING THE FIELD—

In equipment for

THE CONSTRUCTOR and HI-FI ENTHUSIAST

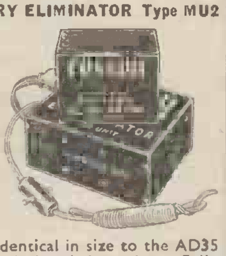
SEND STAMP FOR FULL LIST including F.M. Tuners, Receivers, Amplifiers, Stereo Amplifiers, Tape Pre-Amplifiers, Transistor Portables, Crystal Receivers, Battery Charger, Baby Alarm, etc., etc.
NOTE: ALL components supplied, including valves (even if surplus types) are guaranteed to be BRAND NEW ! ! !

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.

COSSOR BATTERY ELIMINATOR Type MU2



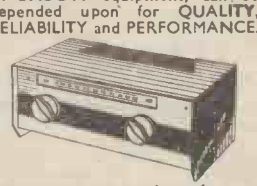
Suitable for converting any All-Dry Battery receiver, employing 1.5 v. L.T. and 90 v. H.T. and modern low consumption valves, to A.C. Mains operation, 200/250 v. Contained in two separate units (L.T. & H.T.) which are identical in size to the AD35 and B126 (or equivalents) batteries. Fully stabilised 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 ear piece for above, 12/6.

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.

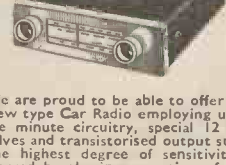


Incorporates the very latest features in design to ensure simplicity of operation and faultless performance. Housed in smart metal shelf mounting cabinet in pastel green with grey plastic dial. Built-in power supplies enable connection to any amplifier or radio fitted with Pick-up sockets, without complication. 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

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).

Our advantageous H.P. and Credit Sale terms are available on any single item over £5. Your enquiries invited.

CLYNE RADIO LTD.

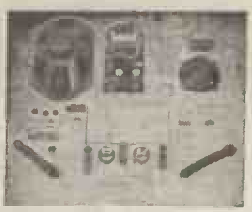
162, HOLLOWAY ROAD, LONDON, N.7. NORth 6295/6/7.
18, TOTTENHAM COURT ROAD, W.1. MUSeum 5929/0095.
(50 yards only from Tottenham Court Road Tube)

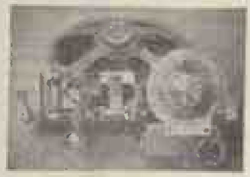
Open: Tottenham Court Rd: 9 a.m. to 6 p.m. Mon to Fri., Sat. 1 p.m. Holloway Road: 9 a.m. to 6 p.m. daily. Thurs. 1 p.m., Sat. 5.30 p.m.

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

COSSOR KITS! *A unique opportunity to obtain a first-class amplifier and/or the latest type VHF/FM receiver at the most reasonable price ever.*

COSSOR AUDIO AMPLIFIER KIT 562K. This excellent amplifier supplied in kit form in manufacturer's original presentation carton comprising: Pre-assembled printed-circuit board, valves: 6V4, 6BQ5, EF86 output transformer, two loud-speakers, 4in. circular and 10 x 6in. elliptical, wiring wire, nuts, bolts, attractive escutcheon and control knobs, mounting brackets and fully illustrated assembly Instructions. With negative feedback incorporated, and the high performance loudspeakers 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 manufacurer'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/-.)**

EXTRA SPECIAL OFFER!!

A small three-valve **PORTABLE RECORD-PLAYER AMPLIFIER** mounted on baffle 12 x 7in. with High Flux 6½in. Loudspeaker, Valve line-up ECC83, EL84, EZ80. Incorporates separate bass and treble controls. Max. output 3 watts. Will match all types of high impedance pick-up. Ready to use, **£5/12/6** plus 3/6 P. & P.

NEW STYLE CABINET finished in two-tone Leatherette. Will accommodate above Amplifier and Baffle without modification, also most types of Ancillary Equipment. Overall size 18 x 13½ x 8½in. Fitted with carrying handle, **£3/9/6** plus 5/- P. & P. **NOTE. If both items purchased together they will be supplied at a special inclusive price of £8/7/6 plus 6/6 P. & P.**

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. UA8 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.121D 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 autochanger with GC2 insert. Brand new. fully guaranteed. **£9/19/6.** P. & P. 3/6.

A QUALITY RECORDER FOR 39 GNS.

Collaro Mark IV Tape Transcriptor Deck......	£17 19 6
Special amplifier	£14 14 0
8 × 6in. loudspeaker	£1 10 0
De Luxe Cabinet with gilt fittings	£4 10 0
CollaroMike(orsimilar)	£2 5 0
1,200ft. EMI tape	£1 15 0
TOTAL	**£42 13 6**

OUR SPECIAL INCLUSIVE PRICE ONLY 39 GNS. if all items purchased together. Terms: **£4/19/-** dep. and 12 monthly payments of **£3/6/-.** C. & P. 15/- extra. Full assembly instructions provided. Note: We shall be pleased to wire the tape deck switches at extra charge of £1. Send stamp for further details.

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 5in. Loudspeaker with High Flux magnet: Separate Power Pack. Dimensions: Amplifier 5¾in. H. x 11½in. W. x 2¾in. D. Power Pack: 6½in. x 6in. x 5in. High (overall). Full modification details are supplied. Price **£6/19/6.** P. & P. 3/6.

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: 24½in. 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.

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

VERDIK "QUALITY 10". A superb Hi-Fi amp. and pre-amp. with 10 watt push-pull ultra linear output. Beautifully finished in grey-green stove enamel. Controls: Bass, Treble, Volume and input selection for Radio, Mike, Tape, Std. and L.P. Records. Limited stocks at only **£14/19/6 plus 7/6 P. & P.** (List 20gns.). Terms available.

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 4SP player, but is easily modified for the Collaro Junior, B.S.R. TU9 etc.). Overall dimensions are: 15¾in. wide x 13in. x 7½in. high. Clearance above motor-board (inc. lid) 3¾in. Clearance below motor-board 3½in. 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 autochanger at 79/6 plus 6/6 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.

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 3½ x 8¾in. Only 59/6 plus 2/6 P. & P.

SPECIAL CELESTION 8 x 6in., elliptical high flux loudspeaker 30/- plus 1/- P. & P.

VERY ATTRACTIVE PORTABLE CABINET in Red and White polka dot for accommodating the above items and ancillary equipment, 75/-, plus 5/- P. & P.

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

CLYNE RADIO LTD.

RC

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

SEE OVER FOR MORE BARGAINS→

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 failing emission. Full instructions supplied.
Type A. Low Leakage windings. Optional Boost 25% and 50%. Tapped mains primaries.

2 volt ....12/6 each
4 volt ....12/6 each
6.3 volt ....12/6 each
10.8 volt ....12/6 each
13.3 volt ....12/6 each

OUR LATEST SUPERIOR PRODUCT. Type A2. High Quality. Low capacity, 10/15 pf. Optional boost 25%, 50%, 75%. 16/6 each
Type B. Mains input. Low capacity. Multi Output 2, 4, 6.2, 7.3, 10 and 13 volts. Optional boost 25% and 50%. Suitable for all Cathode Ray Tubes, 21/-.

RESISTORS. All preferred values. 20% 10 ohms to 10 meg., ¼ w. 4d.; ½ w., 4d.; 1 w., 6d.; 1½ w., 8d.; 2 w., 1/-. HIGH STABILITY. ½ w., 1%, 2/-. Preferred values 100Ω to 10 meg. Ditto 5%, 9d., 100Ω to 5 meg.
5 watt 1/3, 10 watt 1/6, 15 watt 2/- WIRE-WOUND RESISTORS 25 ohms—10,000 ohms
15,000 ohms—50,000 ohms 5 w., 1/9; 10 w. 2/3

WIRE-WOUND POTS, 3 w. Pre-set Min. T.V. type Knurled Slotted knob. All values 25 ohms to 25K. 3/- ea., 30 K., 50 K., 4/-. Ditto, ½ w. Carbon Track 50 K. to 2 Meg., 3/-.

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

O/P TRANSFORMERS. Heavy Duty 50 mA., 4/6. Multi-ratio push-pull, 7/6. Miniature 3V4, etc., 4/6. Hygrade Push-pull 10 watts, 15/6. MULLARD "510" 6k or 8k 30/-. L.F. CHOKES 15/10H 60/65 ma., 5/-. 10H 85 ma. 10/6. 10H 150 ma. 14/-.

MAINS TRANSFORMERS 200/250 v. A.C.
STANDARD 250-0-250, 80 mA., 6.3 v. 3.5 a. tapped 4 v. 4 a. Rectifier 6.3 v. 1 a., tapped, 5.v. or 4 v. 2 a. Ditto 350-0-350 .... 22/6
MINIATURE 220 v. 20 mA., 6.3 v. 1 a. 10/6
MIDGET, 250 v. 45 mA., 6.3 v. 2 a. 15/6
SMALL, 250-0-250 100 mA., 6.3 v. 3.5 a. 19/6
STANDARD, 250-0-250, 65 mA., 6.3 v. 3.5 a. .. 17/6
HEATER TRANS., 6.3 v. 1½ a. 7/6. 3 amp. 10/6
GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 A. 22/6.

ALADDIN FORMERS and cores, ¼in. 8d.; ⅜in. 10d. 0.3in. FORMERS 5937 or 8 and Cans TV1 or 2, ⅜in. sq. × 2⅛in. or ½in. sq. × 1¼in. 2/- with cores.
SLOW MOTION DRIVES. Epicyclic ratio 6:1, 2/3.
TYANA. Midget Soldering Iron, 230 v. 40 w., 16/9.
REMPLOY INSTRUMENT IRON, 230 v. 25 w., 17/-.
MAINS DROPPERS. 3 × 1½in. Three Adj. Sliders, .3 amp. 750 ohms, 4/3. .2 amp., 1,000 ohms, 4/3.
LINE CORD. .3 amp., 60 ohms per foot, .2 amp., 100 ohms per foot, 2 way, 6d. per foot, 3 way, 7d. per foot.

CRYSTAL MIKE INSERT by Acos 6/6
Precision engineered. Size only ¼ × 1⅛in.
ACOS CRYSTAL DESK MIKE. Bargain. 35/-.

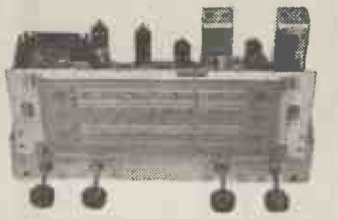
MIKE TRANSF. 50:1, 3/9 ea.; 100:1 Potted, 10/6.
LOUDSPEAKERS P.M. 3 OHM. 5in., Rola 17/6. 6in. × 4in. Rola, 18/-. 7in. × 4in. R.A. 21/-. 10in. × 6in. Rola, 27/6. 8in. Plessey, 19/6. 6½in. Rola, 18/6. 8in. Rola, 21/-. 10in. R.A., 30/-.
HI-FI TWEETERS, 4in. 25/-. 12in. Plessey, 30/-.
12in. Baker 15 wt.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

I.F. TRANSFORMERS 7/6 pair
465 kc/s. slug tuning miniature can 2½ × 1 × 1in. High Q and good bandwidth. By Pye Radio. Data sheet supplied.
Wearite M800 I.F. Miniature 465 kc/s., 12/6 pair.
Wearite 550 I.F. Standard 465 kc/s., 12/6 pair.

CRYSTAL DIODE G.E.C. 2/-. GEX34, 4/-. 40 Circuits, 3/-.
H.R. HEADPHONES, 4,000 ohms, brand new, 16/6 pair.
SWITCH CLEANER Fluid, squirt spout, 4/3 tin.
TWIN GANG CONDENSERS. 365 pf. Miniature, 1⅜in. × 1⅛in. × 1⅛in. 10/-. .0005 Standard with trimmers, 9/-; less trimmers, 8/-. Midget, 7/6; Single 50 pf., 2/6; 100 pf., 150 pf., 7/-. Solid dielectric 100, 300, 500 pf., 3/6.
VALVE HOLDERS. Pa. int. Oct., 4d. EF50, EA50, 6d. B12A, CRT, 1/3. Eng. and Amer. 4, 5, 6, 7 pin, 1/-.
MOULDED Mazda and Int. Oct. 6d., B7G, B8A, B8G, B9A, 9d. B7G with can, 1/6; B12A, 1/3. B9A with can, 1/9.
CERAMIC, EF50, B7G, B9A, Oct., 1/. B9A Cans 9d.
SPEAKER FRET. Gold Cloth 17in. × 25in., 5/-, 25in. × 35in., 10/-. Tygan 54in. wide, 10/- ft. 27in. wide, 5/- ft. Samples, S.A.E.
WAVECHANGE SWITCHES.
2 p. 2-way, 3 p. 2-way, short spindle 2/6
5 p. 4-way, 2 wafer, long spindle 6/6
2 p. 6-way, 4 p. 2-way, 3 p. 3-way, long spindle 3/6
3 p. 4-way, 1 p. 12-way, long spindle 3/6
Wave change "MAKITS" 1 wafer, 8/6; 2 wafer, 12/6; 3 wafer 16/-; 4 wafer 19/6; 5 wafer 23/-; 6 wafer 26/6.
TOGGLE SWITCHES S.P., 2/-; D.P. 3/6; D.P.D.T., 4/-.
MORSE KEYS, good quality, 2/6.
SUB-MINIATURE ELECTROLYTICS (15 v.), 1, 2, 4, 5, 8, 25, 50 mfd. 3/- each.

EDISWAN TRANSISTORS JUNCTION TYPE P.N.P.
AUDIO XB102, for amplifiers, and output stages up to 250 milliwatts in push-pull. PRICE 10/-
R.F. XA104 frequency changer up to 4 Mc/s. 18/-
XA103 IF amp. up to 2 Mc/s. 15/-
Goltop Power V15/10P, up to 10W with heat sink 20/-.

1959 RADIOGRAM CHASSIS



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

FIVE VALVE
LATEST MULLARD
ECH81, EF89, EBC81
EL84, EZ80

12 month Guarantee. A.C. 200/250 v., 4-way switch Short-Medium-Long-Gram. A.V.C. and Negative Feedback, 4.2 watts. Chassis 13½in. × 5½in. × 2¼in. Glass Dial Size 10 × 4½in. horizontal or vertical. 2 Pilot Lamps. Four Knobs. Walnut or Ivory, aligned and calibrated. Chassis isolated from mains.

BRAND NEW £9. 10. 0 Carr. 4/6

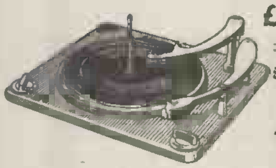
TERMS: Deposit £5/5/ and 5 monthly payments of £1. MATCHED SPEAKERS 8in., 17/6; 10in., 25/-; 12in. 30/-

SUPERIOR FM-AM MODEL
Six Mullard Valves. ECC85, ECH81, EF89, EABC80, EL84 EZ80. V.H.F. 108-87 Mc/s. Med. 190-550 m. Long 1000 1900 m. Gram input. Ready for use. A.C. Mains 200 250 v. Isolated chassis. Output point for use as Hi-Fi Tuner. 12 month guarantee. Circuit supplied. Leaflet S.A.E.

£18-19-6 Carr. 5/6

★ GARRARD 4-SPEED RECORD CHANGERS RC121/D MKII MODELS ★
Brand new and fully guaranteed 12 months.
AUDIO PERFECTION
Designed to play 16, 33, 45, 78 r.p.m. Records 7in., 10in., 12in. With plug-in NORMAL HEAD.
OUR PRICE £10.10.0 STEREO HEAD £2 extra

LATEST COLLARO AUTOCHANGER £7-19-6



STUDIO 'O' Pick-up
4 Speeds—10 Records
Or With Cabinet, Amplifier and Speaker
£11 - 19 - 6 Carr. 5/6.

B.S.R. MONARCH UA8 4-SPEED AUTOMATIC RECORD CHANGERS
Brand new and fully guaranteed 12 months.
OUR PRICE £6.19.6 post free
STEREO MODELS UA8, £7 19/6. UA12, £10/10/-.

AUTOCHANGER ACCESSORIES
Suitable player cabinets (uncut boards) ... 49/6
Amplifier player cabinets with cut boards 63/-
2 valve amplifier and 6½in. speaker for above 79/6
3 valve amplifier and 6½in. speaker for above 95/-
Wired and tested ready for use.

★ GARRARD 4-SPEED SINGLE RECORD PLAYER 4SP ★
£7.10s. AUDIO PERFECTION POST FREE
MODEL TA MK II £8 - 10
MODEL 4 HF £18
Stereo Heads £2 extra.

Teletron Pocket Radio.
Transidyne Superhet Six £11.19.6
T.C.C. Printed Circuit, internal Ferrite aerial, Rola loudspeaker, push-pull output. All parts, cabinet 6 × 4 × 1⅜in. Ediswan transistors.

THE HI-GAIN BAND 3 PRE-AMP
Cascode circuit using Valve ECC84. 17db gain. Kit 29/6 less power; or 49/6 with power pack kit. Plans only 6d.
Also Band I version same Prices.

LATEST E.M.I. 4 SPEED SINGLE RECORD PLAYER Acos 73 Hi Fi Stereo and normal xtal pick-up for 7in., 10in. and 12in. records. Silent motor, heavy turntable. Special offer £6/19/6. Post 3/6.

Volume Controls
Midget size:
Long spindle. Guaranteed 1 year. All values 5 K. ohms up to 2 Meg., No Switch. D.P. Sw. 3/- 4/9
Linear or Log Tracks.

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

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

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

BLACK CRACKLE PAINT. Air drying, 3/- tin.
P.V.C. CONN. WIRE, 8 colours, single or stranded. 2d. yd.
EON AIRFLOW TER CREWDRIVER
CORED SOLDER RADIOGRADE 4d. yd., ½lb. 2/6.
PAXOLIN 1/16in. 8in. × 10in., 1/6. 10 ..... 5/-

"GEVAERT GEVASONOR"
50% Extra Long Play Plastic Tape.
1,700ft. 7in. Reel 35/-, 850ft. 5in. Reel 21/-
SUPERIOR 1,200ft. 7in. Plastic Tape 24/-
600ft. 5in. 15/-. All Spare Reels 3/- each.
LONG PLAY 5¾in. 1,200ft. 28/-. 3in. 225ft. 7/6.
"INSTANT" Bulk Tape Eraser and Head Demagnetiser: 200/250 v. A.C. 27/6.

MAINS TYPE. RM1, 125 v., 60 mA., 5/-; RM2, 100 mA. 6/-; RM3, 120 mA., 8/-; RM4, 250 v. 275 mA. 16/-.
MINIATURE CONTACT COOLED RECTIFIERS. 250 v. 50 mA., 7/6; 60 mA., 8/6; 85 mA., 9/6; 200 mA., 21/-; 300 mA., 27/6; Full Wave 120 mA., 15/-.
COILS. Wearite "P" type, 3/- each. Osmor Midget "Q" type adj. dust core from 4/- each All ranges.
TELETRON. L. and M. T.R.F. with reaction, 3/6.
FERRITE ROD AERIALS. M.W., 8/9; M. & L., 12/6.
T.R.F. COILS A/HF. 7/- pair. H.F. CHOKES, 2/6.

JASON F.M. TUNER COIL SET, 26/-. H.F. coil, aerial coil, Oscillator coil, two I.F. transformers 10.7 Mc/s., Detector transformer and heater, choke. Circuit and component book using four 6AM6 2/6. Complete kit with Jason Calibrated dial and 4 valves .... £6/15/- With new Jason Cabinet 20/- extra.

CONDENSERS. New Stock. .001 mfd. 7 kV. T.C.C. 5/6. .25 kV., 9/6. 7 kV. 9/6. 100 pf. to 500 pf. Micas, 6d., Tubular 500 v. .001 to .01 mfd., 9d.; .05 .1 1/-; .25 1/6; .5 1/9; .1/350 v., 9d.; .1/1,000 v., 1/9; 0.1 mfd., 2,000 v., 3/6; .001 mfd., 2,000 v., 1/9.
CERAMIC CONDS. 500 v., .3 pf. to .01 mfd., 9d.
SILVER MICA CONDENSERS. 10% 5 pf. to 500 pf., 1/-; 600 pf. to 3,000 pf., 1/3.
CLOSE TOLERANCE (±1 pf.) 1.5 pf. to 47 pf., 1/6. DITTO 1% 50 pf. to 815 pf. 1/9; 1,000 pf. to 5,000 pf., 2/-.
TRIMMERS. Ceramic, 30, 50, 70 pf., 9d.; 100 pf., 150 pf. 1/3. 250 pf., 1/6. 600 pf. 750 f. 1/9. Phillips, 1/- ea.

NEW ELECTROLYTICS. FAMOUS MAKES

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

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

NEW and boxed VALVES 90-day guarantee

1R5	8/6	6L6G	10/6	EA50	1/6	EY51	12/6
1S5	8/6	6N7M	7/6	EABC80	10/6	EZ81	8/6
1T4	8/6	6Q7G	10/6	EB91	6/6	HABC80	12/6
2X2	2/6	6SA7M	10/6	EBC33	3/6	HVR2A	7/6
3S4	8/6	6SJ7M	10/6	EBC41	10/6	MU14	10/6
3V4	8/6	6SN7	8/6	EBF80	10/6	P61	6/6
5U4	8/6	6V6G	7/6	ECC84	12/6	PCC84	12/6
5Y3	8/6	6X4	7/6	ECF80	11/6	PCF80	11/6
5Z4	10/6	6X5	7/6	ECH42	10/6	PCF82	11/6
6AM6	8/6	12A6	8/6	ECL80	12/6	PCL82	11/6
6BE6	7/6	12AT7	10/6	ECL8	12/6	PEN25	6/6
6BH6	10/6	12AU7	9/6	EF39	7/6	PL82	10/6
6BW6	10/6	12AX7	9/6	EF41	10/6	PY80	8/6
6D6	7/6	12BA6	9/6	EF50	5/6	PY81	10/6
6F6G	7/6	12BE6	9/6	EF80	10/6	PY82	8/6
6H6GT	3/6	12K7	8/6	EF86	14/6	SP61	5/6
6J5M	6/6	12Q7	8/6	EF92	5/6	UBC41	10/6
6J6	7/6	35L6	9/6	EL32	5/6	UCH42	10/6
6J7G	8/6	35Z4	9/6	EL41	10/6	UF41	10/6
6K6GT	6/6	80	10/6	EL84	10/6	UL41	10/6
6K7G	5/6	807	6/6	EZ40	8/6	UY41	8/6
6K8G	8/6	954	1/6	EZ80	8/6	U22	10/6

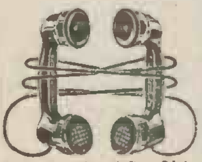
RADIO COMPONENT SPECIALISTS
OUR ONLY ADDRESS
337 WHITEHORSE RD., WEST CROYDON

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

G.W. SMITH & CO (RADIO) LIMITED

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

SOUND POWERED INTER-COM-SYSTEM

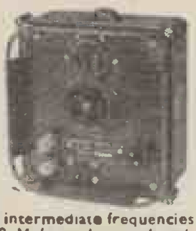


Ideal for office, home or workshop. Comprises 2 sound powered telephone handsets and 72ft. of twin connecting flex. No batteries required, just speak and listen. COMPLETE, ONLY 35/-, P/P 3/-. Additional flex 2½d. yd. extra.

BENDIX BC-453 COMMAND RECEIVERS "Q" FIVER

Coverage 190 to 550 kc/s. Complete with 6 valves, 3-12SK7, 12K8, 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., 8in. mirror scale. Accuracy within 2%. £5/19/6 ea. P/P 3/6.

BRAND NEW RCA EXTENSION LOUDSPEAKERS

8in., 3 ohm Quality Speaker mounted in attractive black crackel 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 11. 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.

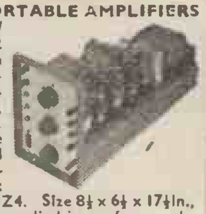
COSSOR DOUBLE BEAM OSCILLOSCOPES

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. £27/10/- 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, 6J5, 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. 8in. 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.

nput 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. ¼in. shafts. Brand new. 19/6 each. P/P 1/6.

FERRANTI TESTMETERS TYPE Q

D.C. VOLTS	A.C. VOLTS	D.C. Current	Ohms
3 v.	15 v.	7.5 ma.	25,000
30 v.	30 v.	30 ma.	
150 v.	150 v.	150 ma.	
600 v.	600 v.	750 ma.	

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 19in. 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.

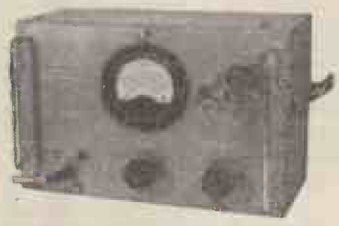
NIFE ALKALINE ACCUMULATORS. 12 volt 45 ampere. £4/19/6 each. P/P 7/6.

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 6¾ x 6½ x 5½in. 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

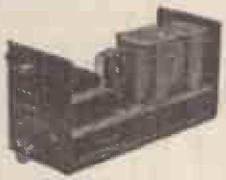


MARCONI TF.428 B/I VALVE VOLTMETERS. 5 ranges A.C. and D.C. 1.5, 5, 15, 50 and 150 volts. Operation 200/250 volts A.C. Supplied in perfect working order complete with internal H.F. probe. Brand new. £17/10/- each. P/P 10/-.

R.1155 COMMUNICATIONS RECEIVE S.

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 nstructior boo with l receivers.

EDDYSTONE MA N POWER PACKS

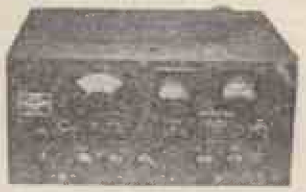


200/250 volt n-put. Output 75 volts 60 mA nd 12 volts .5 amps. Double hoke nd ondenser moothed 5Z4 ectifier Supplied as new no unused, 22 each. P/P

BATTERY CHARGING OR MODEL RECTIFIERS AND TRANSFORMERS

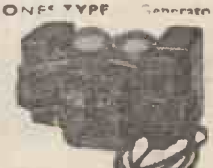
Rectifiers. All full wave and bridged. 12/18 volt 1.5 amp. 4/3; 12/18 volt 2.5 amp., 6/9; 12/18 volt 4 amp., 9/9; 12/18 volt 6 amp., 18/6; 24/30 volt 1 amp., 12/6; 24/30 volt 4 amp., 22/6; 24/30 volt 15 amp., 62/6.

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.



HALLICRAFTER 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.l. 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 Generato



bell ringing. Supplied omplete wit batterie fully ested nd omplete with woo en ca ryin cas 59 6 ach P/P 2/6 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

Car radio components 8/-; A.V.C. 4/3;
Size 9in. x 7in. x 3½in. Weight 4lb.

Complete set of parts including cabinet and all components. Now
£10 . 19 . 6
P. & P. 2/6
All parts sold separately
FREE BOOKLET

325mW version £11/11/6. P. & P. 2/6.

TRANSISTOR TRANSMITTER

- ★ Top Band 150 metres ★ 3-Transistor
- ★ Size 4½ x 3 x 1¼in.
- ★ 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. "ADDON" 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 5¾ x 3½ x 1¼in.

All components complete, 59/6 P. & P. 1/6
FREE LIST AND DIAGRAM

MINOR—1

(Transistor Pocket Radio)

- ★ 3 x 2 x ¾in.
- ★ 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; tuneable!
- ★ Very sensitive
- ★ No aerial or earth
- ★ Complete layout
- ★ Over 6 months on one battery
- ★ 4½ x 3 x 1¼in.
- ★ 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 4½ x 3 x 1¼in.
- ★ 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 trans stor printed circuit set ever offered.

AUDIO GENERATOR

Transistor Oscillator, ideal for audio circuit checking or RF modul.tor. Size 2¼ x 1⅝ 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 2¼ x 1⅝ 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 4½ x 3 x 1¼in.
All parts with phones, etc., 37/6. P.P. 1/6
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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

Full List on request

OZ4	5/-	6AM6	5/-	12AT7	8/-	DK91	7/-	ECL80	10/-	EZ81	7/-	UBC41	9/-
1C5	10/-	6C4	5/-	12AU7	7/6	DL91	7/-	EF22	7/6	KT33C	8/6	UBF89	9/-
1R5	7/-	6F12	5/-	12A8GT	10/-	DK96	9/-	VS70	6/-	MU14	7/6	UCC85	9/-
1S4	7/-	813	65/-	12K8M	10/-	DL33	9/-	EF36	5/-	PCC84	9/-	UCH42	10/-
1S5	6/6	GT1C	15/-	12SN7GT	10/-	DL35	10/-	EF39	5/-	PCF80	9/-	UCL82	12/-
1T4	6/-	6L6G	8/-	12SL7GT	10/-	DL92	7/-	EF40	11/6	PCL82	12/-	UF80	9/6
3A5	9/-	6L6M	10/-	CV135	5/-	DL94	7/6	EF42	11/-	PY80	7/6	UF85	9/6
3Q5	9/-	6Q7G	7/6	CV136	5/-	DL96	9/-	EF89	8/6	PY81	8/6	UF89	10/-
3S4	7/-	6SL7	6/-	CV138	5/-	EB91	5/-	EF91	5/-	PY82	7/6	UL41	8/-
3V4	7/6	6SN7	6/-	CV140	5/-	EBC41	9/6	EF92	5/-	VR105/30	6/-	UL84	9/-
5U4	6/-	6V6G	7/-	723A/B	55/-	EBF80	9/6	EL42	10/-	VR150/30	6/-	UY41	7/6
5Y3GT	6/-	6V6GT	6/6	2K25	65/-	EBF89	9/6	EM34	7/6	U50	6/-	UY85	8/-
6A7	9/-	6X4	6/-	DAF91	7/-	ECC81	8/-	EY51	10/-	U52	6/-	VR54	2/6
6A8GT	9/-	6X5GT	5/-	DAF96	9/-	ECC82	7/6	EY86	10/-	UABC80	9/-		
6AC7	5/-	7Y4	7/-	DF91	7/-	ECC91	5/-	EZ40	7/6	UAF42	9/-		
6AL5	5/-	7Z4	7/-	DF96	9/-	ECF80	12/-	EZ80	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 TR1920

★ 9.72 MC/S IF ★ 4-CHANNEL CRYSTAL CONTROLLED
★ 40 KC/S BANDWIDTH ★ 100 to 120 MC/S COVERAGE

Unit complete with 21 valves; crystal; 24 volt rotary power unit, etc., in metal case. In new condition with full circuit diagram

£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. 1S5 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

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

P.P. 2/- any type.

AIRCRAFT RADAR TYPE AN/APA-1

Complete scope indicator unit with amplifier; aerial switching unit; full scope controls. Includes 3BP1 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 BC624A & BC625 **15/-** P.P. 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) F.S.	6/-
0–12 amp.	2½in	T.C. (RF) P.	10/-
0–20 amp.	2in.	M.C. (DC) P.	7/6
0–30 amp.	2in.	M.C. (DC) F.S.	7/6
5–0–5 amp.	2½in.	M.C. (DC) P.	10/-
0–10 amp.	4in.	M.C. (DC) P.	25/-

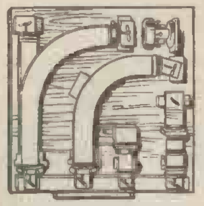
FREE COMPLETE LIST ON REQUEST

AN/ARN—5D GLIDE PATH RECEIVER

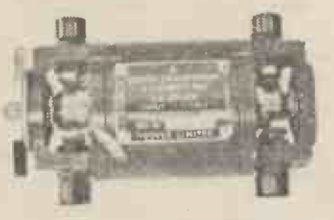
3-channel U.H.F. Receiver; uses plug-in crystals (not supplied): operating on 332.6; 333.8; and 335 Mc/s. Unit contains 7—6AJ5; 28D7; 2—12SN7; 12SR7; Relays, etc. BRAND NEW and boxed; a bargain at **59/6** P.P. 5/-

HENRY'S RADIO LTD.

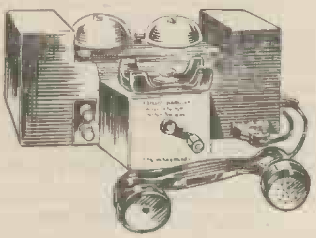
5, HARROW ROAD, PADDINGTON, W.2
(AT JUNCTION OF EDGWARE ROAD AND HARROW ROAD)
PAD 1008/9



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/-.

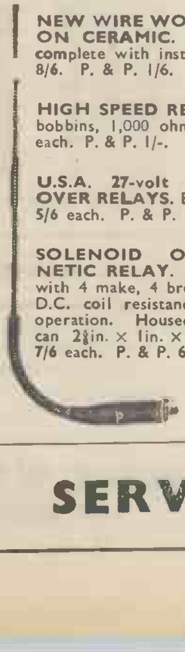


MIDGET ROTARY TRANSFORMERS. 2¼in. dia. × 4¾in. Input 11.5 volt. Output 310/365 volts at 30 mA. Brand new. 12/6 each. P. & P. 1/6.



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.

SOUNDPOWER TELEPHONE HANDSETS. New, 17/6 each. P. & P. 2/-.



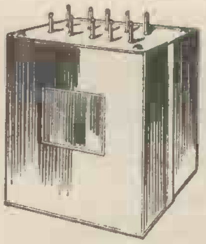
AERIAL AS ILLUSTRATED. Ideal for Car. Overall length 33in., khaki, with flexible shaft which enables the aerial to be fixed firmly in any position. Price 8/6, plus P. & P. 1/6.

NEW WIRE WOUND RHEOSTAT ON CERAMIC. 58 ohms, 50 watt, complete with instrument knob. Price 8/6. P. & P. 1/6.

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.

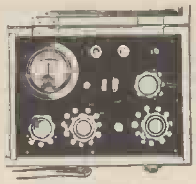
SOLENOID OPERATED MAGNETIC RELAY. Type 5. 5CW/3942 with 4 make, 4 break 25 Amp. contact, D.C. coil resistance 160 ohms, 24 v. operation. Housed in metal screening can 2⅜in. × 1in. × 1⅞in. Brand new. 7/6 each. P. & P. 6d.



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.

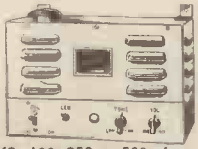


WHEATSTONE BRIDGE UNIT. 4-stud switches 0–10, 0–100 ohms, galvanometer centre zero, F.S.D. 2.5 mA. In oak carrying case 16 × 7½ × 6in., 40/- each. P. & P. 3/6.

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

EVERSHED & VIGNOLES "Wee 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 3½in. meter 3in. scale, mounted in bakelite carrying case 7½in. × 4½in. × 3in. complete with handle and test leads. 27/6 each. P. & P. 2/-.

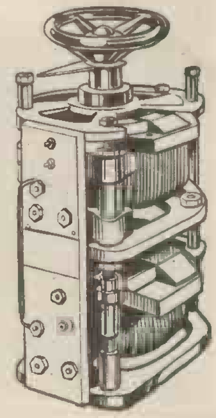


12 v. D.C. AMPLIFIER, as new, for operation on 12 v. car battery, 10 watts undistorted output, with 6L6 valves in push-pull. Mike/Gram input, tapped output 7½, 15, 62, 100, 250 or 500 ohms. £12/10/- each. Carr. 15/-.

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

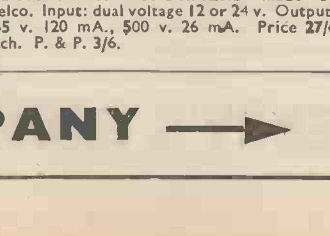
400 cycles, maximum input 180 v. Output variable from 0 to 180 v. at maximum 15 ampere. Brand new in original manufacturers cases. Price £10. Carr. 12/6.



METERS BRAND NEW GUARANTEED PERFECT

Charging Types	
2½ amp. D.C. M.I. 2in. fl. rnd.	7/6
5 amp. D.C. M.I. 2½in. fl. rnd.	11/6
7½ amp. D.C. M.I. 3½in. proj. rnd.	12/6
9 amp. D.C. Hot Wire W.R. 2½in. fl. rnd	6/6
Voltmeters	
12 v. D.C. M.C. 2½in. proj. rnd.	8/6
20 v. D.C. M.C. 2in. fl. sq.	9/6
25 v. D.C. M.C. 2in. fl. rnd.	7/6
30 v. M.I. 3in. proj. rnd.	10/6
40 v. M.C. 2in. fl. sq.	9/6
150 v. D.C. M.C. fl. rnd. 2½in.	10/6
250 v. A.C. rectified moving coil linear scale 3½in. fl. rnd.	35/–
300 v. A.C. M.I. 2½in. fl. rnd.	22/–
400 v. A.C. M.I. 4½in. fl. rnd.	35/–
Milliammeters	
2 mA. M.C. 2½in. fl. rnd.	14/6
5 mA. M.C. 2in. fl. square	12/6
10 mA. M.C. 3½in. fl. rnd.	30/–
30 mA. M.C. 2½in. fl. rnd.	9/6
50 mA. M.C. 2in. fl. sq.	8/6
200 mA. M.C. 2½in. fl. rnd.	9/6
500 mA. M.C. 2½in. fl. rnd.	9/6
Microamp	
100 microA. M.C. 2½in. rnd. fl.	42/6
200 microA. M.C. 2½in. rnd. fl. (calibrated 0–50)	29/6
50 microA. 2½in. square, sidefitting 3 scales	35/–
500 microA. M.C. 2in. rnd.	16/6

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



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.

SERVICE TRADING COMPANY ⟶

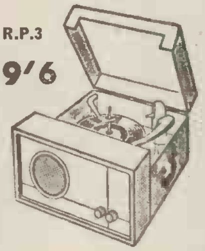
RECORD PLAYER CABINETS

R.P.4

79/6 Stylish cabinet by famous manufacturer. Cloth covered in contrasting colours (red and grey). Grilled front controls panel. Size 15 × 19 × 8¾in. deep. Beautifully made—a cabinet of which you can be really proud. Takes 4-speed B.S.R. Autochanger; 6½in. round of 7 × 4in. elliptical speaker. Room for any amplifier of your own choice. Carr. & Ins. 4/6.

R.P.3

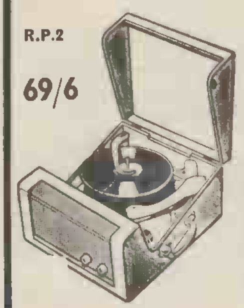
69/6



A delightful looking cabinet 14¾ × 17¾ × 8¾in. in 2 tone leatherette. Will take a B.S.R. Monarch 4-speed autochanger and 6½in. round speaker. Carr. & Ins. 4/6.

R.P.2

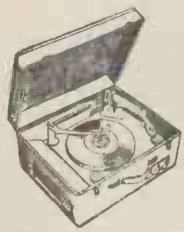
69/6



A beautifully styled cabinet. Made by a famous manufacturer. In polka dot cloth with clipped lid and carrying handle. Size 16 × 14½ × 8½in. deep. Will take a B.S.R. Monarch 4-speed Autochanger and 7 × 4in. 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 × 17 × 8in. deep. Takes a B.S.R. Monarch 4-speed Autochanger; 7 × 4in. 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 × 5¼ × 9¾in. 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. 15⅜ × 10⅞ × 24⅞in. deep. Takes B.S.R. 4-speed stereo autochanger. Printed circuit amplifier. Two 8in. speakers. Carr. & Ins. 12/6.

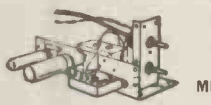
The World's Finest Autochanger

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 × 2¼ × 5in. A.C. only. Mains isolated. 2-3 watts output. Incorporating EL84 as high gain output valve. Volume and tone controls. Knobs 2/6 extra. P. & P. 3/6.

PORTABLE AMPLIFIER Mk. D. 2 79/6
Printed circuit. Latest design. Dimensions 7 × 2¼ × 5in. A.C. only. Mains isolated. 3-4 watts output. Incorporating the latest ECL82 triode pentode output valve giving higher undistorted output. Volume and tone controls. Knobs 2/6 extra. P. & P. 3/6.

PORTABLE AMPLIFIER Mk. D. 3 89/6
De luxe model. Printed circuit. Latest design. Dimensions 7 × 2¼ × 5in. A.C. only. Mains isolated. 3-4 watts output. Incorporating the latest ECL82 triode pentode output valve giving higher undistorted output. Volume, treble and bass control. Knobs 3/6 extra. P. & P. 3/6.

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 14⅜ × 12½ × 6in. Takes B.S.R. T.U.9 4-speed record player unit. 8 × 3in. elliptical speaker. Single control amplifier.

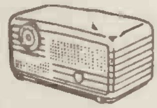
C.H.1 CABINET 69/6
Size 14¾ × 16⅜ × 8½in. Takes B.S.R. U.A.8 4-speed autochanger. 7 × 4in. elliptical speaker; most of the modern portable amplifiers. Attractive speaker grille and recessed control panel.

T.W.1 CABINET 79/6
Size 15⅜ × 19¾ × 10⅜in. Takes B.S.R. U.A.8 4-speed Autochanger. 8in. round speaker. 3 control amplifier.

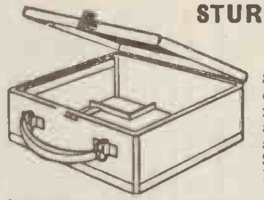
Carr. & Ins. on above 4/6.

PHOTOGRAPHIC SLIDE CASE
(List price £2/10/-) **17/6**

Size 8 × 12¾ × 2¾in. 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 × 7 × 5½in. Ideal for small receivers, converters etc. P. & P. 3/9.

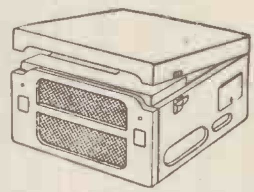


STURDY CASE
12/6

8½ × 7½ × 3½ 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 13¾ × 15 × 8½in. 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 8in. P.M. speaker W.B. or Goodmans of the highest quality. Standard matching to any receiver (2-5 ohms.) Switch and flex included. Ins. carr. 3/9.

IDEAL FOR STEREOPHONIC SOUND

8in. P.M. Speakers 8/9. With O.P. transformer fitted 10/-. 6½in. P.M. Speakers 12/6. Postage 2/6. 7 × 4in. elliptical speaker 19/6. 9½ × 4½in. 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. A.10 ULTRA LINEAR 30 WATT AMPLIFIER

HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. EF86, EF86, ECC83, 807, 807, GZ34. Tone Control Pre-amp. stages are incorporated. Sensitivity is extremely high. Only 12 millivolts minimum input is required for full output. THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP. Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. An extra input with associated vol. control is provided so that two separate inputs such as "mike" and gram, etc., etc., can be simultaneously applied for mixing purposes. AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 v. 1.5 A. FOR A RADIO FEEDER UNIT. Price in kit form with easy-to-follow wiring diagrams.

Only **11 Gns.** Or Factory built with 12 months' guarantee £13/19/6. TERMS ON ASSEMBLED UNITS. DEPOSIT 24/9 and 12 monthly payments of 24/9.

Carr. 10/-
Cover as illustrated 18/9 extra.

Type 807 output valves are used with High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE. Frequency response ± 3 D.B. 30-20,000 c/cs. Tone Controls ± 12 D.B. at 50 c/cs. + 12 D.B. to — 6 D.B. at 12,000 c/cs., hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue hammer. Overall size 12 × 9 × 9in. approx. Power consumption 150 watts. For A.C. mains 200-250 v. 50 c/s. Outputs for 3 and 15 ohm speakers. EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS OR OUTSIDE FUNCTIONS. IDEAL FOR USE WITH MUSICAL INSTRUMENTS SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc., etc. We can supply Microphones, Speakers, etc., at keen cash prices or on terms with amplifiers. EXPORT ENQUIRIES INVITED.

LINEAR "DIATONIC" 10 WATT HIGH FIDELITY AMPLIFIER. A compact attractively finished unit. 12 gns. Cash. Send S.A.E. for leaflet. H.P. Terms. Dep. 22/3 and twelve monthly payments of 22/3.

LINEAR L5/5 HIGH QUALITY STEREO AMPLIFIER. Total output 10 watts. Handsome Perspex Facia Plate. All controls ganged. Only 11 Gns.

LINEAR L45 MINIATURE 4/5 W. QUALITY AMPLIFIER. Suitable for use with any record playing unit and most microphones. Negative feedback 12 D.B. Bass and Treble controls. For A.C. mains input of 200-250 v. 50 c.p.s. Output for 2/3 ohm speaker. Three miniature Mullard valves. Size only 6 × 5 × 5½in. high. Chassis fully isolated from mains. Guaranteed 12 months. Only **£5/19/6** Or Deposit 22/- and 5 monthly payments of 22/-. Send S.A.E. for leaflet.

LG3 MINIATURE 3 WATT GRAM AMPLIFIER

For 200-250 v. 50 c.p.s. A.C. mains. Overall size only 6¼ × 4¼ × 2¼in. Fitted vol. and Tone Control with mains switch. Designed for use with any kind of single player or record changeing unit. Output for 2-3 ohm speaker. Guaranteed 12 months. Only 57/9.

R.S.C. A7 3-4 WATT QUALITY AMPLIFIER. Spec. exactly as A5 below with exception of output wattage. Complete kit of parts, diagrams and instructions £3/15/-, carr. 3/6.

R.S.C. A5 4-5 WATT HIGH GAIN AMPLIFIER

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum level is negligible being 71 D.B. down. 15 D.B. of negative feedback is used. H.T. of 300 v. 26 mA. and L.T. or 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/cs. 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 2½in. Perdio 21/9. 5in. Goodmans 17/9. 7 × 4in. R.A. Elliptical 19/9. 6½in. Rola 19/9. 8in. Rola 19/9. 8in. Goodmans 21/9. 8 × 6in. Elac with high flux magnet 25/9. 10in. R.A. 28/9. 10 × 6in. Elliptical Goodmans 29/9. 12in. R.A. 29/11. 12in. R.A. 3 or 15 ohms, 10 watts, 12,000 lines, 59/6.

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.

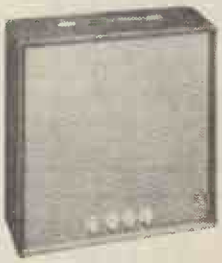
ACOS HGP59 Hi-Fi Crystal Cartridges. (Turnover type with sapphire stylus.) Standard replacement for Garrard and Collaro. Only 19/9. B.S.R. Ful-fi 17/9. Garrard GC2 19/9.

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, 5Y3. High Quality sectionally wound output transformer specially designed for Ultra Linear operation, and reliable small condensers of current manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut" Frequency response ±3 D.B. 30-30,000 c/cs. Six negative feedback loops. Hum level 60 D.B. down. ONLY 2? millivolts INPUT required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs. For STANDARD or LONG PLAYING RECORDS. For MUSICAL INSTRUMENTS such as STRING BASS, GUITARS, etc. OUTPUT SOCKET with plug provides 300 v. 30 mA. and 6.3 v. 1.5 a. For supply of a RADIO FEEDER UNIT. Size approx. 12-9-7in. For A.C. mains 200-250 v. 60 c/cs. Output for 3 and 15 ohms speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. (Or factory built 45/- extra.) Only **8** Gns. Carr. 10/-
If required louvred metal cover with 2 carrying handles can be supplied 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, Microphone 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 8in. 1/speaker. Input sockets for Radio/Tape or Gram Pick-up and Mike /Instrument Pick-up. Handsome strongly made cabinet (Size approx. 14 × 14 × 7ins.). Finished in satin walnut and fitted carrying handle.
£8/19/6 Carr. 7/6. Or Deposit £1 and nine monthly payments £1.
Send S.A.E. for leaflet.

SENIOR 10 WATTS. High Fidelity Push Pull output. Separate Bass and Treble "cut" and "boost" controls. Twin separately controlled high gain inputs so that two instruments such as Guitar and String Bass can be used at the same time. Two Loudspeakers are incorporated, a 12in. P.M. for Bass notes, and a 7 × 4in. elliptical for Treble. Cabinet is well made and finished satin walnut. Size approx. 18 × 18 × 8in. 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 styli. Many exclusive features. Unique design motor virtually free from rumble. For 200-250 v. A.C. mains. Limited number tested and guaranteed £5/19/6. Carr. 4/6.

PORTABLE CABINETS

For Record Players or Tape Recorders. Rexine covered. Wide selection of attractive designs and colour combinations PRICES FROM **15/9**

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

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

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

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

SPECIAL OFFER

Above cabinet Staar Changer, Gram amplifier, and 5in. or 6in. × 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. (LEEDS) LTD.

MANCHESTER, LEEDS & BRADFORD

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.

R.S.C. (LEEDS) LTD., MANCHESTER BRADFORD and LEEDS

For addresses and terms see page 169

TANNOY RE-ENTRANT LOUDSPEAKERS. 8 watt 7.5 ohms 19/6

HIGH FIDELITY 10 watt PUSH-PULL AMPLIFIERS Separate Bass and Treble controls. Inputs for Gram. and Mike. Mullard latest type valves. Brand New Guaranteed in perfect order but slightly store soiled. Very limited number. £6/15/-. Carr. 7/6.

ELECTRIC BELLS. 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. ½ a. h.w.	1/9	120 v. 40 mA.	3/9
6/12 v. ½ a. h.w.	2/9	250 v. 50 mA.	3/11
Following F.W. (Bridge).		250 v. 60 mA.	4/11
6/12 v. 1 a.	3/11	250 v. 80 mA.	6/11
6/12 v. 2 a.	6/11	250 v. 250 mA.	12/9
6/12 a. 3 a.	9/9	Contact Cooled.	
6/12 a. 4 a.	12/3	250 v. 80 mA.	6/11
6/12 v. 5 a.	14/6	250 v. 75 mA.	8/11
6/12 v. 6 a.	15/6	F.W. (Bridge).	
6/12 v. 10 a.	25/9		
6/12 v. 15 a.	35/9		

JACK PLUGS. Standard type complete with 4ft. screened lead. 1/11 each.

JUNCTION TRANSISTORS. R.F. type, 12/6. Audio type 6/9. Power type Goltop V15/10P 2 watts 17/9. OC71, 10/-, OC72, 17/-, XB102, 10/-, XB104, 10/-, OC45 17/6, OC44 22/6.

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

2 v. 16 A.H. EX. GOVT. ACCUMULATORS. New boxed. Only 5/6 each, 3 for 15/-, plus 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
265-0-265 v. 150 mA., 6.3 v. 11 a., 5 v. 3 a., 5 v. 3 a. 29/11
350-0350 v. 100 mA., 6.3 v. 2 a., 5 v. 2 a. 18/9
350-0-350 v. 160 mA., 6.3 v. 5 a., 5 v. 3 a. 27/9
400-0-400 v. 250 mA., 5 v. 2 a., 5 v. 2 a. 18/9
450-0-450 v. 250 mA., 6.3 v. 3 a., 6.3 v. 1 a., 5 v. 6 a. 49/9
0-24-26-28 v. 15 amps. A.C. conservative Govt. rating (marked with D.C. rating after rectification) 69/9. Carr. 15/-.
0-10-20-25 v. 24 a. (Govt. rating) 79/6. Carr 15/-.
AUTO 500 watts, 0-215-220-225-230-235-240 v. 29/9 Carr. 7/6. 50 watts, 0-110/120-230/250 v. 8/11.

ARDENTE DEAF AID EARPIECES with lead and plug. Brand New. Only 15/6.

SPECIAL OFFER. Brand New Ex-Govt. 24 v. 15 amp. F.W. Bridge Selenium Rectifiers. Only 27/9 ea.

D.C. SUPPLY KITS. Suitable for electric trains Consists of mains trans. 200-250 v. 50 c.p.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.

EX. GOVT. SMOOTHING CHOKES
200 mA., 3-5 H., 50 ohms,
Parmeko 8/9; 100 mA., 5 H., 100 ohms 3/11
150 mA., 10 H., 50 ohms 9/9; 80 mA., 20 H., 900 ohms 5/9;
120 mA., 12 H., 100 ohms 8/9; 50 mA., 50 H., 1000 ohms 6/9;
100 mA., 10 H., 100 ohms 6/9; 60 mA., 5-10 H., 250 ohms 2/11

EX. GOVT. CASES. Well ventilated, black crackle finished, undrilled cover. Size 14 × 10 × 8½in. high. IDEAL FOR BATTERY CHARGER OR INSTRUMENT CASE, COVER COULD BE USED FOR AMPLIFIER. Only 9/9, plus 2/9 post.

BATTERY CHARGING EQUIPMENT

Trade supplied. Discounts according to quantity.

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

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. 1½ a. 11/9
0-9-15 v. 2½ 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. 31/6
6 v. or 12 v. 2 amps. 42/9
(inclusive of ammeter)
6 v. or 12 v. 4 amps. 53/9
6 v. or 12 v. 4 amp. with variable charge rate selector and ammeter 59/9

CHARGER AMMETERS

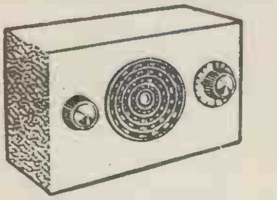
0-1.5 amp., 0-3 amp., 0-4 amp., 0-7 amp., 0-25 amp., 0-60 amp 8/3

ASSEMBLED CHARGER

6 v. or 12 v. 2 amps. Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads. Double Fused. Only 49/9 Carr. 3/9.
As above, but for 3 amp. charging. Only 59/6. Carr. 3/9

ASSEMBLED 6 v. or 12 v. 4 amps.

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. 69/9 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.



LOOK AT THIS AMAZING OFFER - *IDEAL AS XMAS GIFT*

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.

BUILD THIS YOURSELF

The Transette Medium Wave 2 transistor, pocket portable. Neatly designed, using 2 transistors and diode. Simple to assemble. Enlarged working diagram. All components colour coded. Ferrite wound aerial. Will play indoors and outside with self contained aerial. All components and diagram complete 62/6. Post & Pckg. 1/6.

Plug in ear piece 12/6
Single phone 4/6
Battery 2/-

All components available separately
Stamped addressed envelope for details

SPECIAL OFFER IN TRANSISTORS

Audio PNP transistors type TS1 ....5/- each
Sensitive diodes type GD3 ....2/6 each
Ediswan × B104 .... 9/6
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Single ear phones .... 4/6 ea. 1/- p. & p.
Crystal Ear pieces with lead and ear plugs. Low impedance. Our price 12/6. 1/- p. & p.
Transistor Condensers. Miniature Electrolytic Capacitors. 32 mfd. 3v., 25 mfd. 25v., 25v., 25 mfd. 6v., 16 mfd. 12v., 8 mfd. 6v., 5 mfd. 12v. 2.5 mfd. 25v., 1.6 mfd. 6v., 1 mfd. 12v. All these types of condensers are 2/6 each.

EVERYBODY IS CLAMOURING FOR THE 2 COSSOR KIT BARGAINS

The new **Cossor 6 valve FM receiver kit** comprising all components including 6 valves, Goodman's 10 × 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 × 6 speaker, 4in. tweeter, and all components including easy to follow instructions. Cossor's price £9/15/-. 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.

STOP PRESS FEW ONLY

BRAND NEW by famous manufacturer. 10 × 8 elliptical speaker. 3 ohm impedance. Only 17/6. P. & Pkg. 1/6.

ANOTHER SNIP OFFER

SLIGHTLY SOILED
AT THE LOW PRICE
29/6
and 4/- post and packing.

Surplus to manufacturer s requirements, well made 2-tone colour portable player cabinets, will take non-auto player. Amplifier and 4in. or 5in. speaker. The above portable cabinet, B.S.R. T.V.9 and Acos pick-up, 4-speed player and 2-watt amplifier and 6×4 elliptical speaker making an ideal portable player, at the special price of £8/5/- plus 7/6 Post and Pkg.

3 NEW RECEIVERS FOR CONSTRUCTORS

One valve SW radio, 24-40 metres. All components, 35/-. P. & P. 2/-.
Beginners' transistor pocket radio, miniature components, 30/- complete. P. & Pkg. 2/-.
Personal portable radio. All parts, complete, 35/-. P. & Pkg. 2/-.

Acos 73 stereo and monaural t/over cartridge. Our price 42/6 post paid.

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THE LAST OF THIS ASTOUNDING OFFER

The VERDIK QUALITY TEN

10 WATT PUSH-PULL ULTRA LINEAR FEEDBACK

Reduced from makers price of 20 gns. Now only

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complete. Fully guaranteed for valves and service. Post & Pkg. 7/6. Fully guaranteed

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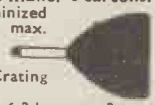
FOUR ASTOUNDING TV TUBE OFFERS
All brand new in famous maker's cartons.



(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/-. OUR PRICE £4/4/-. Crating and carr. 12/6.
(4) Ferranti 9in. Tube round white fluorescence, 4 v. heater, max. anode voltage 7 kV. OUR PRICE £2/10/-. Crating and carr. 11/6.

MAKE YOUR OWN PRINTED CIRCUITS
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/-.

B.S.R. UA8 4-speed mixer autochanger, manual and autochanger with latest Ful-Fi cartridge. £6/19/6. P & P. 5/-. Can be altered for stereo.

4-speed **Collaro** 4/546 single player with Studio t/over pick-up. **OUR PRICE** £6/6/-. P. & P. 3/6.

B.S.R. 4-speed motor and t/table with Acos crystal t/over cartridge featherweight p/up. 72/6 complete. Post & Pkg. 3/6.

SPECIAL OFFER
For the Hi-Fi enthusiast—Collaro 4-speed transcription motor and p/up using the new TX88 Studio cartridge. Brand new. List price £19/10/-. **OUR PRICE** £15/19/6. Carr. & Crating 12/6.

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As above, using stereo cartridge, £18/17/6, plus 5/- post and pkg.

NOW IN STOCK AND DEMONSTRATING
Rogers Stereo Control Unit, designed to match RD Junior Units. Price 11 Gns.
Jason JSA Stereo Amplifier, 4 w., £23/15/-.
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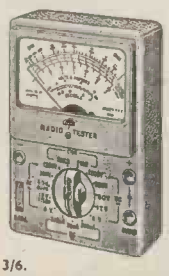
Leak Stereo 20 pre-amp., 29 gns.
Leak Point 1 Stereo pre-amp., 20 gns.
Elpico stereo compact amplifier., 15 gns.
Armstrong stereo 12 radiogram chassis, 6 w. each channel, FM, p/pull, L. and M. bands, tape record and playback for stereo and monaural. £37/16/-.

THE ALPHA MULTI-RANGE POCKET METER



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:
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BUILD YOURSELF A HI-FI TAPE RECORDER AT HALF THE NORMAL PRICE
LIMITED NUMBER AVAILABLE
BRAND NEW AND GUARANTEED

The famous **COLLARO Mk. 4** Transscriptor 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.

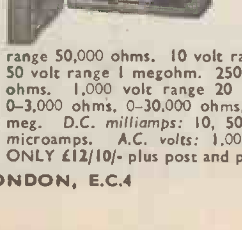
The above two items at a special price of £30. Carr. and pkg. 22/6 the two units.

The Linear Tape Deck Amplifier with power pack and oscillator incorporated. Switched for 3¾, 7½ and 15in. per sec. Suitable for the Mk. 4 Deck. **12 gns. only.** Post and pkg. 3/6.

HI-FIDELITY TAPE HEADS
Made by famous manufacturer. Brand new. Upper or lower track, record/play-back, high impedance giving up to 12,000 c.p.s. at 7½ I.P.S. output 5 m/volts at 1 KC at 7½ I.P.S. Erase heads low impedance.
Only 39/6 per pair. Post 1/-. *State upper or lower track.*

SNIPS IN TAPE ACCESSORIES
Brand new E.M.I. 7in. take-up spools in polythene bag, 3/9 each post free. 6 for 20/-. Brand new 5in. Scotch Boy take-up spools 3/3 post free. 6 for 18/-.
KLENZATAPE, the new method for cleaning record and erase heads, 12/6. P. & P. 1/-.
Special offers in tape by famous maker:
3in. L.P. tape 225ft., 7/- post free.
4in. Std. tape 300ft., 10/6 post free.
METROTABS for identifying recorded passages on tape, 3/11 plus postage.

A GIFT FOR THE SERVICE MAN



BRAND NEW IN WOODEN CASE
The Weston Mode 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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ELLIOT Single Pen Recording Milliameter 0–1	£35 0
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★MARRIOTT R/RP/3 medium impedance for transistor recorders, record playback. List £2/6/-. OUR PRICE. Each	£1 5
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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.
TS 175/U, 85-1,000 Mc/s.
Prices on written request.

PLEASE NOTE. We have many, many items of Equipment at **SALE** Figures for the personal shopper . . . Receivers, Test Equipment and Sound Equipment.

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NEW HALLICRAFTERS direct from U.S.A.
All types available, kindly write for details of types and prices.

NEW HALLICRAFTERS:	
SX100	£138 10
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750	£45 0
680	£60 0
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HQ 120X	£45 0
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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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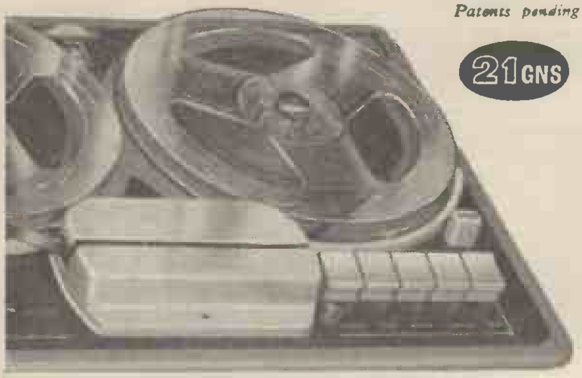
Look at the NEW

MOTEK K10 ☆☆☆☆☆ TAPE DECK

Patents pending

Incorporating many new features and a greater frequency response.

21 GNS



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.

★ Frequency response better than 40 c/s—12,000 c/s at 7·5" per sec. with extremely low hum pick-up.

Please send for brochure of K.10

More and more manufacturers are installing Motek Tape Decks in their recorders.

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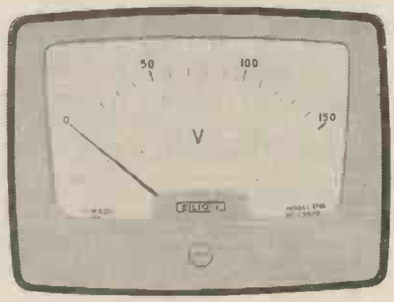

ELLIOTT now make four

spring differential coil D.C. meters?

As with every other item and component of Elliott instrumentation systems these instruments are designed and built with one aim: absolute functional efficiency.

Model No.	Barrel dia.	Case size	Scale length
2705	$2\frac{1}{2}$in.	$4\frac{1}{2}$in. × $3\frac{1}{4}$in.	3.40in.
3705	$3\frac{1}{2}$in.	$5\frac{3}{4}$in. × $4\frac{1}{8}$in.	4.20in.

	First Coil	Second Coil	
Minimum F.S.D.	50 mic/A 1 Volt D.C.	100 mic/A 1 Volt D.C.	Both coils 50 Volts D.C. Self-contained. Tag boards and resistance boxes extend ranges to 1000 Volts.
Maximum F.S.D.	65 m/A	65 m/A	

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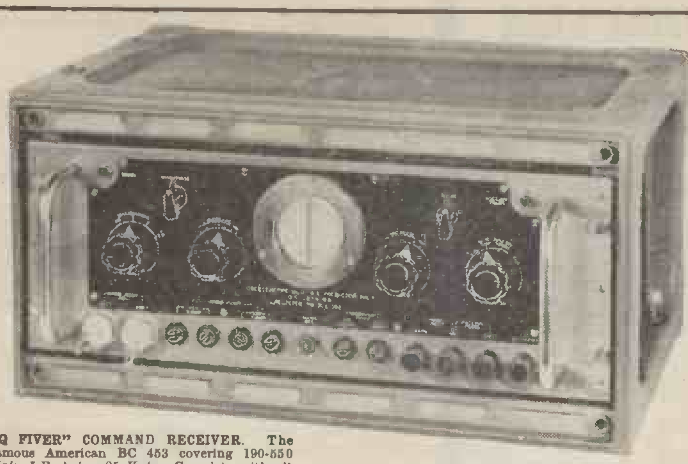

OSCILLOSCOPE No. 11

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 2¾in ACR10. Will make up into an ideal workshop or servicing oscilloscope. Has grey and black engraved front panel size 19in.×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.Fs being 85 Kc/s. Complete with all 6 valves and circuit. Size 11 × 5½ × 5ins. 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. × 7in. BRAND NEW. ONLY 59/6 (carriage, etc., 7/6).

MARCONI SIGNAL GENERATOR TF-517-F/1. 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 mills. Size 5½ × 3¼in. diameter. Ideal for running Radio or Electric Shaver, etc. from car battery. ONLY 32/6.

EHT TRANSFORMERS. 5.5 kV. (Rect.) with 2 v. 1 a., 79/6. 7 kV. (Rect.) with 2 v. 1 a., 89/6. 2.5 kV. (Rect.) with 2-0-2 v. 1.1 a., 2-0-2 v. 2 a. (for VCR 97 tube etc.), 47/6 (postage 2/- per trans.).

6 v. VIBRATOR PACKS. Output approx. 130 v. at 30 mA., fully filtered and smoothed. Complete. ONLY 12/6.

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.× 8½in.×5½in. Recently made for the Air Ministry, by Everett Edgcumbe, and in perfect order. Brand New and Unused. ONLY £7/10/0. 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 11×13×11 in. New Condition internally, but externally store soiled. ONLY £7/19/6 (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. "LF" Model, covers 75-140 kcs. and 1.2-30 mcs., ONLY £50. "D" Model, covers 500 kcs-31 mcs. ONLY £55 (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 IT4, 1 or 1R5 and 1 of CV286 (Neon Stabiliser), and Instruction Book. Size 7in.×7½in.×4in., weight 5lbs. Used but in first class condition. ONLY £2/19/6. Carr. 3/6.

TRIPLETT UNIVERSAL TEST METER. Made by the famous American meter manufacturers Size 7¾ × 6½ × 6¾in., and incorporates a unique tilting bakelite container size 5½ × 3¼in., which has two meters, a 25,000 ohms per Volt moving coil for D.C. measurements, and a first grade moving iron for A.C. Reads Resistance up to 40 Megohms, A.C. & D.C Volts to 1,000, D.C. Current to 250 mA., and also has 0-50 Microamps range. Facilities for measuring Condenser Capacity etc., and Audio Output. Completely portable, with protective face cover. Complete with leads batteries, and instructions. Fully re-conditioned. ONLY £12/10/- (post, etc. 5/-).

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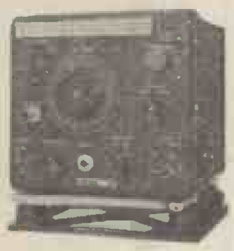
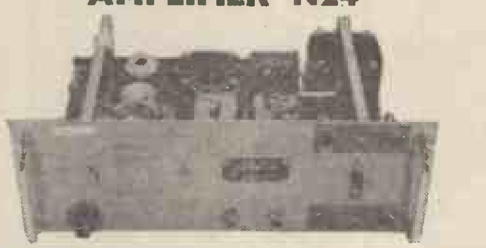
HETERODYNE FREQUENCY METERS
TYPE LM14



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×8in.×8½in. Weight 11½lb.
★ Brand New and Unused. Further details on application.

AMPLIFIER N24



Manufactured for the Admiralty in 1952 by Burndept, 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.×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 MAKER'S PACKING. ONLY £4/9/6 (carriage 10/6).

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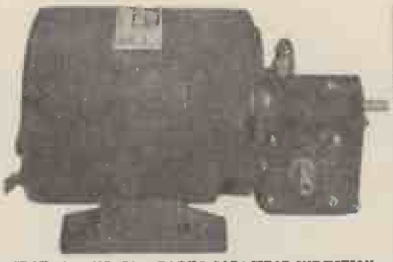

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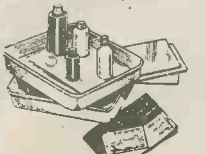

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Frequency range 20–27.9 Mc/s. Crystal controlled, operating on any two of 80 different channels in 100 Kc/s steps. Average range 5–10 miles. Contains 14 valves, filament plate, alignment meter, volume control, mike and 'phone inputs. 6 and 12 volt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

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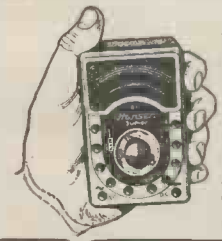

2,500 o.p.v. Multi range. 6/30/120/300/1200 v. A.C., ditto D.C. 0-1k., 0-1 megohm; 400 micro-A., 12 M.A., 300 M.A.; —00 to +64-DB, 5 ranges 3×4½×1¾in. Large clear dial. Leads supplied. (List price £6/19/6.) OUR PRICE £4/7/6. P. & P. 2/6.

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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 24×13×17ins. These sets are extensively tested prior to despatch.

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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.

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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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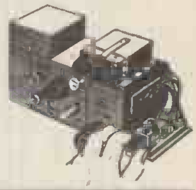
COMPLETE MORSE TRAINING UNIT

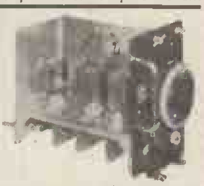


Complete Code Set, contains key, buzzer, headphones, pitch control, operating internal battery, housed in portable wooden case. Brand new, only 12/6. Carr. 5/-. Battery 1/6 extra.

HI-FI CO-AXIAL SPEAKERS

BRAND NEW—U.S.A. MADE. 12in. Co-axial Speaker. The woofer uses 6.8 oz. Alinco 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., 2½in. tweeter, 10 watts, etc., 90/-. P. & P. 4/- on each.

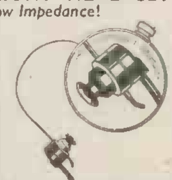
CONVERT TO V.H.F.



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.

AMERICAN LIGHTWEIGHT HEAD SET

They're High and Low Impedance!



These H.S.30 phones are the smallest used by the U.S. Air Force. 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.

Relda Radio Ltd

Callers: **87 TOTTENHAM COURT ROAD, LONDON, W.1**
Mail orders: **(DEPT. W,) 32a COPTIC ST., LONDON, W.C.1.** MUS. 9607
WOT! You don't own a Relda catalogue! It's terrific and fully illus. Only 1/3.

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 M/cs. (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-crackled steel cabinet to match the R-1155. Fitted with 8in. speaker. Just PLUG IN and switch on! Only the finest quality com-ponents 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

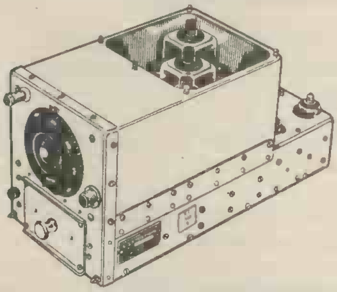
Covers from 540 Kc/s. to 44 Mc/s. in 5 bands. With separate bandspread tuning, variable selectivity crystal filter, B.F.O., "S" meter, noise limiter etc. For 117-230v. A.C. mains. In perfect working order and first class condition. £25. Carr. 10/-.

RCA AR-88 SPEAKERS

A high quality 3 ohm unit fitted into heavy gauge black crackled 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.

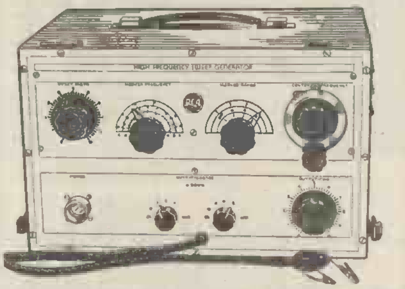
LOUD HAILER EQUIPMENT

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. £4/19/6. CARRIAGE 25/6.

CRYSTAL CALIBRATOR

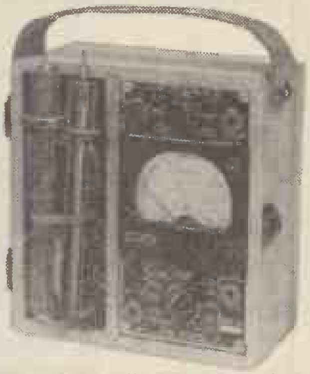
No. 10. Consists of 500 Kc/s. crystal oscillator and a variable 250-500 Kc/s. heterodyne oscillator. This enables all intermediate frequencies between 500 Kc/s. and 10 Mc/s. to be produced. These frequencies are indicated on the calibrated scale. The calibrator may actually be used up to 30 Mc/s. The unit uses a CV-286 neon modulator, IT4 crystal osc., IT4 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 7×7½×4in. 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 crackled steel case 17 × 10 × 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 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 6½×6×4½in., 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

DECADE RESISTANCE BOXES. Type 750L. Manufactured by Daven Co., U.S.A. Five decades 1Ω to 111, 110Ω. In oak cases with aluminium top and copper lining. BRAND NEW. £10/10/-. Post 3/6.

MINIATURE RELAYS (ALL BRAND NEW AND BOXED)

G.E.C. sealed, wire ends, 670 ohms.	2 H/D makes,	M1099	15/–
G.E.C. sealed, wire ends, 670 ohms.	4 C/overs, platinum,	M1092	19/6
G.E.C. sealed, wire ends, 5000 ohms	2 C/overs, platinum,	M1052	17/6
S.T.C. size 1½ × ⅝ × ⅞in. 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 × 9×11in. Despatched in transit case, in perfect condition, tested, complete with 7 valves, circuit and instructions. A laboratory instrument for ONLY £12/10/-. Carr. 10/-.

CHARLES BRITAIN (Radio) LTD.

11 UPPER SAINT MARTIN'S LANE

LONDON, W.C.2 *TEMple Bar 0545*

One Minute from Leicester Sq. Station. (Up Cranbourne St.)
Shop Hours: 9-6 p.m. (9-1 p.m. Thursday.) Open all day Saturday.

SPECIAL THIS MONTH

Battery Charger Rectifier—selenium 12-15 v., 5 amp, **9/6**.

Blank Metal Chassis—all 2½in. deep from 18 gauge aluminium. Sizes: 6in.×2in., **4/6**; 7½in.×5in., **6/-**; 13½in.×9in., 10in.×7½in., **7/-**; 11½in.×7½in., **8/-**.

Metal Chassis—punched for Mullard 510 Amplifier, complete with inner screening sections and stove enamelled, **12/6** set.

Geiger Counter Tubes—20th century type, Type No. G24, with circuit of geiger counter, **29/6**.

Waterproof Heater Wire—suitable electric carpets, electric blankets, hand muffs, foot pads, etc., **7d.** per yard.

Twin Twisted Lighting Flex—equivalent 14/36, rubber insulated, cotton covered, **17/6** per 100 yard coil.

Moving Coil Meters

0-500 microamp	2in. flush	17/6
250-0-250 microamp	2½in. surface	27/6
750 microamp	2½in. surface	17/6
5-0-5 microamp	2½in flush	17/6
0-30 milliamp	2½in flush	17/6
0-100 milliamp	2½in. flush	15/-
0-300 milliamp	2½in. flush	15/-
0-500 milliamp	2½in. flush	15/-
0-1 milliamp	2½in. 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**.

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

.8 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 nded, ideal mains tester, etc., **2/-**, ex Govt., **1/6**.

Philips 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, **8/6**.

Install those extra points, 3·029 twin flat T.R.S. cable. Big purchase enables us to sell this at **45/-** per 100 yds., carriage 3/6.

Low Resistance Head Phones. Ideal crystal sets, etc., **7/6**, plus 2/6.

Goodmans Multi Ratio Output Transformer. 6 watt, 8 ratios, from 12-1 to 72-1. Centre tapped for push/pull, **7/6**, plus 1/-. Ditto, unbranded, **6/6**, post 1/-.

Cold Cathode Valve CV413. Voltage regulator or trigger switch—unused but ex-equipment. **2/-** each.

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

Slydlok Panel Mounting Fuses with carrier, 5 amp, **2/-** each, 15 amp, **2/6** each. Belling Lee 2BA fully insulated terminals for mounting through metal panels, **2/-** each.

Terminal Heads, insulated 4BA, **2/-** doz.

.1 mFd. 350 v. Small tubular metal cased condensers made by Dubilier, **2/6** doz.

50 Assorted Resistors. Well mixed and useful values ¼ and ½ watt. **5/-** for 50. Ditto, but 1 watt, **6/6** for 50.

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 465 k/c. I.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 3¾in. per sec., gives playing time of 1½ hours from standard 5in. reels (twin tracks). Uses 7in. × 4in. 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 25½ gns.** H.P. terms and full technical details on request.

SIX USEFUL ARTICLES

Our 1960 catalogue now ready gives constructional hints and circuits for the following items:

- Moisture operated switch
- Simple but clever signal tracer
- Versatile power pack costing only 10/-
- Instantaneous heater for workshop or den
- Six transistor pocket superhet
- Simple bed warmer
- 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 whiteall use canister type plug in starters, and all are fitted with interference suppressors. Guaranteed for two years:

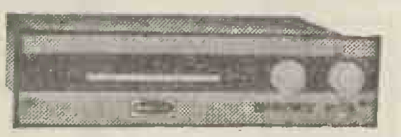
Inductor 80 for 5ft. 80-watt lamp	39/6+5/- carriage and ins.
Inductor 40 for 4ft. 40-watt lamp	32/6+4/6 ,, ,,
The Three-Forty: for 3ft. 40-watt lamp	31/6+3/6 ,, ,,
Inductor 20 for 2ft. 20-watt lamp	29/6+3/6 ,, ,,
Circle Light for 40-watt circular lamp	49/6+3/- ,, ,,

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

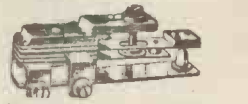


The Tuner which includes every feature and refinement for perfect reception' reliability and simplicity of operation. An exclusive feature Automatic frequency control makes this the finest tuner available. Uses 7 valves and metal rectifier has its own internal power supply and sockets for audio output and aerial input. Limiting on two stages provides constant output free from interference and is therefore ideal for tape recording. Engraved copper bronze facia and modern styling complete a perfect tuner. Size approx. 2¾in. × 3½in. × 9¼in. 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 6 Transistor Set as currently being sold at £17/17/-. Parcel comprises motifed two-tone cabinet as illustrated, tuning dial, two gang tuning condenser, combined bakelite chassis/printed circuit and easy-to-follow circuit. Costing value 57/6—offered while supplies last at only **29/6**, plus 2/6 post. Suitable for your own circuit or to build original circuit. All parts available at highly competitive prices. Do not miss this tremendous bargain.

Thermostats



1½ amp	3/6
2 amp Q.M.B.	5/6
5 amp	8/6
15 amp	15/-
15 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/-
6 Pole 3 Way	2/6
6 Pole 3 Way Ceramic	3/6
8 Pole 2 Way	2/-
9 Pole 3 Way	2/6
12 Pole 2 Way	2/-

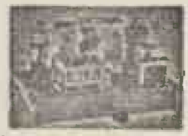
Crystal Mike by Acos

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. milliamps. 0-5, 0-100 0-500. Ohms 0-50,000. 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, 2in. moving coil meter, selected resistors, wire for shunts, range selector, switches, calibrated scale and full instructions, price **19/6**, plus 2/6 post and insurance.

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—I.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, Midland, North, Scotland, etc. All the parts including 2 EF80 valves, coils, fine tuner, contrast control, condensers and resistors. (Metal case available as an extra). Price only **19/6**, plus 2/6 post and insurance. Data free with parts or available separately, 1/6.

Please send two more kits, the one you sent last week is performing magnificently. We receive this sort of letter every day of the week, so if you have hesitated because you thought our kits too cheap you need hesitate no longer.

If ordering by post, address your order to the Company nearest to you. *Please include postage.*

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520 High Street North,
Manor Park, E.12.

Electronics (Ruislip) Ltd.,
42-46 Windmill Hill,
Ruislip, Middx.
Phone: RUISLIP 5780.
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Electronics (Croydon) Ltd.,
266 London Road,
Croydon.
Phone: CRO 6558.
Half day, Wednesday.

W.W.—L

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.

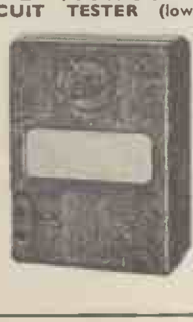
AVO MODEL 40

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.25 A.H. New and unused. Housed in strong wooden case for extra protection, 45/-. Carr. 7/6. 2 v. 100. A.H. 75 actual. Ex Govt. New and unused. Complete with carrying handle. Size 6½ x 6½ x 3½in., 15/- each. Carr. 3/6. 3 sent for 50/-, or 6 for £5, carr. paid. Ditto 16 A.H., 5/-. P. & P. 2/-; 6 for 24/-. P. & P. 10/-. Ditto 14 A.H., less handle, 5/-. P. & P. 2/-; 6 for 24/-. P. & P. 10/-.

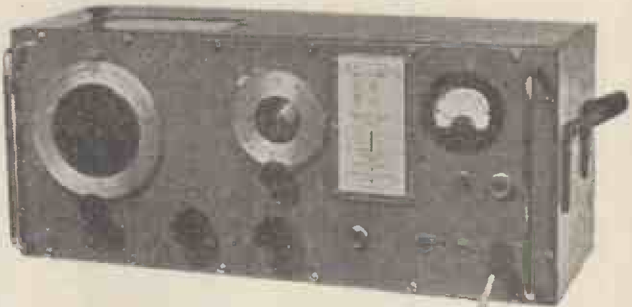
EVERSHED & VIGNOLES MEGGER CIRCUIT TESTER (low reading ohm meter). 2 ranges. 0-3, 0-30 ohms. The perfect meter for continuity and polarity testing. Complete with test leads and ready to use. Brand new. Only £4/17/6. P. & P. 3/-.



GEE Bros RADIO Ltd.

15, LITTLE NEWPORT STREET, LONDON, W.C.2. *GER 6794/1453*
ADJOINING LEICESTER SQUARE TUBE STATION — Open 9-6 Weekdays 9-1 Sat.

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/-.

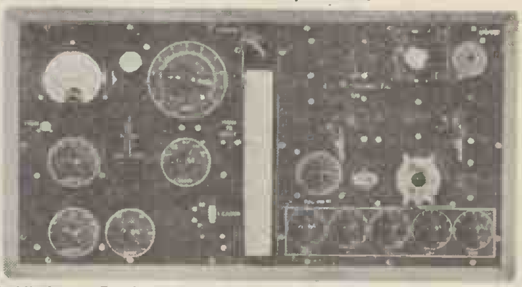


ALSO MARCONI SIGNAL GENERATOR TYPE TF390G for 200-250 v. A.C. mains input. Freq. range 4-16 Mc/s. and 32-100 Mc/s. indirect calibration. Output 1 uv to 100M/V. 400 c/s internal modulation. In good order Only £12/10/-. Carr. 20/-.

BRIDGE MEGGERS

Evershed and Vignoles Series 2 in perfect condition. 250v. £22 carr. paid. Leather case available at 20/- extra.

VALVE TESTER, TYPE 4



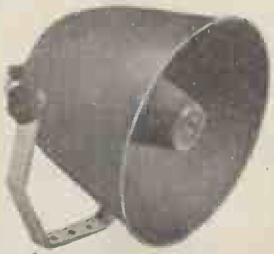
200/230 v. A.C. input. Ex Govt., in good condition, with descriptive book containing circuit diagram of instrument and how to test valves from 1.4 v. to 40 v. With valve holders for Brit., 4, 5, 7 pin and Octal, U.S., 5 and 7 pin, 1/Octal, side contact large Brit., 4 and 9 pin. Acorn and diode. Housed in substantial wooden case with hinged lid. £7/19/6. Carr. 10/-.

RECORDING TAPE
S.A.E. for money saving price list

D.C./A.C. ROTARY CONVERTERS

ROTARY CONVERTER. 24 v. D.C. to 230 v. A.C. 50 cycles, 150 watts. Brand new and unused £8/10/-. Carr. 7/6. Ditto, 100 watts, £6/9/6. Carr. 7/6
ROTARY CONVERTER (as illus.). Ex-Govt. 12 v. D.C. input 230 v. A.C. Output 50 cycles at 135 watts. Complete in carrying case with lid. Voltage control, sliding resistance, mains switch and 0-300 v. A.C. flush meter. In good condition, £10. Carr. 10/-.
Motor only, without case, etc. Brand new and unused £8/10/-. Carr. 5/-.

PRECISION SERIES 834-S. (U.S.A.). Multi range tester for A.C./D.C. volts, ohms and milliamps. Basic movement 400 microamps. Housed in wooden box with carrying strap. Overall size 7½ x 7in. x 5in. Complete with test prods, batteries, etc. Ready to use, £4/19/6. Post 2/6.



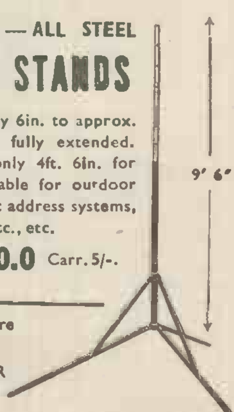
RE-ENTRANT LOUD HAILERS (Ex-Govt.)
Heavy duty 20 watts all-metal. 15 ohms. Diameter 15in., length 15in. (approx.). Good condition. £6/10/-. Carr. 10/-. Ditto. Brand new £8 Carr. 10/-.

BAKER'S SELHURST SPEAKERS
12in. P.M. 15 ohms 15 watts, 30–14,000 c.p.s. Our price £4/10/-.
"AUDITORIUM" 12in. 15 ohms. 12 watts, 35–16,000 c.p.s. Flux density 14,500. OUR PRICE £7/10/-.
"SUPER HI-FI 25" 12in., 15 ohms, 25 watts 25–20,000 c.p.s. Flux density 17,600. OUR PRICE £9/9/-. All the above speakers are Brand new and full descriptive specification is available.

HEAVY DUTY — ALL STEEL
TRIPOD STANDS

Adjustable every 6in. to approx. 9ft. 6in. when fully extended. (Folds up to only 4ft. 6in. for storage). Suitable for outdoor speakers, public address systems, floodlighting, etc., etc.

OUR PRICE **£3.10.0** Carr. 5/-.



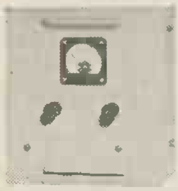
These stands are ideal for our RE-ENTRANT LOUD HAILER as described on left.

SELENIUM RECTIFIERS

40 ma. to 10 amp., 6 v. to 100 v. Bridge, H. Wave or P.P.

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. bdge., 48/-, 130 v. 80 ma, bdge., 21/-. Postage 9d. extra each.

CHARGER KITS



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/-.

Economy 12 v. 3 amp. kit, no ammeter needed, 34/6, pp. 2/6, all with 12 months' guarantee.

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Telephone LAB 4457

5,000v. INSULATION TESTERS

5,000v Insulation Testers

Output voltage 0–5,000 v. A.C. or D.C., continuously variable from zero.
Output current 5 milliamp max. for D.C. 10 milliamp max. for A.C. Voltageindicatormeter for both A.C. and D.C. Voltage reading drops to zero and Magic Eye closes.
Voltage indication by Magic Eye.
Power supply 200–250 A.C.
Dimensions 18 x 18 x 13in. Weight 30lb.
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
Our price brand new in fitted transit case **£24**
LIMITED QUANTITY ONLY

Tape Recorder or **Gram Unit cases** size 16in. x 18¼in. x 14½in. Walnut 35/- each, carriage 5/-.
G.45 16 mm. Cine Cameras with magazine, ex Govt., f/3.5 lens, £4 each, polished.
Rectifier Units. 240 v. A.C. in, 100/120 v. D.C. out. at 2.5 amps. £12/10/-. Carriage 20/-
Transformers. 210/250 v. in 275 v./0/275 v. 50 mA 6.3 v. at 3a CT 17/6. 0–200–220–240 v. 50 cycles in, out 250–0–250 v. 250 m. 0.4–6.3 v. at 4 amps, 0.4–6.3 v. at 4 amps, 0.4–6.3 v. at 3 amps, 0.4–6.3 v. at 3.5 amps, 37/6.
Pots. 1K, 2.5K, 10K, 40K, 2HEG 4/- each. Post 9d.
Tygan fret 2/- sq. ft.
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200 250 v. in 30 v. out 100 watts 17/6, post 2/-.
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Voltage Regulators 230 v. 150 w. by Selec 15/-
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a complete range of moving coil—moving iron—electrostatic—thermocouple—also multirange meters—meggers—pyrometers and laboratory test instruments, etc

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Phone No.: GERrard 3977/8 Grams: "Radiotrade"
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TRANSISTOR CONDENSERS. Miniature Electrolytic Capacitors. 32 mfd. 3 v. 25 mfd. 25 v. 25 mid. 6 v., 16 mfd. 12 v. 8 mfd. 6 v., 5 mfd. 12 v., 2.5 mfd. 25 v., 1.6 mfd. 6 v. 1 mfd. 12 v. All these types of condensers are 2/6 each. SPECIAL DISCOUNTS FOR QUANTITIES.

THREE ASTOUNDING TV TUBE OFFERS
All brand new in famous makers' cartons.
(1) 17in. rectangular aluminised 6.3 HTRS .3A current; max. anode voltage 16 kV. Usual price £17.5.0. **OUR PRICE £9.19.6.** Crating and carr. 15/-.
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ALL ORDERS FOR LESS THAN £2 ADD POSTAGE
We invite your enquiries for items not listed.
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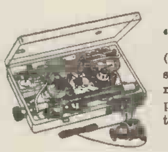
Large stocks of all types of resistors, condensers, valveholders always available ex stock. Manufacturers' enquiries welcome.

RECO KITS

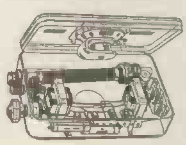


"RECO" MIDDY ONE TRANSISTOR KIT
(M/L or M/S Waves.) Size 4⅞in. x 3½in. x ⅞in. Variable sensitivity control Vari Q ferrite rod aerial. "Sonotone" min. dynamic earpiece with insert. Months of listening pleasure from pencell battery. Complete kit with Ediswan transistor and easy build diagrams 37/6. P.P. 2/-.

"RECO" PUSH-PULL FIVE KIT
M/L. Waves & Trawler Band. (size: 6⅞in x 4⅝in x 1⅞in)
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 £6/7/6. P.P. 2/6. Easy build practical wiring diagrams free with kit.

"RECO" TRANSIGEN THREE KIT
(M/L. Waves and Trawler Band.)
Entirely self contained (no external aerial required), R.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 good reception areas. Complete kit with easy build diagrams, battery and B.A. Hand Speaker-Phone, 75/-. P.P. 2/6.

"RECO" TRANSIGEN TWO KIT
(M/L waves)
Oscillating detector stage for sensitivity. Fine for good reception areas. Has combined volume/sensitivity control. Complete kit with 3-volt pencell, Personal Phone, easy build diagrams and EDISWAN TRANSISTORS, 59/6. P.P. 2/6.



"RECO" PUSH-PULL FOUR KIT
(M/L or M/S Waves) with Two S.W. Coils FREE
Four EDISWAN transistors. Volume control. 3in. speaker (now mounted at end of case and not as shown). Gleaming pale blue polystyrene case with red speaker grille. Complete kit with easy build diagrams and battery, £5/3/6. P.P. 2/6.
Parts price list and circuits for the above kits 2/6 set of four.

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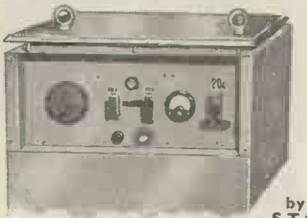

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Essential equipment for Electronic Engineering, research laboratories, schools. Ideal for battery charging, etc. Guaranteed for 20 amps.

Output: D.C. Variable up to 20 amps. and 24V or trickle charge 125/350/700 ampere hours.
Input: A.C. 100/260 volts 45/65 cycles.
Size: 16 x 24 x 32in. high.
Available in Grey Cabinet.

ex-Warehouse **£22-10-0**

(Circ. diags. and instru. loaned for 10/- deposit)

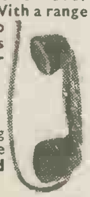
G.E.C. L.T. SUPPLY UNIT

OUTPUT: 24 volts, 10 amps. D.C.
INPUT: 200/250.
New and in original cases.

£13.10.0 Carr. 9/6.

WORLD FAMOUS
TELEPHONES "F" Type

IN ATTRACTIVE CASE



The best portable telephone ever made. With a range of up to 5milesis ideal for FACTORIES, BUILDING SITES, FARMS, CIVIL ENGINEERING PROJECTS, OUTSIDE BROADCAST UNITS AND OFFICES.

2 perfect sets in individual carrying cases, complete with long life batteries, bells, magneto and 100ft. telephone cable.

£7.10.0 per pair. Carr. 9/6.

TELE "F" HIGH POWER as above, but complete with amplifier, £6/10/- each. Carr. 12/6

DON Mk. V TELEPHONES. Few remaining, complete with 100ft. telephone cable £5/11/- per pr. Carr. (G.B.) 9/6.

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ROTARY CONVERTORS. 12 v. D.C. input. 230 volt A.C. 150 watts, 50 cycles output. Housed in wooden case and fitted with voltage control slider resistance, switch, plugs and A.C. mains voltage output check meter. Supplied in perfect condition, individually tested, £9/19/6 each. P. & P. 10/-.

VARIAC TRANSFORMERS

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OUTPUT (2KVA) Completely Variable 0 to 270 volts. 9 amps.
INPUT 230 Volts, 50/60~
A SHROUDED FULLY VARIABLE TRANSFORMER FOR BENCH OR PANEL MOUNTING
SIZE:—Approximately 8½ Cube.
WEIGHT:—Approximately 30 lb.
PRICE:–RIDICULOUS, ONLY £15.0.0
Plus 12/6 carr., supplied and boxed new

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Stabilized output voltage in the range 200-250 v. Plug-board tappings. The selected output voltage is constant with ±½% at all loads 0 to 30/37½ amps. when the supply voltage is varying over the range +8% to −12%.

- Frequency compensated 45-55 and 54-66 c/s.
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3 KVA Air Cooled (100% underrated).
GUARANTEED 6 KVA
230/250 tapped, 12 amps.
105/120 tapped, 28.5 amps.

Made by well-known manufacturer and housed in strong metal case. Weight: 2 cwt.

Brand new, in original maker's cases.

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MINISTRY RELEASE
(MK. 4 BR. METAL BODY UNIVERSAL CONTACT A.M. Ref. 5C/4098)
Compare this remarkable almost half-price offer.

78/- per Doz. (min. quantity) **£25 per 100**

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For detonating explosive charges.

A must for **mining, demolition, road building and construction operations.** May also be adapted as photo-flash generator giving 1,800 volts D.C. across o/p. terminals.

In Hide leather case

(Usual price 17gns.)
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COMPLETE WITH POWER MICROPHONE

For public address from cars, boats, etc., similar to Police Type ex-H.M. Forces. Simply connect to a 6/12-volt car battery and use. **Amazingly powerful.** Why pay £2 a day hire charge for amplifiers. Buy this complete unit.

only **£7.14.6**
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PUBLIC ADDRESS SYSTEM

Complete with amplifier unit, 4 speakers, microphones, headphones and all spares packed in wooden cases. 6 or 12 volt D.C., handling capacity 8 watts. Ideal for cars, boats, factories, etc.

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AERIAL MASTS

IMPROVED TYPE 50 MK II
36ft. HIGH

Kits comprise—6 2¼ in. dia. Tubular Steel Sections of 6ft. length, top-section and base, Pickets, Guys and Fittings. YOU can purchase this normally expensive MAST for a fraction of its cost. Please add £1 for (returnable) wooden carrying case. The MAST is particularly suitable to take aerials for Tx., Rx., F.M. and T.V. (especially COMMERCIAL) and has many other uses. Extra 6ft. sections can be supplied at 17/6 per section

£8.10.0 only Carr. 15/6

U.S.A. Type 45ft. TELECOM. AERIAL MAST. (7 sections, 6ft. 8in. x 2¼in., guys, etc.) This entirely complete set in carrying case 12½ Gns. Carr. 17/6. Or 2 sets for £25. Carr. extra. *British Manufacture only.*

ARMY TYPE 32ft. MASTS similar to above but 10 1in. screw-sections, suitable for permanent lightweight installation. Kit in canvas bag, £5/10/-. Carriage 12/6.

U.S.A. R-9B/APN-4 Radio Receivers.

First class for conversion, originally designed for R.D.F. Valve line-up: 1-6SN7GT, 4-6SK7GT, 1-6SA7GT, 1-VR105-30, 1-5U4G, 1-6H6-GT, 1-6SL7GT, 3-6B4G, 2-879/2-2, 1-6SJ7GT. Chassis size 20 x 9 x 11in. Weight 26lb. Brand new.

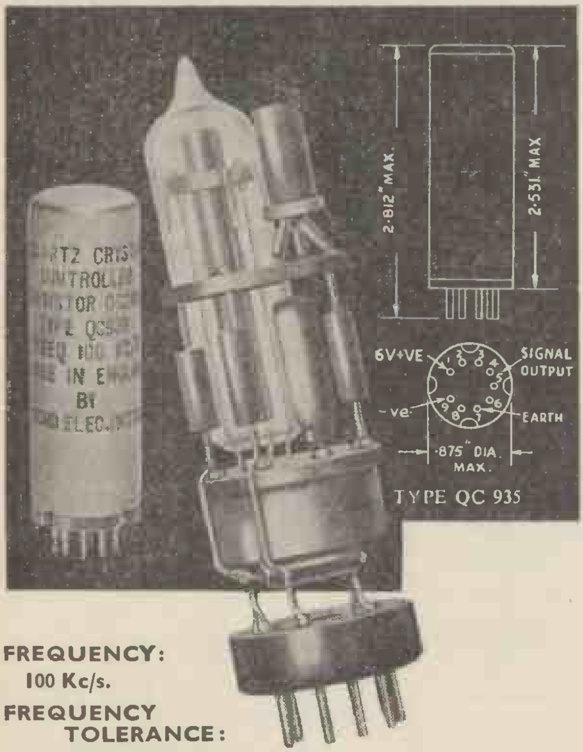
85/- P. & P. 12/6

Components value (transformers, condensers, switchgear, etc.) far exceeds this remarkable low price. Buy now. Only 150 sets available.

THE IRONGATE (M.O.) CO., Dept. (WWI)
2/4 IRONGATE WHARF ROAD, PRAED STREET, LONDON, W.2.

PAD. 2231/2/3

Quartz Crystal Controlled TRANSISTOR OSCILLATOR 100Kc/s



FREQUENCY:
100 Kc/s.

FREQUENCY TOLERANCE:
± ·015% over temperature range — 10°C. 60°C.

FREQUENCY STABILITY: Less than 5 parts in 2 million change with a 10% change in supply voltage.

OUTPUT: 3 Volts on open circuit conditions. 1½ Volts across a 20,000 ohm load.

POWER SUPPLY: 6 Volts D.C. Power consumption 5 milliwatts.

WEIGHT: 30 grams.

ALSO AVAILABLE IN FREQUENCIES 1 and 5 Mc/s.

The design of quartz crystal controlled oscillators is of a specialist nature, and there are many problems associated with their use. In order to obtain the best performance and consistent operation, it is often desirable that not only the circuit configuration but also the physical layout should be related to the design of the crystal unit used.

As established manufacturers of such units, we have developed a packaged crystal controlled transistor oscillator. Available in two forms, they will provide an accurate 100 Kc/s. suitable, for example, as a time base master frequency.

By the provision of a suitable power supply, these units may be used as portable frequency sub-standards.

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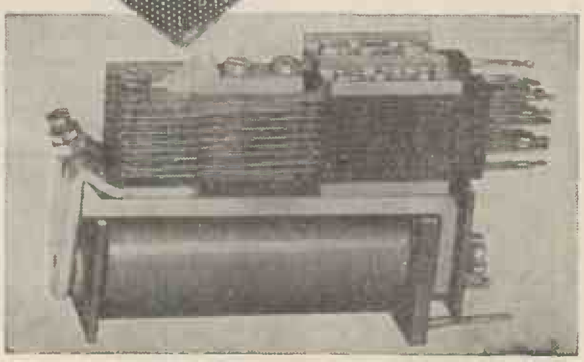

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AL60 ...... 6/–
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AR8 .... 5/–
ARDD5 ... 2/–
ARP3 ...... 3/–
ARP4 ...... 3/6
ARP12 ...... 2/9
ARP21 ...... 5/6
ARP24 ...... 3/6
ARP34 ...... 4/6
ATP4 ...... 2/9
ATP7 ...... 5/6
AU1 ...... 5/–
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B30 .... 3/6
BL63 .... 6/–
D41 .... 3/3
D42 .... 4/–
D77 .... 4/3
DA30 ...... 12/6
DD41 ...... 4/6
DD620 ...... 4/6
DET5 ......20/–
DET18 ......30/–
DET19 ...... 2/6
DET20 ...... 2/6
DH76 ...... 4/9
DLS10 ...... 4/6
E1148 ...... 2/–
EA50 .... 1/6
EAC91 ...... 4/6
EB34 .... 2/–
EBC33 ...... 6/–
EC52 .... 3/9
EC54 .... 3/6
ECC32 ...... 4/–
ECC81 ...... 6/6
ECC82 ...... 6/9
ECC83 ...... 7/–
ECC84 ...... 7/9
ECC91 ...... 4/–
ECL80 ...... 9/6
EF22 .... 7/3
EF32 .... 5/–
EF36 .... 3/6
EF39 .... 4/6
EF50 .... 2/6
EF52 .... 5/–
EF54 .... 3/6
EF55 .... 6/–
EF70 .... 4/–
EF80 .... 6/9
EF85 ....6/10
EF89 .... 8/9
EF91 ....4/10
EF92 .... 5/–
EL32 .... 3/9
EL84 .... 8/3
EL91 .... 7/6
EY91 .... 3/6
EZ40 .... 7/–
EZ80 .... 7/6
FA15 .... 4/–
FW4/500 ... 8/–
H30 .... 5/–
H63 .... 3/6
HP4101 ...... 6/–
KBC32 ...... 5/–
KF35 .... 5/–
KT31 .... 8/–
KT33C 7/–
KT66 .... 7/6
KT241 ...... 9/–
KTW63 ...... 6/6
L30............ 4/–
MH4 .... 4/–
MH40 ...... 6/6
MH41 ...... 6/6
MHL4 ...... 2/6
ML4 .... 4/–
ML6 .... 6/–
MS/PEN ... 6/–
MS/PENB ... 6/–
MS/PEN/T ... 6/–
N34 .... 8/–
NR15A 3/–
NR61 ...... 7/–
NT37 (4033A)... 14/–
OD3 .... 6/–
OZ4 .... 5/–
OZ4A 5/–
P61 .... 2/6
PCC84 ...... 8/–
PCC85 ...... 8/–
PEN25 ...... 4/6
PEN46 ...... 5/6
PEN65 ...... 6/6
PEN141 ...... 4/–
PEN220A ... 3/–
PEN1340 ... 6/–
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PL82 .... 8/–
PL83 .... 9/–
PM4DX 3/–
PT25H 7/6
PY82 .... 8/–
QP21 .... 6/–
QP25 .... 5/3
QS75/20 ... 6/9
QS95/10 ... 6/9
QS108/45 ... 6/9
QS150/15 ... 6/9
R10 ....12/6
RG1-240A... 17/6
RG3-250 ... 17/6
RG4-1250 ... 9/–
RK34 ...... 2/6
RL37 .... 3/6
SP4B 7/6
SP13C 4/6
SP41 .... 2/6
SP61 .... 2/6
SU2150A ... 4/9
T41 ....19/–
TT11 .... 3/–
U18 .... 6/–
U19 .... 7/–
U27 .... 8/–
UU4 .... 4/6
V2D33B ... 8/–
VP23 .... 5/–
VR78 ...... 4/–
VR99 .... 8/–
VR105/30 ... 7/6
VR150/30 ... 7/3
VS110 ...... 4/–
VT25 .... 8/6
VU111 ...... 3/–
VU120 ...... 3/3
VU133A ... 3/–
W31 .... 7/–
W42 .... 7/–
Y66 .... 8/–
Z31 .... 6/–
1A3 .... 3/6
1A5GT 5/–
1B23 .... 11/–
1B24 ....11/–
1B26 ....11/–
1B32 ....10/–
1D8GT 6/–
1L4 .... 3/9
1LD5 .... 3/6
1R5 .... 6/9
1S5 .... 6/–
1T4 .... 4/–
2A3 .... 8/–
2A6 .... 7/–
2C34 .... 2/6
2D4A 4/–
2X2 .... 4/–
3A4 .... 6/–
3B24 .... 3/–
3E29 (829B) ... 60/–
3Q5GT 9/–
4A1 .... 4/6
4D1 .... 2/6
5U4G 5/–
5V4 .... 7/–
5Y3GT 6/9
5Z3 .... 8/6
5Z4G 8/–
6A6 .... 5/–
6AB7 .... 5/–
6AC7 ...... 4/3
6AG5 ...... 4/6
6AG7 ......10/–
6AK6 ...... 7/6
6AK7 ......10/–
6AM5 ...... 5/–
6AM6 ...... 6/3
6B4G 4/6
6B8 .... 5/6
6B8G 2/6
6C4 .... 4/–
6C5 .... 6/–
6C6 .... 4/6
6C8G 5/–
6F5G 5/6
6F6 .... 7/–
6F8G 6/6
6F12 .... 4/6
6G6G 3/–
6H6M 2/–
6H6GT 1/9
6J5 .... 3/6
6J6 .... 4/3
6K6GT 6/6
6K7G 2/3
6K7GT 5/3
6K8G 6/6
6L5G 6/–
6L6 ....10/–
6L6G 6/6
6L34 .... 4/6
6N7GT 7/–
6Q7G 6/3
6SA7 .... 6/–
6SC7G 5/6
6SC7GT ... 6/–
6SG7 .... 5/–
6SH7 .... 5/–
6SJ7 .... 6/9
6SJ7G 6/6
6SK7 .... 5/6
6SL7GT...... 6/9
6SN7GT ... 4/6
6SQ7 .... 6/6
6SR7 .... 6/6
6SS7 .... 6/6
6V6G 5/6
6V6GT 6/–
6X5GT 6/6
8D2 .... 2/6
9D2 .... 3/–
11E5 .... 5/–
12A6 .... 5/–
12AH7 ...... 7/–
12AT7 ...... 6/6
12AU7 ...... 6/9
12AX7 ...... 7/–
12C8 .... 7/6
12E1 ....22/6
12H6 .... 2/6
12JSGT 3/6
12SC7 ...... 4/6
12SG7 ...... 6/6
12SH7 ...... 4/9
12SJ7 ...... 6/–
12SK7 ...... 5/–
12SL7 ...... 7/–
12SR7 ...... 6/–
15D2 .... 6/–
15E 8/–
15R 7/6
19E2 .... 5/–
28D7 .... 8/–
35T 30/–
35Z4GT ... 7/–
39/44 .... 6/–
41FP 1/9
524G 8/–
53A 3/–
58 .... 6/–
59 .... 6/–
71A 4/6
77 .... 6/–
80 .... 6/3
82 .... 8/–
83 .... 9/6
83V 12/–
84 ....12/6
89 .... 6/–
210LF 3/–
210VPT 3/–
217C 17/6
220VSG ... 3/–
350B 8/–
393A 25/–
446A 14/–
446B 14/–
705A 17/6
715B 97/6
717A 8/6
801 .... 6/–
803 .... 22/6
805 ....30/–
807 AMER... 5/3
807BR 3/9
813 .... 70/–
815 .... 80/–
816............30/–
829A......... 30/–
833A £14
843 .... 7/6
866A 10/–
872A 35/–
930 .... 8/–
954 .... 2/–
956 .... 2/9
1619 .... 6/–
1625 .... 6/–
1626 .... 4/6
1629 .... 4/6
4242A 6/–
7193 .... 1/9
7475 .... 5/–
8010AR ...22/6
8020 .... 6/–
9001 .... 5/–
9003 .... 5/6
9004 .... 4/–
9006 .... 4/–

Cathode Ray Tubes:

3BP1 ....25/–
5CP1 ....42/6
5FP7 ....45/–
PG7/5 ......15/–
VCR517 ...10/–
VCRX258 (with scanning coil) 45/–

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2J31 .... 45/–
3A/1481......45/–
3J/170/E ... £35
3J/192/E £37/10
723AB 52/6
726A 27/6
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VX7110 ...15/–
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All U.K. orders below 10/-. P. & P. 1/-; over 10/-, 1/6; orders over £2 P. & P. free. C.O.D. 2/- extra. Overseas postage extra at cost.

BRAND NEW ORIGINAL SPARE PARTS FOR AR88 RECEIVERS.

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

Please write your other requirements.

Complete set of strong aerial rods (American). Screw-in type MP49, 50, 51, 52, 53; total length 15ft. 10in., top diameter 0.615in., bottom diameter 0.185in. together with matched aerial base. MP37 with ceramic insulator, ideal for car or roof insulation, £2/10/-, post free.

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

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

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

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

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

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

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Modulation Transformers (U.S.A. Collins), primary imp. 6,000 ohms. C.T., secondary 6,000 ohms, 20 W., 9/6 each, post free.

Microphone Transformers. Balance input 30 or 250 ohms. U.S.A. manufacture. 7/6. P. & P. 1/6.

P. C. RADIO LTD.

170, GOLDHAWK RD., W.12 SHEpherds Bush 4946

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

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813 Ceramic Valveholders 3/- each. P. & P. 1/6.

Mains Power Supply Unit for No. 19 wireless set. Made by RCA of Canada. 115 v. A.C. Brand new, £15. P. & P. £1.

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VIBRATOR UNIT. 12 v./180 v. 60 mAmps. Exceedingly well filtered and smoothed, excellent for car radios. New. Including one OZ4 valve and vibrator. 12/6. P. & P. 5/-.

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Speech Amplifiers BC614 E or H ... £17.10.0

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Junction Boxes JB70 ... ... £10.0.0

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No. 1 Mark III. Ref. ZA. 15208.
Input: 12 volts.
Output Dual: 250 volts at 125 mA. 490 volts at 65 mA.
Non Tropicalised.
No. 2 Ref. ZA. 10572.
Input: 12 volts or switched to 24 volts.
Output Dual: 265 volts at 120 mA. 500 volts at 26 mA.
Also 12 volt vibro Pack Rectified OZ4 Valve.
Mallory Type G634C Vibrator.
All these units are smoothed.
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Input: 12 volts.
Output Dual: 275 volts at 110 mA. 500 volts at 50 mA.
All these units are smoothed and fused on both H.T. supplies.
All at **57/6.** Plus 7/6 carriage.

DEPENDABLE 4-5 WATT TRANSISTOR AMPLIFIER

Can be supplied for 6 or 12 volt operation

Standard Model input supplied for low impedance microphone or high impedance pickup.
Transistor Line-up. Power Transistor output V3030P. OC 72. OC 75.
Current consumption. Standing current 220 M/A. consumption. On full volume 350–400 M/A. consumption.
Controls. Volume control and tone control with on/off switch.
Output socket. Tapped at 3 ohms., 7½ ohms., 15 ohms.
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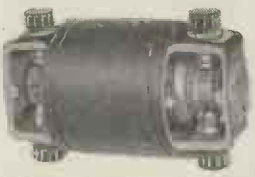

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Delivery ex stock. Quotations on application.

H.T. 31
Input 11.5 v.
Output 250 v. at 125 mA.

H.T. 32
Input 11.5 v.
Output 490 v. at 65 mA.

AS SUPPLIED TO GOVERNMENT DEPARTMENTS AND LEADING MANUFACTURERS. NEW AND BOXED.

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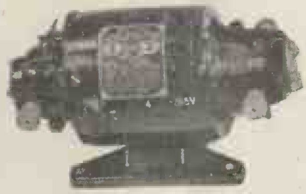
Made by DELCO

TYPE 1 27/6. P. & P. 3/6.
TYPE 2, 37/6. P. & P. 3/6.
Type 1. Dual voltage 12 or 24 v., input 265 v., 120 mA. output; 500 v., 26 mA. output.
Type 2. 12 v. input 275 v., 110 mA. output; 500 v., 50 mA. output.
Both types dual output.



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D.C. input 27 v. Output 285 v. at 75 mA., 37/6. D.C. input 12 v. Output 250 v. at 50 mA. 47/6. Postage and Packing on each, 3/6.

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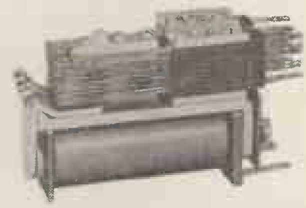
Brand new single phase motors suitable or tape recorders, radiograms, workshops, etc., etc. Has many uses. Reversible 200–230 v. 5in. oz. torque. 1,400 r.p.m. Capacitor start. Weight 4½lb. Length overall 5in., spindle both ends. ¾in. × ½in., ⅜in. × ½in. Price, incl. P.P. and capacitor, 55/-.

HEADPHONES. D.L.R.2 and D.L.R.5. **Brand New.** Low resistance. Balanced armatures. 6/6 pair, P. & P. 1/6. Single earpieces 3/6.



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BUILT UP TO YOUR REQUIREMENTS

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Yokes, 3/- each.
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Adjustable, 1/3 each.
Spindles, 1/- each
Top Plates, 3d. each.
Bottom Plates, 3d. each.
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1. C/O	1/3	4/-
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6. C/O	6/6	24/-
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Up to 100 Ohms	3/-	5/-
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„ „ 40,000 „	16/-	20/-
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*Slugged coils extra.

Type 600 also available

SIEMEN'S HIGH SPEED C/O RELAYS

250+250 ohm Twin Coils 6/6 — 1,000+1,000 Ohm Twin Coils 10/6
850+850 „ „ „ 8/6 — 1,700+1,700 „ „ „ 17/6

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No.	Ohms.	Build Ups	Voltage	Price
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Z.530005	2	2C	1.3	12 6
Z.530006	40	2C	6	15 0
Z.530008	670	2C	24	19 6
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
Z.530016	180	1C	12	19 6
Z.530018	2,500	1C	48	£1 2 6
Z.530019	2	2C 2K	1.3	14 6
Z.530020	2	4C	1.3	16 6
Z.530022	2	M.B.	1.3	12 6
Z.530023	2	2B 2M	1.3	12 6
Z.530024	40	2M	6	12 6
Z.530025	40	M.B.	6	12 6
Z.530027	180	2M	12	17 6
Z.530028	180	M.B.	12	17 6
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4184GD	700	2C	24	19 6

1/6 Post & Packing on all relays.

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Supplied in two types
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CLASS MODIFICATION
Primary 10,400 ohms.
Seconday 4,300 ohms.
NEW, BOXED, £3/10/- carriage extra.

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No. 2 ZB 0300. Input 6 v. Output 230 v. 100 mA. BRAND NEW. Completely encased 25/- each, plus 3/6 carr.

LOUDHAILER SPEAKER UNIT. Impedance 7½ Ω. 6–8 watts output. Weight 10lb. Size: depth 7½in., diam. 10in. Easy fixing. Weatherproof spun solid steel. Hammered finish. PRICE 57/6. Carriage & Packing 7/6. IDEAL FOR SPORTS EVENTS, ELECTIONEERING AND SOCIAL FUNCTIONS.

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A GRADUATE, OR EQUIVALENT, IN ELECTRICAL ENGINEERING, ELECTRONICS, MECHANICAL ENGINEERING, PHYSICS?

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you have a place in

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. . . *sending full information of your qualifications, age, experience and interests.*

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With servicing experience and good theoretical knowledge, required for interesting and varied work, mainly experimental.

Good security and outstanding prospects in expanding organisation.

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Duties cover inspection and testing of electronic equipment including radio and radar, accessories and components, and involve the use of meters, signal generators, oscilloscopes, bridges, etc. Applicants should be familiar with electrical and electronic specifications and be able to read circuit diagrams

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Prospects of advancement.

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UNITED KINGDOM ATOMIC ENERGY AUTHORITY

INSTRUMENT MECHANICS

The Dounreay Experimental Reactor Establishment requires experienced men with knowledge of electronic equipment and/or industrial instrumentation for fault diagnosis and repair and calibration of a wide range of instruments used in nuclear reactors, radiation laboratories and chemical plant. This interesting work involves the maintenance of instruments using pulse techniques, wide band low noise amplifiers, pulse amplitude analysers, counting circuits, television, and industrial instruments used for measurement of pressure, temperature and flow.

Men with Services, Industrial or Commercial background of radar, radio, television, industrial or aircraft instruments are invited to write for further information. Training in our Instrument School will be given to successful applicants.

Married men living beyond daily travelling distances will be eligible for housing. A lodging allowance is payable whilst waiting for housing. Working conditions and promotion prospects are good.

Applications to:

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Senior qualified Electronics Engineers of Degree or Higher National Certificate standard are required for interesting work in connection with a number of projects in the field of Electronics, including the application of transistors to television and similar equipment. Applicants must have suitable academic qualifications and experience in laboratory procedure. They will normally be expected to be able to handle a project from its inception to its final conclusion. Box No. 1952, c/o "Wireless World."

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MAINTENANCE ENGINEERS
CALIBRATION ENGINEERS
DRAUGHTSMEN

with experience of electronic production test equipment.

These are staff appointments and there are excellent opportunities for advancement. Generous salary according to qualifications and experience. The successful candidates will be invited to join the Company's Superannuation and Life Assurance Scheme.

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Men aged 19 or over for interesting work providing and maintaining aeronautical telecommunications and electronic navigational aids at aerodromes and radio stations in the U.K. Fundamental knowledge of radio or radar with some practical experience essential; training provided on special types of equipment. Salary according to age and station, approx. £670 at age 25 rising to £795. Prospects of permanent pensionable posts. Good opportunities for those who obtain O.N.C. in Electr. Eng. and certain C and G. Certificates for promotion to posts with maximum salaries of £875, £1,035 and £1,260. Apply to the Ministry of Transport and Civil Aviation (ESB1/RT), Berkeley Square House, London, W.1 or to any Employment Exchange (quoting Order No. Westminster 3552).

MARCONI INSTRUMENTS, ST. ALBANS

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Please write giving full details of experience and qualifications to Dept. C.P.S., Marconi House, 336/7 Strand W.C.2, quoting reference WW 2970H.

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Duties: Testing and calibrating of a wide range of telecommunication and industrial electronic instruments.

Qualifications: We shall be pleased to receive applications from any men with, or, without academic qualifications, who are able to demonstrate suitable experience and training.

HOLIDAY ARRANGEMENTS CAN BE MAINTAINED

Apply any day, including Saturday mornings.

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Opportunities for men of ability and initiative

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Saturday Morning Interviews will be arranged if desired

E.M.I. ELECTRONICS LTD.

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PRODUCTION GROUP

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Windscale and Calder Works, and Chapelcross Works require experienced men with knowledge of electronic equipment and/or industrial instrumentation for fault diagnosis, repair and calibration of a wide range of instruments used in nuclear reactors, radiation laboratories and chemical plant. This interesting work involves the maintenance of instruments using pulse techniques, wide band low noise amplifiers, pulse amplitude analysers, counting circuits, television, and industrial instruments used for the measurement of pressure, temperature and flow.

Men with Services, Industrial or Commercial background of radar, radio, television, industrial or aircraft instruments are invited to write for further information. Training in our Instrument School will be given to successful applicants.

Married men living beyond daily travelling distance will be eligible for housing. A lodging allowance is payable whilst waiting for housing. Working conditions and promotion prospects are good.

Applications to:

Works Labour Manager, Windscale and Calder Works, Sellafield, Seascale, Cumberland.

or

Labour Manager, Chapelcross Works, Annan, Dumfriesshire, Scotland.

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with degree or equivalent, to take an important position with small Company on South Coast. The post would quickly lead to a directorship for a man with a keen and versatile mind. Design of Transistorised Radio circuitry, particularly marine, would be a specialisation. A good salary will be offered to the right Engineer. Write stating full details career and salary expected.

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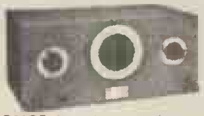
HEWLETT PACKARD MODEL 200A RESISTANCE TUNED AUDIO OSCILLATORS



Frequency Range 35 to 35,000 c/s. Power output 1 watt into 500 ohms. Distortion—less than .5%. Power Supplies—115v. A.C.
PRICE brand new and guaranteed £28 0 0
Packing and carriage 15 0

TYPE 106 SIGNAL GENERATOR

Frequency Range: 5.5 to 52mc/s. Output 1 microvolt to 100 mV. Output Impedance: 70 and 100 ohms. Internal modulation. Provision for External Modulation. Power supplies: 230 v. 50 c/s, or 80 v. 1,000 c/s.
PRICE, unused, complete with calibration charts, ... £12 10 0
Without calibration charts £8 10 0
Packing and carriage 15 0

WWV STANDARD FREQUENCY CALIBRATOR

(Browning Laboratories) Model RH-10. A special Radio Receiver for the reception of Standard Frequency Signals at 5 and 10 mc/s. Built-in selective audio filters for making use of modulation frequencies at 440 and 600 c/s. Sensitivity: 0.5 microvolts; Selectivity—10db at 5kc off; Image Rejection Ratio 50db. Audio Output Voltage 5 volts. max. Power Supplies 115 v. A.C.
PRICE, unused and guaranteed........... £38 0 0
Packing and carriage 1 0 0

WHEATSTONE BRIDGES

Sullivan Portable Wheatstone Bridge
Four Decades 0.1–1.0–10–100 ohms steps. Ratio Arms Settings .001–.01–.10–1.0–10–100–1000. Built-in Galvanomoter approx. 30 microamps FSD. Provision for use with an external Galvanometer. Battery and Galvanometer Key.

PRICE, fully overhauled and guaranteed £38 0 0

TS-27/TSM WHEATSTONE BRIDGE (AC CAPACITANCE BRIDGE) Slidewire Wheatstone Bridge with range up to 50 megohms. Accuracy 2%. Capacitance Range 0.075 to 3 microfarads. Accuracy 5%. Power Supplies: Dry Batteries. The Instrument provides also full facilities for testing telephone lines, viz. conductor and insulation resistance, location of ground shorts, measurements of capacitance and location of opens in lines.
PRICE, fully guaranteed £35 0 0
Packing and carriage 15 0

INSULATION TESTERS

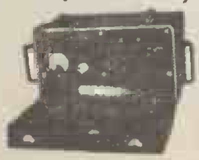
EVERSHED BRIDGE MEGGERS SERIES 2, 500 volts 100 megohms, with built-in four-decade box and ratio arms of .01–.10–1.0–10–100; Selector Switch for Bridge, megohms and Varley tests. Unused and fully guaranteed............. £55 0 0

EVERSHED SERIES 2 MEGGER INSULATION TESTERS, 1,000 v., 200 megohms, in leather case, unused and fully guaranteed £45 0 0
DITTO, 500 volts, 100 megohms, in leather case, second hand, fully overhauled and guaranteed. £17 10 0

EVERSHED SERIES 1 MEGGER INSULATION TESTERS, 500 volts, 40 megohms, second hand, fully overhauled and guaranteed... £25 0 0
Packing and carriage 15 0

B.T.H. "X" BAND PERFORMANCE TESTING RESONATOR (ECHO BOX)

Directly calibrated frequency dial, graduated from 9170 to 9470mc/s; Graduated Attenuator; Microammeter Resonance Indicator; complete with R.F. Cable and Waveguide Adaptor.
PRICE £32 0 0
P. and Carr. 15 0



SPECIAL TEST EQUIPMENT

TS-3 Wave-Wattmeter 2,700-3,400 m/cs.
TS-12 S.W.R. Indicator, 9,305-9,445 mc/s.
TS-13 Portable Signal Generator/Wavemeter 9,305-9,445 mc/s.
TS-14 Signal Generator, 3,200-3,370 mc/s.
TS-34 Portable High Speed Oscilloscope.
TS-35 Portable Signal Generator 8,700-9,500 mc/s.
TS-36 Power Meter, 8,700-9,500 mc/s.
TS-45 Signal-Generator, and Wave/Wattmeter, 8,700-9,525 mc/s.
TS-47 General Purpose Oscillator 40-3,000 mc/s.
TS-56 Slotted Line, 358 mc/s-690 mc/s.
TS-61 Echo. Box 3,140-3,360 mc/s.
TS-118 R.F. Output Power Meter, 20-750 mc/s.
TS-226 Peak Power Meter 405-425 mc/s.
Type 57 STANDING WAVE INDICATOR 9,100-9,700 mc/s.
Details and prices of all the above equipment will be supplied on request.

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AN/APR-4 Search Receivers. These can now be supplied with Tuning Units TN-19, extending frequency range to 2,000 mc/s.
AN/APR-4 Search Receiver 1,000-6,000 mc/s.
R-1294, 500-3,000 mc/s.
R1619, 1,250-5,000 mc/s.
Panoramic Adaptors type RDO for use with 30 mc/s I.F. Receivers.
Prices and details on application

SPECIAL VALVES

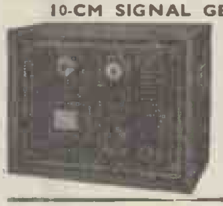
Thyratrons C3R14, 10/-.
Klystrons: 417A, 40/-; 723A/B, 70/-.
Magnetrons: 2J36, 120/-; 5J30, 40/-; QK59, QK60, QK61, QK62, 40/-.

CATHODE RAY TUBES:

	V_{a1}	V_{a2}	V_{a3}		
3ACP2	4,000	2,000	550	ES	... 15/–
3BP1	2,000	—	575	ES	... 12/6
5CP1	4,000	2,000	575	ES	... 40/–
5FP7	7,000	—	—	EM	... 50/–
5SP7	4,000	2,000	450	ES	...•140/–
7BP7A	7,000	250	—	EM	... 70/–

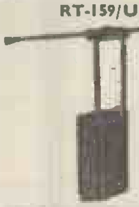
Packing and carriage 2/6 in £.
•Double Gun

10-CM SIGNAL GENERATOR TYPE BC-1277



Range: 2,700-3,400 mc/s. Power Measuring Range: 6W RMS, 6kW peak. CW output: –15 to –120db down on 6 milliwatts.
PRICE, in new condition £120 0 0
P. & carr. 2 0 0

RT-159/URC-4 RADIO SETS

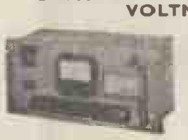


Crystal controlled pocket transmitter-receivers Two spot frequencies, one in 120-130 mc/s and one in 240-260 mc/s band. PRICE, complete with Mercury Battery, in perfect condition each £35 0 0
Packing and carriage 15 0

PLUGS, SOCKETS, CONNECTORS, etc.

We have in stock a large variety of American Connectors (Cannon, Amphenol, Bendix, Hubbel) and British Connectors in 5X and 10H Series. Please write for latest stock list.

CATHODE FOLLOWER VALVE VOLTMETER



Voltage Range: 100 microvolts to 200 volts in six steps. Frequency Range 300 c/s to 200 kc/s. Noise level: 50 microvolts max. Accuracy: better than 3%. Input Impedance 100 megohms/15pF. The Instrument can also be used as an A.C. Amplifier with a maximum output of 10 volts. Power supplies: 200-250 v. A.C. Mains.
PRICE £35 0 0
Packing and carriage 1 0 0

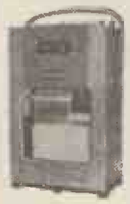
FOR EXPORT ONLY

WIRELESS SETS No. 38 WALKIE TALKIES. (Infantry and AFV), complete with Kits. Please write for details.

TWIN PEN SWITCHBOARD PATTERN RECORDING MILLIAMMETER

(made by Evershed & Vignoles)
Sensitivity: 5 mA. D.C. Damping: Oil Dashpot. Chart width: 6in. Chart drive: Electric motor, 230 v. A.C. Chart Speed: ½in. per minute. Interior light.
PRICE, unused, complete with two gravity type pens, two syphon pens with trough, two bottles of ink, two bottles of dashpot oil and two charts fully guaranteed ... £65 0 0
Packing & carr. £1.
This model can also be supplied for 1mA Range at an extra cost of £7 10 0

EVERSHED 12-PEN TIME RECORDER



Portable 12-channel instrument for simultaneous recording of 11 events with time marks provided by 12th pen. The recording is presented in the form of "on-off" pulses. Chart Speed 2 in. per sec.
PRICE, unused, in original packing, complete with accessories and a supply of charts £30 0 0

ELLIOT PORTABLE SINGLE PEN RECORDERS, 150 mV, 3½in. chart; Chart speed 1in. and 6in. per minute. Clockwork drive £32 0 0

EVERSHED SWITCHBOARD PATTERN SINGLE PEN RECORDERS, 2.5–0–2.5 mA D.C. 6in. Chart. Electric Chart Drive 230 v. at 3in. per minute.......................... £50 0 0

V.H.F. RECEIVER UNITS BC-624 (part of SCR-522 Transmitter-Receiver).

4 Crystal controlled channel, 100-156 Mc/s., (3.0-1 93 metres). Valves: 9003 R.F. stage; 9003 Mixer; Three I.F. stages 12SG7: Det/AVC/Audio 12C8; Second Audio 12J5GT; Oscillator 12AH7GT, Harmonic Generator 9002; Harmonic Amplifier 9003; Audio Squelch—other section of 12AH7GT. High and Low Impedance output.
PRICE, complete with valves, with description and circuit diagram, but without squelch relay.................................. p.p. 5/- 25/–
PRICE, chassis only, less valves...p.p. 3/6 7/6

ALSO LIMITED QUANTITY ONLY:
TRANSMITTER UNITS BC-625 (part of SCR-522 Radio Set). Valves: Speech Amplifier 6SS7; Push Pull Modulator (two 12A6); Oscillator 6G6G; 1st Harmonic Ampl. 12A6· 2nd Harmonic Amp. 832; Power Ampl. 832. Output 8 watts.
PRICE, complete with valves, description and circuit diagram .... p.p. 5/- 22/6
PRICE, chassis only, less valves... p.p. 3/6 7/6
Descriptions and circuits available at 8d. each.

COMMUNICATION RECEIVERS

All brought up to the original specification and fully guaranteed.
CREDIT TERMS IF REQUIRED
AR-88LF, 75-140 kc/s and 1.2-30 mc/s £80 0 0
AR-88D. 540 kc/s to 32 mc/s. £85 0 0
Also Marconi CR100 and CR150, Hallicrafter S-27, etc.

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Rate 7/- for 2 lines or less and 3/6 for every additional one or part thereof average lines 6 words. Box Numbers 2 words plus 1/-. (Address replies: Box 0000 c/o "Wireless World" Dorset House Stamford St. London S.E.1.) Trade discount details available on application. Press Day January 1960 issue Friday, November 27th, 1959. No responsibility accepted for errors.

WARNING

Readers are warned that Government surplus components and valves which may be offered for sale through our displayed or classified columns carry no manufacturers' guarantee. Many of these items will have been designed for special purposes making them unsuitable for civilian use, or many have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such items purchased.

NEW RECEIVERS AND AMPLIFIERS

AM/FM stereo chassis, 6w output with 2 speakers, only £20.—Bel Sound Products, Marlborough Yard, N.19. [0182

RECEIVERS AND AMPLIFIERS—SURPLUS AND SECONDHAND

HRO Rx's, etc., AR88, CR100, BRT400 G209, S640, etc., etc., in stock.—R. T. & I. Service, Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [0053

ZENITH "Transoceanic" all transistor short wave portable, 9 transistors, 8 bands, 540-1600KC, 2-22.4MC, 500 milliwatts output, 3 antennas, tone control, phono, earphone, log-book, world wide, tropicalised. Operates on 9 torch batteries; mint condition. Leather case.—Mr. Kossak, 5, Watling St., St. Albans, Herts. Tel. 53813. [8739

TRANSMITTING EQUIPMENT—SURPLUS AND SECONDHAND

TEN Signals Vans fitted complete with R 10 units, 2 Wireless senders, 2 Reception sets, 2 Power supply, 1 Unit Pulser, 1 Monitor, Auto Transformer 1.6 KVA 50 cycles 130/250 volts. Offers for whole or part.—Broadbent Bros, (Nottm.) Ltd.. Daleside Road, Nottingham. Telephone 53927. [8703

TEST EQUIPMENT—SURPLUS AND SECONDHAND

AVO Testmeter, H.R., 50-m.a., as new; unused; £16 o.n.o.—Box 5461. [8758

SIGNAL generators, oscilloscopes, output meters, valve voltmeters, frequency meters, multi-range meters, etc., etc., in stock.—R. T. & I. Service, Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [0056

BANKRUPT Stock for disposal. 20 xtal mics., over 2,000 yds. wire and cable, 1,000 assorted resistances, 22 multirange test meters, 50 vol. controls, hundreds of other items, £50 the lot. Will separate. S.a.e. list.—W. C. Symons, 28 Jewel Road, Walthamstow, E.17.

AMERICAN Test Oscilloscopes type TS-34/AP. These instruments are a self-contained portable unit with built-in 110 volt power pack and were made for checking all types of radio and other electronic equipment. They are ideal for all service engineers for TV, radio or similar purposes.
VALVES used 4-6AK5, 2-6AG7, 2-6SL7GT 1-6SN7GT, 1-5Y3, 1-6×5 and a two inch tube 2AP1, all controls are fitted along the sides of instrument and a carrying handle is fitted. All are complete but due to storage are not sold as being in working order. All spare parts available. Our price £8/10 each or 2 for £15, plus 10/- part carriage and packing.
DO not be put off by the price, they are a rare bargain and are worth many times this figure. WALTONS Wireless Stores, 46-47, 48-49 Stafford St., Wolverhampton. [0105

TEST EQUIPMENT WANTED

REQUIRED secondhand Marconi Circuit Magnification Meter. Type TF329G. Interested in up to total quantity of three off. Advise in writing—Brayhead (Ascot) Limited. Kennel Ride, Ascot, Berks. [8725

NEW COMPONENTS

NUMBER 187 Nylon Transformer Bobbins 5/6 per doz. Sample on request.—Film Industries Ltd., 90, Belsize Lane. N.W.3. [8744

AMAZING value: Philco Shortwave Car Radio convertors, originally £10; to fit any existing car radio and add six extra wavebands, 16-19-25-31-49 metre bands, also standard broadcast, 6/12 volts, compact under dash mounting, chromium control panel with six press buttons, complete all fittings and instructions, easily fitted; 45/- post free; each instrument brand new with Mullard valves.—Tomlins, 127, Brockley Rise, Forest Hill, S.E.23.

COMPONENTS—SURPLUS AND SECONDHAND

VALVES, new and used, from 1/6 each; all guaranteed, all types components cheap, radio, television books; lists free.—Hamilton Radio, 237 Sedlescombe Rd., N., Hastings. [0212

COMPONENTS—SURPLUS AND SECONDHAND

WEYMOUTH and Wearite coils, all at half list prices, cannot be repeated. Valves used but guaranteed at 5/- each.—Jackson Electrical, Terminus Place, Eastbourne. [8761

AMERICAN Condensers: New "Sangamo" 2/600v. 2/- and 1/- postage; others 4k.v. Electronic and Lamp lists 4d.—Automaster, Glenmore Rd., Birkenhead. [8764

MAGSLIPS at low prices, fully guaranteed, 3 in Receiver No. 5 (AP 10861), 50v, 50c/s, unused, each in tin, 35/-, post 2/1; large stocks of these and other types.—P. B. Crawshay, 94, Pixmore Way, Letchworth, Herts. Tel. 1851. [0087

WE have large stocks of modern Wire-wound Resistors, from 1 to 20 watts in over 100 different values ranging from 10 ohms to 3.3 megohms. All well known makes such as Painton, Zenith, Welwyn, and at less than half manufacturers' prices. Enquiries are invited from manufacturers and overseas' buyers.—Altham Radio Co. Ltd., Jersey House, Jersey St., Manchester 4. Tel. Cen. 7834/5/6. [8723

NEW GRAMOPHONE AND SOUND EQUIPMENT

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TAPE decks: Wearite Brenell, Truvox Bradmatic, Dulci-Harting, Amplifiers and tuners, Leak, Quad, R.C.A., Dynatron and Dulci Microphones: Reslo, Lustraphone, Philips, Acos, Grampian, etc. All tapes and accessories. Audio service department and recording studio. HIRE purchase facilities available.
LAMBDA Record Company Ltd., 95 Liverpool Rd., Liverpool, 23. Great Crosby 4012.

OUR Nov. recommendation, a Unimixer 3-way mixing unit, to go with tape recorder you buy from us.—Sound News, 10, Clifford St., W.1. [0131

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CINE-VOX disc recording mechanisms for L.P. or standard operation from 30gns.-56gns.; also complete tape-disc or direct channels from 50gns.-112gns.
DEMONSTRATIONS can be arranged in London.—For full details write to K.T.S. Ltd., "Coplow," Park Rd., Braunton, N. Devon. Callers by appointment only. [0210

"EROICA" RECORDING STUDIOS (Est. 1949).—For the better class tape recorders for industry. research, music and private use, Ferrograph, Brenell, etc. Complete recording service; Music for Industry; Tape/disc.—31, Peel St., Eccles, Manchester, Eccles 1624. Studio Director, Thurlow Smith, A.R.M.C.M. [0122

GRAMOPHONE AND SOUND EQUIPMENT—SURPLUS AND SECOND-HAND

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ALSO from us! Post free, insured, Belgian 1,800ft. new L.P. tape, 32/-; 850ft. 19/6; CMI-std., 1,200ft. on strong Ferrospools, boxed, 25/-; Ferrograph 3AN and AH dem. models occas. also available.—Sound News, 10 Clifford St., W.1 [0194

SAVE 30%; the Tape King makes possible the impossible once more Agfa-Wolfen tape 1,800ft. L.P. on 7in. spools; would be 50/-, only 35/-; limited quantity; also tape bargains in sizes from 3in. to 8¼in.; many secondhand recorders; all new makes: s.a.e. for list.
ONCE again a few only of the famous E.M.I. Professional Tape Deck at a fractional cost, 7½in. per sec. 7in. spool. Same price as before only 22 gns. or terms.—E. C. G. Kingsley & Co., 132, Tottenham Court Rd., London, W.1. EUS. 6500. [0320

DISC and Tape Recording Equipment comprising Ferrograph Tape Recorder, M.S.S. Disc (78 r.p.m.) B.S.R. Turntable and Pickup all enclosed in a beautiful walnut veneer console cabinet. Complete with Ribbon and Crystal Mikes. Floor and Desk Stands. Stock of Tapes and Blank Discs. Wearite De-fluxer. £200.—15, Market Street, Keighley, Yorks. [8749

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RENDEZVOUS RECORDS offer comprehensive 78/LP tape to disc recording facilities.—Leaflet from 19 Blackfriars St., Manchester, 3. [8168

TAPE to disc recording: Microgroove LP from 27/6. 78 r.p.m. from 11/-, also 45 r.p.m.; 48-hour service; s.a.e. for comprehensive leaflet to.—A. D. Marsh, "Derov" Sound Service, Little Place, Moss Delph Lane, Aughton, Ormskirk, Lancs. Aughton Green 3102. [8651

TAPE RECORDINGS, ETC.

TAPE/DISC/TAPE transfer, editing, copying; if quality and durability matter (especially with LP's from your own tapes); consult Britain's oldest full-time transfer service; delivery 2-4 days; at long last we can insure your tape recorder, TV set, gramophone to cover replacement of all components (including valves, tubes); unlimited service calls, free annual check in every part of Britain; state certified date of purchase for quotation.—Sound News, 10, Clifford St., London, W.1. Reg. 2745 [0192

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RECLAIMED valves, Mullard tested and perfect. Huge stock, every type, price 5/- plus 6d. postage each; delivery by return.—Lewis, 57, Chalford Walk, Woodford Green, Essex. [8734

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ALL types of valves British or American, transmitting and receiving; keenest cash prices paid. What have you to offer?—Write or call Lowe Bros., 9a, Diana Place, Euston Rd., N.W.1. Tel. Euston 1636-7. [8494

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A PROMPT cash offer for your surplus brand new valves, speakers, components, test instruments, etc.—R.H.S., 155, Swan Arcade, Bradford, 1. [0190

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URGENTLY wanted, manuals or instruction books, data, etc., on American or British Army, Navy or Air Force radio and electrical equipment.—Harris, 93, Wardour St., W.1. Gerrard 2504. [8550

WANTED, BC610 Hallicrafters, ET4336 transmitters, BC312 receivers, BC221 frequency meters and spare parts for all above; best cash prices.—P.C.A. Radio, Beavor Lane, Hammersmith, W.6. [0079

REQUIRED secondhand Douglas Wave Winders. Interested in up to total quantity of three off. Advise in writing—Brayhead (Ascot) Limited, Kennel Ride, Ascot, Berks. [8726

WANTED, good quality communication RYS tape recorders, test equipment, domestic radios, record players, amplifiers, valves, components, etc., estab. 18 years.—Call, send or 'phone Ger. 4638, Miller's Radio, 38a, Newport Court, Leicester Square, W.C.2. [8563

PROMPT cash for the purchase of surplus stocks of televisions, tape recorders, radios, amplifiers and domestic electrical appliances of every description, substantial funds available.—Spears, 14, Watling St., Shudehill, Manchester. Deansgate 7705 (3 lines). Bankers: Midland Bank, Ltd. [0216

REPAIRS AND SERVICE

MAINS transformers rewound, new transformers to any specification.
MOTOR rewinds and complete overhauls; first-class workmanship; fully guaranteed.
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LOUDSPEAKERS, electric clocks and shavers repaired promptly.—Model Loudspeaker Service, Sonic House, Shipton-on-Cherwell, Oxford.

SPEAKER repairs, cones fitted, fields and clock coils wound, guaranteed satisfaction, prompt service.—L.S. Repair Service, Pluckley, Ashford, Kent. [0223

WE undertake the manufacture of transformers singly or in quantities to any specification; all work guaranteed for 12 months.
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TRANSFORMERS.—Suppliers to B.B.C., I.T.A., and leading radio manufacturers, single or long runs, prompt delivery, home and export, rewinds to all makes.
FORREST (TRANSFORMERS), Ltd., Shirley, Solihull, Warwicks. Tel. Shi. 2483. [0128

RENEW to stock your faulty speakers of all sizes, pressure units, microphones, coils, fields and cone assemblies in cartons.—D. C. Boulton, 134 Thornton Rd., Bradford, 1. Telephone 22838. [0171

TRANSFORMERS to any specification. Singles, rewinds, small or large batches; quick and efficient service, competitive prices, estimates by return of post from:
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MISCELLANEOUS

METALWORK, all types cabinets, chassis, racks, etc., to your own specification, capacity available for small milling and capstan work up to 1in bar.
PHILPOTT'S METAL WORKS, Ltd., Chapman St., Loughborough. [0208

THRILLING PERFORMANCE

Certain conductors can extract from an orchestra the most thrilling and exciting performances, making others seem lifeless and uninteresting. The same can be said for a Massicore output transformer. With a good amplifier and other equipment it can bring to life such performances that will thrill in a way you may not have experienced before.

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NURSTEED ROAD
DEVIZES, WILTSHIRE

Telephone: Devizes 932

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PANL, recognised for many years as the unique one-coat black crackle finish, brush applied, no baking; available by post in 1/8 pint cans at 3/9 from: G. A. Miller, 255, Nether St., London, N.3. [0260

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FAR EAST market research and/or representation is offered by Clyde International Ltd.—Box No. 20, Newton, Singapore. [8714

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ELECTRONIC assembly, wiring, tag boards, prototypes, etc.—Park Television Service Ltd., 96 Horsenden Lane North, Greenford. Wem 8313. [8684

ELECTRONIC assembly, coil winding and machining, A.I.D. approved.—Bel Sound Products, Marlborough Yard, London, N.19. Tel. Arc. 5078. [0185

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REQUIRED for 1st January, 1960, Lecturer in Electrical Engineering (heavy current). Candidates should have industrial and teaching experience and should be Graduates or possess equivalent professional qualifications. Salary in accordance with Burnham Technical Scales. London Allowance payable. Further particulars and application form on receipt of stamped addressed envelope from the Principal, to be returned as soon as possible. [8740

TELEVISION Designer for Rhodesia.

LARGE Radio Manufacturer in Bulawayo requires the services of Engineers with a minimum of 5 years' experience in the design of television receivers. Transmissions are due to commence in 1960 using C.C.I.R. system.
FULY equipped laboratory will be available for experimental work. Salary £1,700 per annum. Fully paid passages for self and family.
WRITE giving details of experience and qualifications to: Mr. J. Cosham, Durrant House, Chiswell Street, London, E.C.1. [8760

UGANDA ELECTRICITY BOARD.

COMMUNICATIONS Technician.
APPLICATIONS are invited for the post of Communications Technician.
DUTIES will include the installation and maintenance of automatic telephone equipment, telemetering, supervisory remote control systems, carrier and carrier protection equipment, teleprinters, V.H.F. radio telephone and miscellaneous electronic equipment.
CANDIDATES should have sound technical and theoretical training, with experience in the installation and maintenance of automatic telephone systems, and preferably some experience of V.H.F. radio communications and/or line transmission equipment. Possession of City & Guilds certificate in telephony, transmission or radio communication subjects will be an advantage.
SALARY scale £1045×£30—£1315. Entry point according to age and experience.
Uganda has a pleasant climate and Income Tax is moderate. Free passages, partly furnished accommodation, medical and dental treatment. Five days leave for every completed month of service in East Africa. Normal tours of duty 30 to 36 months.
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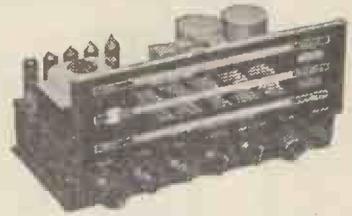

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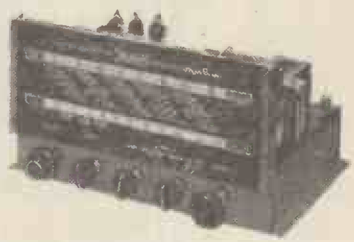

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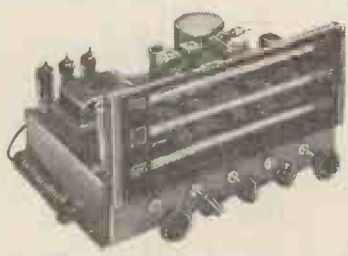

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SALES Correspondent required by radio and electrical component manufacturer of international repute situated in West London. Applicants must be experienced in conducting semi-technical correspondence, submitting quotations and generally dealing with customers. Knowledge of electrical/radio industry an advantage but not essential. Superannuation scheme up to 55 years of age. Write giving full details of experience, age and salary required to Personnel Manager, Box SC 1279. A.K. Advg. Ltd., 212a Shaftesbury Ave., London, W.C.2. [8735

TECHNICAL Sales Engineer is required by the Sales Director of a leading Company, marketing a wide range of Domestic and Electronic products. Sound technical knowledge, coupled with practical commercial outlook, are basic requirements, together with a pleasing personality and tact in dealing with Executives within the organisation and externally. In reply please submit fullest information, without which your application may have to be discarded. All applications will be treated with the confidence such correspondence merits, and no references will be taken up without the applicants permission.—Write Box 5283. [8743

ARMY SCHOOL OF SIGNALS, Catterick, Yorks., require Male Senior Lecturers in (a) Physics with good mathematical background (Ref. A.421/9A) and (b) Telecommunications (Ref. D.457/9A). Age min. 30 but less for exceptional quals. 1st or 2nd class hons. in Mathematics or Physics; for (a), Electrical Engineering or other relevant subjects for (b), with experience of two of following fields: Telecommunications, Electronic Engineering; Computers and Electronic Data Transmission. Lecturing ability essential. Burnham Salary Scale £1,550-£1,750. Starting salary under Burnham Scale. Teachers' Superannuation. Candidates required to take up duty as soon as possible but this may not debar those not available until 1960. Forms and details from M.L. & N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1 quoting appropriate reference. Closing date 20 November, 1959. [8727

MINISTRY OF SUPPLY require a Technician for the maintenance and operation of the United Kingdom terminal of an overseas radio-teleprinter link in London, and for liaison with G.P.O. (Cable and Wireless) staff; also to assist in the installation and maintenance of cypher equipment at headquarters and other stations as necessary. Applicants must be prepared to do regular shift work, e.g. to undertake duties beginning at, possibly 4 a.m. or finishing at 10 p.m. Quals.: Recognised apprenticeship or equiv. training; O.N.C., C. & G. Finals in electrical engineering, or equiv. Specialised knowledge of principles of electronics as applied to modern cryptographic equipment. Experience in telegraphic radio transmission, ability to maintain all types of teleprinting machine, knowledge of Murray code, morse and general signals routine desirable. Salary £720 (age 26) —£900 p.a. Application forms from Manager (P.E.2343) M.O.L. & N.S., Professional & Executive Register, Atlantic House, Farringdon Street, London, E.C.4. [8755

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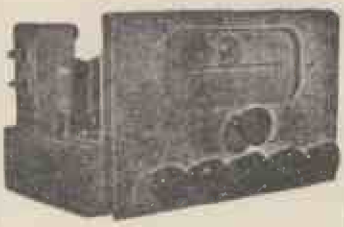

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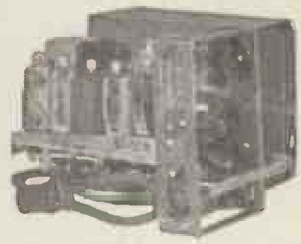

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