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Wireless World

ELECTRONICS, RADIO, TELEVISION

AUGUST 1961

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HUGH S. POCOCK, M.I.E.E.

Editor:

F. L. DEVEREUX, B.Sc.

Assistant Editor:

H. W. BARNARD

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Educating Television

THE title of this month's comment is ambiguous but we hope that before we have finished the obscurity will have been clarified and the dual meaning established.

In the voluminous evidence submitted both publicly and privately to the Pilkington Committee the quality of television programmes has been the subject of a little praise and much criticism. It would seem that in order to fill the existing channels and transmission time the broadcasting authorities must make use to a considerable extent of routine repetitive material and that this material must be the kind which causes upward trends in the audience research departments' statistical curves. If in the future we are to have, as is technically feasible, three, four or even five alternative programmes, where is the extra programme material to come from? There is little doubt that television audiences already suffer from a surfeit of quiz programmes, lower than top-flight variety shows and "horse operas" and that many licence holders are returning to sound broadcasting, the much maligned "steam radio," for relief. There is, metaphorically, a turn in the tide, a period of slack water which may look dull to lubberly on-lookers on the shore, but which sailors and professional watermen recognize as a period of opportunity for getting things done before the stream takes a new direction and dictates their future movements. In our view the time has come to experiment once again with more programmes of a documentary and "educational" character in peak viewing hours, though they must not be so labelled. With so much emphasis by politicians and the Press on the need for more scientists and technologists the layman's interest and curiosity is already beginning to stir. He would like to know more of what it is all about. Here is an inexhaustible source of arresting programme material—enough to keep a score of programmes going, and without having to pay "star" entertainers' fees. But there must be no attempt to "popularize" or talk down to adult audiences; after all, their mental age is at least as high as the sixth formers whose schools broadcast programmes are enjoyed by many a housewife during the afternoons. The Royal Institution lectures of Sir Laurence Bragg, seen recently in "Science on Saturday" set the

standard by which any future plans might well be judged. We hope that the response to these lectures will help in educating television programme directors to a re-assessment of public taste and interest.

Of the importance of the role of television in educating those who would or must acquire knowledge there can surely now be little doubt. We agree with our contributor "Diallist" (June issue, p. 338) on the distinction between lecturing and teaching and of the value of personal relationships in adjusting the difficulties arising from differences in the rate of absorption of ideas, but the scale of the educational programme and the size of classes does not always permit the achievement of this ideal. Many must reach the end of their schooling half taught and will have to complete their education, as many have done before them, from books. Television can not only stimulate but powerfully help them to do so. The television broadcast of a physical experiment is already more convincing than any still picture, and, with colour, the teaching of chemistry and biology will be greatly reinforced.

The way ahead can already be seen in the United States where Educational Television, a non-commercial and widely distributed service, is already being broadcast by more than 50 stations, serving an estimated 70 million people. In sparsely populated areas the service is supplemented by airborne transmitting stations. Outside school hours (6.30 a.m. to 7 a.m. each morning) programmes such as "Continental Classroom" give courses on contemporary mathematics and physics and claim a large following.

Here we have all the clues as to how television can benefit and benefit by education. From the vast store of human knowledge subjects selected primarily to awaken interest can be introduced during peak viewing hours. For those who wish to pursue the matter further, other channels could provide courses for serious study at intermediate and advanced levels, with repeats for the slow learners and even for bright people who do not find the first times of viewing convenient. We are in favour of as many television channels as the spectrum will hold; there should be no difficulty in keeping their programme time fully and beneficially occupied.

Negative Feedback and Power Output

EFFECT OF NEGATIVE FEEDBACK ON THE OVERLOADING OF A.F. AMPLIFIERS

By S. W. AMOS,* B.Sc. (Hons.), A.M.I.E.E.

IN his article "Negative Feedback and Non-linearity" in the April 1961 issue of the *Wireless World*, Cathode Ray has shown that the effects of negative feedback on distortion caused by curvature of valve characteristics are not so straightforward or so beneficial as might be supposed. In his article "Cathode Follower Distortion" in the following month's issue, Cathode Ray continued his critical appraisal of negative feedback by pointing out that distortion may arise in negative feedback amplifiers if the rise time of signals is short or their frequency high.

This article shows a further limitation of negative feedback which has nothing to do with the curvature of valve characteristics and is not confined to signals of short rise time or high frequency. The effect discussed here would in fact occur with perfect valves (having straight, parallel and equidistant characteristics) and at low frequencies. Briefly the main point of this article is that the application of negative feedback to an amplifier can reduce the maximum undistorted power available from it. Because negative feedback reduces harmonic distortion it might appear that feedback would increase the power output for a given percentage of total harmonic distortion and, in an output stage incorporating a perfect output transformer, this would be true. For practical amplifiers, however, and in particular for the small a.f. amplifiers incorporated in receivers, feedback reduces the power output available.

We will first consider an ideal amplifier containing a single output pentode rated for 10 watts maximum anode dissipation. Such a valve is probably rated by the manufacturers as providing 4.5 watts output at 10% total harmonic distortion. Now suppose negative feedback is applied to the valve and that the input signal is increased to keep the power output constant. By this means it should be possible to obtain the 4.5 watts output at, say, 1% total harmonic distortion and if the input signal is now further increased in amplitude until the distortion again reaches 10%, the power output must exceed 4.5 watts. The increase in power cannot be very great because, for a sinusoidal signal, the maximum efficiency of a class-A stage is 50% and for a 10-watt pentode this corresponds to 5 watts. We would expect, therefore, that negative feedback would enable us to obtain a power output between 4.5 and 5 watts for 10% total harmonic distortion.

In this calculation we did not mention any effects due to the output transformer: in other words we assumed it to be a perfect component with no resistance, with infinite primary inductance and with no

leakage inductance. The effects of the finite primary inductance of a real transformer are considerable, and, in fact, turn the power gain deduced above into a loss.

To understand this consider again the pentode discussed above. Let the h.t. supply be 250 volts and the mean anode current 40mA; this corresponds to the rated maximum anode dissipation of 10 watts. If the knee voltage is taken as 50 volts the maximum undistorted anode voltage swing is 200 volts. The maximum undistorted anode current swing is 40mA and the most efficient use is made of the valve when maximum voltage swing and current swing occur together. This can be assured by using the optimum value of anode load which is given by $200/(40 \times 10^{-3})$, i.e., 5,000 ohms. For such a load value the maximum power output is given by

$$P = \frac{V_{pk} I_{pk}}{2} \\ = \frac{200 \times 40 \times 10^{-3}}{2} \\ = 4 \text{ watts}$$

To obtain this power the load into which the pentode operates must be 5,000 ohms at all frequencies in the passband of the amplifier. Now the resistive anode load is shunted by the reactance of the primary winding of the output transformer and part of the output current of the valve flows in the reactance. This represents a loss of output power because only the current flowing in the resistance load is available as useful power output. The primary reactance is, of course, directly proportional to

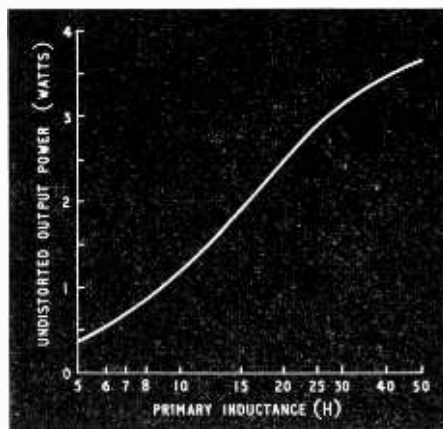


Fig. 1. Dependence on primary inductance of the maximum undistorted output power available at 50c/s from a pentode rated at 10 watts anode dissipation.

* Engineering Training Department, British Broadcasting Corporation.

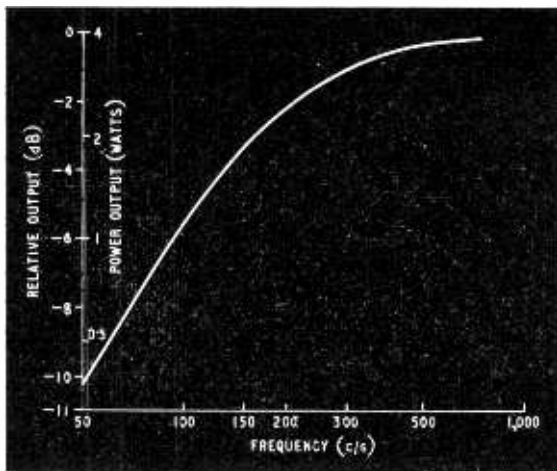


Fig. 2. Illustrating the fall in power output at low frequencies for a primary inductance of 5H.

frequency and this loss is therefore most serious at low frequencies. This reactance causes, in fact, a bass loss the magnitude of which depends on the inductance of the transformer primary.

Suppose we decide that a 3 dB loss can be accepted at 50 c/s: this means that half the output of the valve is lost, half the current flowing in the resistance load and the other half in the shunt reactance. This occurs when the reactance of the primary winding at 50 c/s is equal to the optimum load (5,000 ohms). This gives the primary inductance at 16 H.

A larger value of inductance gives a smaller bass loss and a smaller inductance a greater loss. The small output transformers used in receivers have an inductance of the order of 5 H. This has a reactance of 1,571 ohms at 50 c/s and the signal-frequency output current of 40 mA from the pentode divides, at this frequency, 12 mA flowing in the resistive load and 38 mA in the shunt reactance. These currents are in the ratio 1,571:5,000 and are in quadrature, their sum being given by $\sqrt{(12^2 + 38^2)} = \sqrt{1600} = 40\text{mA}$.

The current in the resistance load is thus only 12/40, i.e., 3/10th of the value at higher frequencies, e.g., 1,000 c/s. If the load is a true 5,000 ohm resistance the voltage across the load is also reduced in the same ratio (to 60 volts), and the power output at 50 c/s is only $(12 \times 10^{-3} \times 60)/2$, i.e., 0.36 watt. This corresponds to a loss of more than 10 dB compared with the output available at 1,000 c/s. It is surprising to find that the shunting effect of the primary reactance limits the power output at 50 c/s to as little as 0.36 watt. More power could be obtained, of course, by using a larger primary inductance and Fig. 1 illustrates the dependence of power output on inductance. Fig. 2 gives the power output plotted against frequency for a primary inductance of 5 H.

The bass loss of over 10 dB which occurs with 5 H primary inductance is not as obvious in reproduction as might be expected largely because loudspeaker and cabinet resonances tend to hold up the response at low frequencies.

A significant feature of the amplifier is that the output valve overloads at the same amplitude of input signal no matter what the frequency. Thus if the valve

overloads with, say, a signal of 5 volts peak at 1,000 c/s it will also overload with 5 volts at 50 c/s even though the power output is 4 watts at 1,000 c/s and 0.36 watt at 50 c/s.

Now suppose, in an effort to produce a better frequency response than that shown in Fig. 2, that negative feedback is applied to the amplifier. This cannot affect the ratio in which the output current divides between the resistance and the reactance. It corrects the frequency response by increasing the signal applied between grid and cathode as frequency falls so as to maintain constant voltage across the resistance-reactance combination. To obtain a frequency response level down to 50 c/s the feedback circuit increases the grid-cathode signal in the ratio 3.3:1 as frequency falls from 1,000 c/s to 50 c/s, although the input signal to the amplifier remains constant. Suppose the input signal is adjusted to give 0.36 watt output at 50 c/s. What happens as the frequency is increased? The grid-cathode signal falls to 1/3.3 of the value it had at 50 c/s and reduces the output power to $1/(3.3)^2$, i.e., 1/11 of the maximum value of 4 watts. This reduced output is, of course, 0.36 watt as would be expected in an amplifier with a level frequency response: in other words for a given voltage input we get the same power output at all frequencies.

But the overload characteristic of this feedback amplifier is quite different from that of the amplifier without feedback. At 50 c/s the amplifier overloads at an input corresponding to 0.36 watt output: at 1,000 c/s it will accept 3.3 times the input, corresponding to an output of 4 watts. Thus the amplifier overloads more readily in the bass than at higher frequencies. This has some significance in the apparent loudness of reproduction at the point where overload distortion is detected. For suppose the amplifier is fed with a signal containing equal-amplitude 50 c/s and 1,000 c/s components. How does feedback affect the ability of the amplifier to handle such a signal? The amplifier without feedback can accept without distortion an input which delivers the maximum output (4 watts) from the 1,000 c/s component and the maximum (0.36 watt) from the 50 c/s component. The amplifier with feedback will also overload when 0.36 watt is delivered from the 50 c/s component but this will coincide with an output also of 0.36 watt from the 1,000 c/s component. Any attempt to obtain more than 0.36 watt from the 1,000 c/s component will result in distortion due to overloading of the 50 c/s component. Although there is no doubt that the feedback amplifier has the better performance it is also true that the amplifier without feedback will produce more power output before distortion becomes apparent.

This argument is, of course, based on the assumption that the input signal has equal-amplitude 50 c/s and 1,000 c/s components. A different answer is obtained if a different amplitude ratio is chosen and thus the importance of this point depends on the relative amplitudes of low-frequency and high frequency components in the sound we are trying to reproduce.

Investigations have been carried out into this subject and, as might be expected, the results show that the distribution of energy over the audible spectrum depends on the type of sound. In many examples of music the amplitude of 50 c/s components is of

the order of 10 dB lower than that of 1,000 c/s components but in other types of music these components can be of equal amplitude and in organ music the 50 c/s components can be appreciably larger in amplitude than the 1,000 c/s components.* This suggests that the feedback amplifier mentioned above could, on certain samples of music, be operated to give 4 watts output at 1,000 c/s without overloading. For other samples, however (with larger bass components) a much smaller output must be accepted to avoid overloading. To be on the safe side it is best to design equipment to give the required output without distortion when the input has a uniform distribution of energy over the spectrum.

One way of achieving this, of course, is to employ an output transformer of adequate primary inductance but this would be a large and costly component. Another method is to introduce a bass cut in the input to the output stage, the cut being designed so that overloading occurs simultaneously at 50 c/s and 1,000 c/s when these have equal amplitudes in the original input. It might be argued that there is little point in using negative feedback to level the frequency response of the amplifier if the bass cut is to be restored by a circuit ahead of the output stage. Except for improving frequency response however, this arrangement has all the advantages of a feedback amplifier, namely reduction of harmonic distortion, reduction of hum and reduction of output resistance. Alternatively, improved overloading characteristics can be obtained by using only a limited degree of negative feedback (say 6 dB instead

of 20 dB) or by designing the feedback circuit to give a bass cut instead of levelling the frequency response in the bass.

This article has so far dealt with the problems of reproducing middle-frequency and low-frequency signals simultaneously and has shown that the finite shunt reactance of the output transformer primary winding is the chief cause of the difficulties that arise. A similar problem arises in reproducing middle-frequency and high-frequency signals if there is a capacitive reactance in parallel with the load resistance and if this has a reactance at, say, 10,000 c/s which is comparable with the load resistance. Such a reactance may be due to a capacitor across the primary winding of the output transformer: it is quite common to include such a component in circuits incorporating output pentodes. The origin of the distortion can be understood from the following calculation. Suppose the capacitance is 0.01 μ F: this has a reactance of approximately 1,590 ohms at 10,000 c/s. This is approximately equal to the reactance of a 5 H inductance at 50 c/s. Thus the output current from the valve divides between the shunt reactance and the load resistance in the ratio 5,000 to 1,590 and the maximum power output at 10 kc/s is limited to 0.36 W as explained earlier in the article. Thus if equal amplitude 1 kc/s and 10 /c/s signals are present together in the input, 0.36 W is the greatest undistorted output possible and the application of negative feedback cannot improve this situation. Fortunately there is an easy cure for this form of distortion and that is to connect a resistor in series with the shunt capacitor. If this resistor is made equal to the optimum load resistance of the valve (or larger), the reduction of output power is not so marked.

* These results are taken from the article by J. G. McKnight "The Distribution of Peak Energy in Recorded Music and its Relation to Magnetic Recording Systems". *Journal of the Audio Engineering Society*, April 1959.

BRIT.I.R.E. CONVENTION ON

Radio Techniques and Space Research

LACK of space unfortunately prevents us from even mentioning all the papers given at this convention. In particular we have neglected all non-radio topics (such as satellite launching and other mechanical problems) and also topics (such as noise reduction, microminiaturization, and general reliability) not essentially connected with space. The full papers will, however, be published in the *Journal of the Brit.I.R.E.*

We would like to commend the Institution on the very smooth running of this convention—with one exception, i.e., that many delegates were allowed to read their papers word for word although pre-prints of them were already available, this was unfortunate in view of the shortage of time for discussion.

Space Measurements from the Ground.—The use of scattered rather than reflected radiation for observing the whole ionosphere rather than merely that part below the region of maximum ionization has already been mentioned in our November 1960 issue (p. 573) and was discussed at this convention in a paper by Greenhow and Watkins. The echo power gives a direct measure of the electron density, and the Doppler spread of the received wavelengths a measure of the temperature. The density can also be determined from the plasma resonance (and transmission cut-off) frequency,

which could be measured by detecting the narrow lines separated from the main echo by plus and minus this frequency.

Recent techniques in radio astronomy discussed in a paper by Jennison included the intensity type of interferometer. Here the two spaced interferometer aerials are connected to completely separate receivers and detectors. The detector outputs are caused to interfere by cross-multiplication, and their cross-correlation coefficient obtained by dividing the output of the cross multiplier by the product of the r.m.s. values of the two separate detector outputs. This coefficient then gives a measure of the distribution of brightness across the source, and thus its angular diameter. This type of interferometer can be considered as providing a comparison between the noise envelopes at the two aerials.

The interferometric principle of aperture synthesis by which the results which would be given by very large aerials are obtained by combining the results from small aerials which are moved about has already been described in our October 1957 issue (p. 477). The above-mentioned paper by Jennison also showed how this technique can be applied to a radar system (in this case for mapping the moon's surface). The transmitter oscillator phase is made stable over a long train of

pulses so that the relative motion between the earth and moon allows an aperture synthesis to be performed. **Ionospheric Measurements from the Ground Using Satellite Transmitters.**—The use of the Faraday rotation of the plane of polarization of the received signals to give a measure of the total number of electrons up to the transmitter has already been described in our December 1957 issue (p. 578).

The Faraday rotation can be regarded as measuring the difference between the Doppler shift frequencies of the ordinary and extraordinary rays, as was pointed out in a paper by Blythe. The mean of these frequencies provides a much larger and thus more sensitive measure of the total electron content. This mean can be obtained from the Doppler curve of the satellite. This curve mainly depends on the satellite motion but effects due to this may be eliminated by making observations at different frequencies, since the Doppler shift due to satellite motion depends in a different way on the frequency from that due to the total electron content.

Satellite Tracking.—The use of radar, interferometer and Doppler shift measurements for tracking satellites has already been described in our December 1957 issue and these methods were reviewed at this convention in a paper by Pressey.

This paper also described a combined radar and interferometer method of tracking passive satellites. The transmitter has a vertically directed fan-shaped beam. As the satellite passes through this beam the angle of the reflected signals is measured by interferometers at two receiving stations several hundred miles apart on either side of the transmitter.

Radio Measurements from Satellites.—The extension of radio astronomy measurements down to lower frequencies normally absorbed in the ionosphere is, of course, possible with the aid of satellites, and the use of simple wire dipoles 2×75-ft long for this purpose was described in a paper by Graham Smith.

The gain and directivity of such dipoles can possibly be increased according to a paper by Jennison by taking advantage of the facts that, in the region of decreasing electron density in the upper part of the ionosphere, refraction focuses the beam in the direction of the vertical, and interference from signals reflected from the top of the ionosphere modulates this vertical conical beam pattern by fine conical shell fringes which produce an extremely sharp termination of the edge of the focused cone. The focus angle decreases sharply as the operating frequency approaches the plasma transmission cut-off frequency (from above it). Changes and irregularities in the electron density (and thus the plasma frequency) thus introduce complications, but even so this focusing should give useful increases in aerial gain by factors of ten or so. The fine fringes are, unfortunately, not likely to be of much use because for bandwidths of more than a few kc/s they become smoothed out. The very sharp edge of the reception pattern (even for fairly wide bandwidths) could possibly be taken advantage of in two ways. In the first of these the detected output is low-pass limited at an upper frequency which is adjusted according to the fastest rate of change of signal that could be caused by a point source entering the edge of the reception cone as the satellite orbits. This eliminates the large component of background radiation from other sources. Alternatively, the receiver could be rapidly switched between two similar frequencies, the difference in the two outputs so produced then corresponding to the signal from a narrow ring.

By measuring the frequency below which the natural background is cut-off (plasma frequency) the electron density in the neighbourhood of the satellite can also be determined.

A paper by Boyd discussed the use of current/voltage curves from Langmuir probes for measuring electron and ion concentrations and temperatures. The standard laboratory techniques are complicated in space by the effects of satellite motion both on its potential

(which must be used as a reference, there being no "earth" available) and also on ion velocities, the problem of returning the collected charge to the ionosphere and photo-emission. Photo-emission currents can be eliminated and the electron and ion currents separated by using an additional grid in the probe. Photo-emission and ion currents can also, since they are nearly constant, be eliminated by modulating the probe voltage. By modulating this voltage at two frequencies, the electron temperature can be measured directly. The ratio of the current amplitude to depth of modulation (of one frequency upon the other) is measured. It can be shown that this is proportional to the ratio of the first and second differentials of probe current with voltage, and thus also to the electron temperature.

Satellite Communication.—The use of a few satellites in an equatorial orbit at such a distance (22,300 miles) that they rotate round the earth once every 24 hours and thus appear stationary relative to the earth was first suggested by Clarke in 1946 and has since been widely discussed. This system has, however, the following disadvantages: projecting a satellite to this altitude is very costly and the payload which can, at present, be placed in orbit is very small, if the "stationary" feature of the orbit is to be fully exploited the satellite must be placed accurately in orbit and must contain altitude stabilizing and station keeping equipment (with its attendant reliability problems), destruction of even one satellite would completely disrupt the service, at this range transmission and reception problems become acute and the use of passive repeaters can in practice be ruled out, and finally, increased noise is produced by transmission through interplanetary plasmas. Several of these disadvantages are avoided by the other often-proposed communication system using a considerably larger number of satellites in a much lower orbit. This system brings, however, its own attendant disadvantages, viz., as a result of the high satellite speeds complicated tracking equipment must be used and the Doppler frequency shift must be allowed for, complications due to having to change from one satellite to another, and finally the satellite environment (partly in the van Allen belts of charged particles) may cause greater deterioration of its equipment. A sort of compromise between these two systems using a few satellites near their furthest distance (about 12,500 miles) in a highly elliptical orbit was described in a paper by Buss and Milburn.

The operating frequency will probably be somewhere in the broad band between the maximum frequency at which ionospheric losses are serious (about 100Mc/s) and the minimum frequency at which atmospheric absorption can become serious (about 7,000Mc/s), since, if one of the new low-noise devices is used, the variation of receiver noise with frequency will not affect the choice of frequency.

The maximum possible satellite weight will limit the transmitter power to a few watts. A usable signal-to-noise ratio can then probably only be obtained with a modulation system in which increased signal to noise can be exchanged for increased bandwidth. This suggests the use either of some sort of pulse coding, probably in binary form by 180° shifts in the phase of the transmitter carrier, or alternatively (or in addition) frequency modulation.

With frequency modulation, which is often proposed because the techniques required are well known, a bandwidth or the order of tens of Mc/s would be required for a 600-channel telephone system. In this case the noise in the corresponding wideband receiver would be prohibitive. A narrow-band receiver can, however, be used provided its local oscillator is phase locked to the incoming sub-carrier.

The use of the moon as a passive reflector was discussed in a paper by Webster. Useful signal to noise ratios can be obtained with transmitter powers of the order 5kW and aerial diameters of the order of 50ft. Unfortunately scattering produced by the uneven surface of the moon limits the usable bandwidth to a few kc/s.



Experimental installation of S.S.R.4G. One masking aerial is in centre of long interrogator array (below obstruction light), other is at back of main array. Splitting of interrogator array rendered design so difficult that computer was used: strip-line feeds are employed to 48 unipoles to give $2\frac{1}{2}^\circ$ beam width.

EXPERIMENTAL INSTALLATION
FOR OPERATIONAL
EXPERIENCE

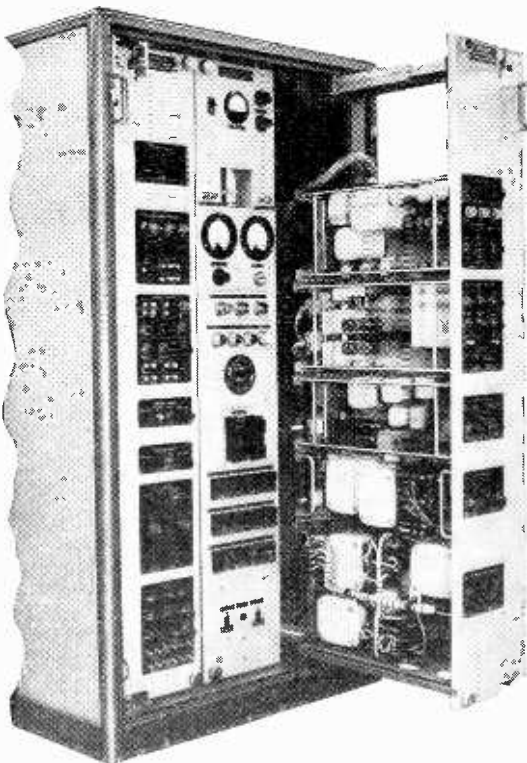
Secondary Radar at London Airport

AIR TRAFFIC control poses some problems not easily answered by primary radar in spite of the highly sophisticated systems that have been developed: it cannot, for instance, automatically identify a particular aircraft or give to the ground controller the accurate height information known in

the aircraft. One facility that civil a.t.c. has—a facility hitherto neglected apart from R/T contact—is that it can enlist the co-operation of the controlled aircraft.

For many years* Cossor have been developing, as a private venture, secondary radar—in which a signal from the ground causes a transmitter in the aircraft to “reply”—for a.t.c. purposes and recently a demonstration of their latest equipment which meets, and indeed, formed the basis for, the I.C.A.O. requirements, was given at London Airport. The S.S.R.4G ground equipment employs pulse transmission from a highly directional aerial (which can be rotated in synchronism with a primary radar aerial so that the information gained can be correlated

* See, for instance, “Secondary Surveillance Radar,” by D. A. Levell, *Wireless World*, Vol. 60, p. 227 (May, 1954).



Above: Airborne-transponder control-box with manual code-selection facilities.

Left: Ground-equipment racks—chassis pulled out are aerial-synchronizing circuits, in centre is power supply, on left are 1,000-Mc/s crystal-controlled transmitters, receiver and mode-generating circuits.

easily) and a "covering" aerial whose signal masks the side lobes of the directional array. When the airborne transponder equipment (Type S.S.R.2A) receives pulses with the correct amplitude and time relation it transmits a train of pulses back to the ground equipment.

This train consists of two framing pulses marking the beginning and, normally, the end of a transmission period which can contain any combination of six information-bearing pulses. These pulses by their presence or absence, give a maximum of 64 possible codes which can be used to relay automatically height information.

To identify an aircraft, the pilot is requested by R/T to "ident": he then presses a button which causes a pulse to be radiated after the last framing pulse. This is obviously simpler and quicker than, for instance, the making of a temporary change of

course and is apparent immediately as a lengthening of the "paint" on the p.p.i. display.

An interesting feature of the equipment as installed at London Airport is the automatic monitoring of the performance of the ground transmitters and receiver by a transponder mounted some distance away. This is, of course, interrogated by the transmitters in the normal way. The selection circuits for side-lobe suppression are set to the extreme limit of the specification, so any deviation from correct performance of the ground equipment results in triggering on side lobes which shows up as responses from several bearings. A counter registers the number of interrogations in a given time and, assuming a known aerial rotation speed, this number is proportional to beam-width ($2\frac{1}{2}^\circ$ with a 10% tolerance). Also an attenuator can be switched in to stimulate propagation attenuation of the extreme range.

AUTOMATIC PRODUCTION LINE FOR RESISTORS

DESIGNED to manufacture deposited-carbon resistors, the Western Electric Company's production line at Winston-Salem, North Carolina, is almost completely automatic and incorporates a computer-controlled statistical quality-control. The process consists of eleven operations, each being programmed by the computer, which sets the line to manufacture resistors in four power-ratings and a vast number of resistance values. The computer also accepts feedback information from three points in the line, compares this with requirements and initiates corrections. The output of the computer is binary or binary-coded decimal, depending on the operation in question.

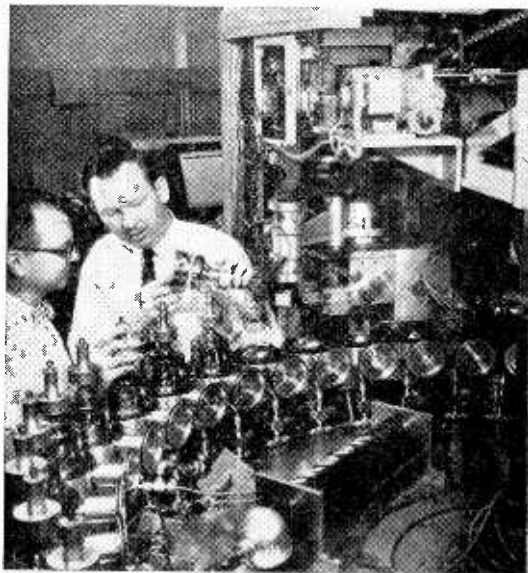
The first operation is the deposition on a ceramic rod of crystalline carbon obtained from methane decomposing at high temperature. As the coated rod leaves the coating machine, a Kelvin bridge provides the computer with an input proportional to the resistance of the coating. This analogue of voltage is digitized, stored on a magnetic drum and compared against a stored programme. Any difference output is used to control the speed of the core through the machine, the flow of gas and the temperature.

The next process is the application of a sputtered gold contact to each end of the core. Each core is fitted with a mask to protect the coating, the size of mask being chosen from four by programmed instructions from the computer. The core is now placed in a bell jar which is first evacuated and then filled with argon at low pressure. Sputtering takes place, giving a coating 0.00001-in thick.

End caps are now applied, the attachment of wire leads to the caps being the only operation performed outside the production line. The cap is applied with sufficient force to weld the gold-plated cap to the sputtered ends of the core. The computer selects cap sizes.

The helical groove giving a precise value of resistance is cut by rotating the resistor against a diamond-impregnated wheel. A wheatstone bridge, pre-set by the computer, disengages the wheel when the required value is reached and the bridge is balanced. Allowance for machine inertia and heat changes caused by the cutting process are stored in the computer. Helixing takes only three seconds.

The second inspection process now occurs. A computer-preset bridge measures the resistance, any off-balance being fed back to the computer, where it is digitized. Comparison between the fed-back and stored information is effected, and differences are used to adjust the setting of the helixing machine.



The 36-station gold sputtering machine, which applies a gold coating to the resistor ends. The gold cathode in one of the bell jars is being inspected. Loading of resistors into the machine is, in this as in all other processes, automatic.

The resistors are now encapsulated in epoxy resin. The pre-cured shell rests on the end-caps, leaving an air-space between the carbon and the shell, a feature said to prevent organic contamination of the carbon. Pellets of resin are formed over the ends and cured at 300° F.

After air-leak inspection—an underwater bubble test—the resistor is marked with its value by a computer-controlled offset printing machine.

A third inspection station operates a feedback loop to reset the second station, compensating for resistance changes caused by encapsulation heat.

Packing completes the process, which produces 1,200 resistors per hour, in any variety of power ratings and values, as programmed by the computer, which may be fed with sufficient instructions for a month's production.

Soviet Exhibition in London

RUSSIAN RADIO, TELEVISION AND ELECTRONICS ON SHOW

ENTERING the Soviet Exhibition at Earls Court was almost like stepping into another world: gone was the familiar ugly building, hidden behind yards of bunting and giant displays reaching almost to the roof. The exhibition was arranged in 23 halls which each exemplified achievement in a particular field, the central hall being devoted to space exploration. In the "Atom" hall models of many famous devices such as OGRA—a magnetic-mirror device for controlled thermo-nuclear fusion—were shown.

The introductory hall was concerned with science, and in it were shown many instruments for the measurement of physical and geo-physical phenomena and an example was equipment used for the frequency-analysis of seismic waves. A single cycle of seismic oscillation is photographed and presented repeatedly to the input, where it is mixed with the output of a variable-frequency heterodyne oscillator. The resulting frequencies are applied to a crystal filter during the open time of a gate; the output of the filter is detected and used to deflect a galvanometer, which records the amplitude of frequency components selected by the heterodyne oscillator on a pen recorder. The mechanism operating the paper feed also shifts the frequency of the oscillator and a complete spectrum is built up. Centre frequency is from 0.1c/s to 100kc/s.

What appeared to be a typical industrial batch counter—the PS100—was shown in its radiation monitoring application. The instrument is a low-frequency counter using one counting decade and four neon counting tubes.

An extremely comprehensive circuit-checker—the POOMA—will check the operation of circuit blocks requiring up to 3,000 connections. A punched-tape-programmed comparator samples the parameters of each circuit, compares them with the information in store and indicates the presence of a fault by coded lights. This method is 40 times faster than the normal procedures.

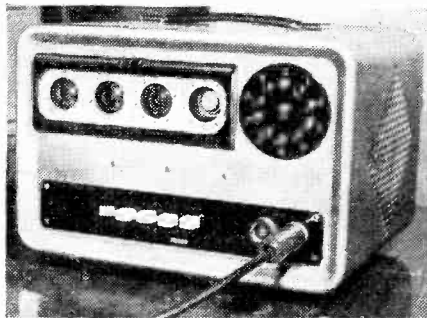
Electronic applications in industry and medicine were numerous: among the ultrasonic equipment was a "fountain" in which a liquid is excited strongly, the surface breaking up into a mist of droplets a few microns in diameter. This effect has been applied in medicine for the production of inhalant mists. Computer equipment shown included a Boolean function machine and some self-optimizing automation devices. A geophone and amplifier set, explosion proofed, for

gas-leakage detection and roof-fall warning in coal-mines had a companion tape recorder and encoding apparatus for feeding the signals over telephone lines. Also for coal-mine use was a dust-determining meter: this uses a radioactive isotope (thallium 204) as the source and works on the back-scatter principle.

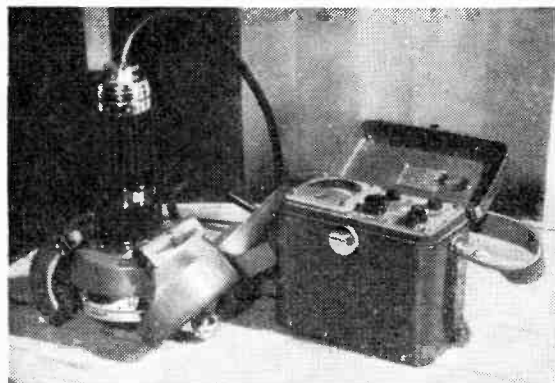
Electronic measuring instruments were grouped, for some inscrutable reason, in the section devoted to the expression of "Public Well-Being." The performance claims of many of the instruments were modest by comparison with Western standards: it is possible that the more advanced equipment was not on show.

Two oscilloscopes of fairly advanced design were shown, the UO-1M—a single-beam instrument, and the DEO-1—a double-gun instrument with extensive facilities. The UO-1M has a frequency-response of 0-20Mc/s (-3dB) and a sensitivity of 100mV/cm. The time-base speeds are from 25nsec/cm to 25msec/cm and rise-time is 20nsec. A selection of vertical amplifiers is available. The DEO-1 employs identical vertical amplifiers, with a bandwidth of 0-20Mc/s and a double-gun tube is used.

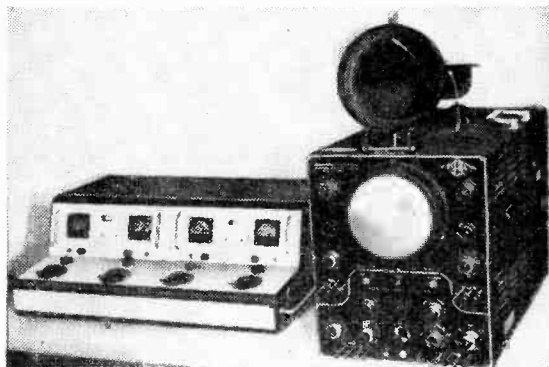
A low-frequency Q-meter, known as the IMI-3, covers the range 1kc/s to 100kc/s and will measure Q from 2 to 200 at an accuracy of $\pm 6\%$. Inductance measurements may be made in the range 0.1mH to 1H, with $\pm 10\%$ accuracy. The frequency is indicated by



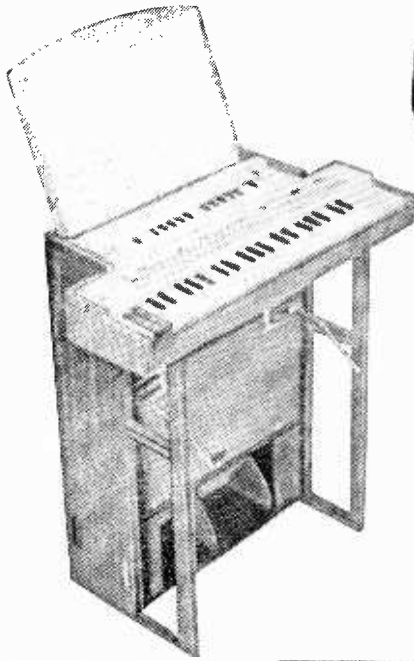
PS-100 batch counter employing counting decade and neon counting tubes.



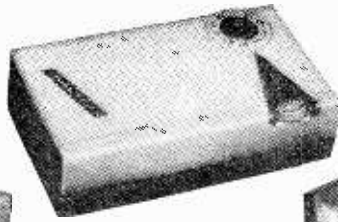
Back-scatter coal-dust monitor for use in mines.



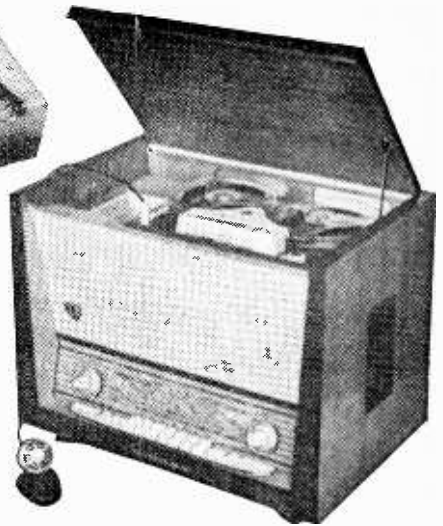
Four-channel electroencephalograph built by students of a vocational school at Omsk.



Electronic musical instrument, Ekvodin, uses valve tone generator.



Above: "Mir" transistor portable receiver uses six transistors and produces 50mW at 20dB signal-to-noise in a field-strength of 5 μ V/m.



Right: "Neringa" Magnitola consists of a.m./f.m. radio with 7.5 in/sec twin-track tape recorder.



Television receiver and gramophone using 24 valves, 110° c.r.t. and six loudspeakers.

an in-line digital system. A range of slotted-lines working in the range 2,600Mc/s to 8,300Mc/s was shown. The frequency-range is covered by five separate instruments and the accuracy of measurement is $\pm 4\%$.

Domestic apparatus was, more understandably, also shown in this section. The television receivers cover a wide price range, from about 160 roubles* for the cheapest 17-in set, up to about 750 for a colour receiver using a shadow-mask tube. These latter have not yet reached quantity production and are only intended for communal viewing in clubs or "palaces of culture". The Russians are making their own shadow-mask tubes and they use an adaptation of the N.T.S.C. standard.

For black-and-white TV both 110° and 70° c.r.t.s are in use, as are frame-grid valves which are sometimes

* 2.5 roubles \approx £1 sterling

employed for the video amplifier. Vision a.g.c. and timebase stabilization are common in the newer sets and some employ ingenious means for f.m. broadcast reception: for instance, the "Rubin 104" and "Almaz 105" have a second frequency changer to convert the 8.4Mc/s f.m. i.f. to the 6.5Mc/s sound i.f. so that the set's intercarrier circuits can be used. Headphone and tape-recorder outlets are often fitted and semiconductor rectifiers are used widely. A notable feature was the use of a 4:3 aspect ratio, even for the 110° tubes.

Combination sets are popular—sometimes a radio tuning medium and long waves as well as a turntable and pickup is incorporated with the television and f.m. receiver all in one small table-model box.

A transistor TV receiver (the Moskva) was on show—this was housed in a leather case and used a c.r.t. of about 8-in diagonal. Nickel-iron cells (12V) are used for power supply and the price is about 250 roubles.

Radio receiver production follows closely the "Continental" pattern with bandsread s.w. ranges, high sensitivity and selectivity and multiple loudspeaker systems in all but the cheapest and smallest models. Like the television receivers, several printed-circuit panels are often used and the whole is very strongly constructed.

Combinations are popular here, too. A less usual grouping seen included a tape recorder under the top lid ("Neringa" Magnitola) and some models also embody a turntable and pickup with provision for disk-copying. Tape speeds in common use are 7½ and 3¼ in/sec with two-track recording and a transistor model was shown.

Demonstrations of CTEPEO (stereo) recordings were given in the "Hall of Sterophonic Sound," and some of the radiogramophones shown had provision for the playing of stereo disks. Stereo broadcasting, too, is being tested, using polarity modulation in which alternate half-cycles of the carrier are amplitude modulated with the two channels. For radio transmission this carrier forms a 30kc/s subcarrier to an f.m. carrier.

The Ekvodin—an electronic musical instrument—is available in two versions, mono- and di-phonic. Keyboard played, these provide many timbres, imitating most orchestral and folk instruments.

In the field of electromedical equipment, the Luch apparatus, which is an automatic reading-machine for blind people, was probably the most interesting. This device works on the light-reflection principle, the differing areas of black in each letter reflecting a different amount of light on to a photoelectric device, when scanned by a narrow beam of light. The varying output of the light-sensitive device is decoded, each level corresponding to a letter. The sound of this letter is generated electronically and fed to a speaker.

Problems in Standardization

WITH PARTICULAR REFERENCE TO

SPECIFICATIONS FOR MAINS SWITCHES

By M. G. B. MASON

IT is interesting to investigate the history of long-established components employed in electronics circuits and to discover the changes in design and specification made necessary by modern techniques. The manufacturer of these components usually has two methods of ensuring the adequacy of his product. First, by environmental testing in collaboration with the equipment manufacturer; where equipments and circuits likely to place different demands on the component are used. Secondly, by testing in the way laid down in the appropriate specifications, and meeting the limits. Test standards and specifications are developed, published and adopted as a result of liaison between the various representative associations of the electronics industry, nationally and internationally.

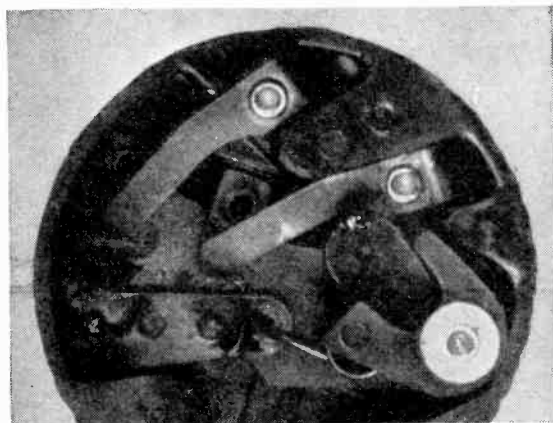
Ideally, the two methods should be complementary as a test standard agreed by the industry at large cannot always anticipate the very sudden changes and advancements of circuit techniques. In general it may be said that for "earth-bound" equipment at least climatic test conditions in terms of temperature and humidity, now a feature of all these test standards, are not subject to frequent change.

Potentiometers with Switch

This article is concerned with commercial, as distinct from Services, standards, and takes as an example the experience of a manufacturer of potentiometers incorporating a mains switch. This form of switch has been used in domestic radio and television receivers for a considerable number of years and, although it has from time to time become harnessed to wave-change switches, tuners, separate knobs and push-buttons at the dictates of styling, it is invariably the same basic switch.

Safety and reliability of the mains switch are vital, and in this country British Standards Specification 415 "Safety Requirements for Radio and

other Electronic Apparatus" prescribes minimum creepage distances in relation to working voltage and current ratings as well as test proof voltages. These conditions must apply equally to all parts of the equipment where may be found mains potentials and metal conductors likely to be accessible to the user. Primarily, therefore, the mains switch must be designed so as to meet these requirements. For the purpose of environmental testing, the Radio Industries Council, in consultation with component manufacturers, produced and published Specification R.I.C.122 some years ago. This, in addition to prescribing tests and climatic gradings for the potentiometer itself, included test load conditions for cyclic endurance of the switch, calculated to

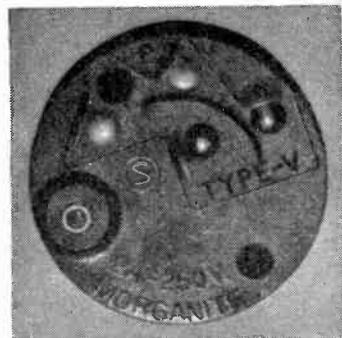


Obsolete pattern of switch showing arcing and contact burning after a few hundred cycles at 2 amps, power factor 0.6.

represent ten years of normal usage. This specification provides the basis for tests to evaluate the suitability of potentiometers for use in equipments, whether in this country or for export, according to their climatic grading. A forthcoming British Standard equivalent in function to this specification is intended, which will be our national standard.

National and International Standards

Many countries have their own national test standards and committees comprised of delegates from each country's representative national-standards committees meet regularly to formulate international standards, based on the International Electrotechnical Commission in Geneva. The standards thus produced show much evidence of the acceptance of parts of various national test standards; but clearly



The "S" mark (near centre). Only switches which bear this mark may be sold in Sweden.

the ideal objective is a common test standard for each component. For switches employed in domestic and other mains-operated equipment the Commission on Rules for the Approval of Electrical Equipment have produced Publication C.E.E.14, "Specification for switches for Domestic and Similar Purposes."

The application of national standards varies from country to country and only a few governments make them mandatory when concerned with other than Services requirements.

The exceptions are notably the Scandinavian countries and where safety, for instance, is concerned, approval for use in equipments is granted only after arbitrary tests carried out by their government test houses. These standards are very similar to the requirements of C.E.E.14 in detail.

The Swedish government's test organization ("SEMKO") carries out tests on production samples submitted to them. If every sample passes these tests, the switch manufacturer is permitted to mark his product with the special "S" mark. The manufacturer's adherence to the required standard is checked by demanding further test samples from time to time.

Equipment manufacturers must use mains switches so marked and approved before they are permitted to sell in Sweden. Denmark, Norway and Finland adopt similar practices, but will usually accept the "SEMKO" mark, if applicable, in lieu of their own test approval.

The "SEMKO" test is most stringent: it does not countenance a single failure or momentary hesitation in 20,000 operations on full rated load at a power factor $\cos \phi = 0.6$. An automatic monitoring system is employed to detect faults. Other tests in the "SEMKO" specifications include overload, temperature rises of contacts, resistance to heat, fire, tracking, and humidity environmental tests. Approval will not be granted if a single specimen fails any test.

Switches designed for attachment to potentiometers are tested by "SEMKO" as a complete assembly. Hence it is necessary not only to ensure satisfactory performance of the switch; but also to ensure that the entire assembly and method of operating the switch are reliable.

Specific Problems

To enable a switch to meet the "SEMKO" requirements, the following attention was required to an otherwise fully acceptable and reliable article. The switch was rated to break 2A at 250V and the two most difficult requirements were the full loading at 0.6 power factor and 20,000 operations at this loading without a single falter by any test specimen.

Comparing contact burning under load conditions (0.8 power factor) as required by our own domestic specification with those required by "SEMKO," it was found that 2A at 0.6 power factor was equal to 6A at 0.8 power factor, at like voltage. Tracking problems were rendered complex by the fact that for 10,000 operations one pole was at line potential and the metal work of the potentiometer at neutral and, for the second 10,000 operations, the other pole took the line voltage and load.

Therefore tracking paths had to be increased by the moulding of baulks, and the use of non-tracking grades of moulding powder was, of course, essential.

Choice of contact lubricant was found to be critical and the lubricant had to be non-carbonising.

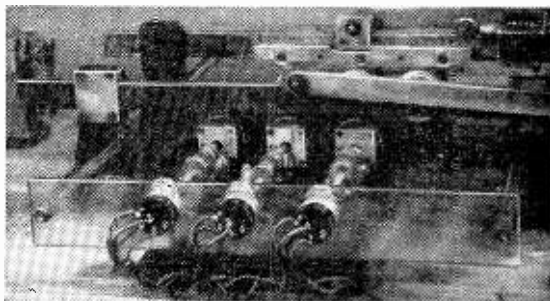
Friction between moving parts had to be controlled carefully both in production as piece parts and during assembly; the operating spring had to be consistent in manufacture, both in dimensions and in tensile performance.

The resultant article was then "quality controlled" by sampling, and to pass 20,000 operations under these conditions meant that at least 50,000 operations had to be achieved before mechanical breakdown.

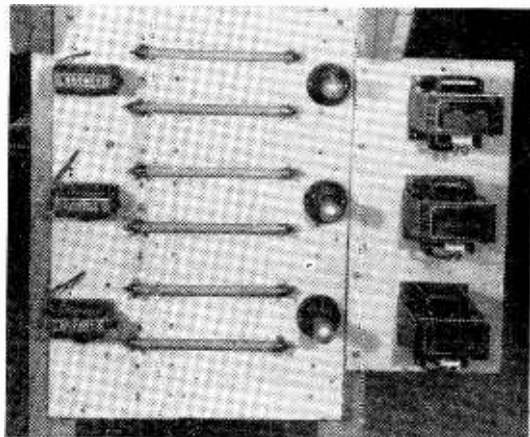
Conclusions

The achievement of "SEMKO" approval is costly and far from easy. Its attainment means that the article concerned is tested to a very high degree of safety and reliability.

It is interesting to reflect that if the switch in a radio or television receiver carries one of the



Equipment for endurance testing of switches (above). Resistive parts of loads (below) are electric fire elements, inductive parts are special chokes of Swedish manufacture identical with those used in the "SEMKO" laboratories.



Scandinavian approval marks, it is not only smaller in physical size; but is tested to a higher standard than is often appropriate to a switch used in bathroom and kitchen, where the consequences of failure are liable to be much more serious.

The author is indebted to the Directors of Morganite Resistors Limited for permission to publish this work.

WORLD OF WIRELESS

European V.H.F./U.H.F. Broadcasting

WHAT is believed to be the first international broadcasting conference since the war at which all accredited delegations signed the agreement ended in Stockholm a few weeks ago. The plans, covering frequency allocations in Bands I, II, III, IV and V have been approved in draft form and will in due course be issued by the International Telecommunications Union. Until the "Final Acts" of the Conference are available we must confine ourselves to unofficial reports.

The plans for the v.h.f. bands include only stations with an e.r.p. of 1 kW or more and in the u.h.f. bands only those of 10 kW or more. Requests for frequencies for lower-powered stations are being collated by the International Frequency Registration Board who will send a list to all European administrations for comment preparatory to approval.

So far as the U.K. is concerned we understand we have retained our existing assignments in Band I and there has been some easing of the power restrictions in the direction of the Continent, laid down in the 1952 Stockholm Plan.

At present we do not utilize for sound broadcasting the whole of Band II, the upper 5 Mc/s being used for other services. However, our delegation secured assignments in this section of the band so that the v.h.f. sound broadcasting service could be extended if desired.

Our position in Band III is unchanged although provision has been made for many stations to increase their power.

Until this conference there had been no allocations in Bands IV and V, although, of course, a number of stations were already in operation in West Germany. All European administrations have agreed to 8-Mc/s channel spacing in these bands. The maximum is fourteen channels in Band IV (470-582 Mc/s), but considerably fewer than the maximum number of 47 channels in Band V (610-960 Mc/s) have been assigned to television stations. The frequency band 860-960 Mc/s will, it appears, be used largely for fixed services, including, in accordance with the Geneva Radio Regulations, tropospheric scatter links. However, our application for sufficient channels in these bands for four programmes, each with almost national coverage, was granted.

Berlin Radio Show

THIS year from August 25th to September 3rd the German Radio Exhibition returns once again to Berlin after a series of biennial shows in Düsseldorf and Frankfurt-am-Main. The Berlin exhibition grounds, including the summer garden, surrounding the Funkturm have an area of 25 acres of which no less than 16 acres is under cover. The big firms have each taken separate pavilions and special television shows will be staged in the Deutschland-Hall. The B.B.C. have taken a pavilion to mount an exhibition on the theme "B.B.C. Greets Berlin."

Visitors are expected from all parts of Germany and from abroad and the railways and air lines will supplement the normal services to and from Berlin. The organizers expect a total attendance of the order of 750,000 (compared with 532,000 in 1959, and 493,000 in 1957).

Earls Court Radio Show

THE 28th National Radio and Television Show opens at Earls Court, London, on August 23rd until September 2nd (excluding Sunday, 27th). At this show the B.B.C. and the industry will be celebrating the 25th anniversary of the British television service which was introduced at the 1936 exhibition. To mark the occasion the B.B.C. is staging a demonstration of colour television. In addition to some 70 manufacturers, many user organizations have taken space and in all there will be nearly 100 exhibitors. Our next issue will include a plan and pre-view of the show.

The Paul Instrument Fund Committee, set up in 1945 "to receive applications from British subjects who are research workers in Great Britain for grants for the design, construction and maintenance of novel, unusual or much improved types of physical instruments and apparatus for investigations in pure or applied physical science," has awarded £3,900 to Dr. P. B. Hirsch, lecturer in physics, University of Cambridge, for the construction of an electron optical instrument which will measure the energy distribution of the electron beam passing through small areas (diameter less than 1μ) in the crystal specimen which can be observed and selected on the electron microscope image. The Committee has also awarded £3,000, supplementing a previous grant, to Dr. H. Motz, Donald Pollock Reader in engineering sciences, University of Oxford, for the construction of a linear accelerator working at 1.6cm (J-band).

1963 Computer Conference.—The second congress of the International Federation of Automatic Control (I.F.A.C.) will be held in Basle, Switzerland, in September 1963. Papers will deal with the theory or application of automatic control and the components of control devices. Offers of papers from this country should be made to the British Conference on Automation and Computation, c/o The I.E.E., Savoy Place, London, W.C.2. General inquiries concerning the congress should be made to the secretary of I.F.A.C., Dr.-Ing. G. Ruppel, Prinz-Georg-Strasse 79, Düsseldorf, Germany.

Science and Parliament.—The Marquess of Salisbury is the new president of the Parliamentary and Scientific Committee which this year celebrates its coming of age. This is an unofficial non-party group of nearly 200 members of both Houses of Parliament and representatives of over 100 scientific and technical organizations. The Committee sponsored the first European Parliamentary and Scientific Conference, held in London in March, which was attended by representatives from 17 European countries.

Colour TV Book.—As we go to press we learn from our publishers that the long-awaited book "Colour Television," by P. S. Carnt and G. B. Townsend, will be available at the end of July. The 478-page book, which costs 85s, describes the N.T.S.C. system with particular reference to 405 lines, but wherever there are differences between the 405, 525 and 625-line systems these are fully explained.

I.E.E. Council.—Officers and ordinary members elected to fill the vacancies on the I.E.E. Council which will occur on September 30th are:— President, G. S. C. Lucas (A.E.I., Rugby); vice-presidents, A. H. Mumford (G.P.O.) and Dr. R. L. Smith-Rose; treasurer, C. E. Strong (S.T.C.); ordinary members, Dr. J. Brown, (University College, London), Sir Robert Cockburn (Ministry of Aviation), Dr. J. S. McPetrie (Ministry of Aviation), G. Millington (Marconi's), Prof. C. W. Oatley (Cambridge University), P. L. Taylor (A.E.I., Manchester) and H. West (A.E.I., Manchester).

I.E.E. Electronics Committee.—The following have been elected to fill the vacancies occurring on September 30th on the committee of the Electronics and Communications Section of the I.E.E.:— Chairman, R. J. Halsey (G.P.O.); vice-chairman, J. A. Ratcliffe (D.S.I.R.); ordinary members, V. J. Cooper (Marconi's), H. Davies (B.B.C.), G. W. A. Dummer (R.R.E.), Dr. R. Feinberg (Manchester College of Technology), C. A. Marshall (*British Communications & Electronics*) and Dr. R. C. G. Williams (Philips).

B.S.R.A.—The proposal to change the name of the British Sound Recording Association to that of the British Audio Society was discussed at the recent annual general meeting but no change is being made. The re-elected officers include P. J. Walker (president), S. W. Stevens-Stratten (secretary), and R. L. West (technical secretary). The elected council members are R. J. Barton, P. M. Clifford, Hon. J. Dawnay, J. W. Maunder, J. Moir and E. B. Pinniger. To mark the Association's silver jubilee a convention is to be held at the I.E.E., Savoy Place, London, W.C.2, on October 13th, 14th and 15th.

E.C.M.A. are the initials of the recently formed European Computer Manufacturers' Association which has its headquarters in Geneva. The first president of the Association is C. G. Holland-Martin, Research Director of International Computers and Tabulators Ltd. Other U.K. manufacturer-members are:— A.E.I., E.M.I., Elliott Brothers, English Electric, Ferranti and Leo Computers. Four technical working committees are being set up to cover (a) Codes representing characters for use in computer "input" and "output," (b) Common programming languages, (c) Diagrammatic and symbolic representation of processes and (d) Character recognition.

B.R.E.M.A. Vice-Chairman.—E. P. Wethey (Kolster-Brandes) has been elected vice-chairman of the British Radio Equipment Manufacturers' Association in succession to W. M. York (E. K. Cole). A. L. Sutherland (Philips Electrical) remains chairman.

International Television Convention.—The "technological aspects of the whole television field" will be covered during the International Television Convention being organized by the Electronics and Communications Section of the I.E.E. for next year. It will be held at the I.E.E. headquarters in London from May 31st to June 7th. The chairman of the organizing committee is Dr. R. C. G. Williams of Philips.

Photomultipliers.—A symposium on photomultiplier tube applications is being organized by E.M.I. Electronics for September 13th to 15th. It will be held at E.M.I. House, Manchester Square, London, W.1, and a fee of 5gn will be charged. Applications for registration forms should be sent to E.M.I. Electronics, Ltd., Valve Division, Hayes, Middlesex.

Radio Components Show.—We regret that on p. 364 of the July issue a photograph of Sydney S. Bird's (Cylton) Type PC80 transistor push-button television tuner was inadvertently ascribed to A. B. Metal Products. We apologize to both companies for this error.

Colour TV.—The Television Society is organizing a refresher course of six lectures on colour television which will be held on the six consecutive Monday evenings from September 18th at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1. The course will cover a description of the N.T.S.C. system, transmission and receiver problems and the lecturers will be S. N. Watson (B.B.C.) and G. B. Townsend and P. Carnit (G.E.C.). Enrolment forms are obtainable from the Television Society, 166 Shaftesbury Avenue, London, W.C.2, the fee for non-members being two guineas.

Physics of semiconductors, rather than their applications, will be the theme of an international conference to be held at the University of Exeter from July 16th to 20th next year. It is being arranged by the Institute of Physics & Physical Society under the auspices of the International Union of Pure and Applied Physics and the British National Committee for Physics. Dr. R. A. Smith, of the Royal Radar Establishment who in September goes to the University of Sheffield as Professor of Physics, is chairman of the organizing committee. Details of the conference, attendance at which will be limited to 400, are obtainable from the organizers at 47 Belgrave Square, London, S.W.1.

Next year's I.E.A. Exhibition.—Applications from a record number of over 400 manufacturers, including many from abroad, have been received for participation in the fourth International Instruments, Electronics and Automation Exhibition which will be held at Olympia, London, from May 28th-June 2nd, 1962. The organizers are Industrial Exhibitions Ltd., 9 Argyll Street, London, W.1.

Paris Components Show, 1962.—Next year's International Components Show, organized by the Fédération Nationale des Industries Electroniques, will be held in Paris from February 16th-20th.

Noise Measurement.—A five-day course on the measurement of noise begins at the Royal College of Advanced Technology, Salford, on September 11th. Details of the course are obtainable from Dr. Peter Lord, at the College.

Network Theory.—A symposium on network theory will be held at the College of Aeronautics, Cranfield, Bucks., from September 18th-22nd, details of which are obtainable from S. R. Deards of the College's Department of Aircraft Electrical Engineering.

Cardiological Apparatus.—The annual exhibition organized by the Society of Cardiological Technicians of Great Britain will be held at the Londoner Hotel, Welbeck Street, London, W.1, on October 27th (5.30-9.0 p.m.) and October 28th (9.30 a.m.-1 p.m.).

The new address of the National Council for Technological Awards is 24 Park Crescent, London, W.1. (Tel.: LANgham 4879).

CLUB NEWS

North Kent Radio Society is again operating a station (GB3ENT) at the Borough of Erith's annual show at the Erith Recreation Ground on August 7th.

Stamford Radio Club is holding its first rally on August 27th at Burghley Park, near Stamford, Lincs.

Luton and District Radio Society is organizing a mobile rally on August 20th at Stockwood Park, Luton, Beds. The talk-in stations (from 10.30 a.m.) will be G3CGQ/A and G3JZW/A on 2 and 160 metres.

Silverthorn Radio Club will be operating a field station (GB3SRC) on the borders of Epping Forest from the evening of August 4th until the evening of the 7th. It will operate on 160 metres.

Personalities

G. Darnley-Smith, C.B.E., is retiring at the end of September from the managing directorship of Bush Radio Ltd., which he has held since the formation of the company in 1932, but he will remain on the board. He will be succeeded by **Dudley Saward** who has been managing director designate since February. Mr. Darnley-Smith relinquished the managing directorship of Rank Cintel Ltd., on June 30th and is succeeded by **J. C. G. Bell**, managing director designate since January. Notes on the appointments of both Mr. Saward and Mr. Bell appeared in our March issue (p. 118). Mr. Darnley-Smith is retaining the position of joint deputy chairman of the associated company Bush and Rank Cintel Ltd. He has been chairman of the Radio Industry Council's Television Reception Policy Committee since its formation in 1948 and is one of the two representatives of the R.I.C. on the Government's Television Advisory Committee.



G. Darnley-Smith



G. A. Smith

George A. Smith, who joined the Plessey Company in 1957, has been appointed general manager of the company's Electronic and Equipment Group of which he has been commercial executive for the past year. He spent the war years as a radar officer in 60 Group of the R.A.F. and was for 10 years with Pye, initially as a development engineer and later as export manager of the Pye Telecommunications Division.

Air Cdre. C. M. Stewart, C.B.E., has succeeded **A.V.-M. G. C. Eveleigh, O.B.E.**, as Director General of Signals at the Air Ministry, with the acting rank of Air Vice-Marshal. Since 1958 he has been chief electronics officer at Fighter Command. From 1955 to 1957 he was chairman of the Communications Electronics Committee of the N.A.T.O. Standing Group, Washington, and was subsequently Air Officer Commanding No. 27 Group Technical Training Command, R.A.F. A.V.-M. Eveleigh has become Air Officer, Administration, at Fighter Command.

R. J. Bailey has been appointed vice-president of The English Electric Corporation in New York, which was recently formed to co-ordinate the American activities of the English Electric Group. Mr. Bailey joined Marconi Instruments in 1938 and served in the Royal Navy during the War attaining the rank of Lieut. Commander as Radar Officer of H.M.S. *Formidable*. In 1946 he rejoined Marconi Instruments and was manager of their London office before going to America in 1954 as U.S. manager of Marconi Instruments which is, of course, a member of the English Electric Group.

Olliver W. Humphreys, C.B.E., B.Sc., F.Inst.P., M.I.E.E., technical director of the G.E.C. and director of the Hirst Research Centre, Wembley, has been appointed chairman of the new company, International Systems Control Ltd., which, as announced elsewhere, has been formed jointly by the G.E.C. and Thompson Ramo Wooldridge Inc., of Los Angeles. Mr. Humphreys, who is 58, joined the G.E.C. Research Laboratories (now the Hirst Research Centre) in 1925 and has been director for the past 10 years.

David N. Truscott, O.B.E., A.C.G.I., D.I.C., B.Sc., Ph.D., Sc.D., M.I.E.E., has been released by the G.E.C. from his position as general manager of its Electronics Division to become managing director of the new company, International Systems Control Ltd. Before joining the G.E.C. in 1951 Dr. Truscott had been in Government service for 12 years and from 1935 to 1939 was in the engineering department of Murphy Radio. He studied communications engineering at Imperial College, London, and then went to the Massachusetts Institute of Technology where he undertook research in communications and in 1935 received his Sc.D. degree. **Dr. Eugene M. Grabbe**, vice-president and a director of Compagnie Européenne d'Automatisme Electronique, an associate company of Thompson Ramo Wooldridge, has been appointed deputy managing director of I.S.C. The non-executive members of the board of I.S.C. are **G. W. Fenimore** and **M. E. Mohr** of T.R.W., and **W. A. C. Maskell, B.Sc.**, managing director of the G.E.C. Telecommunications Group, who has been with the company since 1925.

Eliot E. Dweck, L-e-S., A.M.I.E.E., recently joined the Westrex Co., as head of the Projects Division. He was at one time a departmental head in the Nelson engineering laboratories of English Electric Company and more recently has been engaged on special investigations into advanced problems of radar and computing equipment for Decca Radar. It is also announced by Westrex that **Commander F. Holmes** has been appointed a director with responsibility for sales.



E. E. Dweck



H. C. Briggs

H. C. Briggs, the new vice-president of Collins Radio International, is also the company's European manager, and as such has administrative responsibility for Collins Radio Company of England Ltd, and other European subsidiaries. Before joining Collins, with whom he has been Director of Government Relations in Washington for some time, he was vice-president of Hoffman Laboratories. His headquarters are in London.

G. S. C. Lucas, O.B.E., F.C.G.I., president of the I.E.E. for 1961/62, is a director and chief engineer of A.E.I. (Rugby), and a director of A.E.I. Sound Equipment. He joined the B.T.H. research laboratories in 1925 and was head of the electrical and development section from 1932 until 1944 when he became head of the electronics engineering department. He has been chief engineer of B.T.H. (now A.E.I. Rugby) since 1953. He received the Fellowship of the City and Guilds of London Institute in 1959 "for radar and electronic research and services in technical education."



G. S. C. Lucas



R. J. Halsey

R. J. Halsey, C.M.G., B.Sc.(Eng.), F.C.G.I., D.I.C., chairman of the Electronics and Communications Section of the I.E.E., is Director of Research in the Post Office and also a director of Cable & Wireless Ltd. He is well known for his work on the planning and engineering of the first transatlantic telephone cable and since 1959 has been controller of the joint G.P.O./C.&W. submarine cable and repeater development unit. He entered the engineering department of the Post Office in 1927 at the age of 25.

Frank Poperwell, Assoc. Brit. I. R. E., has joined the Derritron group of companies as group technical sales supervisor. He had been with the G.E.C. for 35 years. In 1945 he was appointed engineer-in-charge of the G.E.C. Radio Department's Sound Equipment Section and last year he became technical supervisor of the Sound Equipment Division. He is a vice-president and vice-chairman of the Association of Public Address Engineers.



F. Poperwell

G. D. Monteath, B.Sc., A.R.C.S., A.Inst.P., A.M.I.E.E., D.I.C., who joined the B.B.C. in 1947 as a research engineer, has been appointed head of the Television Group of the Research Department in succession to **Dr. R. D. A. Maurice** who recently became assistant head of the Department. Mr. Monteath was for five years in charge of the aerial section of the Research Department.

A. J. Henk, who contributes the article on page 425, is senior engineer (maintenance) with Alpha Television Services (Birmingham) Ltd. who operate the Midlands Independent Television Studio Centre for A.T.V. and A.B.C. Television. For 18 months prior to going to the Midlands in 1956 he was with the B.B.C.

J. W. Murray, M.B.E., Assoc.I.E.E., A.M.Brit.I.R.E., has relinquished his post as chief engineer of the Nigerian Broadcasting Corporation and is succeeded by **E. Credgington**. Mr. Murray went to Nigeria as chief engineer of the Department of Broadcasting in January, 1951, after serving in a similar capacity for four years in Northern Rhodesia. Prior to going to Rhodesia he was with the B.B.C. for seven years. Mr. Credgington has been assistant chief engineer (operations and maintenance) with the Nigerian Broadcasting Corporation since October 1957, prior to which he was in Malaya's Department of Broadcasting for 12 years. He was seconded from the B.B.C. to Malaya in 1945.

W. H. Taylor, B.Sc.(Eng.), M.I.E.E., education officer to the I.E.E. from 1947 until 1953 when he joined the G.E.C. as Controller, Education and Personnel Services, has been appointed Manager, Group Personnel Services of A.E.I. (Rugby).

OBITUARY

Dr. Lee de Forest died in California on June 30th, aged 87. He will be mainly remembered as the inventor of the "audion" valve (1906) which added a control grid to the Fleming diode, but this was by no means his only contribution to the early development of wireless. After long litigation he was finally awarded priority for the discovery of "feedback" and the oscillating valve and he was active earlier in the fields of spark and arc generation and later developed the "Phonofilm" a method of synchronizing sound with cinematograph film.

H. V. Griffiths, M.B.E., who had been engineer-in-charge of the B.B.C.'s Measurement and Receiving Station at Tatsfield since 1933, died on June 28th at the age of 59. He joined the B.B.C. in 1924 as an assistant maintenance engineer at the Birmingham transmitting station (5IT). He was engineer-in-charge of the experimental short-wave "Empire" station (G5SW) at Chelmsford for a short time before transferring to the Research Department in 1928. He was widely known as an authority on radio propagation and frequency measurement on which subjects he has contributed to *Wireless World*.

Leslie E. C. Hughes, Ph.D., B.Sc.(Eng.), M.I.E.E., who died suddenly on June 10th at the age of 57, was the first president of the British Sound Recording Association, 1946-8. His teaching career began in 1927 at the City and Guilds College, where he was a demonstrator. From 1932 to 1941 he was lecturer and degree-examiner at the College, and for 3 years from 1936 was evening lecturer at Regent Street Polytechnic and Northampton Polytechnic, London. Dr. Hughes was for a time with Multitone Electric Co. on hearing aid design and from 1943 to 1947 was head of the Research Dept., Broadcast Relay Service at their Wandsworth factory. In 1955 he became Head of Technical Publications for Ultra Electric.

Phillip D. Canning, the well known representative of the Plessey Company on many national and international councils and committees, died in Basle on July 1st whilst returning from a conference of the International Electrotechnical Commission in Interlaken. He was chairman of the sub-committee of the I.E.C. which deals with climatic and durability testing of telecom. He joined Plessey in 1933 and was for some years responsible for the development and production of transmitting equipment and for radio installation work. Since 1948 he had been acting as liaison between the company and trade associations.

Stanley G. Wilby, at one time editor of *Wireless & Electrical Trader* and for some years until 1959 head of the press and public relations section of the British Standards Institution, died on June 23rd aged 60. He had been in failing health for several years.

News from Industry

Bristol/Ferranti Bloodhound.—The Royal Swedish Air Force Board has placed a substantial order running into many million pounds with Bristol Aircraft Limited for the Bloodhound Mark 2 surface-to-air guided weapon system which is to be supplied to the R.A.F. Dr. Norman Searby, C.B.E., manager of Ferranti's Guided Weapons Establishment, has said that the most important single factor in the improvements in performance compared with the earlier version is the use of continuous-wave radar guidance, developed in conjunction with the Ministry of Aviation by Associated Electrical Industries and Ferranti. Sweden became the first overseas country to adopt a British guided weapon for defence purposes when she placed an order for Bloodhound I in 1958. The new contract is the largest overseas order yet placed for British missiles.

International Systems Control Ltd. has been formed jointly by the G.E.C. and Thompson Ramo Wooldridge Inc., of Los Angeles, with a share capital of £430,000 equally shared by the two parent companies. It will market industrial process control systems in the U.K., the European Free Trade Area and the Commonwealth. It is announced that this "venture is complementary to and in no way clashes with" the G.E.C.'s present association with International Computers and Tabulators Ltd. in the development and manufacture of digital computers. Details of the board of the new company, which will have its headquarters in London, are given on page 404.

Thorn-A.E.I. Tube and Valve Merger.—Thorn Electrical Industries and Associated Electrical Industries are merging their respective interests in the manufacture and sale of cathode-ray tubes and radio valves. Trade names involved include Mazda, Ediswan and Brimar. The productive capacity of both companies in this field, including factories at Sunderland, Harlow, Rochester and Footscray, will be pooled. Management of the new joint company will be vested in Thorn Electrical Industries with Jules Thorn as chairman.

Multimusic Ltd., a wholly-owned subsidiary of Multicore Solders Ltd., has disposed of all its interests in Reflectograph tape recorders to Pamphonic Reproducers Ltd., a member of the Pye Group. Service enquiries should be addressed to Pamphonic Reproducers Ltd., Westmoreland Road, Queensbury, London, N.W.9 (Tel: Colindale 7131). Other enquiries concerning Reflectograph recorders should now be sent to Pamphonic at 17 Stratton Street, London, W.1 (Tel.: Grosvenor 1926).

G.E.C.'s Applied Electronics Laboratories at Stanmore, Middlesex, have been entrusted with the development of the guidance receiver for the Mark 2 Seaslug ship-to-air missile, the existence of which was made known in the recent Navy Estimates. Four County Class destroyers are about to start their operational careers with Seaslug 1 for which the G.E.C. was responsible for the development of the guidance receiver.

India's first transistor manufacturing company—Semi-conductors Private Ltd.—has been established in Poona. Raytheon Company, of Lexington, Mass., owns a one-third interest.

Iraqi Ports Authority has placed a £100,000 contract with Pye for the supply and installation of a v.h.f. and u.h.f. radio-telephone network for the country's marine and air ports.

British Railways' first multi-channel radio-telephone system is to be installed between York and Newcastle via Darlington—a distance of 78 miles—with two intermediate repeater stations. The radio equipment operating on a frequency of 7500Mc/s is to be supplied and installed by Marconi's and the carrier equipment by A.T.E. The system is designed for a maximum capacity of 300 telephone channels, but initially 180 will be in operation.

Ireland's first centimetric radio link for trunk telephone transmission, which was installed by S.T.C., has been brought into service. The 7400-Mc/s system, which links Galway, Cappataggle and Athlone, can handle 240 telephone circuits on each of two biway radio-frequency channels.

Anglo-Swedish Link.—The Electronic Apparatus Division of A.E.I. has been appointed sole agents in the U.K. and the Commonwealth (except Canada) for the Carousel random access magnetic-tape memory manufactured by Facit Electronics AB, of Sweden. A.E.I. will also handle the transistorized high-speed tape punch and reader made by Facit.

Decca wind-finding radars (five) and a weather radar have been ordered by the British Government for deployment along the air route Ankara-Teheran-Karachi as a contribution under its programme of technical assistance to the regional countries of the Central Treaty Organization. Decca wind-finding radar has also been ordered by the government of Indonesia for its Meteorological Department.

Ever Ready's consolidated net profit for the year ended in February, after all charges, including taxation, amounted to £1,706,526, an increase of £155,544 on the previous year's figure. The taxation charged was £1,368,932.

Currys, the retail radio and cycle company with a total of 325 branches, report a record group profit for the year ended on January 28th of £1,516,467 before taxation. This figure was an increase of £313,700 on the previous year. The total capital and reserves of the company and its subsidiaries is £5,710,791.

A. H. Hunt (Capacitors) Ltd., which this year celebrates its silver jubilee, reports a gross trading profit for 1960 of £487,397.

Simms Motor and Electronics Corporation, of which N.S.F., Cawkell Research & Electronics and Dawe Instruments are subsidiaries, records a group net profit of £702,647 in 1960 against £489,490 the previous year.

Johnson Matthey are now able to supply scandium, yttrium, and most of the 14 rare earth metals in sheet form in thickness down to 0.001in and with a maximum width of three inches. The sheet is available either cold worked or annealed.

SCI Designs Ltd., 30-34 Ingate Place, Queenstown Road, London, S.W.8, has been formed to produce economically transistor inverters and converters to specifications outside the standard ranges already on the market.

Hammarlund Manufacturing Co., Inc., the well-known New York manufacturers of telecommunications receivers, this year celebrate fifty years in the radio industry.

Versatile Stereophonic Pickup

NECESSITY FOR LOW TIP MASS

By J. WALTON*

THE July issue of *Wireless World* contained a report of some preliminary research which is used here as the basis for the design of a stereo pickup to track without impairing the recorded modulations. As will be shown, very few stereo pickups are at present capable of reproducing all that is recorded on a modern stereo disc.

Now, the main conclusions drawn from the above-mentioned work were (a) that the relation between tracking weight and stylus radius was apparently a linear one (*not* a square law) as far as record reproduction is concerned, and (b) that the motion of the record advantageously affected the upper weight limit for elastic tracking.

(Unfortunately certain errors were made in this article, namely that in Figs. 5, 11 and 12 the "stylus friction" is in fact the side thrust. In order to obtain the stylus friction the values given should be multiplied by 1.8. Similarly, apparent inconsistencies between Figs. 6, 7 and 8 arise because in general the stylus radii quoted are nominal values only and in particular the "0.0005"-in radius stylus used for the results of Fig. 6 had a larger radius than the other "0.0005"-in styli.)

It should be noted that many of the stylus indent measurements were in the region of 1.5 micro-inches (which is about one-tenth of the wavelength of light) and are near the limit of audibility in relation to any signal or noise content of the present record groove. Consider a signal recorded at the standard level of 1cm/sec at 1kc/s. The useful range of a normal stereo record on standard reproducing equipment may be from +26dB to -26dB referred to this, where the requirement for the groove not to be inclined at more than 45° to its unmodulated direction (so that the stylus does not ride obliquely up the groove wall) sets an upper limit on velocity, and amplifier and recording tape noise and reproducing turntable rumble set a lower limit. It should be noted that the disc material itself as "seen" by the stylus has a surface roughness that is less than 1/20th of the wavelength of light.

Consider a signal that is still usefully audible, e.g. a 10kc/s tone recorded at a level corresponding to a

Fig. 1. Stylus in an unmodulated groove. *S* is the stylus stress.

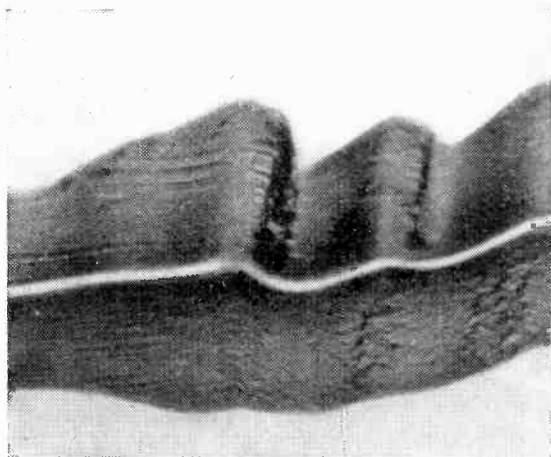
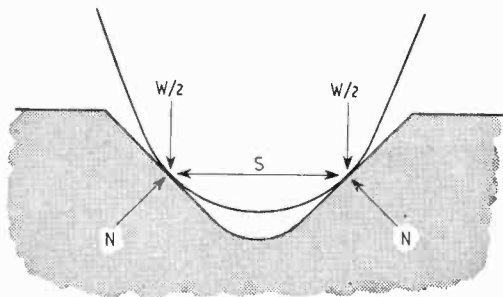


Fig. 2. Optical micrograph of an unplayed record with a fantastic modulation velocity—since the groove turns a complete right angle! No names—no pack drill—and no guesses please.

velocity of 20dB below a 1cm/sec, 1kc/s tone. The 10kc/s recorded level (C.C.I.R.) will be 5cm/sec minus 20dB. This corresponds to an amplitude of $0.5/2\pi \times 10^4$ cm or 3×10^{-6} in, which is $\frac{1}{4}$ th of the wavelength of light. The elimination of tape noise and reproducer turn-table rumble could make the present gramophone record capable of a range of nearly 70dB since the above signal could ideally be reduced a further 15dB or so before it merged with the minute surface roughening of the vinyl pressing caused by the action of even the best recording cutters. Recourse to an indenting process for the recording of a master record might conceivably add a few more decibels to this already enormous possible range, or rather the improvement might be used in conjunction with a smaller groove to give an extended playing time.

Considering the above and on examination of an electron micrograph (Fig. 10) it appears that, at up to about 2 gm force on a "half-thou" stylus tip and normal to the plane of the record material, the deformation of the record even after repeated playings is one of depressing the surface irregularities to even greater smoothness and is not of a magnitude that exceeds such original roughness as may exist. This is confirmed audibly, since below about 1-gm tracking force there appears a rather more transient, crackly sort of surface noise on the first few playings of "mint" discs. So if we consider an unmodulated groove (Fig. 1) we find that, for the normal reaction *N* on the groove wall not to exceed 2gm, the stylus force *W* must be below $2N/\sqrt{2} = 3$ gm.

Now considerable controversy is apparent over the

*Decca Record Co., Ltd.

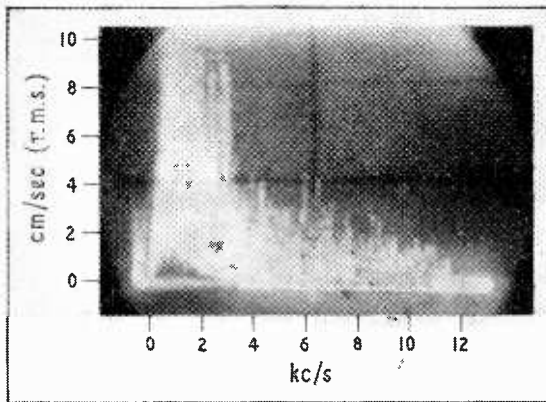


Fig. 3. Several minutes time exposure of output (in terms of modulation velocity) of a 1½-gm pickup with a 0.4mgm tip mass when playing Tchaikovsky's 1812 Overture.

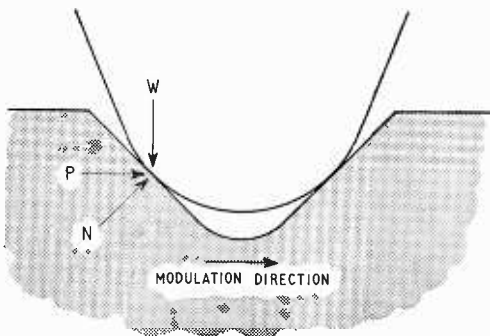


Fig. 4. Stylus in a groove modulated laterally (rightwards)

extent of recorded modulations, particularly in the upper register, and this can become a weak link in the chain of factors involved in a pickup design. Signals as large as 20cm/sec at 10kc/s have been mentioned and, of course, examples such as shown in Fig. 2 (not a Decca disc!) can be found. Fig. 3 however shows several minutes time exposure of velocities on an oscilloscope when Tchaikovsky's 1812 Overture is reproduced with a 1½-gm pickup having 0.4-mgm tip mass. This shows a common feature of no velocities greater than 4cm/sec r.m.s. above 2½ kc/s.

Even where there are higher levels, the radius of curvature of the modulation soon becomes less than that of the stylus at low groove speeds. At the condition where the groove curvature is the same as the stylus radius the acceleration would be infinite if the materials were infinitely hard. Now the maximum radius of curvature of a sinusoidal modulation = $S^2/2\pi fV$ where S is the groove speed, f the frequency and V the peak velocity of modulation. Therefore, for example, for a 0.0006-in radius stylus and a 45° 10-kc/s signal, even at an average diameter of 8in, the r.m.s. velocity at which the modulation curvature is equal to the stylus radius is given by $(\pi \times 8 \times 2.54 \times 33\frac{1}{60})^2/2\pi \times 10^4 \times 6 \times 10^{-4} \times 2.54\sqrt{2} = 9\text{cm/sec}$.

From this set of conditions on, the stylus cannot possibly trace, let alone track, to say nothing of the

inevitable damage to the record. However, consideration of even some of the better pickups now available shows that they often fall far short of much more modest requirements than those of ultimate physical possibility which should have no place on a truly high-quality recording.

Let us consider the Decca frequency test record (SXL 2057) which, with its 5cm/sec r.m.s. at 10kc/s towards the outer diameter of the disc, presents a criterion for tracking capabilities which should surely be universally acceptable as a minimum requirement at least. To find out what tip mass is necessary to track this level of modulation (either laterally or at 45°) with not greater than 2 gm force normal to the groove wall consider first the lateral case (Fig. 4).

If P is the accelerating force, then at the tracking limit, since the groove wall is at 45°

$$P = W$$

$$\text{If } N \leq 2\text{gm}$$

$$\text{Then } W = N/\sqrt{2}$$

$$\leq 1.4\text{gm}$$

$$\text{Now } P = m\alpha$$

where m is the stylus tip mass and the recorded acceleration

$$\alpha = 2\pi \times 10^4 \times 5\sqrt{2}\text{cm/sec}^2$$

$$= 450\text{g (neglecting the small effect of groove curvature due to tracing with a finite stylus)}$$

$$\therefore m \leq 1.4/450\text{gm}$$

$$\leq 3.1\text{mgm}$$

If a pickup is to track this level of modulation at 45°, the force supplied by the tracking weight W must be sufficient to accelerate the tip mass to 450g when the wall is receding (see Fig. 5a).

$$\therefore W/\sqrt{2} = 450m \quad \dots \quad (1)$$

When the modulated wall is advancing (Fig. 5b), since there is no vector of the accelerating force P normal to the unmodulated groove wall, there is

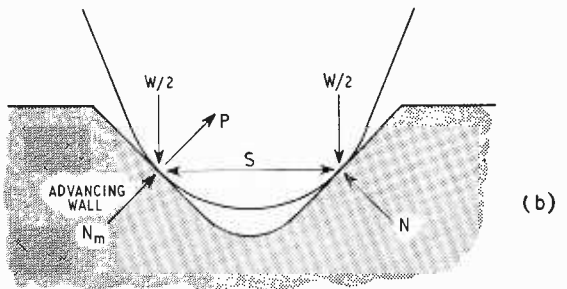
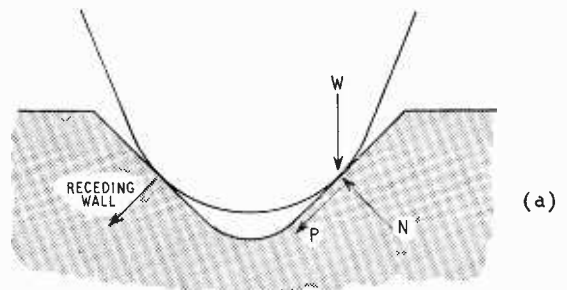


Fig. 5a. Stylus in a 45° modulated groove with the modulated wall (on the left) receding.

Fig. 5b. Stylus in a 45° modulated groove with the modulated wall (on the left) approaching.

no change in the static reaction normal to this wall, and so W is equally distributed on to both walls. Thus the reaction normal to the advancing wall

$$N_m = P + (W/2 + S)/\sqrt{2} \quad \dots \quad (2)$$

Now $S = W/2$, $P = 450m$ and N_m must be $\leq 2gm$

$$\therefore N_m \leq 2 = 450m + W/\sqrt{2}$$

$$\therefore m \leq 2/900gm \text{ from equation (1)}$$

$$\leq 2.2mgm$$

And substituting m in equation (1)

$$W \leq 450\sqrt{2} \times 2.2/1000$$

$$\leq 1.4gm$$

This is for a pickup tracking without any other, lower, frequency to cope with at all, so in order to track even the test record levels of modulation under practical "music conditions" without any groove deformation at all the pickup must have a combination of a tip mass of 1 mgm, a compliance of 10×10^{-6} cm/dyne (see *Wireless World* for April 1959, p. 182) and a tracking weight of $1\frac{1}{2}$ gm. If this pickup has also some mechanical resistance incorporated in the stylus movement (which I would consider desirable from an operational point of view, and almost essential for smooth response in a piezo-electric type of pickup) then the above impedance figures must be made still smaller. The output from such a pickup becomes proportionately smaller, and its use becomes restricted to more specialized amplifier equipment. It was considered therefore that provided that the waveform suffers no permanent deformation and that the groove itself is merely smoothed after a hundred or so playings, the most useful arrangement could be achieved. To this end, whilst it is clear that the tip mass must remain less than 2 mgm, the tracking weight could conceivably be raised to 3mgm, the extra tracking weight either in itself or with its associated lower compliance not causing any differential deformation of the groove and thus no distortion of the waveform.

Comparative Assessments

Now the best available ceramic-element cartridge which audibly tracks at the bottom limit of its recommended 2 to 4 gm but has a tip mass of 3mgm was assessed on the above theoretical basis. (The harmonics of non-tracking above 7kc/s, whilst not directly audible, are still the result of the most critical record wear and lead to loss of clarity.) In the 45° case a tracking weight of $450 \times 3\sqrt{2}mgm = 1.9gm$ is required. This means that for practical tracking purposes, even allowing only for a vector addition of low- and high-frequency modulation forces, the tracking weight is required to be $1.9\sqrt{2} = 2.7gm$. (A vector addition not only gives the "benefit of the doubt" to the 3-mgm pickup, but is also consistent with the direct comparison of both the 3-mgm and 1-mgm styli at the same tracking weight, as shown photographically.) With a 2.7-gm tracking weight a 3-mgm stylus produces a normal reaction (see equation 2) of $450 \times 3 + 2.7/\sqrt{2} = 3.25 gm$ on the advancing modulated wall. Thus, according to the figures determined in the previous article, at the crest of the modulation wave the indentation rises sharply to between 4 and 10 micro-inches compared to practically nil elsewhere. Now the peak amplitude of the modulation is given by $5\sqrt{2}/2\pi \times 10^4 cm =$

44 micro-inches. Thus up to 25% of the 10 k/cs modulation on the test record will be removed on the very first playing. If the tracking weight is increased the indentation is greater; if it is decreased the stylus cannot follow the undulation and the impacts between stylus and groove cause even greater destruction. Thus it is impossible to track even the test record modulation levels with a pickup which has a tip mass of 2 mgm or over.

Optical micrographs demonstrate this with considerable visual emphasis (see Figs. 6, 7). They also show that after 250 playings of the new pickup with the 1-mgm stylus, at the same tracking weight of

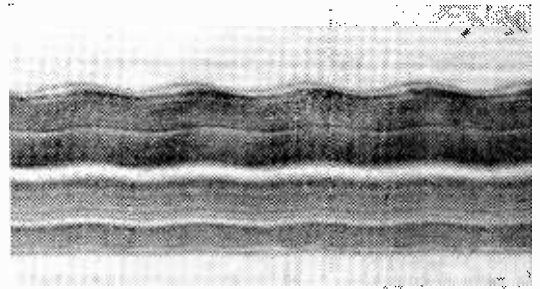


Fig. 6. Optical micrograph (X300) of un-played 5cm/sec r.m.s. 10kc/s stereo test record groove.

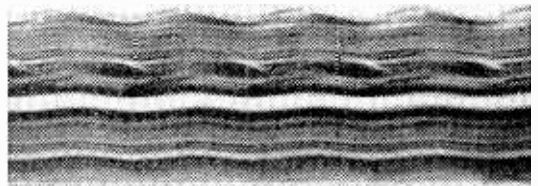


Fig. 7. Optical micrograph (X300) of 5cm/sec r.m.s. 10kc/s stereo test record groove taken after one playing with a 3-mgm stylus at 2.7gm tracking weight.

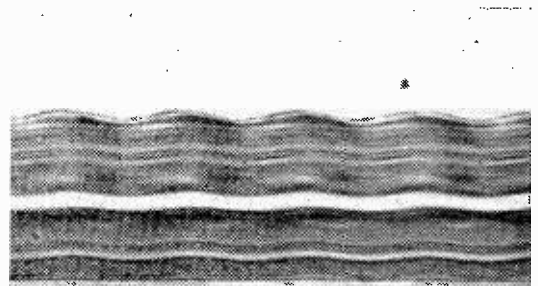


Fig. 8. Optical micrograph (X300) of 5cm/sec r.m.s. 10kc/s stereo test record groove after 250 playings with a 1-mgm stylus at 2.7gm tracking weight.



Fig. 9. Section of a flattened electron micrograph impression (X2400) of 5cm/sec r.m.s. 10kc/s stereo test record groove taken after one playing with a 3-mgm stylus at 2.7gm tracking weight. While the width of the indent shows a depth of permanent deformation equal to nearly half the amplitude of the modulation, the actual path of the stylus described on the unmodulated wall indicates that it penetrated to a depth nearly equal to that of the modulation.



Fig. 10. Section across similar groove to Fig. 9 taken after 250 playings with a 1-mgm stylus at 2.7gm tracking weight. The path of the stylus is only perceptible as a smoother surface.

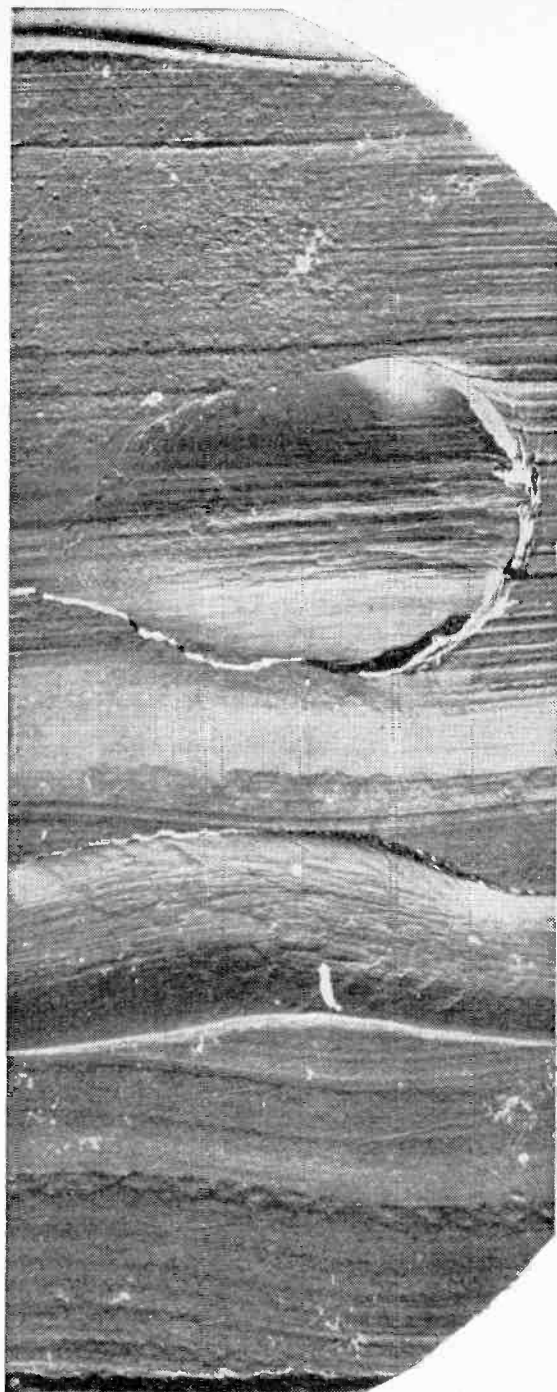


Fig. 11. Section across similar groove to Fig. 9 after repeated playings with a 3-mgm stylus at 2.7gm tracking weight. It can be seen from the path of the stylus described on the unmodulated wall, and from the fact that there is no loss of contact, that the original modulation has been completely obliterated.

2.7 gm, there is no practical deterioration of the groove (see Figs. 6, 8).

Electron micrographs verify the above quantitatively showing that even at the first playing the 3-mgm stylus does not track the test record but ploughs through the crests 40° out of phase with the original signal, penetrating to a depth equal to that of the original modulation and leaving a depth of permanent deformation equal to nearly half of this (see Fig. 9). They also show that after 250 playings with the 1-mgm stylus at the same tracking weight of 2.7 gm, the groove surface is if anything improved and the waveform itself is nowhere distorted (see Fig. 10). After repeated playings of the 3-mgm stylus it can be seen from Fig. 11 that not only has the active groove wall been indented to a depth equal to that of the original signal and 120° out of phase with it, but that a modulation has been indented on the inactive groove wall to a depth of the order of the amplitude of the "wanted" signal. *In other words, a large stylus tip mass could eventually ruin the upper frequency separation of a stereophonic disc, no matter what the channel separation of the pickup itself might be.*

With the exception of Fig. 2 all these micrographs are of the 10kc/s band of the Decca stereo frequency test record (SXL 2057). This photographic evidence has been prepared by Dr. P. Chippindale of the Royal College of Advanced Technology, Salford, by a process which he has specially developed. The electron micrographs are taken from carbon replicas of the groove walls. During the replicating process the carbon film becomes somewhat flattened and therefore some of the indentations will in fact be deeper than they appear. There is also some buckling at the bottom of the groove (appearing lighter). Small cracks occasionally appear in the replica because of the very delicate nature of the carbon film. In spite of this the lines left by the cutter still provide a datum for accurate quantitative interpretation.

Stylus Arm Design

With the validity of a 1-mgm half-thou stylus, tracking at 3 gms thus proven, the remainder of the pickup design followed therefrom in a similar manner to that described for a mono pickup in *Wireless World* for April 1959. The problem of achieving adequate channel separation is considerably aggravated by the flexible stylus arm used in this type of design, for here the transducing elements are more free of positive control by the record groove. This was particularly confusing in the early stages of development when it was found that transmission of impulses from the stylus to the elements was taking place through the rear of the assembly. When this was eliminated the separation became the usual 20dB over the main mid-audio range. The suspension pocket was then arranged for practically aperiodic response to amplitude excitation from its front end. A frequency response within ± 1 dB to 12 kc/s could be achieved experimentally and ± 2 dB overall for production, practically regardless of how flimsy a stylus arm was used. Before further experiment with the stylus the transmission geometry was finally adjusted (by angling the ceramic elements and offsetting the 45° transmission arms to them) to allow for its dynamic flexing conditions and to achieve maximum separation. The complete complex moulding (see Fig. 12) is a feat of modern tool-making

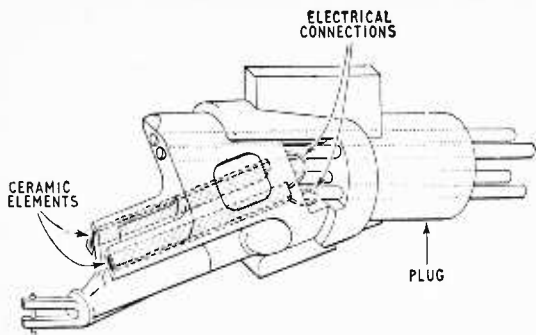


Fig. 12. Schematic side view of new stereo pickup with cover removed.

for which all credit must go to Ablex Tools Ltd. whose skill and patient co-operation have made it possible. Although the form and function of this "suspension" is long since finalized, development is still proceeding which should eventually lead to automatic production of the whole pickup.

Vertical Motion

One problem of a stereophonic pickup stylus is that its vertical motion must be such as to cause negligible vertical tracking error distortion (see *Wireless World* for July 1960, p.340).

Several stereo pickups have nearly 30° such error which would be considered intolerable by lateral tracking standards. In order to improve this motion and still give tolerance on the clearance of the remainder of the pickup above the record surface, a "parallel-motion" linkage system was arranged in the stylus arm (see Fig. 13). By using a material of lower mechanical resistance for the stylus arm than for the remainder of the transmission, the linkage system is made more operative where velocities are larger and tracking errors become more important. The actual improvement is only four or five degrees for slow vertical motion, but is greater when the decoupled tip mass moves more independently of its support, i.e. when the parallel arms flex most. This construction also has the advantage of reducing the vertical tip mass (and increasing the vertical compliance) for a given longitudinal stiffness. The final version will have the stylus moulded *in situ* (patent pending) so as to give greater robustness at this point.

Since all-round usefulness of the pickup is an

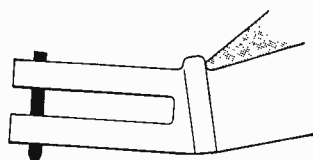


Fig. 13. "Parallel motion" stylus arm linkage system.

important consideration the stylus is made in replaceable form. In fact special materials have been produced with the aid of I.C.I. Plastics Division and is possible by changing the stylus arm material, to change the tracking weight, tip mass, compliance and output of this pickup at will. A stylus with a 0.6-mgm tip mass and a tracking weight of 2 gm giving a pickup output of 30 mV/cm/sec will be available, as well as the standard one with diamond tip, 1-mgm tip mass, tracking weight of 3 gm and an output of 60 mV/cm/sec (i.e. about $\frac{1}{2}$ V from many recordings).

Measuring Tip Mass

The figures quoted are for the "total effective tip mass" and it may be as well to mention here that the usual methods of measuring tip mass either by finding the upper resonance of the pickup (stylus-groove resonance) or its free resonance (with its own compliance) do not work well with this type of pickup, owing to its decoupled stylus tip and somewhat distributed mass. The methods used were those of measuring the pickup's reaction to groove acceleration and also watching its tracking performance by observing its output wave-shape on an oscilloscope, whilst varying the tracking weight (on a previously unplayed test record). This gives the effective tip mass at any frequency and will include some vector addition due to mechanical resistance in the stylus arm.

In fact it is more important to consider not only the component parts of the mechanical impedance of a pickup stylus (i.e. mass, compliance and resistance) but also its impedance over the whole frequency range. Fig. 14 shows a limiting curve according to record modulation levels which takes into account the necessity of much lower strains on the smaller undulations at the high-frequency end of the scale. It can be shown in practice that beyond the region 4 to 7kc/s there is a rapid falling off of the recorded amplitude and wavelength combined with an increase in the acceleration, so that above this region the effects of replay deformation and wear become much more serious. The tracking performance of one of the better 5-gm ceramic pickups is shown in Fig. 14 as well as that of the 2-gm pickup with the 3-mgm stylus mentioned before. It is interesting to note the rise in tracking impedance due to an internal resonance of the former pickup compared with the smooth curve of a "decoupled" stylus. A rough comparison might be made by listening to the needle talk from a

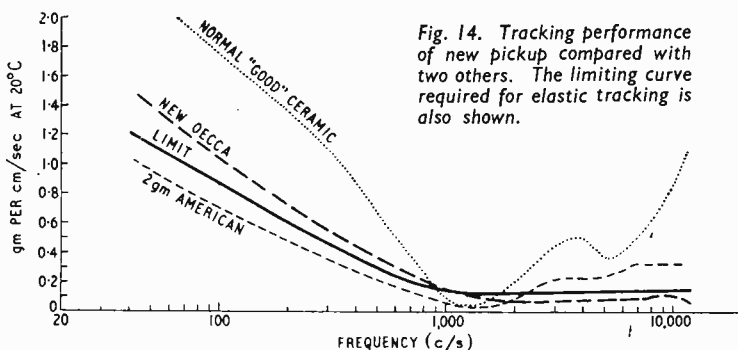


Fig. 14. Tracking performance of new pickup compared with two others. The limiting curve required for elastic tracking is also shown.

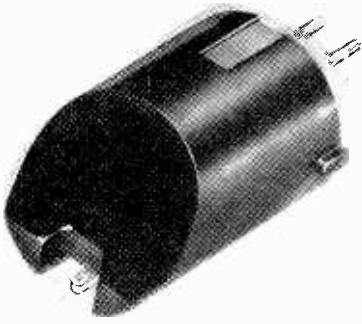


Fig. 15. Photograph of new stereo pickup.

frequency record. I specify frequency record because it is then possible to distinguish between that impedance that is resistive and may make a louder noise on mid-frequencies without damaging the record, and the upper register noise which indicates the first and most critical source of record damage.

Whilst on the subject of stylus construction it may be of interest to mention that the actual stylus tip has been made visible over a wide angle in order to ease accurate positioning of the pickup on to the record (see Fig. 15).

A criticism of piezo-electric type pickups may be their variability with temperature. In this case the softening of the plastic stylus arm may be said to be an advantage in that the effective tip mass decreases somewhat as the compliance of the stylus increases with temperature. Thus the vinyl record groove is appropriately under proportionally less strain at higher temperatures. The pickup has been operated satisfactorily, response- and separation-wise, at temperatures of 55°C, when the output is reduced by about 7dB on the normal 20°C room temperature.

A universal fixing bracket enables the pickup to be mounted in record changers where the arm may

be balanced, the 3½ gm of the pickup head itself being then added and used as the tracking weight. For the cheaper changers that need several grams to operate their mechanisms alone, a special high-output stylus will be available that can withstand over 6 gm playing weight.

This should prove to be a very inexpensive stereophonic pickup and to take advantage of this a suitable pickup arm for both transcription and changer purposes is also being developed which should then enable both types of users to operate at the lighter tracking weights.

Production testing of a pickup of this sort could add appreciably to its cost and offset much of the gain of its simple assembly. The production of a special test record enables this pickup to have a thorough test on production that would otherwise hardly be economic even on the most expensive pickups.

It is felt that Dr. Chippindale's photographic evidence shows that the considerable research and development which has laid the basis for this pickup has borne useful fruit.

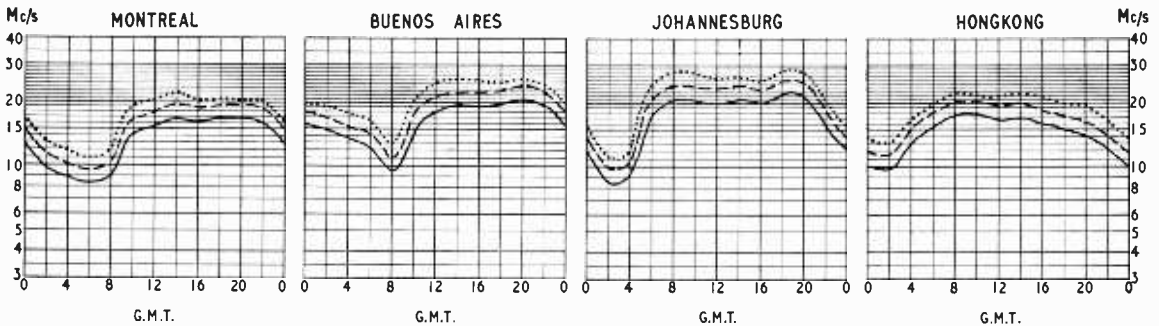
Transistor Data

COMPILED primarily as an adjunct to the Avo Transistor Analyser, "International Transistor Data Manual" contains details, we estimate, of about 2,500 transistors. In some cases the parameters listed are somewhat limited in scope; but generally should serve to indicate suitable types and for the working out of rough circuit values. In the first part of the data types are classified into American and European (pp. 16-65) followed by a short list of CV types and some connection details. The remaining 78 pages form a "stop-press" unclassified list. A most valuable feature of the book is a list of manufacturers names and addresses and, in the case of overseas firms, their agents or subsidiaries in Great Britain.

The "Avo International Transistor Data Manual" edited by C. E. Bull and published by Avo Ltd., Avocet House, 92-96 Vauxhall Bridge Rd., London, S.W.1, costs £1 15s by post.

SHORT-WAVE CONDITIONS

Prediction for August



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 August.

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

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

TECHNICAL NOTEBOOK

Two-Signal Bridges are discussed under this title in an article by G. W. Short in the December 1960 issue of *Electronic Technology*. In a normal four-arm bridge, either the signal source or the detector must be left floating since they are connected to opposite bridge diagonals. This could, in principle, be avoided by connecting a rectifier in the normal detector position across one bridge diagonal and placing the detector at an earthed point either in series with one of the arms or in series with the signal source. With this arrangement, when the bridge was off-balance the signal across the rectifier would result in a d.c. output and signal harmonics being produced in the detector. Unfortunately the exact balance point would be difficult to determine by this method since rectifier efficiencies are low at low input levels. This difficulty can be avoided by using two very-different bridge input frequencies and detecting the intermodulation products (produced by the rectifier) between the signal and other input frequency (their differences frequency, for example). If the bridge is nearly balanced at one input frequency, it will be well out of balance at the other. This other frequency will thus produce a substantial signal across the rectifier so that its intermodulation efficiency will be high. In a somewhat different system, one of the intermodulation frequencies produced by the rectifier is used as the signal frequency so that the rectifier then acts virtually as a compact floating oscillator. Another advantage of using two input frequencies is that the input and detector frequencies are different and so can be carried on the same cable. This would, of course, be very useful for making measurements at a distance.

New Display Device:—When mechanical stresses are applied to a flat plate of piezoelectric material, electric charges are developed on the face of the plate. Electroluminescence involves the excitation of a phosphor by the application of an electric field, which causes the phosphor to give out light. The new device, developed by Stephen Yando of General Telephone and Electronics Laboratories, Inc. (U.S.A.), combines these effects, consisting of a thin, flat panel composed of a piezoelectric ceramic material, one surface of which is coated with a layer of electroluminescent material. When signals are applied to electrodes on the edges of the panel, acoustic travelling waves are propagated in the ceramic and

the electric fields accompanying the acoustic waves cause the electroluminescent layer to produce a "spot" of illumination on the panel. The position of the spot is controlled by varying the relative timing of the electrical pulses to produce a wave pattern and the light intensity is modulated by varying the electric field applied by a transparent conductive layer covering the electroluminescent layer.

High-conductivity Springs are a necessity in many miniature components where, for instance, the current-carrying capacity of a contact may well be limited by the rise in temperature due to its internal power loss. Johnson Matthey have recently introduced a new alloy, Mallory 53, which has mechanical properties at least as good as those of the common phosphor-bronze materials, combined with electrical conductivity between 40% and 45% of that of the interventional annealed-copper standard. The thermal conductivity, too, is high and this aids the cooling of spring contacts. Mallory 53 is also less prone to the formation of high-resistance oxide films at high temperatures.

Aerial Matching:—As is well known, the impedance of an aerial drops considerably when parasitic elements are fitted: so much so, in fact, that the impedance of a folded dipole, made from one length of tubing and consequently of constant diameter, falls from 300Ω to 50 to 70Ω when used in a Yagi array. So that different-diameter sections are not necessary to restore the impedance to 300Ω for the matching of ribbon feeder Antiference are using transformers wound on dumb-bell-shaped ferrite sections. These transformers drop into the connection box on the aerial insulator, mounting on the terminals therein. Alternatively $75-\Omega$ coaxial cable can be used and the transformer (which now has to transform unbalance to balance also) is fitted at the set end of the feeder in a small moulded box.

Character Recognition by autocorrelation is being investigated by Dr. M. B. Clowes and Mr. J. R. Parks at the National Physical Laboratory. The points of overlap between displaced rotating images of the character are determined. Straight lines will tend to overlap along their length at one angular rotation position whereas curves will tend to overlap at one point over a range of

angular rotation. The position of straight lines and curves can thus be found and the character recognized.

Microwave Mekometer is an instrument developed by the National Physical Laboratory for the measurement of distances above 10 metres to an accuracy of a few thousandths of a centimetre. A crystal of ammonium dihydrogen phosphate is placed in the electric field of the output of a magnetron, oscillating at $9,300\text{Mc/s}$. Plane-polarized light, obtained from a xenon flash, is transmitted by the crystal, but by virtue of the properties of the crystal in an electric field, the emergent beam is elliptically-polarized, and the direction of rotation is reversed twice in each cycle of the microwave oscillation. The magnetron and flash tube are pulsed to avoid damage to the crystal. The polarization-modulated light beam is aimed at a distant reflecting prism—from which it is returned, via a light path of variable length, to the crystal. On emerging from the crystal, the elliptical polarization is either enhanced or degenerated, depending on the relative phases of the modulation and the microwave field across the crystal. The resultant signal is focussed on to two photoelectric detectors—in the case of one, via a polarizer. The output of the detector fed via the polarizer will vary in intensity due to the effect in the crystal, and the difference in the two signals, displayed on a meter, is a measure of the distance between the crystal and the reflector in relation to the modulation wavelength. If the process is performed at three settings of the magnetron frequency, and a null obtained on the meter each time by use of the micrometer-controlled variable light path, it is possible to calculate the distance.

New Superconductor developed at the Bell Telephone Laboratories—a niobium-tin compound (Nb_3Sn)—remains superconducting at much higher magnetic fields and temperatures than other known substances—in fact up to at least 88,000 gauss and 18°K . This compound should thus be of great value in making very-low-loss high-flux solenoid magnets. Nb_3Sn is normally very brittle, but Bell have developed a method of making it inside a hollow niobium tube which is already formed in the required solenoid shape. With this method of manufacture, the superconducting Nb_3Sn can carry currents of over $150,000\text{A/sq cm}$.

Transistor Measurements

2.—CONTINUATION OF THEORY, MEASUREMENT METHODS

By C. BAYLEY

LAST month we saw how four-pole and the basic "T" transistor parameters are related to actual quantities measurable in a circuit. In this concluding instalment we shall examine hybrid- and conductance-parameter terms and consider some means of measuring their various values.

Basic Parameters Expressed in Conductance and Hybrid-parameter Terms

Very often transistor parameters are expressed by conductance terms because in high- α junction transistors, due to the very small alternating base current, it is easier to create constant-output or -input voltage conditions by short-circuiting the respective circuits to a.c. No formulae will be deduced and only the basic principle of setting out equations is given.

Looking back to Fig. 4 (repeated here for convenience) and the general relation between $I_1 v_1 I_2 v_2$ (using again the general notation, as "1" might

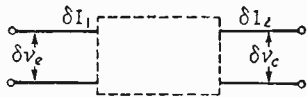


Fig. 4. Four-pole-parameter representation of transistor. Here measurable quantities are labelled generally 1 (input) and 2 (output) and replaced by notation appropriate to mode of connection. For instance, mode: common base, then 1 becomes e and 2 becomes c (repeated).

indicate either emitter or base quantities) a different set of equations can be written:—

$$I_1 = f_1(v_1 v_2) \dots I_2 \text{ constant}$$

$$I_2 = f_2(v_1 v_2) \dots I_1 \text{ constant}$$

which, rewritten with conductance terms, become:—

$$I_1 = G_1(v_1 v_2) \dots \dots \dots (29)$$

$$I_2 = G_2(v_1 v_2) \dots \dots \dots (30)$$

Operating by increments now, δI_1 and δI_2 can be expressed as:

$$\delta I_1 = \frac{\partial I_1}{\partial v_1} \delta v_1 + \frac{\partial I_1}{\partial v_2} \delta v_2 \dots \dots (31)$$

$$\delta I_2 = \frac{\partial I_2}{\partial v_2} \delta v_1 + \frac{\partial I_2}{\partial v_2} \delta v_2 \text{ and } \dots \dots (32)$$

$$\delta I_1 = g_{11} \delta v_1 + g_{12} \delta v_2 \dots \dots (33)$$

$$\delta I_2 = g_{21} \delta v_1 + g_{22} \delta v_2 \dots \dots (34)$$

g_{11} g_{12} g_{21} and g_{22} are the input, feedback, forward and output conductances of the transistor for $\delta v_2 = 0$ $\delta v_1 = 0$ $\delta v_2 = 0$ and $\delta v_1 = 0$ conditions respectively (short-circuited output or input circuits)

As with the relation between internal resistances and four-pole r parameters, there is similar relation between conductance four-pole parameters (as above) and conductance parameters forming a π network.

Apart from π and T parameters which are used in

both the U.S.A. and this country there is also a π hybrid-parameter system, used mostly here. It is based on another, mixed set of equations such as:

$$v_1 = f_1(I_1 v_2) \dots I_2 \text{ constant} \dots (35)$$

$$I_2 = f_2(I_1 v_2) \dots v_1 \text{ constant} \dots (36)$$

After similar transformation as in the two foregoing cases, incremental relations for δv_1 and δI_2 can be expressed as:

$$\delta v_1 = h_1 \delta I_1 + h_r \delta v_2$$

$$\delta I_2 = h_i \delta I_1 + h_o \delta v_2$$

where four hybrid-parameters are defined as:

$$h_i = \frac{\partial v_1}{\partial I_1} = \text{input impedance with output short-circuited } (\delta v_2 = 0) \dots (37)$$

$$h_r = \frac{\partial v_1}{\partial v_2} = \text{the open-circuit voltage-feedback ratio } \dots \dots (38)$$

$$h_i = \frac{\partial I_2}{\partial I_1} = \text{the short-circuit current "transfer ratio" equal to } -\alpha \dots (39)$$

$$h_o = \frac{\partial I_2}{\partial v_2} = \text{output admittance with input open circuit } \dots (40)$$

Measurement of r_e , r_b , r_c and r_m

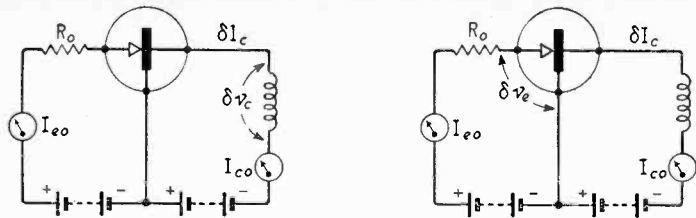
As has been said before, direct measurement of transistor parameters is not possible and four-pole parameters have to be measured first, then values for r_e , r_b , etc. can be calculated from simple relations. The values of the various resistances might in certain cases be measured directly by use of impedance bridges; but sometimes it is more convenient to use an indirect method to measure alternating voltages and currents related to particular impedances, calculate the latter, and finally compute r_e , r_b , etc.

In order to simplify the computing of r -parameters from impedances the common-base configuration is usually preferred for r_e and r_b measurement as then $r_{12} = r_b$ (Eqn. 18) and with very close approximation $r_{22} = r_c$ (Eqn. 19, $r_c = r_{22} + r_{12}$ $r_{12} \ll r_{22}$). For measurement of r_e and r_m however, the common-emitter mode is more useful, as the emitter parameter $r_e = r_{12}$ (Eqn. 26) in this case and r_m can be computed from the relation $r_{22} = r_c - r_m$: that is, $r_m = r_c - r_{22}$ (r_{22} has to be measured first).

Therefore, to determine transistor r parameters, two measurements of r_{22} (output-characteristic slope) and two measurements of r_{12} (feedback-characteristic slope) are required, one each in the common-base and common-emitter configurations.

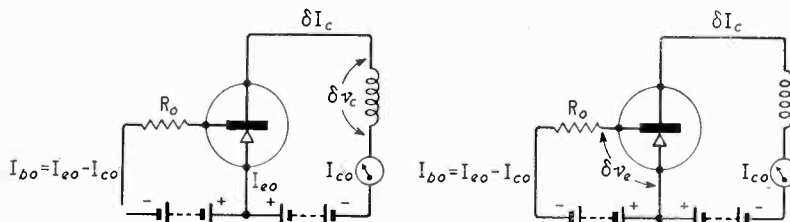
Considering the first indirect method, four main measuring arrangements are shown in simplified form in Fig. 6.

It is significant that the source of the small-signal



(a) Common-base mode
 $r_{22} = \frac{\delta v_c}{\delta I_c}$ I_{e0} constant

(b) Common-base mode
 $r_{12} = \frac{\delta v_e}{\delta I_c}$ I_{e0} constant



(c) Common-emitter mode
 $r_{22}' = \frac{\delta v_c}{\delta I_c}$
 $I_{b0} = I_{e0} - I_{c0}$ constant

(d) Common-emitter mode
 $r_{12}' = \frac{\delta v_e}{\delta I_c}$
 $I_{b0} = I_{e0} - I_{c0}$ constant

Fig. 6. Four main methods for the indirect determination of transistor parameters.

alternating voltage δv_c is always connected into the collector circuit and independent parameters are chosen for collector and emitter direct currents in the common-base configuration (I_{c0} and I_{e0}). Corresponding currents in the common-emitter mode should be exactly the same; but instead of I_{e0} the base current I_{b0} (which is not an independent parameter as $I_{b0} = I_{e0} - I_{c0}$) is shown. Measurements of the small alternating values of δI_c , δv_c and δv_e should be made with a sensitive high-impedance valve voltmeter, to avoid affecting circuit working conditions. The level of v_e is often very low and, to combat noise and other undesirable effects that may affect the measuring device, a narrow-band pass filter tuned to the test frequency (usually 1kc/s) should be inserted in the measuring circuit.

Fig. 7 shows an example of how r_{22} and r_{12} for a p-n-p transistor may be measured in the common-base mode.

With selector switch "S" on the first position the signal δv_c is measured. When "S" is in Position 2 the voltage drop $\delta v_2'$ across known resistor R_s (collector load) is measured, so determining the required δI_c as:

$$\delta I_c = \delta v_2' / R_s$$

In Position 3 δv_c (which is feedback from collector circuit) is measured enabling us to compute r_{12} :—

$$r_{12} = r_b = \delta v_c / \delta I_c$$

Values for r_{22} and r_c would then be calculated from the first two measurements where

$$r_{22} = \frac{\delta v_c}{(\delta v_2' / R_s)} = R_s (\delta v_c / \delta v_2')$$

The main precautions to be observed in the circuit are to keep the value of the resistor R_o at least 100 times higher than estimated value of r_o and the value of R_s at least 100 times lower than r_c to fulfil conditions of open-circuit input (emitter) and shorted

output (collector) circuits with an accuracy of 1%.

The potentiometers R_1 and R_2 set the standing currents I_{e0} and I_{c0} .

Fig. 8 represents a more general arrangement. Here selector switch S_1 carries out the same function as the one just described. S_2 can be set to one of four positions for p-n-p transistor tests in the common-base and emitter configurations (Positions 1, 2) and the corresponding n-p-n transistor tests in Positions 3 and 4.

Measurement of α

Before discussing methods for measuring current gain, this must be defined by other transistor parameters. From a general definition of α :

$\alpha = \delta I_c / \delta I_b$ (for collector circuit short-circuited that is, $\delta v_c = 0$) and from the general four-pole relationship:

$$\delta v_c = r_{21} \delta I_b + r_{22} \delta I_c = 0$$

and

$$\frac{\delta I_b}{\delta I_c} = -\frac{r_{21}}{r_{22}} = \left| \frac{r_{in} + r_b}{r_c + r_b} \right|$$

In most practical cases it would be sufficient to know only r_c and r_{in} to calculate α :—

$$\alpha = \frac{r_{in}}{r_c} \quad (r_{in} \text{ and } r_c \gg r_b)$$

But even so, this would involve the making of at least two measurements with different circuit configurations and as knowledge of α is usually of great importance, a special arrangement for direct measurement is a practical proposition.

Fig. 9 shows two circuits for α measurement. In (a), the transistor is connected in the common-emitter mode and a.c. is injected into the base circuit from the signal generator causing base and collector currents δI_b and δI_c respectively.

From the basic relation between current gain in common-emitter (β) and common-base (α) configurations,

$$\beta = \frac{\alpha}{1 - \alpha} = \frac{\delta I_c}{\delta I_b}$$

and by simple measurement of δI_c and δI_b , the value of β can be calculated, and therefore α as:

$$\alpha = \frac{\beta}{\beta + 1}$$

To measure currents δI_b and δI_c , the input voltage across R_1 and R_2 is exactly 10V (supplied from a signal generator) and assuming that $R_s = 1M\Omega$, base current

$$\delta I_b = 10/10^6 = 10\mu A$$

(The base-to-emitter resistance is of the order of a few hundred ohms and therefore the error introduced by its omission would be less than 1 part in 10^3 .)

Fig. 7. Measurement of r_{22} and r_{12} for a p-n-p transistor in the common-base mode.

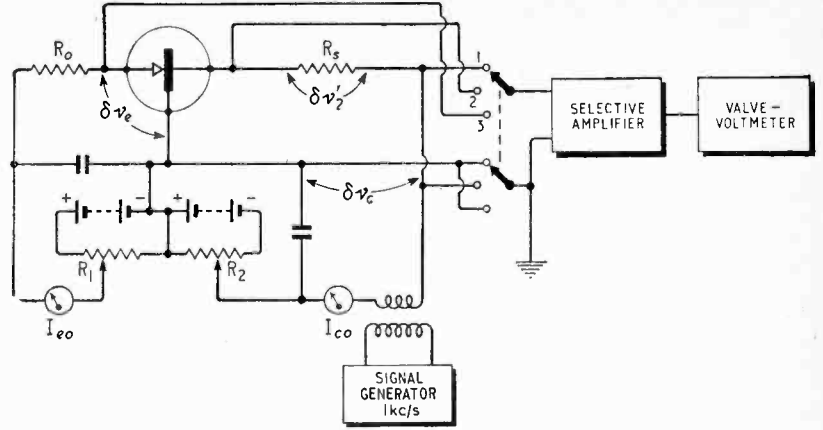


Fig. 8. General transistor-test circuit: S_1 selects parameters to be measured whilst S_2 (wafers c and d) sets common-emitter or common-base connections for both p-n-p and n-p-n transistors (supply reversed by a, b, e and f).

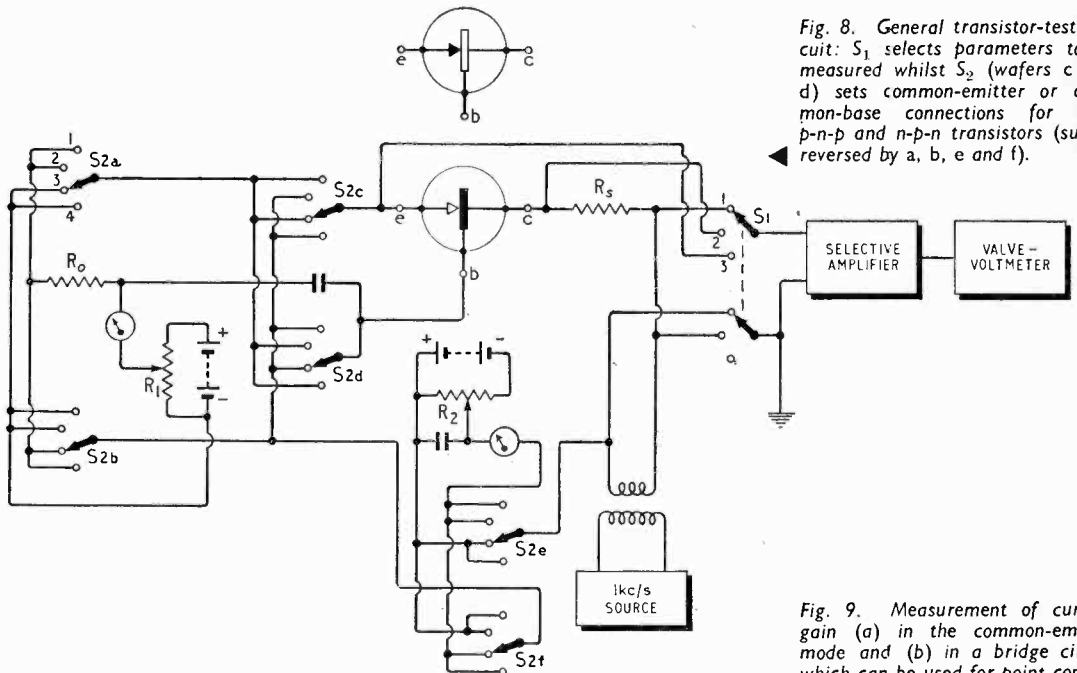
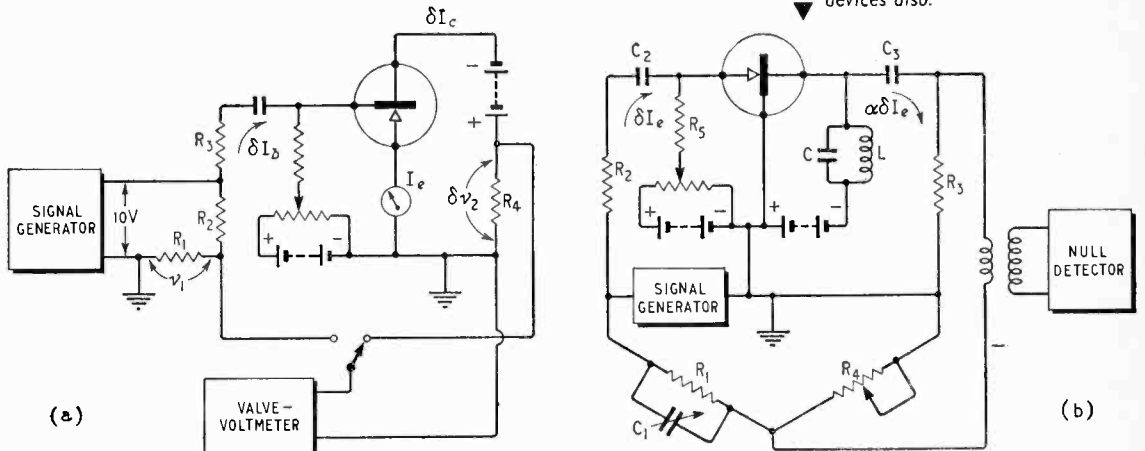


Fig. 9. Measurement of current gain (a) in the common-emitter mode and (b) in a bridge circuit which can be used for point contact devices also.



To make certain that exactly 10V is applied, R_1 is made exactly one thousandth of R_2 : thus when measuring voltage across R_1 a reading $v_1 = 1\text{mV}$ should be obtained. Any reasonable voltmeter impedance would have a negligible effect during measurement, as R_1 could be as low as, say, ten ohms.

To measure δI_c , the voltmeter is switched over to resistor R_4 and current δI_c would be calculated:—

$$\delta I_c = \delta v_2 / R_4$$

By the use of a 100- Ω precision resistor for R_4 the result for β under such conditions will be given by $\delta v_2(\text{mV})$:—

$$\beta = \delta I_c / \delta I_b = (\delta v_2 / R_4) / (10 / R_3) = \delta v_2 R_3 / 10 R_4$$

$$R_3 = 10^6 \Omega \quad R_4 = 10^2 \Omega$$

$$\beta = 10^{-3} \delta v_2 \text{ volts} = \delta v_2 \text{ millivolts.}$$

It is worth mentioning that this method is not practical for transistors with $\alpha > 1$ (point-contact transistors) as the open base circuit might cause instability. However the second method is useful for current gain measurements on any type of transistor (Fig. 9(b)). Here the signal generator supplies the emitter circuit and under conditions such that $R_2 \gg r_e + r_b$ and $R_3 \ll r_e$ the emitter current δI_e causes a collector current equal to $\alpha \delta I_e$, provided that:—

- (a) impedance of $C_2 \ll R_2$
- (b) impedance of $C_1 \ll R_3$
- (c) impedance of the antiresonant supply circuit $LC \quad Z = L/(CR) \gg R_3$ and
- (d) $R_2 \gg r_e$.

δI_e and δI_c would flow only through R_2 and R_3 respectively and the corresponding voltage drops will be δv_2 and δv_3 . The signal generator also supplies current to another pair of resistors R_1 and R_4 forming the second arm of the bridge. As currents δI_e and δI_c are almost in phase (with reference to the signal from the generator) the four resistors forming the bridge can be adjusted so that a voltage null appears across the diagonal of the bridge. The balance condition (detected by a sensitive null indicator) can be expressed by the relation:—

$$\frac{\delta v_2}{\delta v_3} = \frac{\delta I_c R_2}{R_3 \alpha \delta I_e} = \frac{R_1}{R_4}$$

Therefore α would be defined as:—

$$\alpha = \frac{R_2 R_4}{R_3 R_1}$$

To ease the calculation, it can be arranged that $R_2 = R_1$ and $R_3 = 100 \Omega$. Then $\alpha = R_4 / R_3$ and would be read directly from the variable resistor R_4 (a decade box, say) expressed by the resistance in ohms divided by 100, assuming that the balance condition of the detector is maintained. The small capacitor C_1 is sometimes useful as an aid to obtaining a perfect null if there is a very small phase shift between δI_e and $\alpha \delta I_e$.

Capacitance Measurement

The emitter-to-base and collector-to-base capacitance is important in h.f. transistors. These capacitances are of the order of picofarads and generally are dependent on the transistor's working point. Therefore the test frequency has to be chosen rather high (about 500kc/s) in order to reduce the reactances formed by these capacitances, so making the test voltages and currents small. This is necessary to avoid variation of capacitance during the cycles of the test voltage. For measurement of collector capacitance a substitution-bridge or Q-meter method might be employed.

A substitution bridge (see Fig. 10(a)) is an ordinary radio-frequency impedance bridge which has a facility for the connection of the transistor output circuit in parallel with the arm $C_1 G_1$ (via switch S and capacitor C).

During measurement two operations have to be made: First, with switch S open, an initial balance should be obtained; values of $R_1 R_2$ and $G_1 G_2$ (the lower arms are calibrated in conductance terms) should be of the same order (and roughly equal to, say, 20–50k Ω). Then readings of G_1 and C_1 should be noted.

By connection of the transistor circuit in parallel with $C_1 G_1$ the now unbalanced bridge should be brought back to balance by resetting $C_1 G_1$ to smaller values, $C_1' G_1'$. The collector capacitance

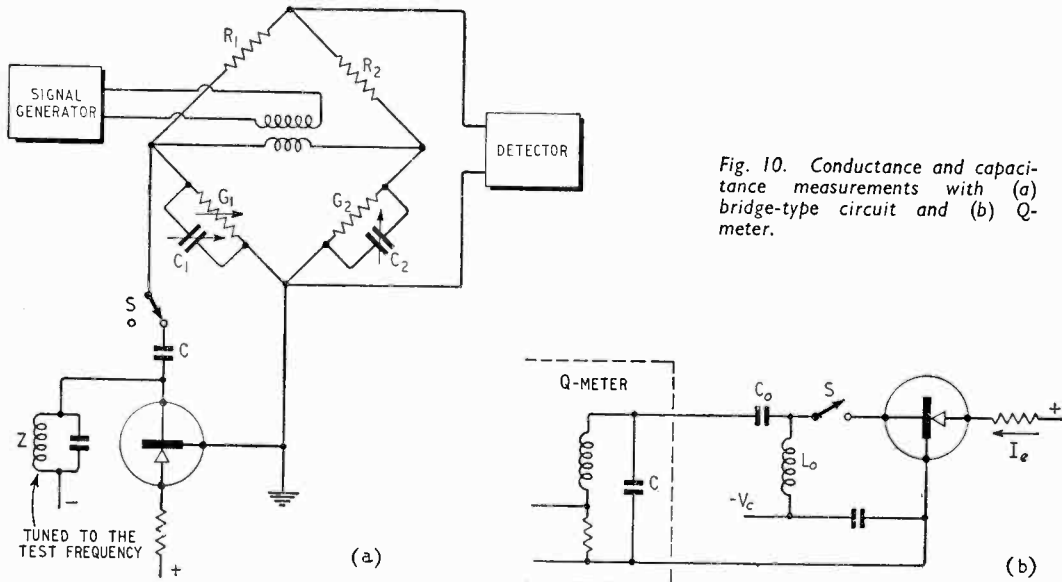


Fig. 10. Conductance and capacitance measurements with (a) bridge-type circuit and (b) Q-meter.

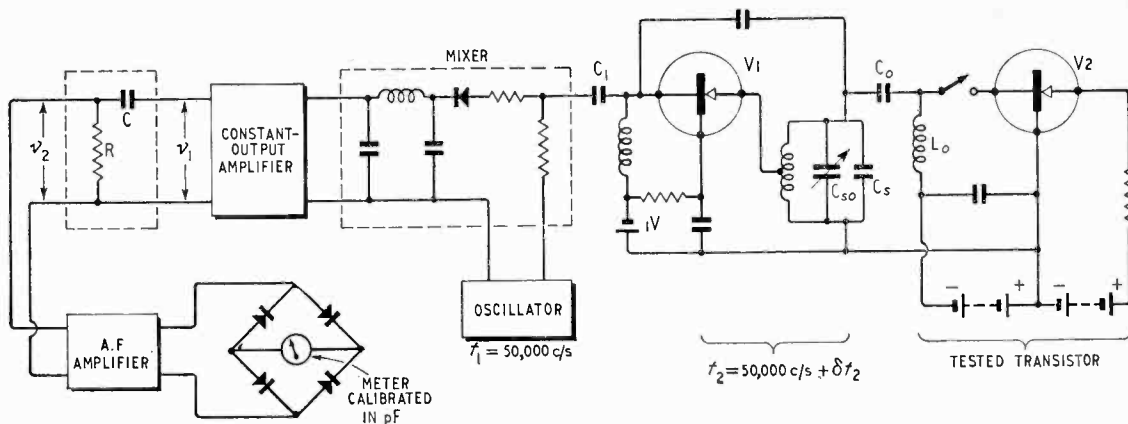


Fig. 11. Transistor capacitance test set. Here the tested transistor is added to a tuned circuit and the change in beat note registered.

c_c and the output conductance g_c will now equal the increments:

$$c_c = C_1 - C_1' \quad g_c = G_1 - G_1'$$

Alternatively a Q-meter might be used for c_c and g_c measurement (Fig. 10(b)).

This is rather simpler and generally more accurate than the previous arrangement. The coupling capacitor C_0 and the collector feed coil L_0 is connected to the Q-meter's internal tuned circuit in the first instance (the transistor's collector is disconnected) and initial values of Q and C established (Q and C).

Next the collector circuit is connected (by switch S) and C has to be readjusted (C') to retain the Q-meter maximum indication and obtain a new value for Q (Q').

Again the value of transistor collector capacity can be computed from the increment: $c_c = C - C'$ (read from the Q-meter's variable capacitor scale) and the value of output conductance g_c can be calculated from the Q readings:—

$$g_c = \frac{\omega C}{Q} - \frac{\omega C'}{Q'}$$

As we can see, the methods described above are useful if it is desired to know both r_c and g_c . Measurement of the former parameter has been treated previously and as we are concerned only with measurement of c_c it is worth mentioning a third practical method useful for production line tests for c_c (see Fig. 11).

Here a transistor oscillator (V1) working at a particularly low collector voltage feeds the transistor under test (V2) via conventional LC (L_0C_0) coupling. By mixing the frequency f_1 and the frequency f_2 derived from another oscillator, a low-frequency beat note is obtained by detection. This beat note, after passing through a control amplifier arranged to give a constant-output sine wave v_1 , is applied to the frequency-conscious circuit CR whose output v_2 is proportional to the frequency of v_1 . After amplification v_2 is rectified and displayed on a meter directly calibrated in frequency.

For instance, by making the frequency-conscious circuit time constant 0.6msec ($C = 0.006\text{mF}$ and $R = 100\text{k}\Omega$), a linear response for v_2 will be obtained for v_1 within the range 0 — 250c/s.

Assuming that the frequency of both oscillators is

the same and equal to 50kc/s ($f_1 - f_2 = 0$) and total capacity $C_{s0} + C_s$ is 5000pF, by increasing $C_{s0} + C_s$ by, say, 50pF, the beat-frequency note would change to 250c/s (50,000–49,750kc/s) which would give full-scale deflection of the output meter. In this way, the output meter scale could be calibrated directly in pF (non linear). In practice, more accurate results can be obtained if the initial beating note is chosen as, say, 10c/s instead of zero frequency and zero of measured capacity would correspond to some initial deflection.

When measuring the capacity of the transistor collector circuit, this initial deflection should be adjusted by setting C_{s0} with the collector disconnected ($f_2 = 50,010\text{c/s}$, $f_1 = 50,000\text{c/s}$). Then ($f_2 = 50,010\text{c/s}$, $f_1 = 50,000\text{c/s}$) after connecting the collector, a direct reading of capacity may be taken from the meter.

Corrections.—In Part 1 of this article (p. 372, July 1961) four lines below Equation 8, the list of increments should have read " $v_c v_c I_c \dots$ " and, on p. 374, the term given as r_c in Equation 24 should have been r_e .

SEPTEMBER ISSUE

Show Guide

Next month's issue, which will be on sale a week earlier than usual—on 22nd August (Preview Day), will contain a stand-by-stand guide to the Earls Court Radio Show together with a plan and list of exhibitors.

This will be in addition to the normal quota of pages devoted to regular features and technical articles covering topics of wide interest.

OCTOBER ISSUE

Show Reviews

In this issue the Technical Staff of *Wireless World* will give their impressions of the year's trends in sound and vision broadcast receivers as exemplified at Earls Court, and of aeronautical electronics as seen at Farnborough. There will also be reports on exhibitions in Germany, Holland and Denmark.

Phase Difference Measurement

UNUSUAL METHOD USING A COUNTER

By R. B. C. COPSEY*, A.M.I.E.E.

IN the design of audio amplifiers, filters, equalizers, transformers and similar equipment, the need often arises for an accurate measurement of phase difference between two sinusoidal voltages of the same frequency.

There are two basic ways of measuring phase differences in common use: one way makes use of a cathode ray-tube, and the other relies on voltage measurements on the combined signals. Both methods can be arranged to give direct readings in terms of phase difference, or, which is perhaps better, can be arranged to be null-reading in conjunction with a calibrated phase-shifting element.

Cathode-Ray Tube Measurements.—Probably the simplest way of measuring phase difference is to apply the voltages to be compared to the vertical

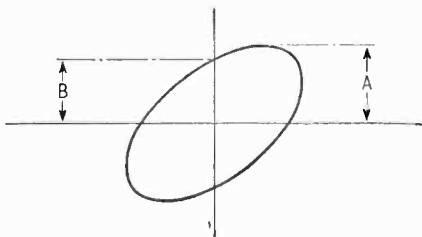


Fig. 1 Use of c.r.t. trace to measure phase difference.

deflector plates of a double-beam oscilloscope, and observe the phase difference. Provided that both voltages are of sufficient amplitude to obtain a reasonable vertical deflection, and the time base is reasonably linear, this method gives an accuracy which may be as good as $\pm 10^\circ$, or may well be far worse, depending on the skill and care of the operator. If one, or both, of the voltages to be compared is too small to obtain a reasonable deflection, then use of the vertical-deflection amplifiers may introduce errors due to the phase shifts in the amplifiers themselves. Any differential phase shift in these amplifiers can be readily checked by applying one signal to both inputs simultaneously and observing the relative phase of the two traces produced.

The more usual method of measuring phase difference with a cathode ray tube is to apply one voltage to the horizontal deflector plates, while the other is applied to the vertical deflector plates.† The resulting pattern will be elliptical (Fig. 1) and by measuring the heights A and B, the phase difference, θ , may be calculated from the formula

$$\sin \theta = \pm \frac{B}{A}$$

Here again (except where the phase difference

is either 0° or 180° , resulting in a straight line) the accuracy of the result obtained depends very much on the skill and care of the operator.

The above methods may be improved considerably in accuracy by the use of a calibrated adjustable phase shifter, which is connected in series with one of the two voltages being compared, and adjusted so that zero (or 180°) phase difference is obtained.

Voltage Measurements.—The method of calculating phase difference from measurements of voltages necessitates the use of a combining circuit in which the two voltages to be measured are added. A suitable circuit is shown in Fig. 2, in which two pentodes share a common anode load resistor. This resistor is made small in comparison with the anode impedance of the pentodes, so that variations of anode voltage due to the current in one valve have virtually no effect on the other valve's current. Three voltage measurements are necessary to determine the phase difference between the applied voltages:—

- (1) E_1 , the output voltage when only one voltage is applied,
- (2) E_2 , the output voltage when the other voltage is applied, and
- (3) E_3 , the output voltage when both voltages are applied.

From these measurements, the phase difference θ may be calculated from

$$\cos \theta = \frac{E_3^2 - (E_1^2 + E_2^2)}{2E_1E_2}$$

One of the limitations of this method of measuring phase differences is that it is not possible to determine the sign of the phase difference, i.e., which voltage leads (or lags) the other.

The accuracy of this method depends on the amount of phase difference involved, and it can be

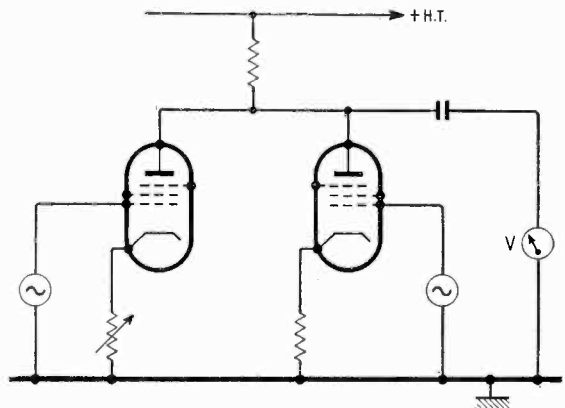


Fig. 2 Circuit for adding two voltages.

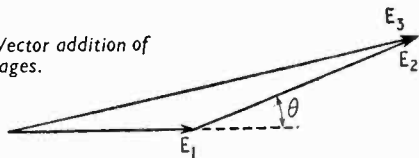
*Redifon Ltd.

††"Electronic Measurements" by Terman and Pettit, second edition, p. 267 (McGraw-Hill).

seen from Fig. 3 that when θ is small and E_3 is almost equal to E_1 plus E_2 , it is impossible to achieve any real accuracy. It is also necessary that E_1 and E_2 should be similar in magnitude. One variation of this method involves the use of a calibrated adjustable phase shifter which is connected in series with one of the applied voltages. The phase difference is then measured by adjusting both the phase shifter and the gain of one of the pentodes until zero output voltage is obtained. Under this condition the two voltages present across the common anode load resistor are equal in amplitude but 180° out of phase, and the phase difference of the two voltages being measured may be read directly from the calibrated phase shifter.

Another variation of the voltage measuring method is perhaps worth mentioning. In this case the amplitudes of the two voltages under test are made accurately equal. This can obviously be

Fig. 3 Vector addition of two voltages.



done by means of a variable attenuator and a voltmeter, or other suitable indicator. However, a more elegant method employs two separate amplifiers with effective automatic gain control. The two output voltages from these amplifiers can be made equal to any desired degree of accuracy. The above formula for the phase angle then reduces to

$$\cos \theta = \frac{E_3^2 - 2E_1^2}{2E_1^2}$$

where $E_1 = E_2$
i.e. $\cos \theta = \frac{1}{2}r^2 - 1$

where r is the ratio of the voltages E_3/E_1 . This ratio can be measured quite accurately by means of an indicator and a good, calibrated variable attenuator. The measurement of the phase angle is thus reduced to two equalizing operations and one measurement of voltage ratio.

None of these methods involving voltage measurements is particularly quick, and only the last two methods are capable of giving any real accuracy.

A New Method.—As far as the author is aware, it is not generally realized that phase differences can be measured easily and with a known accuracy by using a sinusoidal voltage source and an electronic counter.

Fig. 4 shows the set-up of the apparatus necessary to measure the phase delay of a network. The counter must be of the type in which it is possible to count the time interval between a "Start" and a "Stop" signal, and both the "Start" and "Stop" triggers must be capable of being switched to operate on either positive- or negative-going signals. Further, it is essential to the success of this method that both the triggers operate consistently at points on the sine waves which have the same amplitude (and polarity).

The counters available to the author do possess these features, though the same may not be true of all models. Most electronic counters have these facilities, and will count a time interval to an accu-

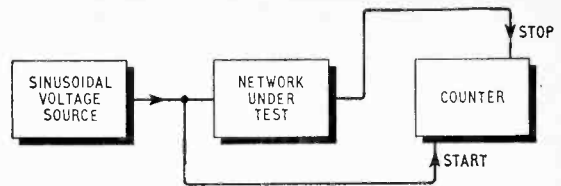


Fig. 4 Use of a counter to measure phase difference.

acy of $1\mu\text{sec}$. At least one counter on the market will count to an accuracy of $0.1\mu\text{sec}$.

The procedure for measuring phase differences is as follows. First, the counter is switched to count "Events per unit time", and the signal frequency source is adjusted accurately to the frequency at which the measurement is to be made. Next, the counter is switched to "Time Interval Measurement", with both the "Start" and "Stop" triggers switched to operate on, say, a positive-going voltage. As will become apparent later, the precise point at which the triggers operate is not important, and the amplitudes of the two voltages fed to the counter do not matter, provided that they are big enough to operate the triggers.

Referring to Fig. 5, let us assume that the input voltage has operated the "Start" trigger at point A. The counter will now count (usually at the rate of one million counts per second) until it is stopped at point B by the action of the "Stop" trigger. The counter will now register a count equal to the time T_1 , which clearly does *not* equal T , the time delay between the two voltages. The trigger polarity switches are now reversed, so that the "Start" and "Stop" triggers operate on the negative-going voltage, and trigger at points A' where counting commences, and B' where counting ceases. The counter will now register a delay time T_2 .

From Fig. 5,

$$T = T_1 - (a + b) \text{ and } T = T_2 + (a' + b')$$

Now the counter operates so that trigger points A and A' have the same amplitude (and polarity), and so do points B and B', though, of course, the

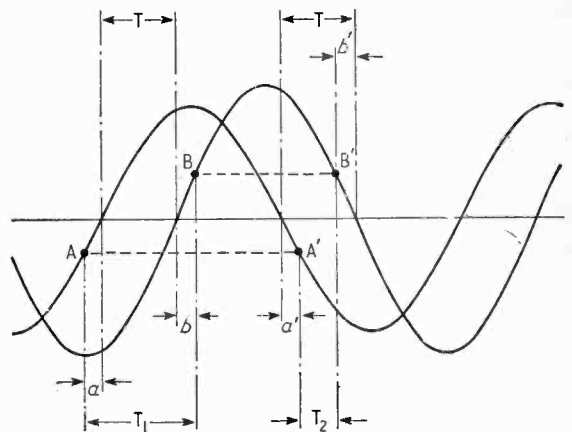


Fig. 5 "Start" and "stop" times using a counter to measure phase difference as in Fig. 4.

latter value is not necessarily equal to the former. Because of the symmetry of the sine wave this equality of amplitudes ensures the equality of time intervals a and a' , and again, the equality of b and b' . And so,

$$T = \frac{T_1 + T_2}{2}$$

The time delay can be readily turned into degrees, since a time delay T corresponds to a phase delay θ of $fT \times 360^\circ$ (with f in c/s and T in seconds).

It can be seen from the diagram that the average time delay T is unaffected by the amplitudes of the two voltages being compared, and is also unaffected by the actual levels and polarities at which the triggers operate.

This method of measurement is essentially one of measuring a time delay, and if this delay is measured to an accuracy of $\pm 1\mu\text{sec}$, at a frequency of 10,000c/s the accuracy would be $\pm 3.6^\circ$, and proportionately better at lower frequencies. A

10Mc/s counter, giving an accuracy of $\pm 0.1\mu\text{sec}$ would of course give ten times greater accuracy, i.e. 0.36° at 10,000c/s. The great advantage of this method of measurement is that it calls for no special skill on behalf of the operator.

It will be appreciated that when measuring the phase shift of, say, a multi-section low-pass filter, the phase shift may exceed 360° as the cut-off frequency is approached. If a series of measurements is made, starting at a low frequency where the angular phase shift is small, there will be a point where the readings show phase differences approaching 360° , and suddenly change to a few degrees. In this case the actual phase shift is 360° plus the reading obtained.

In conclusion, it is worth pointing out that circuits which are usually regarded as giving a phase advance, will of course be measured as a time delay, so that a circuit designed to give, say, a phase advance of 45° will be measured as giving a delay of $360^\circ - 45^\circ = 315^\circ$.

BOOKS RECEIVED

Thyratrons, by C. M. Swenne. An introduction to thyratrons intended to inform the mechanical and control engineer of the advantages which these devices may have over the more familiar mechanical alternatives. Describes the basic principles and operating characteristics, with some descriptions of circuit techniques. A chapter is devoted to applications and an appendix gives data for some eighteen types. Pp. 82; Figs. 68. Philips' Technical Library. Obtainable from Cleaver Hume Press, Ltd., 31, Wright's Lane, Kensington, London, W.8. Price 12s 6d.

Digital Computers and Counters by E. Bukstein. Intended for junior engineers and technically minded laymen, the book presents a simple, non-mathematical exposition of digital computing and counting techniques. Having described the operation of electronic circuitry relevant to the subject, the author goes on to discuss the logical principles involved and methods of information storage, control systems and input/output equipment. A chapter deals with digital and analogue encoding and decoding, and an appendix contains descriptions of commercially available packaged computing circuits. Pp. 248; Figs. 223. Rinehart and Company, Inc., 232 Madison Avenue, New York 16, N.Y., U.S.A. Price \$7.00.

Radio and Electronics, edited by J. H. Reyner. The work of 23 contributors, this two-volume work is intended for the student and junior engineer, and covers a broad field. The first volume is concerned chiefly with the theory of circuit elements and modulation systems, with a chapter on mathematics. In the second volume, the emphasis is on the application of these principles, and the subjects covered include radio transmission and reception, audio engineering, radar, and industrial and medical electronics. The work is well illustrated and indexed. Vol. 1. Pp. 548, Vol. 2. Pp. 494. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price £5 per set.

Television Receiver Servicing. Vol. 1: Time-Base Circuits, by E. A. W. Spreadbury. This is the second edition of an introduction to television receiver servicing for the man who is experienced in the repair of sound radio equipment. The book has been revised to bring it completely up to date and includes descriptions of 110° c.r.t. operation, third-harmonic tuning of the line

output transformer and many of the latest developments in television circuitry. The first volume deals exclusively with time-base and associated circuits, and all facets of servicing in these sections of the receiver are dealt with in an essentially practical manner. E.h.t. circuits and tube operation are discussed, and the final chapter contains advice on the selection and use of test equipment. Pp. 364; figs. 214. Iliffe Books, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 25s (25s 6d by post).

Principles of Feedback Control, by C. H. Wills. An exposition of analytical methods of feedback system design. The book is intended for the graduate or the practising engineer, and it is assumed that the reader is familiar with differential equations and complex-variable theory. Stability is the main problem discussed, with equal attention paid to the frequency-response and root-locus methods of solution. Pp. 271; figs. 146. Addison-Wesley Publishing Co., Inc., 10-15, Chitty Street, London, W.1. Price 66s.

Pratique Electronique by J.-P. Oemichen. A systematic approach to the design of electronic equipment. In three parts, the book deals first with input transducers, in the widest terms. It then treats very fully the design of basic circuits, with reliability the chief goal. The author assumes knowledge of the operating principles of circuits described, and confines his treatment to the evaluation of circuit elements and operating limits. The third part of the book is a discussion of "system planning." Starting with a specification, the author explains the method of arriving at a principle of operation of the complete equipment. Examples of design procedures are given to illustrate methods proposed. The bibliography is extensive. Pp. 304; Figs. 162. Editions Radio, 9, Rue Jacob, Paris 6^e. 1485F by post.

Basic Ultrasonics, by Cyrus Glickstein. The "picture book" approach is adopted in this appraisal of the fundamentals of ultrasonics engineering. Like Gaul, the book is divided into three parts. The first deals with the general theory of sound waves, while the basic types of equipment are discussed in the second section. Detailed descriptions of applications are then given, with an indication of possible future developments in this field. Pp. 137; well-illustrated. John F. Rider, Publisher, Inc., 116, West 14th Street, New York 11, N.Y. Price \$3.50.

LETTERS TO THE EDITOR

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

Colour Tube Costs

THOSE who are worried about the alleged high cost of a colour picture tube will get little comfort from the figures in Donald Macphail's letter (July issue, p. 369). It may be very creditable for R.C.A. to have got the wholesale price of their tubes down to £40-£50, but this is still far too high for British pockets.

To illustrate this, here are two bits of arithmetic. The first takes the most optimistic view of the situation:

Price of colour tube (500 off)	£40
Price of 21in monochrome tube (retail)	£14

Difference

£26

Now, £26 may be a trifling sum to Mr. Macphail, but it is rather more than two weeks' wages to the average Briton.

The second bit of arithmetic is more realistic. It is well known in the trade that the retail price of a picture tube is 2-3 times the price paid by setmakers. Taking the more favourable limit, we have:

Cost of colour tube to viewer	£80
Cost of 21in monochrome tube	£14

Difference

£66

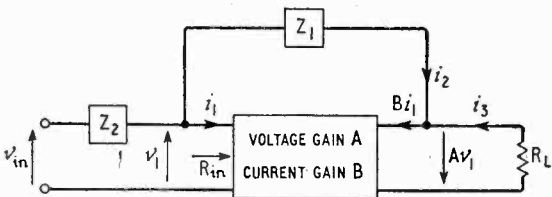
I, too, would like colour television, but as an addition to eating, not an alternative.

R. WAREHAM

Series and Parallel Feedback

IN the March issue the author of "Accurate Record Equalizer" (page 121) discussed two types of feedback amplifier, one using parallel and the other series voltage feedback. The author dismissed the first configuration as unsuitable since he deduced from the relationship $AY_1 \gg Y_1 + Y_2 + Y_{in}$ that the input impedance R_{in} of the amplifier would need to be so high than an emitter follower would have to be used for its input stage. Assuming that a two-stage amplifier were to be used, this meant that only one stage would be available for voltage amplification.

We have successfully designed and built many transistorized amplifiers using parallel voltage feedback and we shall show in the following analysis that if the closed-loop gain is to be Z_1/Z_2 then R_{in} should be less than a value which will be deduced. No conclusions about the value of R_{in} can be drawn directly from the above relationship since the open-loop gain A is dependent on R_{in} . It is necessary, therefore, to find first an expression for A involving R_{in} .



In Fig. 1

$$A = \frac{i_3 R_L}{v_1} \quad \dots \quad (i)$$

$$i_3 = B i_1 - i_2 \quad \dots \quad (ii)$$

$$i_2 = \frac{v_1 (1 + A)}{Z_1} \quad \dots \quad (iii)$$

$$i_1 = \frac{v_1}{R_{in}} \quad \dots \quad (iv)$$

Substituting (iii) and (iv) into (ii) gives:

$$i_3 = v_1 \left\{ \frac{B}{R_{in}} - \frac{(1 + A)}{Z_1} \right\} \quad \dots \quad (v)$$

Then, substituting (v) into (i) we have:

$$A = \frac{R_L (B Z_1 - R_{in})}{R_{in} (Z_1 + R_L)} \quad \dots \quad (vi)$$

The condition for the closed-loop gain to be Z_1/Z_2 can be written:

$$\frac{A}{Z_1} \gg \frac{1}{Z_1} + \frac{1}{Z_2} + \frac{1}{R_{in}} \quad \dots \quad (vii)$$

Substituting (vi) into (vii) and rearranging, gives the final condition that:

$$R_{in} \ll \frac{Z_1 [R_L (B - 1) - Z_1]}{Z_1 + 2R_L + Z_1 (Z_1 + R_L)}$$

Finally, we should point out the different conditions when using transistors or thermionic valves for amplifiers employing this type of feedback. In the transistor case, the output voltage is dependent on the mutual resistance of the amplifier and hence, maximum open-loop voltage gain is obtained for minimum input impedance (ignoring shunting effect of any bias network, of course). In the case of valve amplifiers, however, it is the input voltage which controls the output voltage so therefore the input impedance should be as high as possible, since any input current is merely a drain from the virtual earth point and serves no useful purpose.

J. W. KING,
P. K. WARRICK

Heston, Middlesex.

The author replies:

With regard to the comments of Messrs. J. W. King and P. K. Warrick, I should like to point out that my statement that the input resistance of the amplifier should be high, was meant to imply that for amplifiers with gain A the one with the highest input resistance would introduce least inaccuracy into the closed loop gain. This is clearly true.

An analysis is given by Messrs. King and Warrick which shows that the input resistance should be very low, but if it is reduced, either artificially by shunting elements, or by replacing a c.e. or c.c. stage by a c.b. stage, then in each case the current gain B , is reduced. Thus their conclusion is not as sweeping as it at first may seem. In fact, they are proving that for amplifiers with current gain B , and with given output resistance, the one having the lowest input resistance gives the greatest accuracy of definition of closed-loop gain. Compare this with my statement that for amplifiers of voltage gain A , and with given output resistance, the one having the highest input resistance gives the greatest accuracy of definition of closed-loop gain. Both statements are true, but it must be remembered that increased current gain does not always go hand in hand with reduced input resistance, and increased voltage gain does not always go hand in hand with increased input resistance.

It is also worthwhile pointing out that the output resistance has an effect on the accuracy of definition of closed-loop gain. A simple analysis shows the truth of the following statements: for amplifiers of voltage gain A , and of given input resistance, the one having the lowest output resistance has the best closed-loop accuracy; and for amplifiers of current gain B , and of given input resistance, the one having the highest output resistance has the best closed-loop accuracy. In practice, different

amplifiers will have differing input resistances, output resistances, voltage gains, and current gains, so that different configurations can fairly be compared only when all the above parameters are taken into account. (Note that any three of the parameters specify the other.)

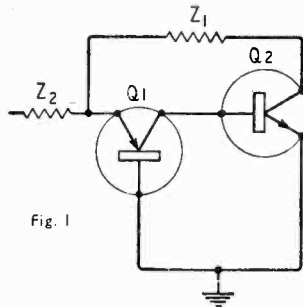


Fig. 1

resistance, which is easily seen to if each transistor has a current gain of β . The output resistance of the first is a little lower than that of the second, both being of the order of $5k\Omega$, so for purposes of comparison we shall neglect output resistance in each case.

The current gain of the first amplifier is β , and of the second amplifier β^2 . The voltage gains can be calculated (assuming zero output resistance) and are $Z_1\beta/R_{in}$ and Z_1/R_{in} respectively.

A measure of the accuracy of a given closed-loop system is

$$D = \frac{AY_1}{Y_1 + Y_2 + Y_{in}}$$

the higher this quantity, the greater being the accuracy.

For Fig. 1.

$$D_1 = \frac{Z_1\beta Y_1/R_{in}}{Y_1 + Y_2 + Y_{in}} = \frac{\beta K}{Y_1 + Y_2 + Y_{in}}$$

For Fig. 2.

$$D_2 = \frac{Z_1\beta^2 Y_1/R_{in}}{\beta^2(Y_1 + Y_2) + Y_{in}} = \frac{\beta^2 K}{\beta^2(Y_1 + Y_2) + Y_{in}}$$

where $\beta \gg 1$ and $K = Z_1 Y_1/R_{in}$

There are now three cases to consider:—

(1) $Y_1 + Y_2 \gg Y_{in}$

Then $D_1 \approx \frac{\beta K}{Y_1 + Y_2}$ and $D_2 \approx \frac{K}{Y_1 + Y_2}$ and $D_1 \gg D_2$.

(2) $\beta^2(Y_1 + Y_2) \gg Y_{in} \gg Y_1 + Y_2$

Then $D_1 \approx \frac{\beta K}{Y_{in}}$ and $D_2 \approx \frac{K}{Y_1 + Y_2}$ and $D_1 > D_2$ depending as $Y_{in} \leq \beta(Y_1 + Y_2)$.

(3) $Y_{in} \gg \beta^2(Y_1 + Y_2)$

Then $D_1 \approx \frac{\beta K}{Y_{in}}$ and $D_2 \approx \frac{\beta^2 K}{Y_{in}}$ and $D_2 > D_1$.

It would therefore seem that in this practical example (which is perhaps typical of attempts to reduce, or increase, the input resistance) the relative merits of the two systems depends not only upon R_{in} , but also upon the magnitude of R_{in} compared with the magnitudes of Z_1 and Z_2 .

The above simple example shows the danger of making general statements such as I did about increasing the input resistance, and as Messrs. King and Warrick did about reducing the input resistance.

Having made the above point, I would agree that I should not have dismissed parallel feedback for the reasons stated. Results just as good, possibly better, can be obtained with parallel feedback around a c.c. stage followed by a c.c. stage.

In conclusion, I should like to thank Messrs. J. W. King and P. K. Warrick for their comments, which were most illuminating, and, for me at least, shed new light on the subject.

T. M. A. LEWIS

Museum Pieces

CONGRATULATIONS to John Munning (July issue). He has the full backing of scores of engineers if they are worthy of the name. How well I remember the receivers of which he writes, and how well large numbers of those sets still function today.

What are the designers of our leading manufacturers paid for today, skimping? In a leading make of the latest radio they have the audacity to anchor the dial cord in a slotted nylon boss (the centre of the drive drum), with a dab of glue. The drive cord is spring loaded, the dab of glue lasts a few days and the customer angrily returns the set. What was wrong with the metal tag retaining system. I have had three new models returned in a matter of weeks with this and other troubles. To get that cord to stay on again wastes engineers' valuable time when their knowledge should be directed to more technical difficulties. Is the trade full of apprentices with nothing better to do? Do the manufacturers think these things will keep them busy? And those plastic pulley wheels, BAH!

Customers are getting fed up with shoddy stuff. They want to know why it has broken down so soon. I open the back and show them the inside but they have no other choice; the sets are all much the same. Yet it is time the public knew what could be theirs if only they would look beyond the glitter and then refuse to buy. If you discuss these shortcomings with the firms' representatives they only reply "It's what the public wants." It is high time that craftsmanship in the above fields returned once more to restore the name of which Britain once was proud.

W. A. MILLS

Cross Gates, Radnorshire.

L'inénarrable Free Grid

"FREE GRID" appeals to Francophilologists to explain Monsieur Aisberg's compliment in calling him "l'inénarrable Free Grid." Without in the least aspiring to such a lofty title as Francophilologist, I think I can supply the answer.

First of all, however, I refuse to consider it to be anything but a compliment. Monsieur Aisberg is a very nice man, who would not think of soiling a whole page of congratulations with a qualification even remotely suggesting "unspeakable" to indicate a member of your "vaillante équipe."

In the French word "inénarrable" you will recognize the English word "narrate." It means something which cannot be related or recounted in any other form or version. As a matter of fact, Free Grid's "Unbiased" can only be cited verbatim. Any change will completely spoil the effect and, above all, translation is impossible.

Monsieur Aisberg must indeed possess a first-class knowledge of colloquial English, and above all have a true appreciation of the English character, an appreciation which we Dutchmen believe we possess, but in our pride consider quite exceptional in other people.

Of course, Free Grid knows quite well what it is all about, but he is up to his well-known and well-appreciated tricks.

This, however, is the season of green herring, not of the red kind.

A. J. VAN GILSE

Köln-Nippes, Germany.

AUTOMATIC DOOR

BATTERY-POWERED TRANSISTOR

PROXIMITY SWITCH

By A. J. HENK

To those who may accuse us of frivolity in giving space to this article we make no apology, for the principles and practical details of the proximity switch described will be useful in a variety of applications.—Editor.



THAT lovable animal the domestic "alley cat"—a remarkably independent creature—asks but little in the way of routine attentions. To grant a cat complete freedom to come and go at will raises problems: a window permanently open has a fascination for burglars and the icy winter winds; holes in a door, even with a hinged flap, admit howling gales, rain and snow in the winter, wasps and midges in the summer and dirt all the year round. Electronics, however, can come to the rescue with an "automatic" door.

Design Considerations

A convenient way for the cats to enter and leave the house is through an opening in the back door. This exit should be closed when not in use and it must be possible for a cat to cause it to open by doing little more than merely wanting to go out. It must also operate when the cat wishes to enter the house from without.

The safety of such a device is obviously of great importance, particularly since it may be left unattended for long periods, so it was considered inadvisable to use a.c. mains to supply the necessary power. Battery operation was therefore employed and for reasons of economy the electronic circuitry was transistorized. A cat cannot be expected to operate contacts or manipulate switches so the device was designed to work on a proximity basis: the natural way for a cat to indicate a wish to go out is to sit near the door. The equipment must operate for 24 hours a day and this emphasizes the need for a design of economical power consumption. Finally, a high degree of reliability must be maintained as, when a cat is used to being able to go out when necessary, an equipment failure can result in unfortunate consequences.

An obvious proximity detector is a light beam and

photocell which, by a system of mirrors or duplication, can be made to operate on both sides of the door. A break in the light path can cause a relay to start a small electric motor lifting a vertical sliding panel covering the opening in the door. Such a system has the advantages of simplicity and stability but, as a torch bulb of sufficient intensity consumes about 300mA the battery would require changing every few hours. Furthermore the life of such a bulb is limited and the sudden failure of the system from this cause would be difficult to anticipate. A system relying on capacitance changes is much more attractive for, although sensitive electronic circuitry would be necessary, battery current drain could be kept low under quiescent conditions and the long life of transistors would ensure good reliability.

The system finally evolved uses the presence of the cat to alter the capacitance between two electrodes and unbalance an a.c. bridge fed from an oscillator running at about 5kc/s. The unbalance voltage is amplified and rectified, the resultant d.c. being used to operate the motor relay. By simply extending the sensing electrodes on both sides of the door the system can accommodate two-way traffic without any duplication of circuitry. The panel is raised in vertical guides by a small electric motor operating through a system of gears and pulleys, and returns under gravity to close the opening when the relay releases.

Circuit Details

Fig. 1 is the circuit which was developed to meet all the above requirements and certain others subsequently encountered. V1 is an oscillator operating at about 5kc/s giving a two-phase output, and L₁ is chosen to resonate with C₂ and C₃ in series at this frequency: a value of 20mH has been found satisfactory, wound on a Ferroxcube pot core. C₂ and C₃ also form two of the arms of the bridge, which

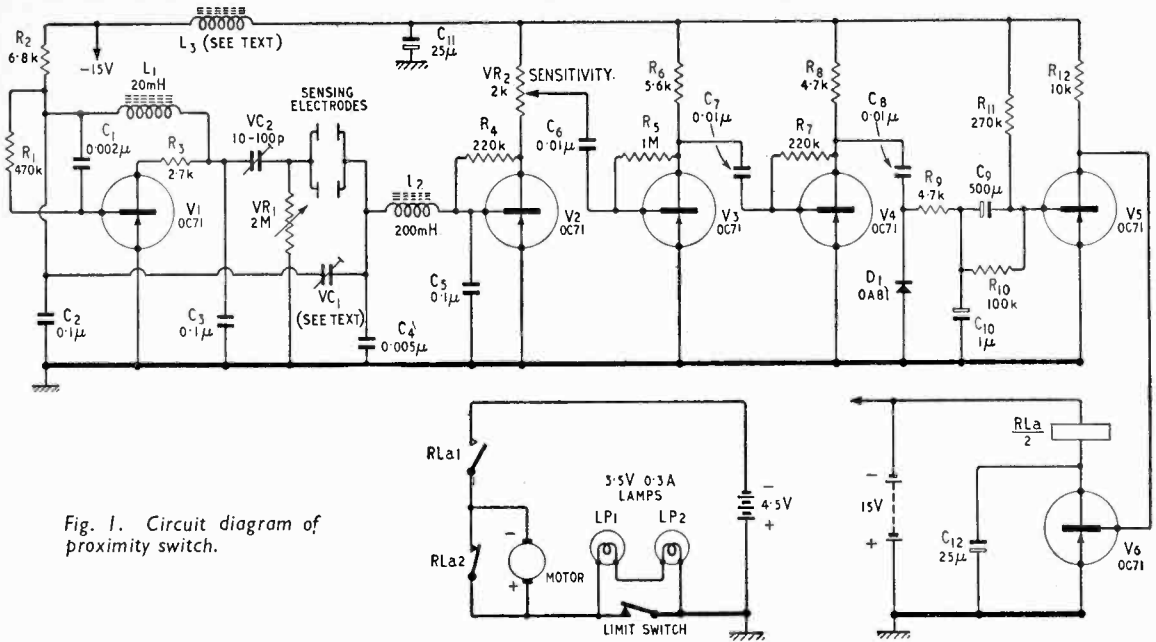


Fig. 1. Circuit diagram of proximity switch.

has been redrawn in Fig. 2. With equal values of C_2 and C_3 the bridge will balance when the value of VC_1 is equal to the capacitance C_3 between the sensing electrodes, about 1 or 2 pF. The required capacitance of the "visible" part of the component VC_1 may well be lower than this, being supplemented by wiring strays. Difficulty was encountered in obtaining a trimmer of sufficiently low capacitance and the most satisfactory system was found to be a pair of short wires twisted together for a few millimetres. Stray wiring capacitance was also responsible for a further effect which resulted in an exact balance with a precise null point being unobtainable. The introduction of a small adjustable phase shift in one of the arms of the bridge by means of VR_1 and VC_2 counteracted this effect satisfactorily. The size and shape of the sensing electrodes can be seen from Fig. 4. There is an identical pair on the other side of the door, the two pairs being connected in parallel.

The bridge output terminal is clearly a very high impedance point and some form of matching is essential if a transistor amplifier is to be used. This is the function of L_2 wound on a Ferroxcube pot core and resonated at the oscillator frequency by C_4 and C_5 in series. The base of V_2 is fed from a suitable low-impedance point in the matching network. V_2 , V_3 and V_4 are used in a largely conventional amplifier, raising the very low bridge output signal to a suitable level for rectification. A measure of thermal stabilization is achieved by returning the base bias resistor of each stage to its collector. A small change in working point with temperature is unimportant since even at the collector of V_4 the signal amplitude is only a volt or so. Rectification of the signal takes place at the cathode of D_1 (a general purpose semiconductor diode) and after smoothing by C_{10} the positive direct voltage is fed to the base of V_5 via C_9 . The value of C_9 is chosen to give a long coupling time-constant such that any rise in the bridge output applies positive bias to the base of V_5 , cutting off its collector current. Under quiescent conditions sufficient bias current

flows into V_5 from R_{11} to cause its collector to bottom, and in this state there is insufficient voltage at the collector to cause V_6 to pass current. When V_5 is cut off, however, the base of V_6 will pass 1.5 mA from R_{12} and this is sufficient to bottom this stage so that almost the whole of the battery voltage is applied across RL_2 . This method of relay operation ensures that the contacts will close very positively when the input to V_5 exceeds a certain positive voltage, about 500 mV, and the margin of voltage change over which the relay energizing current changes from zero to maximum is very small.

Coupling Time-Constant.—The introduction of an a.c. coupling (C_9) into a "d.c." amplifier calls for further comment. This component was added after the installation had been in service for some time to meet an unforeseen circumstance. The life of the battery which energized the motor was found to be unexpectedly short; in fact, on several occasions a battery replaced during an evening was found to be almost completely exhausted the following morning. Further investigation revealed that the writer's cats were in the habit of sitting

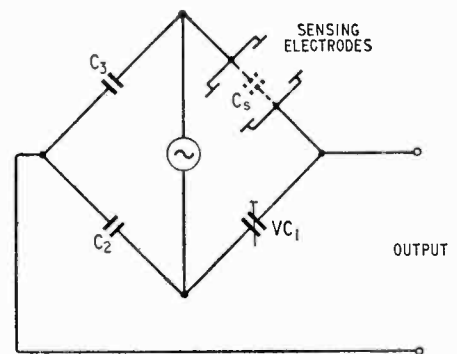


Fig. 2. Basic bridge circuit redrawn from Fig. 1.

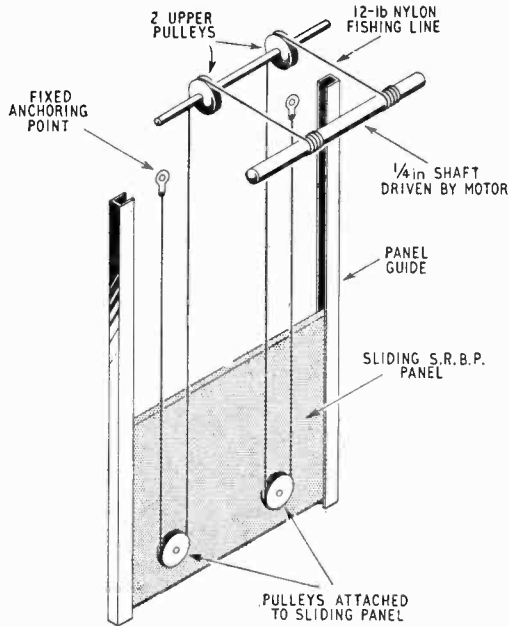


Fig. 3. Arrangement of cords and pulleys.

between the electrodes, opening the panel and surveying the garden from their sheltered vantage point for long periods at a time. During this time the motor was passing current and naturally the battery rapidly discharged. The addition of C_9 allows the relay to remain operated only for as long as this capacitor takes to recharge to the voltage delivered by D_1 —usually about 10-15 sec. After this period has elapsed the base of V_5 is no longer positive and current can once more flow into it, thus the relay releases and the panel closes. When the cat gets fed up with staring at a closed door and goes away C_9 takes about 20-30 sec to discharge into R_{10} , R_{11} and the now low-impedance base-emitter junction of V_5 , after which period the panel can be reopened in the usual way. The addition of C_9 brings with it another important advantage, that of stabilizing the device against gradual changes in the bridge balance point. A critical balance can easily be disturbed by temperature or humidity changes or snow and frost, particularly if any snow or ice crystals form on the surface of the insulation supporting the outside pair of sensing electrodes. This effect was found to be quite troublesome at first, requiring very careful adjustment of the bridge balance and sensitivity controls if satisfactory operation was to be achieved. Re-adjustment was required at fairly frequent intervals as the battery voltage changed and also if there was a considerable change in weather conditions. C_9 introduces sufficient attenuation at very low frequencies to prevent the device operating on signals (due to drifting) which build up very slowly compared with the rate of signal build-up during a normal operation. The gain of the 5-kc/s amplifier can now be increased to maximum by adjustment of the sensitivity control VR_2 and the residual signal will merely charge C_9 to a new steady value. Very small changes in balance will now be communicated to the base of V_5 provided that they occur in a sufficiently short time

(1 to 2 sec) and a large increase in sensitivity is realized.

The purpose of L_3 is to decouple the 5-kc/s amplifier from any oscillator voltage which V_1 introduces onto the negative supply rail. As L_3 works in conjunction with the large capacitor C_{11} a large inductance is not required and about 150 turns of 40 s.w.g. enamelled-copper wire wound on a $\frac{3}{8}$ in dia dust core has been found ample. This component is in no way critical.

Low-power a.f. transistors are used throughout, Mullard OC71 or S.T.C. TS2 being suitable types. Rather higher sensitivity can be achieved by using Mullard OC75 or S.T.C. TS3 for V_2 , V_3 and V_4 , or by selecting units with a high forward current-gain (>50 at 5mA collector current) for these stages. The relay is a Type 3000 unit with a 500- Ω winding and consumes about 30mA when operated. The complete amplifier, oscillator and relay unit draws 10mA from the 15-V battery when quiescent and 40mA when the relay is operated.

Mechanical Details

Details of the arrangement of the winding mechanism can perhaps best be obtained from Fig. 3 and the photograph showing the device with the covers removed. The motor which drives this mechanism is a 3- to 6-V d.c. permanent-magnet-field model motor made by Ever-Ready. This consumes about 750mA from the 4 $\frac{1}{2}$ -V supply when raising the panel and well over one ampere when stalled. In order to limit the stall current when the panel reaches the top of its travel a limit switch (actually a pair of

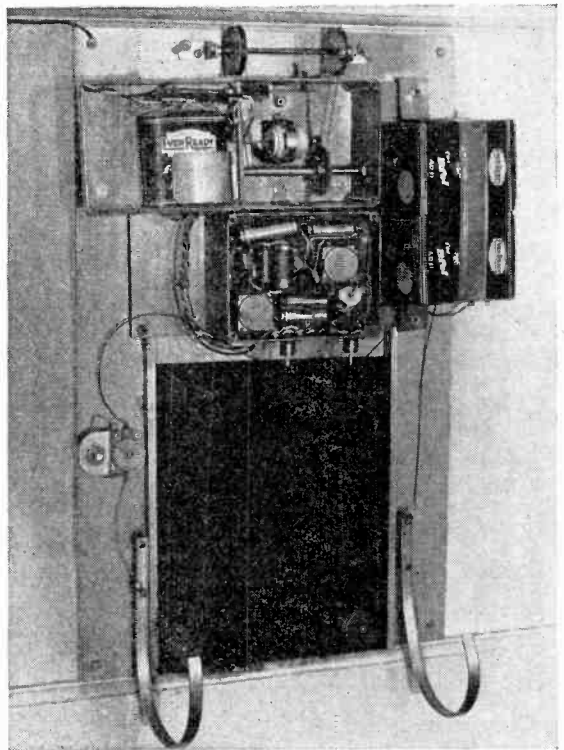


Fig. 4. Proximity switch and door-panel with covers removed.

contacts obtained from a Type 3000 relay) opens, introducing a limiting resistance in series with the supply. A suitable resistance is formed by two 3.5-V 0.3-A torch bulbs, LP_1 and LP_2 , connected in series to allow 200mA to flow into the stalled motor, this being sufficient to maintain the panel in its raised position. On the release of RL_a , the panel falls under gravity and to prevent its descending too rapidly the motor windings are short-circuited by a pair of back contacts on RL_a to introduce dynamic braking. The motor drives a $\frac{1}{4}$ -in diameter shaft via a 4-to-1 reduction gear and winds two lengths of 12-lb nylon fishing line onto the shaft. A further 2-to-1 reduction is achieved by passing each cord over a pulley on the sliding panel and attaching the end to a fixed anchoring point on the upper part of the framework.

The panel itself is of synthetic-resin-bonded paper and measures $7\frac{1}{4} \times 9\frac{1}{2}$ in. An aluminium panel was tried in the first instance but its position was found to affect the balance of the bridge, hence a non-conductor is required for this component.

As can be seen from Fig. 4 the winding mechanism is mounted in a box at the top of the device; a similar box immediately below this houses the oscillator, amplifier and relay. The sliding panel, when raised, occupies the space (about $\frac{1}{2}$ in) between the two boxes and the front plate onto which the device is built. This is of 16-s.w.g. aluminium measuring $19\frac{1}{2} \times 12$ in and is held onto the door by a 4-B.A. nut and screw at each corner. The side of the aluminium plate adjacent to the door is covered with foam plastic to exclude draughts.

Batteries

The power supply for the amplifier consists of two $7\frac{1}{2}$ -V batteries in series (Vidor L5042 or Ever-Ready AD31) mounted on the front panel by means of a springy brass strap. The low quiescent current drain of 10mA enables a useful life of about two weeks continuous running to be obtained from a set of batteries. The motor is driven by a $4\frac{1}{2}$ -V torch battery mounted in the lid of the motor box, and its life is entirely dependent upon the frequency with which the unit is operated. If very frequent operation is required a more economical battery for this purpose is the larger $4\frac{1}{2}$ -V "bell" battery, Ever-Ready type 126, which requires less depolarizing time between operations.

Setting Up

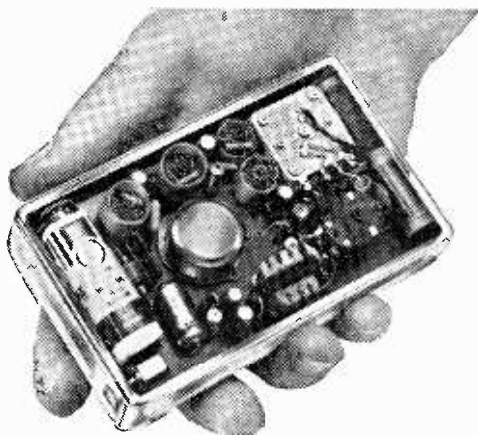
An earth connection greatly facilitates this operation as well as being desirable when the unit is in service. A convenient method of setting up has been found in the connection of a 2-mA (or so) f.s.d. meter between the collector of V5 and the positive supply rail, and the short-circuiting of C_9 ; VC_2 is set at maximum capacitance and VR_1 at maximum resistance. With the sensitivity control VR_2 set to minimum V5 bottoms and only a small current flows into the meter. The precise amount varies with the meter resistance since the collector of V5 is a low impedance point but about 0.5mA appears typical. The presence of a signal on the cathode of D_1 causes V5 to draw less collector current and, with this stage cut off, 1.5mA will flow into the meter. As the sensitivity control is advanced a little at a time VC_1 can be set for minimum meter

deflection. As the sensitivity increases it may be found necessary to adjust VR_1 and possibly VC_2 to obtain a precise balance. At high settings of VR_2 it may well be impossible to obtain complete cancellation by further adjustment, in which case it should be possible to obtain large meter deflections by inserting the operator's hand between the sensing electrodes. On disconnecting the meter, this latter test should cause RL_a to operate and then to release as soon as the hand is withdrawn. C_9 may now be brought back into circuit and the VR_2 further advanced if necessary. This may operate RL_a which should subsequently release when C_9 is charged. The final setting up should be carried out with the device *in situ*, and after an initial settling-down period very little further attention should be found necessary apart from routine battery changes and an occasional drop of oil. When the 15-V supply falls as the batteries near exhaustion it may be of assistance to advance VR_2 further if the amplifier sensitivity falls off before the supply voltage becomes insufficient to operate RL_a .

Conclusion

This automatic door has been in continuous operation for three months at the time of writing and is of great value to the writer's feline family. There were no training problems; the natural curiosity of the animals soon taught them the purpose of the offending appendage and frequent use followed quickly. A friendly cat from across the way also knows how to use it, and a surprising demonstration of the usefulness of the device has been the appearance of postal packets on the kitchen floor, packets too large for even the most considerate of cats to bring in!

Transistor Radio Set



Shown in the photograph is an interior view of the new Fidelity Radio "Coronet" transistor set. This covers both the medium waveband and the Light Programme on long waves. It features a socket for private earphone listening or tape recording, two i.f. stages, and a 90mW push-pull output. It costs $9\frac{1}{2}$ guineas.

Components and Materials

CURRENT PRACTICE AND NEW DEVELOPMENTS DISCUSSED AT THE I.E.E.

MICROMINIATURE components and reliability were the topics that were in the forefront of discussion at the conference. Packing densities of the order of 10^5 components per cubic foot and even greater are spectacular achievements in the former sphere of endeavour, while the requirements of submerged cable repeaters are responsible for the working life of twenty years which is becoming a common specification. The two requirements are not particularly compatible, and at the present state of the art, the only comment to be offered on the use of micro-miniature circuitry for reliability is, as K. E. Latimer remarked in his *rapportage*, "Don't."

On the subject of reliability, G. W. A. Dummer misquoted Sir Winston to the effect that never had so many spoken so much with so few results. After all the work that had been done in the subject, very few manufacturers are quoting estimated working lives. In the absence of catastrophic breakdown, the problem, of course, is to decide at what point in its decline a component can be said to have failed. One speaker pleaded for the craftsman approach to component manufacture, with what he described as the "cathedral atmosphere" in factories. The importance of reliability in submerged repeaters was illustrated by A. A. New, who drew attention to the fact that the cost of replacing a repeater would be in the region of £100,000. In a paper by N. B. Griffin, some evidence to bring blushes to the faces of electronic engineers was presented. Out of all the component parts of a guided missile, electrical components were responsible for 86% of failures, 69% being electronic. Breaking this down further, the highest number of electronic failures were due to wiring and joints (19%), with thermionic valves coming second at 15%. Capacitors and resistors were the most reliable with a failure rate of 3%.

The paper by D. I. Gaffee was an excellent introduction to the types of micro-miniature circuit, the problems involved and some solutions. The three types, micromodules, microcircuits and solid or solid-state circuits were described, and the design of a microcircuit equipment was discussed. The microcircuit consists of a glass or ceramic substrate on which are deposited the passive circuit elements and interconnections; the active components are either attached to the surface or are set into holes. The solid-circuit is formed from a single piece of semiconductor material which is doped and etched to obtain the required operation. The solid-circuit is, as yet, not much more than an interesting possibility, although much work is being done to develop it.

In discussion it was agreed that close co-operation will be needed between circuit designers, component designers, chemical engineers and thin-film physicists. The remark was also made that, in solid circuits, the traditional reluctance to use more than the bare minimum of active components—transistors and diodes—may have to be modified, as they may well be cheaper to form in a piece of semiconductor material than resistors and capacitors.

The session on resistors resulted in an interesting discussion—again concerned with reliability. The existence or otherwise of "rogue" components was argued, and the general opinion was that they do exist, and that the elimination of rogues—components that persistently occur outside the normal gaussian distribution—was responsible for the high cost of good quality resistors. In answer to a query on the testing of resistors guaranteed not to exceed a given tolerance during their lives, R. H. W. Burkett said that a short-term test would determine the slope of the ageing curve which would remain constant. In response to a plea for closer tolerance and more information on resistance wire, B. Walton assured the conference that the subject is under review by the British Standards Institution.

Capacitors

In the session on dielectrics, a paper by R. A. Hill and A. W. Stirling described the design of a junction ceramic capacitor, using a thin-film dielectric. A disc of ceramic material is chemically-reduced, rendering it highly-conducting, at which point silver electrodes are fired on to opposite faces of the disc. Oxygen is then made to diffuse through the disc at high temperature, which oxidizes a layer of ceramic adjacent to each silver electrode, the oxidized ceramic being a high-resistance dielectric. The resultant component is in the form of two capacitors, the layer of unoxidized material acting as a common electrode. Each half of the unit acts as a rectifier; hence the name.

In a review of miniature capacitor development in the U.S.A. read by D. A. McLean, mention was made of multi-layer ceramic capacitors. These consist of layers of ceramic and metal laid down in the "green" state in a sheet about 1ft square. The whole mass is then fired at the curing temperature of the ceramic and diced, whereupon the edges of the metal layers are exposed. Electrodes are applied to opposite edges, providing connection between layers and attachment points for lead-out wires. This structure enables extremely thin sheets of ceramic to be used, while still retaining robustness. Size is greatly reduced.

Mechanical Components

A relay which is designed to be compatible with modern practice in electronic equipment construction was described in a paper by E. R. Myatt. The spring-sets and coil-armature assembly are mounted separately on a printed board—a procedure which gives greater flexibility than is usually the case. The fixed and moving contacts are phosphor bronze wires, either plain or plated with a noble metal, which are fixed into holes in the printed board and soldered to the printed pattern. The moving contacts are bent to an L shape parallel to the board and brought

into contact with the fixed wires by means of a "card," actuated by the armature. Advantages claimed are flexibility of design and the ability to print connections on the same board that carries the relay.

In the same group of papers was described a multi-way socket designed to receive printed boards whose plug-pins form part of the printed wiring. The board may be inserted with a very low pressure, and contact is then made between plug and socket by the operation of a cam. The moving contacts are designed with relay-contact practice in mind, and no circuit exists between plug and socket before the cam is operated, so that the printed-wiring plug-pins are not abraded by insertion and withdrawal. In addition, by the provision of cam-operating push-rods at the front-panel of the equipment, rapid isolation of any board is possible, and this may be made automatic, to take effect if a fault develops.

The paper by J. H. Davis, D. W. Rees and I. H. Riley referred to a newly-developed silicone gel encapsulating compound. The material is intermediate

in consistency between a fluid and a gum and has the advantage that it is self-healing. A probe may be inserted to measure working voltages, etc., and on removal the hole seals. The material is applied in the form of a fluid with a catalyst added, and is cured by heating for about seven hours at a temperature between 75°C and 100°C. The reaction is not exothermic. The material is transparent and offers considerable resistance to mechanical forces.

Although it may appear that use of transistors, with their low voltages and impedances, on printed-circuit boards, would render high insulation resistance of the substrate less important, the point was made in discussion that more failures due to humidity occur at low than high voltages.

Only one or two papers in each session were read by the authors, the rest being summarized by a *rapporteur*. In view of the large number of papers presented, this was necessary to leave some time for discussion. The papers presented will be published in full in 1961 in Vol. 108, Part B of the Proceedings of the Institution.

NEW TELEVISION TUBES

THERE are many reasons why the edges of rectangular cathode-ray tubes for television have been curved: for instance, had a 17-in, 70° c.r.t. been made with edges as straight as its smaller, but older, 14-in brother, the glass would have been thick enough to make the tube unacceptably heavy and very hard to make. However, improvements in glass-working techniques, together with the reduction in the amount of glass used (110° types) have made possible the "straightening out" of the edges of 21- and 17-in, 110° c.r.t.s into the equivalent 23 and 19-in "square-cornered" types which made their British debut (in some cases a "private" one) at the last National Radio Show.

These square tubes offer very little extra in picture height and width, but the picture area is increased appreciably over that of the 21- and 17-in c.r.t.s. For instance,

the Mullard AW59-90 has a useful screen area about 20in² greater than that of its 21-in-diagonal brothers. The radius of curvature of the centre portion of the face plate has also been much increased (Mullard AW53-89, 21-in, 724mm compared with AW59-90, 1225mm) giving a less "bulbous" appearance and a wider effective viewing angle.

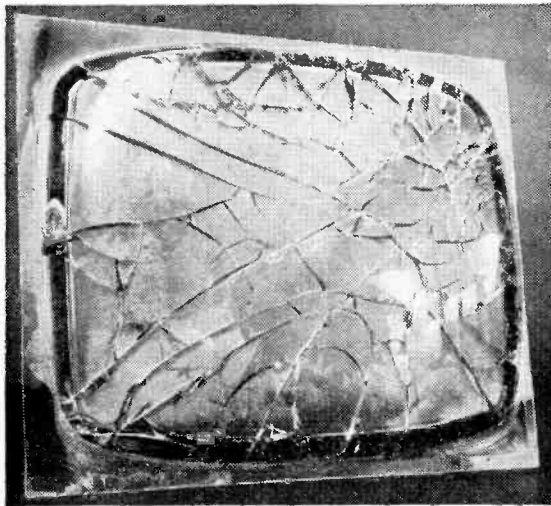
The latest technique in tube-making (as noted in our review of the R.E.C.M.F. exhibition) is the introduction of the integral implosion guard. This banishes the problem of stopping the deposition of dirt on the tube face plate and the inner surface of the safety glass, and also specular reflections. These tubes have the safety "glass"—whether it is glass or acrylic resin—cemented to the face of the c.r.t. Thus no dust can enter and, because cement and safety-screen are chosen to have refractive indices near that of glass, there are only two surfaces or discontinuities at which annoying reflections can occur.

Even these reflections can be reduced. Brimar, in their Type C19AHU tube, use a glass safety cover which is sprayed with fine glass beads or "frit" to give a nearly indestructible satin-like surface. Similarly, safety-covers injection-moulded in Diakon have a slightly "rough" appearance, so reducing surface reflections.

Another advantage of the integral shield is that mounting clamps and straps are no longer necessary: the safety screen is provided with "ears" at the corners which can be clamped to the receiver cabinet. The "mask", too, can be formed by an opaque coating between the cover and face-plates.

Should any doubts be felt about the safety of this technique a glance at the photograph should prove reassuring. This c.r.t., made by Cathode Ray Tubes Ltd., was deliberately imploded. The whole of the c.r.t. screen plate is, although broken into many pieces, still firmly attached to the vacuum-formed Perspex shield: the inside is so smooth that the fingers can be dragged over the cracks without any adverse effects except mental discomfort.

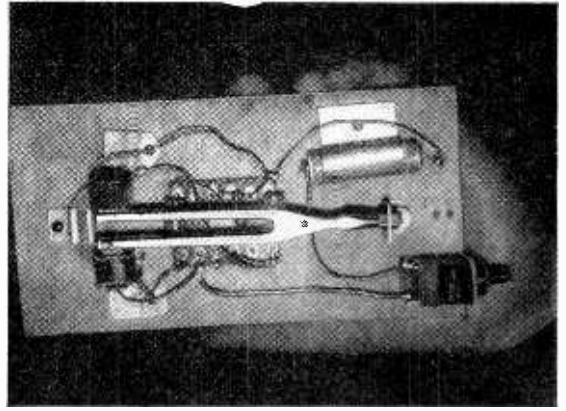
All these advantages are not obtained for nothing, of course. The integral-shield tubes are difficult to re-gun because the shield or shield bonding will not withstand the prolonged high-temperature baking necessary during evacuation. This seems, though, a small price to pay.



A 23-in integral-shield c.r.t. that has been deliberately imploded (Cathode Ray Tubes Ltd.)

AN AUDIO EQUIVALENT OF THE CRYSTAL OSCILLATOR

By L. J. HILLS



A Portable Tuning Fork Standard

HAVING been concerned for many years with the design of electronic musical instruments, it has been necessary on occasions to make use of a valve-maintained tuning fork as an audio frequency standard. It was recently decided that a transistorized version of this could be more compact and could use a self-contained battery power supply. The resulting unit is so useful and turned out to be so simple that it was felt that many amateurs might like to have a similar unit, that is, an audio frequency equivalent of the quartz crystal.

The standard of accuracy will naturally depend upon the characteristics of the tuning fork used, but it is now possible to obtain tuning forks with a

temperature coefficient which is low enough for most applications for which it would be required. A small 1.5-volt pen cell battery provides ample power to maintain the fork in continuous vibration.

Most tuning forks are tuned to the equal-tempered scale and these frequencies may not be the best to use for general audio use unless one is concerned only with musical instruments.

For most general use the most convenient fork is the B, which is nominally 494 cycles per second. This can be raised to 500 cycles by very carefully filing the tips of the tines, and comparing the frequency with a known source by means of an oscilloscope and Lissajous figures. With the aid of a radio receiver comparison may be made with the standard 1000c/s tuning note provided by the B.B.C. A rough check can be made by comparison with the mains frequency. If a C fork is obtained this will be 522 cycles per second and this can be reduced to 500 by filing the crotch.

The maintaining unit is very simple and is as shown in the diagrams and photograph. In the interests of accuracy and stability it is wisest to ensure that the fork does not vibrate too violently and it is best to adjust the unit so that the fork is just maintained in vibration. This can be done by carefully adjusting the magnet spacing.

It was astonishing to find how little power was required to maintain the fork in continuous vibration. In the unit shown the collector current was 200 microamps at 1.4 volts. Some makes of fork may require rather more than this and it may be necessary to increase the transistor base current by changing R_1 in Fig 1 to 47 k.

The base current is, to a large extent, dependent on the voltage developed across C_2 , which is in such a direction as to increase the base current. This means that in the oscillating state, the transistor bottoms and automatic stabilization of amplitude is obtained. Initially, the base current is low, and is set by the value of the potential-divider R_1 , R_2 . If the current were larger, the transistor may be initially bottomed, and the only way of avoiding this would be by an increased V_{cc} . This would then

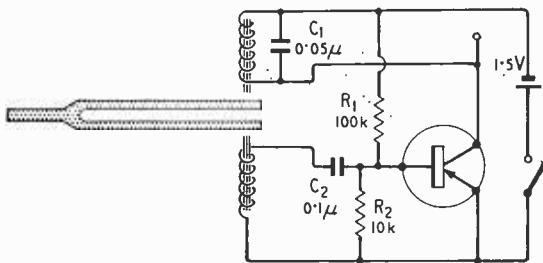


Fig. 1 Circuit diagram of the unit. Any low-power transistor may be used.

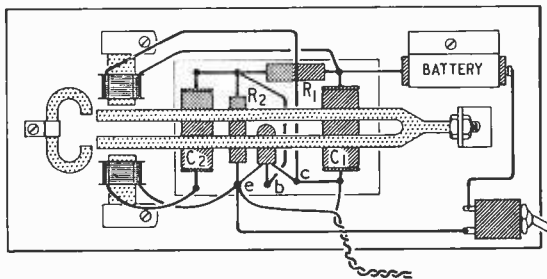


Fig. 2 Suggested layout. The baseboard may be of non-ferrous metal, or wood.

increase the amplitude of vibration of the fork, which would tend to affect adversely the frequency-stability of the unit. Almost any audio type transistor can be used with a current gain of 40 or more.

The exciting coils were obtained from a high resistance headphone and most hams will no doubt have one of these in the junk box. Alternatively, if the reader fancies his skill at winding very fine gauges of wire he may attempt to wind his own. Each coil should be wound with 2,000 or more turns of 42 s.w.g. enamelled copper wire, and should have a resistance of about 1,000 Ω . The pole pieces were cut from ordinary transformer laminations and inserted in the coils to make a tight fit. They were bent to a **L** shape for mounting on the baseboard, which can be of wood or any non-ferrous metal. The bias magnet can be obtained from a damaged meter or an old headphone or small loudspeaker unit, and should be mounted beneath the coils, not necessarily in contact with the laminations. The clearance between the pole pieces and the fork should be about .05 in, and should not be less than that required to just maintain the fork in continuous vibration.

The construction should present no difficulty. The tuning fork can be obtained from most musical instrument suppliers. It is necessary to mount the fork very rigidly so as not to allow any lateral movement other than that due to the vibration. This is done by cutting a thread on the handle with, say, a 4 B.A. die and bolting it to a mounting bracket which should be reasonably stout. The transistor maintaining unit can be mounted beneath the fork, as shown in the photograph. The precise

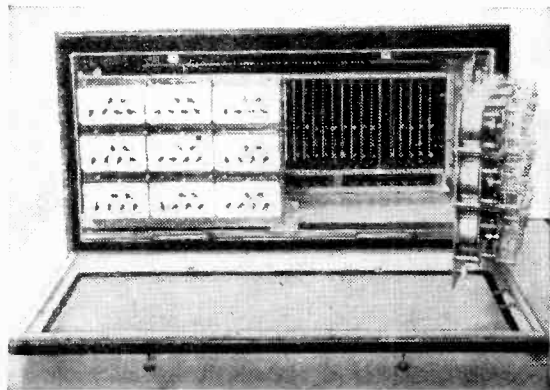
way of mounting the bias magnet will obviously depend on the type of magnet used and in the author's case this was done with a small metal bracket.

The use of a capacitor across the collector coil calls for some comment. This was done to tune the coil approximately to the fork frequency. The actual value will obviously depend upon the inductance of the coil. Although this capacitor is not absolutely necessary, it does improve the efficiency and the waveform. If an output very rich in harmonics is required then this capacitor can be omitted. The circuit will oscillate at some indeterminate frequency without the fork vibrating, but as soon as the fork vibration builds up, the oscillator is pulled into synchronism within a second or so. The winding sense of the coils must be correct for oscillation, but this is no problem as it is only necessary to reverse the connections to one of the coils if the unit fails to oscillate.

If an audible tone source is required, the output can be fed into a suitable amplifier and speaker. A particular musical instrument designed by the author used a whole octave of these units, the upper notes being obtained by tuning the harmonics and the lower notes by frequency division in Eccles-Jordan dividers using transistors. The result was a musical instrument that never required tuning. Its only drawbacks were the very considerable change of tone over the range of the instrument and the fact that the octaves were too mathematically correct, making it impossible to obtain those delicate chorus effects which are so important to any polyphonic musical instrument.

ELECTRONIC WATT-HOUR SUMMATION

WITH the object of increasing reliability in summation metering for bulk supply points in electricity distribution systems and therefore reducing maintenance time, electronic methods have been introduced by Ferranti. Mechanical components have been eliminated as far as possible; contactors, for instance, are replaced by photoelectric devices. The equipment employs semiconductors



Ferranti Electronic Summator. Printed-circuit boards, containing all the logic circuitry, are visible behind the hinged dial-panels

throughout and is contained in a space rather less than a quarter of that occupied by conventional devices.

The input to the summator is derived from a number of changeover switches—one to each of sixteen channels. The two outputs of each switch are gated sequentially by a scanning pulse train, and used to trigger a bi-stable flip-flop, or toggle. The toggle is triggered at the arrival of a scan pulse each time a switch changes state, and will not be triggered again until the next change of state of the switch. Effects of contact bounce are thereby eliminated. The outputs of the toggles are used to drive stepping-motors, which register the number of pulses received in each channel on check dials. A common highway is also fed by the differentiated, rectified toggle outputs and used to drive a stepping motor check dial, which displays the total number of pulses received on all channels.

To avoid the necessity for long contact-dwell time or a high scanning rate, the outputs of the switches are not directly gated, but are stored in toggles, thereby ensuring that all pulses are gated. When the changeover switches are replaced by photoelectric sensing elements, this input toggle employs two photo-transistors, each being triggered in succession by a light source and rotating shutters.

The advantages offered by the new equipment are increased flexibility, absence of mechanical deterioration, and negligible power consumption—all transistors are operated as switches. Ease of maintenance is greatly enhanced, and in the majority of cases, merely necessitates the changing of a printed card.

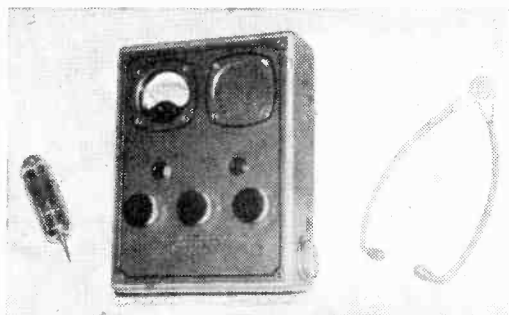
MANUFACTURERS' PRODUCTS

NEW ELECTRONIC EQUIPMENT AND ACCESSORIES

Ionization Detector

THE onset of ionization in a cable or capacitor is often indicative of a forthcoming failure. Similarly in the testing of these items discovery of the point at which ionization occurs can often act as a valuable guide to the standard of construction: ionization occurring at a relatively low voltage in one sample of a batch usually indicates the presence of a gas-filled space in insulating material. One common test procedure involves isolation of the object to be tested: this has disadvantages where a component or cable is in use.

The BICC-Addison Acoustic Corona Detector uses a probe containing a transducer for the detection of the noise produced by ionization in gases in voids in cables,



BICC-Addison ionization test-set receiver 7 x 8½ x 2½ in. Shown also is acoustic probe and headphones.

insulators, capacitors, etc. The output from the probe, which is held against the object under test, is passed to a 5-stage transistor amplifier which incorporates a switched filter to reduce mains "hum" or other unwanted noises and the output is fed to either headphones or a loudspeaker.

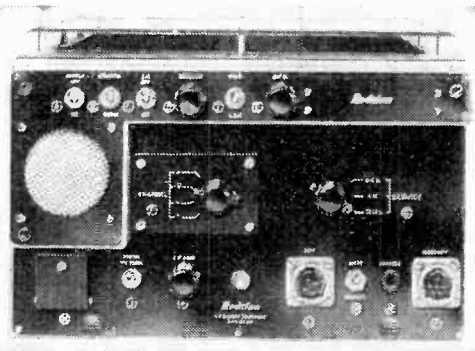
Accessories include an insulating rod for safe use of the acoustic probe on high-voltage equipment and inductive and capacitive probes which may be employed for cable tracing and identification.

Power is supplied by two No. 8 torch batteries and the weight of the complete set in its carrying case is 6lb 7oz.

Addison Electric Co. Ltd., 10-12, Bosworth Road, London, W10.

100-W p.e.p. s.s.b. Transmitter-receiver

THE Redifon Type GR410 transmitter-receiver covers the 3-18Mc/s band, providing operation on four preset, crystal-controlled spot frequencies (eight channels on s.s.b.) with single-sideband or a.m. telephony and c.w. or m.c.w. telegraphy. Transistors are used extensively—the only valve stages are the power amplifier and driver—and the power consumption is low (only 7W on "receive"). Full remote control facilities (including channel and type of emission) are provided by fitting an extra unit to the front of the set, when a 100yd separation of the GR410 and its control box can be achieved by using standard cables. Where control from a nearby position is required (within the same room as the GR410, or mobile use, for instance) the L-shaped unit carrying the



Redifon's GR410 transmitter receiver.

loudspeaker and operating controls can be unclipped and mounted on a separate panel.

Modular construction is used and the output stage consists of three 6146 valves in parallel—thus aiding reliability. "Vox," or voice-operated switching, operation is provided, together with circuits to prevent sound from the set's loudspeaker changing the set from "receive" to "transmit."

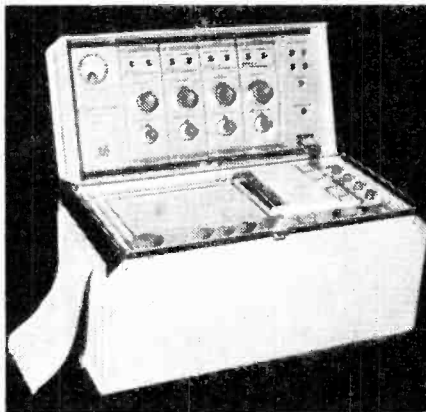
Receiver sensitivity is better than 1µV for 10dB signal-to-noise ratio on s.s.b. and the "third" method of s.s.b. generation and reception is employed.

Redifon, Ltd., Broomhill Road, London, S.W.18.

Industrial Pen Recorders

THE Officine Galileo range of direct-writing pen recorders are now available in England.

The use of interchangeable preamplifiers enables the study of many different types of phenomena to be undertaken by the use of a single instrument. Instruments are available having up to 32 channels, and employing either ink-pens or hot styli. In the multi-channel equipment, photographic recording may be used, which allows the higher frequency components—up to 800c/s—of waveforms to be examined. Response time

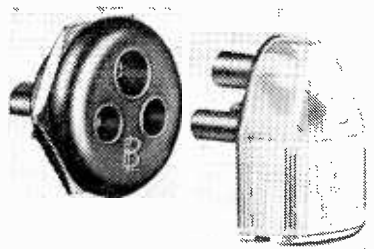


A 4-channel industrial pen-recorder by Galileo.

of the recorders is 0.01 second, and paper speed is variable from 2.5mm/sec. to 100mm/sec. Details may be obtained from Leland Instruments, 145, Grosvenor Road, Westminster, London, S.W.1.

Miniature Mains Connector

DESIGNED to combine small size with safety the Belling-Lee Type L1436 three-pole mains connector is rated at 1 to 2A, 250V r.m.s. The plug body is moulded from black nylon and is thus practically unbreakable: its cover is transparent so that visual inspection for satisfactory cable connection can be carried out without taking it apart. Cables up to $\frac{1}{4}$ -in diameter are clamped firmly in the cord grip and the silver-plated pins are shrouded to avoid danger of contact. The plug itself disengages easily from the socket on application of a pull to the cable—thus accidental damage to equipment, cable, plug and people is avoided.



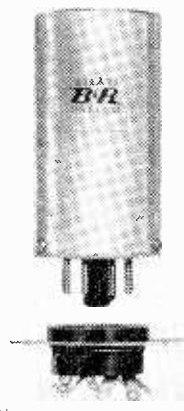
Miniature 3-pole mains connector is about $1 \times \frac{3}{4} \times \frac{7}{8}$ in—socket is 1in dia and $\frac{5}{8}$ in deep, overall

The black phenolic-resin socket for chassis mounting requires a single hole 0.77in diameter and has an anti-twist spigot: again the contacts are completely shrouded for safety.

Belling & Lee, Ltd., Gt. Cambridge Road, Enfield, Middlesex.

“Dry-Reed” Relays

A USEFUL life of 20 million operations and a contact resistance of 0.03Ω are features of “dry-reed” relays produced by B. and R. Relays, Ltd., Temple Fields, Harlow, Essex. The relays are mounted on either 8- or 14-pin bases, and can consist of up to 6 reeds. Operating power is 0.1W for 1 reed and 0.9W for 6 reeds.

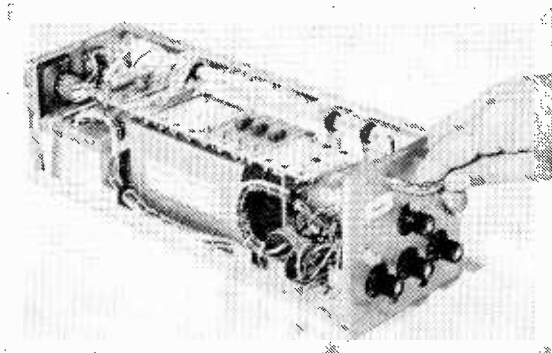


One of the range of B. and R. dry-reed relays. Diameter $1\frac{1}{4}$ ”, height $3\frac{1}{4}$ ”.

Solid-state Industrial Controls

ANALOGUE computer systems for industrial plant control are to be marketed in the U.K. by Hagan Controls, Ltd., 14, Grosvenor Place, London, S.W.1. The equipment, known as Powrmag is comprised of completely solid-state elements—magnetic amplifiers and semiconductors.

A system consists of the output transducer, which



One of the range of computer controls made by Hagan Controls.

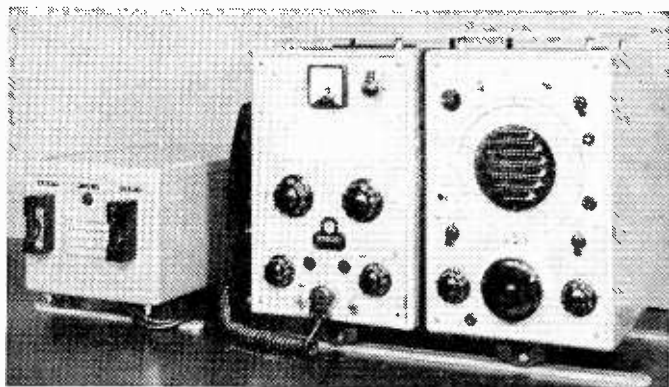
converts the physical phenomena to be controlled into a voltage, the magnetic amplifier analogue computer control unit, which has variable characteristics obtained by plug-in components, a remote control station, and the output device, which may be electrical or mechanical.

Radio-telephone Equipment for Small Craft

INTENDED for small fishing vessels and harbour craft, the Marconi “Kestrel” covers the band 190-4500kc/s, and delivers a power of 36-50W into a 20ft whip aerial, or a 60ft wire aerial.

The receiver has facilities for use with Consol navigation equipment, and may be used with direction-finding equipment—either a radiogoniometer and fixed aerial, or a rotating loop.

The transmitter may be operated on either the duplex or simplex system and provides eleven spot frequencies in the band 1.6-3.8Mc/s. Metering is provided to check for correct working. The power unit will work from either 12V or 24V batteries. Information obtainable from Marconi International Marine Communication Co., Ltd., Marconi House, Chelmsford, Essex.



The Marconi ‘Kestrel’ radiotelephone equipment. From left to right—Power Unit, Transmitter, Receiver.

Elements of Electronic Circuits

28.—Logarithmic Amplifiers

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

THE logarithmic amplifier develops an output which is proportional to the logarithm of the input. Fig. 1 shows an ideal straight-line amplifier response curve with input voltage plotted on a logarithmic base: $v_{out} = \log v_{in}$. Let us now examine how an amplifier can be made to produce a logarithmic response. One method uses the process known as successive detection where the output from every stage of the amplifier is detected and added to that

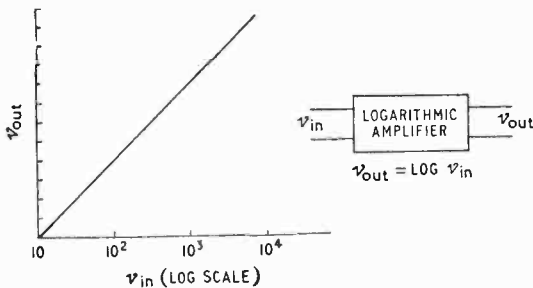


Fig. 1

of successive stages. To overcome the effect of time delay in successive stages it is necessary to apply the output from every stage to the appropriate section of a delay line thus ensuring that all the detected voltages are in time coincidence for summation purposes.

Fig. 2 shows in diagrammatic form how this is done in a five-stage amplifier (only parts of the circuit essential to the description are shown). A feature peculiar to this type of amplifier is that each stage is allowed to saturate or "overload". Every stage

is also arranged to have the same stage gain (m) which implies that each valve has to have a similar g_m . We will now show why the action is logarithmic. Let the output voltage per stage at saturation = v for an input voltage v/m . This output voltage creates a rectified voltage v_1 across the terminating impedance of the delay line. If we now assume that our amplifier has five stages with each stage having a stage gain of m at saturation, to make the last stage saturate the input to the first stage will therefore have to be v/m^5 (see Fig. 3). The rectified outputs to the delay line will be v_1 from the final stage together with contributions from the preceding stages thus:—

- v_1/m from the fourth stage
- v_1/m^2 from the third stage
- v_1/m^3 from the second stage
- v_1/m^4 from the first stage

In other words:—

Input	Output
v/m^5	$v_1 + (v_1/m) + (v_1/m^2) + (v_1/m^3) + (v_1/m^4)$

Now let us increase the input to the first stage to v/m^4 ; this will make the last stage but one saturate. The rectified output to the line will be v_1 from the last stage (as before) together with v_1 from the last stage but one. The contribution from the preceding stages will be:—

- v_1/m from the third stage
- v_1/m^2 from the second stage
- v_1/m^3 from the first stage

In other words:—

Input	Output
v/m^4	$v_1 + v_1 + (v_1/m) + (v_1/m^2) + (v_1/m^3)$

Increasing progressively the input voltage to the

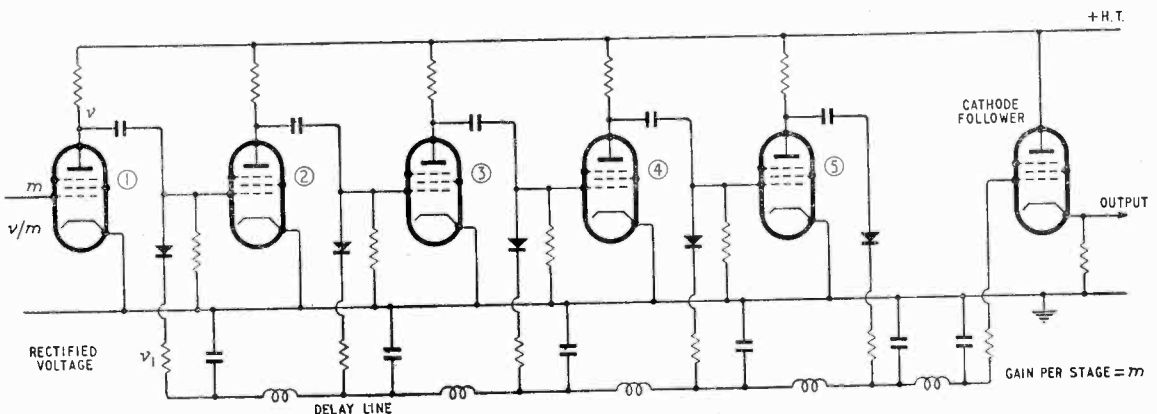


Fig. 2

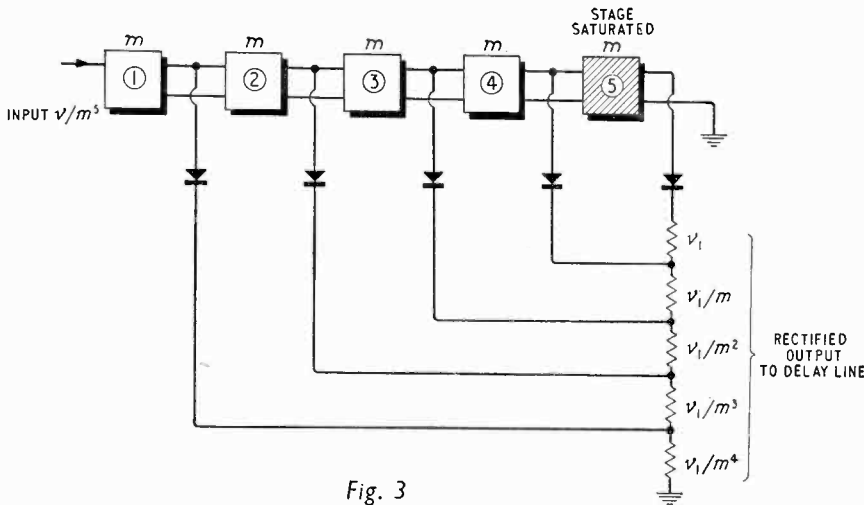


Fig. 3

first stage will cause each stage to saturate in turn. A table can now be constructed thus:—

Input	Output	Stages Saturated
v/m^5	$v_1 + (v_1/m) + (v_1/m^2) + (v_1/m^3) + (v_1/m^4)$	5
$(v/m^5) \times m = v/m^4$	$v_1 + v_1 + (v_1/m) + (v_1/m^2) + (v_1/m^3)$	5 4
$(v/m^5) \times m^2 = v/m^3$	$v_1 + v_1 + v_1 + (v_1/m) + (v_1/m^2)$	5 4 3
$(v/m^5) \times m^3 = v/m^2$	$v_1 + v_1 + v_1 + v_1 + (v_1/m)$	5 4 3 2
$(v/m^5) \times m^4 = v/m$	$v_1 + v_1 + v_1 + v_1 + v_1$	5 4 3 2 1

Now if m is made very large, the rectified output will be seen to increase according to an arithmetical progression $v_1, 2v_1, 3v_1$ etc. as the input is increased in a logarithmic fashion. The output is then proportional to the logarithm of the input.

Another type of logarithmic amplifier makes use of an entirely different principle. Referring to an early article which discusses the differentiation of a square wave, we are reminded that, provided that the period of the square wave is very much greater than the CR-product or time constant of the differentiating circuit, the voltage appearing across the resistor takes the form of a decaying exponential curve (See Fig. 4).

$v_1 = v_0 \exp(-t_1/CR)$
 $v_0/v_1 = \exp(t_1/CR)$
 $\therefore CR \log_e(v_0/v_1) = t_1$
 where t_1 is the time taken for the input voltage v_0 to decay to a level v_1 .

Let us now consider an amplifier based on this principle. The input waveform is assumed to be square and of a low p.r.f. It is ap-

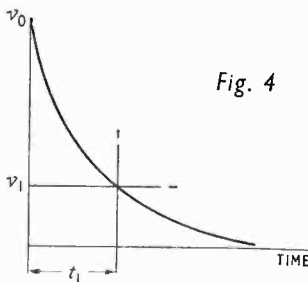


Fig. 4

plied to a differentiating circuit having a time constant much shorter than the period of the wave. The differentiated square wave is fed into a d.c. amplifier which provides a substantially linear amplification for an input ranging from zero to the reference voltage v_1 (See Fig. 5). The output from the d.c. amplifier is fed to a trigger circuit which is "switched on" all the time the amplifier output exceeds v_1' (the amplified reference voltage v_1). The width of the pulses from the trigger circuit, which occur at the p.r.f. of the original square-wave input, is constant and equal to t_1 .

If we rectify these pulses, the rectified d.c. component is proportional to t_1 and clearly dependent on the voltages v_1' v_1 and hence $\log_e v_0$. The output is then proportional to the logarithm of the input. Attention is drawn to the article on Multiplication and Division (No. 22, Feb. 1961) where other arrangements having a logarithmic input/output law are used in multiplying and dividing circuits.

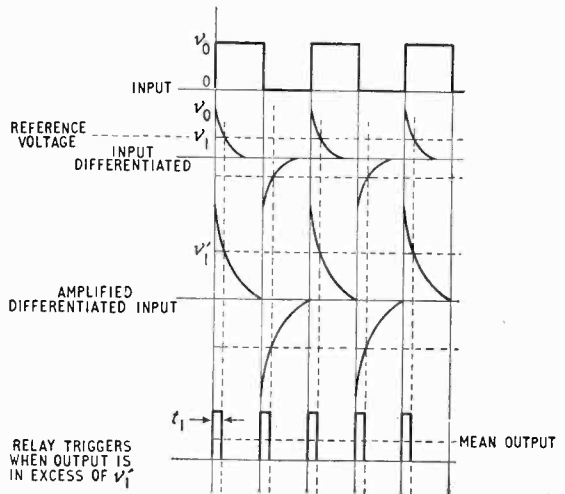


Fig. 5

Logarithmic amplifiers of the current-operated type are often found in the field of reactor instrumentation. Modern radar sets use the logarithmic amplifier to reduce the enormous differences between the heights of target echoes, at the same time reducing rain and sea clutter returns almost to noise level. This is convenient for a p.p.i. presentation for it ensures that, although target echoes are reduced in amplitude, the background is kept at a constant level at all ranges.

Suppose a logarithmic amplifier is fed with r.f. signals of different amplitudes but having the

same percentage modulation. The outputs will be the same except that they are superimposed on different values of rectified r.f. (These d.c. levels are proportional to the logarithm of the mean r.f.) Radar returns comprise echo, rain and sea clutter in addition to noise, all of which combine to form complex modulated signals of the same percentage modulation which are applied to the input of the logarithmic amplifier. At the output, although the d.c. components will be proportional to the logarithm of the mean input level at the particular range, the amplitude of the fluctuation will be constant at all ranges. The d.c. components can be easily removed. The target echo which is superimposed on the noise does not fluctuate and therefore remains clear of the background. In practice it is necessary to filter the radar returns to get rid of a low-frequency component, for the d.c. levels actually fluctuate at the scan rate of the aerial. This is

because the amplitude of the sea clutter return varies according to the aspect of the aerial to it.

Conclusion

This instalment concludes the present series of articles on the elements of electronic circuits. Throughout the series my aim has been to try to give a simple explanation of the operation of some of the more basic electronic circuit devices. Although primarily intended as an introduction to the subject for the student, it is hoped that the notes may have refreshed the memory of the more advanced reader. In conclusion, I would like to express my thanks to the members of the *Wireless World* editorial staff for their helpful suggestions and criticisms, and to acknowledge the assistance I have received from the many standard reference books and other published matter in the preparation of the series.

BEDFORD RELAY

COLOUR TV DEMONSTRATED ON WIRE DISTRIBUTION SYSTEM

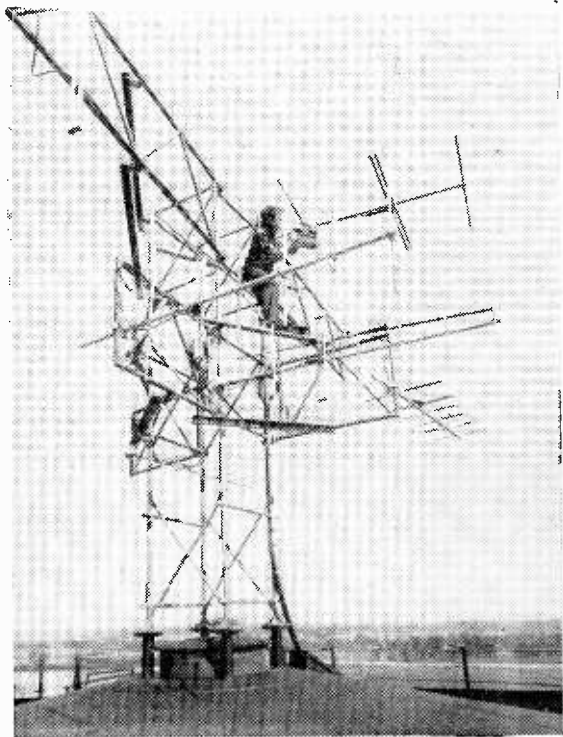
THE town of Bedford, although it lies only some 50 miles from London, is particularly unfortunately situated for television reception. Aerial arrays have to be large,

complex and carefully set up—this, of course, is expensive—and, even then, completely satisfactory results are not always achieved.

Since the spring a Multisignals r.f. relay system has been operating with equipment made by E.M.I. The aerials are mounted on top of Ravensden Water Tower, outside the town, and a four-mile-long underground coaxial cable with repeaters every quarter of a mile carries the amplified signals down into Bedford. A wideband system in which the distributed-amplifier-type repeaters cover Channels 1 to 13 and v.h.f./f.m. radio is employed and Radio Luxembourg is received, converted to Band-II f.m. and passed into the network. B.B.C. Channel I and I.T.A. Channels 9 and 11 are available (London and East Anglia) on their original frequencies. Some idea of the poor signal available in Bedford itself may be gained from the fact that even at the relay receiving site, 379ft above sea level, signals of only 150 to 300 μ V are obtained.

A feature of the opening was the demonstration of B.B.C./N.T.S.C. 405-line colour on two experimental Ekco receivers, one taking its signals from the network, the other from a local aerial. Whilst the receiver working from the network gave, as expected, an impeccable picture, the other was extremely noisy; so bad, in fact, that the noise was evident as twinkling colour, not just background disturbance. Whenever any local interference was generated the picture was blacked out completely and ignition interference was troublesome.

Initially the service was available to 4,000 of the 19,000 houses in Bedford; by the end of the year it is expected that wiring will be extended to another 6,000 dwellings. Charges for the aerial service range between 16s 6d per month for two years and 11s 6d. thereafter and £5-down connection fee and an annual charge of £6 10s, the viewer providing his own standard receiver.



Aerial arrays on top of Ravensden Water Tower.

Typical repeater-amplifier mounted on the wall of a radio-and-television dealer's shop in Bedford.



RANDOM RADIATIONS

By "DIALLIST"

A Unique Award

FOR the very first time the award of an "Emmy" has been made to two non-American firms by the American National Academy of Television Arts and Sciences. An "Emmy" is the TV equivalent of the film-world's "Oscar." The British firms are the English Electric Valve Company and Marconi's Wireless Telegraph Company. An "Emmy" was also presented to R.C.A. All three firms have been concerned with the development of the 4½-inch image orthicon tube. The first version of this, which did not get beyond the laboratory stage, was produced by R.C.A. The English Electric Valve Company saw its possibilities and with Marconi's pioneered the commercial development of the tube and of its associated cameras, the Marconi Mark III and Mark IV. It is now exported to every part of the world where there is a television service, including the United States, for it has proved itself superior to any other in many ways. The resolution, the signal-to-noise ratio and the reduction in spurious effects are unmatched. Work on the tube began ten years ago and as long ago as 1954 it was showing its qualities in the B.B.C.'s Lime Grove Studio E. That was in the Marconi Mark III

camera; now in the Mark IV camera it has proved itself a world-beater.

Electricity from the Sea

THE island of Mauritius gets a pounding by huge Indian Ocean waves during the greater part of the year. At present the Hydraulics Research Station of the D.S.I.R. is working on a project to make use of their energy for generating electric power. The idea is to construct a ramp over which the waves would climb to fill a lagoon above sea level on the far side. This lagoon would be drained through turbines of a type which need only a small head of water, and these would operate generators. Scale models have shown great promise and it is believed that worth-while quantities of power can be produced by this method of harnessing the energy of sea waves. The first station to be erected is expected to generate about 9,000kW, and later the output will be increased about five times. In some ways it's surprising that the enormous energy of tides and great waves has not already been made to do useful work. French engineers are, I believe, developing a plan to use tidal energy for the generation of electricity somewhere on the coast of northern France. One day, I expect, we'll find a way of using the

big tides of the Bristol Channel and possibly the tidal race through the Pentland Firth.

French-English Power Link

BY the end of this year the power link between this country and France should be completed. The peak periods in the two countries are different, so that it will often happen that France has electricity to spare for us or that we can supply her when her need is great and ours comparatively small. At first sight it seems rather curious that the cables between the two countries will carry d.c. But no way could be discovered of phasing up satisfactorily if a.c. were used. The 38-mile undersea link will be connected to converter stations at Lydd in Kent and Echinghen near Boulogne. When the system gets going 160MW of power will be transferable between one country and the other. The link will carry 200kV d.c. and 800A. One can't help wondering what the I²R losses will be—but that, of course, has all been allowed for. So too has the possible effect of magnetic fields on the compasses of passing ships; the go and return cables will be closely spaced throughout their length to keep loop area to a minimum.

Link with the Early Days

SO Magnet House is to be demolished soon after the end of this year. I'm sorry, for I've always regarded it and Marconi House as landmarks in wireless, television and electronics. I suppose that a new and larger building will arise from its rubble, but I sadly fear that it will be of the "pile of boxes" style that is so much in vogue nowadays. Both Magnet House and Marconi House had close associations with the British Broadcasting Company, as it was before its title became British Broadcasting Corporation. The B.B.C.'s entire staff was at first housed in one enormous room in Magnet House and it was from Marconi House that 2LO made its first broadcasts. That again was a one-room business. All the speakers and other entertainers sat at the back of it, waiting for Arthur Burrows to call them to the microphone. His

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name won't ring any bells for the younger generation; but he was the backbone of the early programmes and beloved by the children as Uncle Arthur, the originator of Children's Hour.

A Big Ear

THEY always do things on a grand scale in the United States, especially when the government is finding the necessary dollars. Now comes the news that they are putting up in Maine the biggest horn-type aerial in the world. With a length of nearly 200 feet and a height of just under one hundred it will dwarf all others. It has a double purpose. First of all it will be used in experiments in beaming signals on to orbiting satellites, in which our G.P.O. and certain European authorities are co-operating. Its other job will be to pick up the small signals relayed by them. The whole thing is to be encased in an enormous balloon to protect it from climatic damage. It is rather expected that eventually it may become part of a world-wide system of telephone and television communications depending on reflection from satellites.

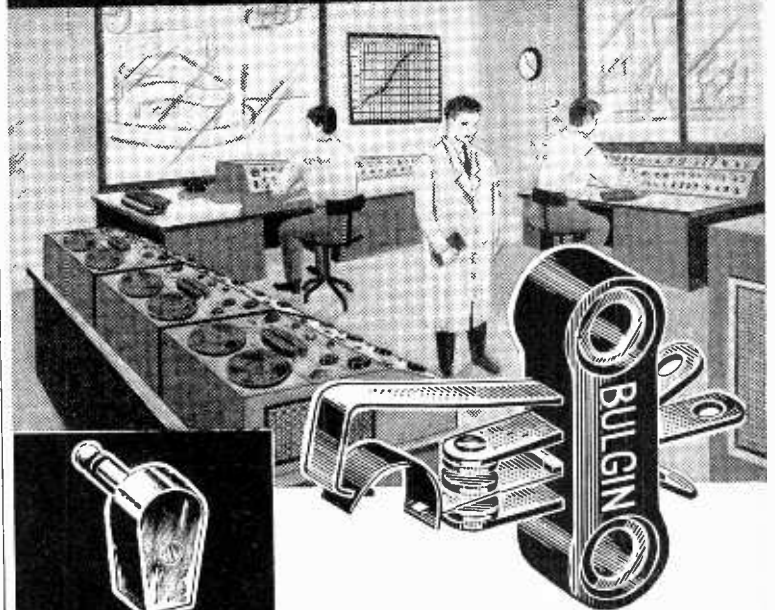
Doing a Good Job

THE Pilkington Committee is taking its task very seriously and when it comes out its report should be of real value. Recently Sir Harry Pilkington and three members of the Committee paid a visit to Canada and the United States in order to obtain first-hand knowledge of some of the television methods in use there. Among the subjects they discussed were colour television, educational broadcasting and pay-as-you-view TV. They also visited Etobicoke, Toronto, to see for themselves how the experimental subscription service of wired television is panning out there. One only hopes that when they come to write their report they won't be unduly swayed by the clamour for this and that by certain bodies, who don't seem to have done enough deep thinking about some of the things they so vehemently advocate.

Correction.—We have been asked to point out that on page 83 of the advertisement section of our July issue a misplaced line of type in the announcement of D.I.A. "Electro-technik" directed inquiries to Berlin. All inquiries from the Commonwealth should in fact be addressed to Telemechanics Ltd., Totton, Southampton.

WIRELESS WORLD, AUGUST 1961

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Ateleorasis

I DON'T think you will find the word of my title in even the very largest dictionary, but those of you who have studied the language of Socrates will have no difficulty in recognizing it as meaning "televisionless." If this word has succeeded in making you read what I have to say, I shall have achieved my object, for I want to talk to you about the deplorable state of hospital wireless which has recently been forced upon my attention.

Nowadays I suppose we take hospital wireless for granted as far as sound radio is concerned, and imagine that hospital TV is quite out of the question except for a set in wards where the patients are not completely confined to bed all day.



The shape of things to come ?

At any rate, I thought this until quite recently when a sudden emergency caused Mrs. Free Grid to be removed at dead of night to one of our largest and oldest-established hospitals.

On visiting her, I was astonished to find that her ward, in common with all the other female wards, was provided only with the old-fashioned 'phones of yesteryear in which the headbands seem to be designed specially for getting entangled in

ladies' hair. I quickly replaced her 'phones with a modern pair of the stethoscope type where there is actually only one "earpiece" which is situated at the junction of the two arms.

Naturally this immediately caused discontent among the other ladies in the ward (you know what women are) whose husbands were promptly put in the doghouse for not being as attentive to their wants as I was to Mrs. Free Grid. It astonishes me that 'phones of this type or of the lorgnette type have not been provided in ladies' wards before this. I think even men patients would find them more comfortable.

But it was the complete absence of TV which surprised me. Surely in these days it would be possible to provide a separate TV screen for each bed. The sets could be suspended from the ceiling, at an angle, by means of a special bracket as shown in my sketch. Of course, they would need no loudspeakers or auxiliary audio apparatus as the "sound" part of the programme would come over one of the normal headphone channels. (This would cheapen the sets, and a further economy could be effected by providing each set with two display tubes presenting a picture to beds on opposite sides of the ward as in my illustration. In fact, still more money could be saved by feeding all the sets in one ward from a common power pack, all high-voltage wiring being run safely above the ceiling of the ward.)

Naturally, all this would cost money, but since TV would be as much a therapeutic measure as some of the other hospital treatment it would probably be an economy in the long run. It would, I feel sure, empty beds quickly even if only on account of the poorness of some of the programmes we get nowadays.

Without doubt I shall be denounced as an irresponsible dreamer, just as were Harvey and Lister in their day, but I am used to that. No doubt some of you will have better ideas than mine of suspending the sets from a ceiling bracket, and if so please let me have them.

Jiggered

IT is always a pity when a beautiful scientific theory is shattered by a nasty little fact, but all the same I feel honoured to be corrected by so eminent a radio authority as Captain H. J. Round concerning the origin of the word jigger (July issue).

It is all the greater pity because I had abandoned the theory I expounded in the June issue. I had decided that Marconi used the name jigger because he had noted the resemblance between the electrical oscillatory motion in the windings of his r.f. transformer and the rapid up and down oscillatory motion of the Irish jig and Italian Giga.

I am a bit surprised at Captain Round's revelation that the large I.f. chokes hanging by ropes from the roof at Clifden were named "Crippens." The misguided little doctor didn't achieve notoriety until late 1910, by which time, surely, the Clifden station had been in existence several years.*

* True, but it did not then cease. In fact it was operating up to 1922.—Ed.

Palæalgia

I HAVE suddenly remembered that these words will appear in August, the month when the National Radio Exhibition once more opens its doors. I, who have seen so many of our radio shows, cannot help thinking that present-day exhibitions lack the excitement and "romance" of those held in the 'twenties when there always seemed to be a new circuit for us to try out.

In 1926, for instance, it was Sir Oliver Lodge's N circuit. What became of that I wonder? In that year too came W.W.'s famous "Everyman Four" receiver. But I expect that at the exhibition of 2000 A.D.—only 39 years ahead—there will be palæalgic lament for the days of 1961 before broadcasting had become a mere adjunct of the G.P.O. telephone service.

As for the word in my title, it can be translated as "pain for the past" or, more poetically, as "heartache for scenes of long ago." It is not a very elegant word I'll admit, but surely more accurate than the misleading B.B.C. word "nostalgia" which means "homesickness" and nothing else. No doubt some of you Homeric scholars can think of a better word than mine and, if so, I shall be glad to hear of it; but it must be reasonably compact.

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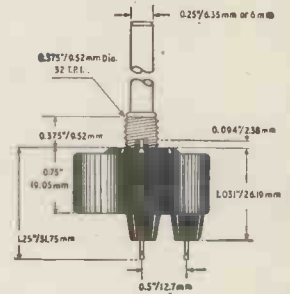
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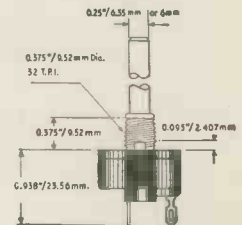


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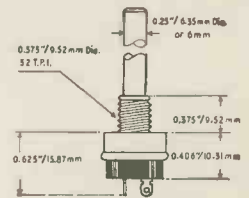
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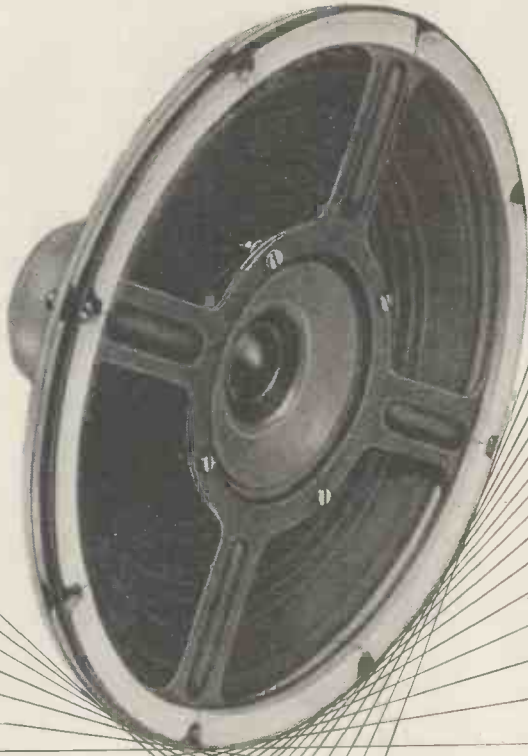
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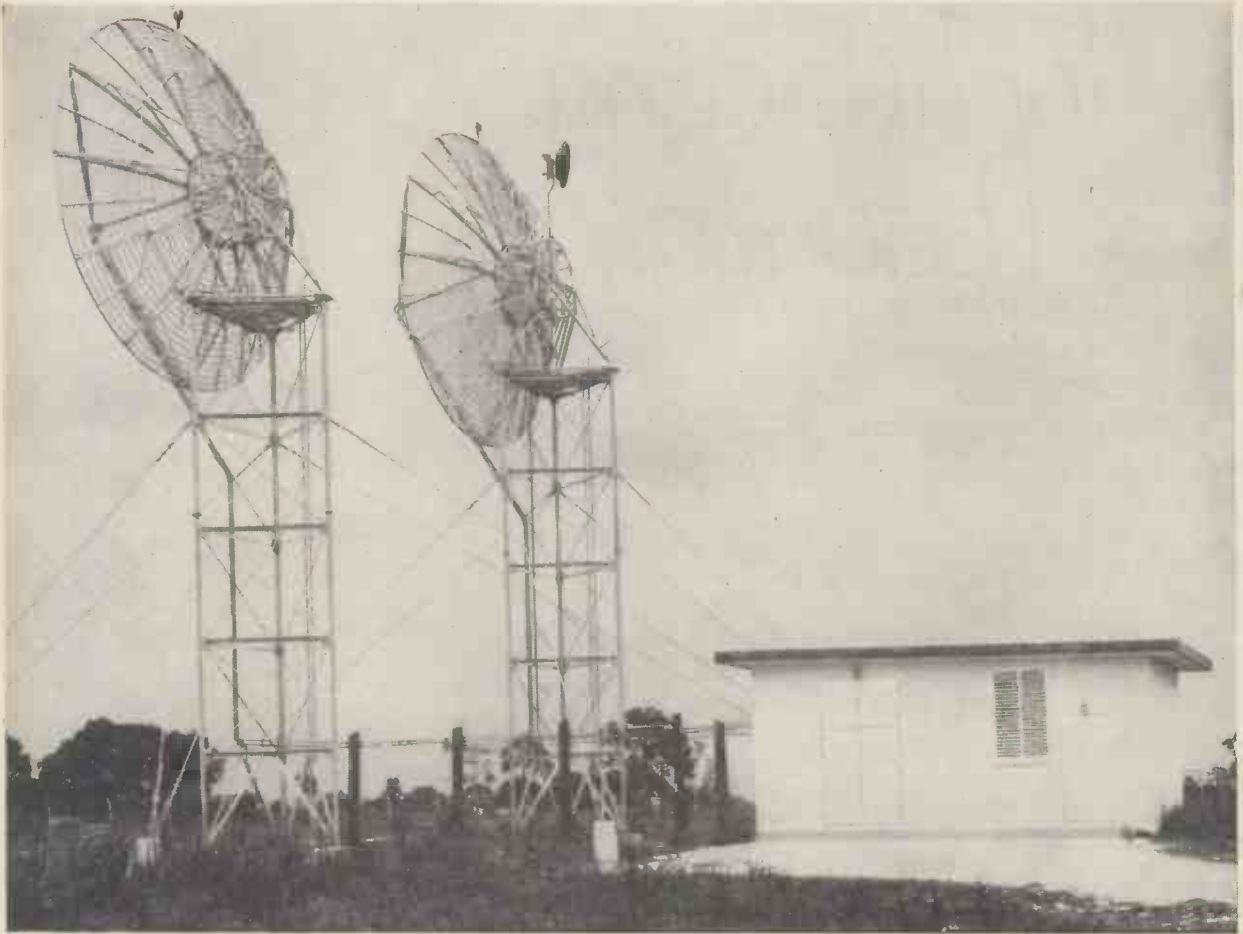


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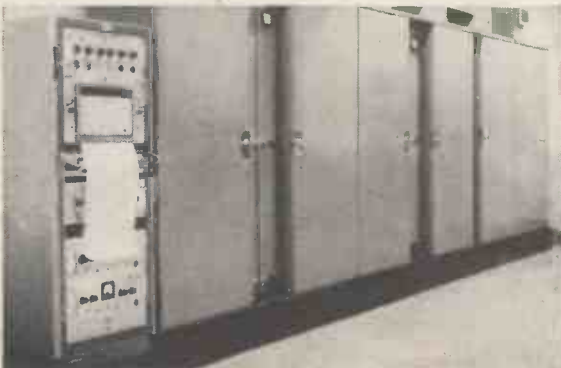
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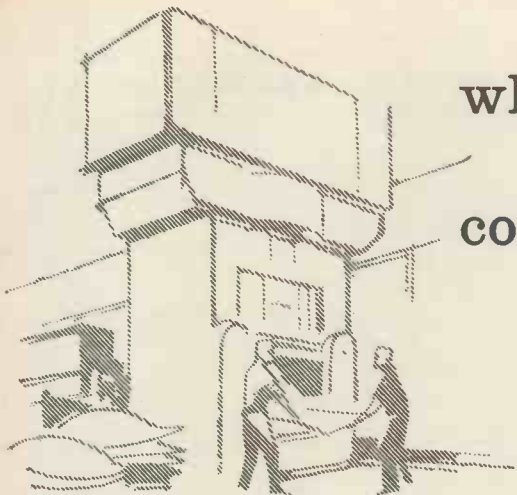
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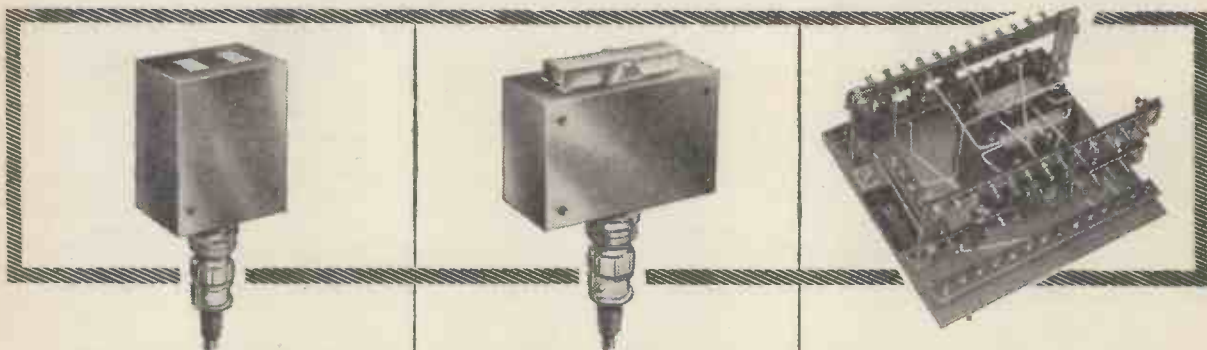
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NP0	13- 27	28- 39
N330	28- 47	48- 68
N750	48- 70	71-100
N1100	71-150	151-220
N1300	150-200	201-300
N1750	201-270	271-400
N2600	800	1000
LENGTH :	0.220"	0.300"
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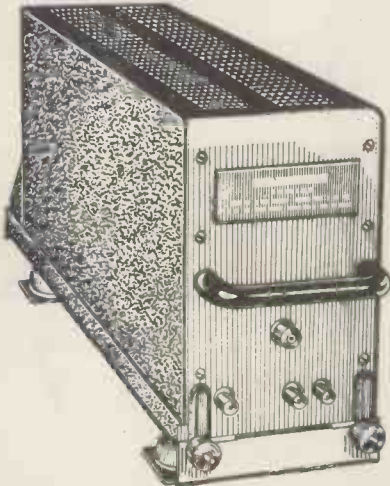
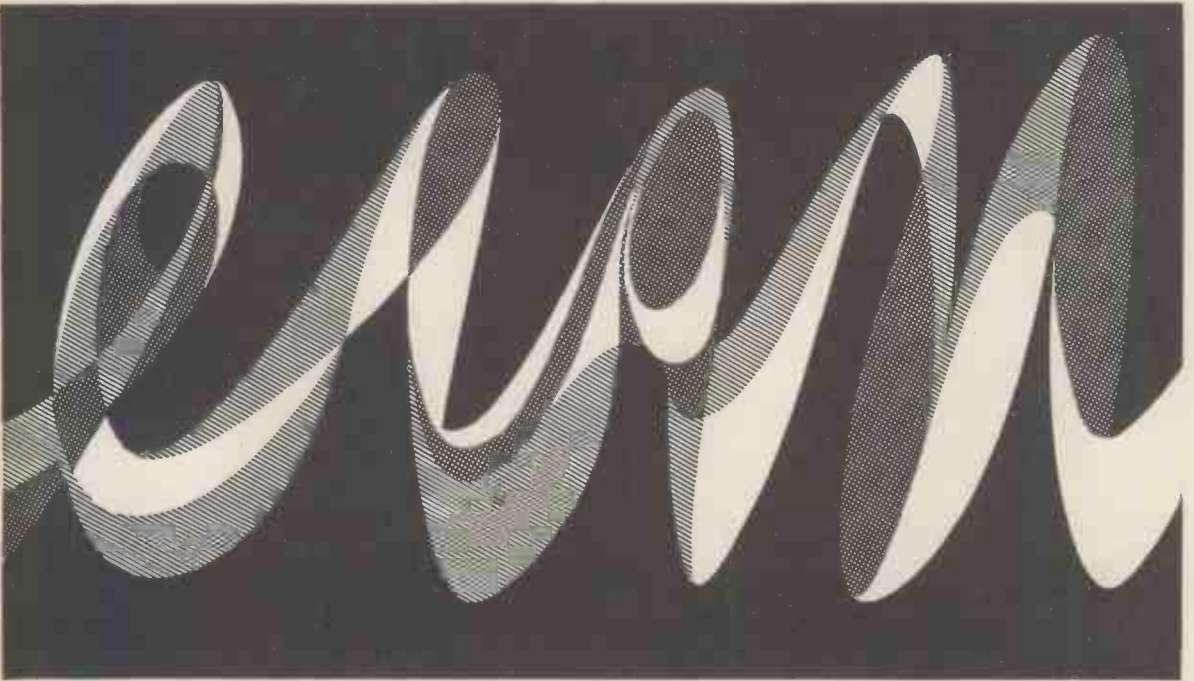
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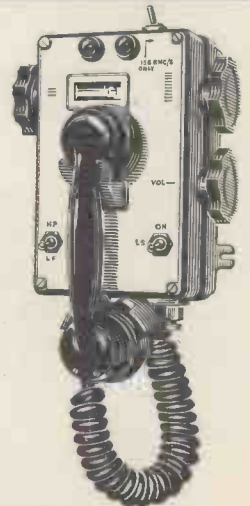
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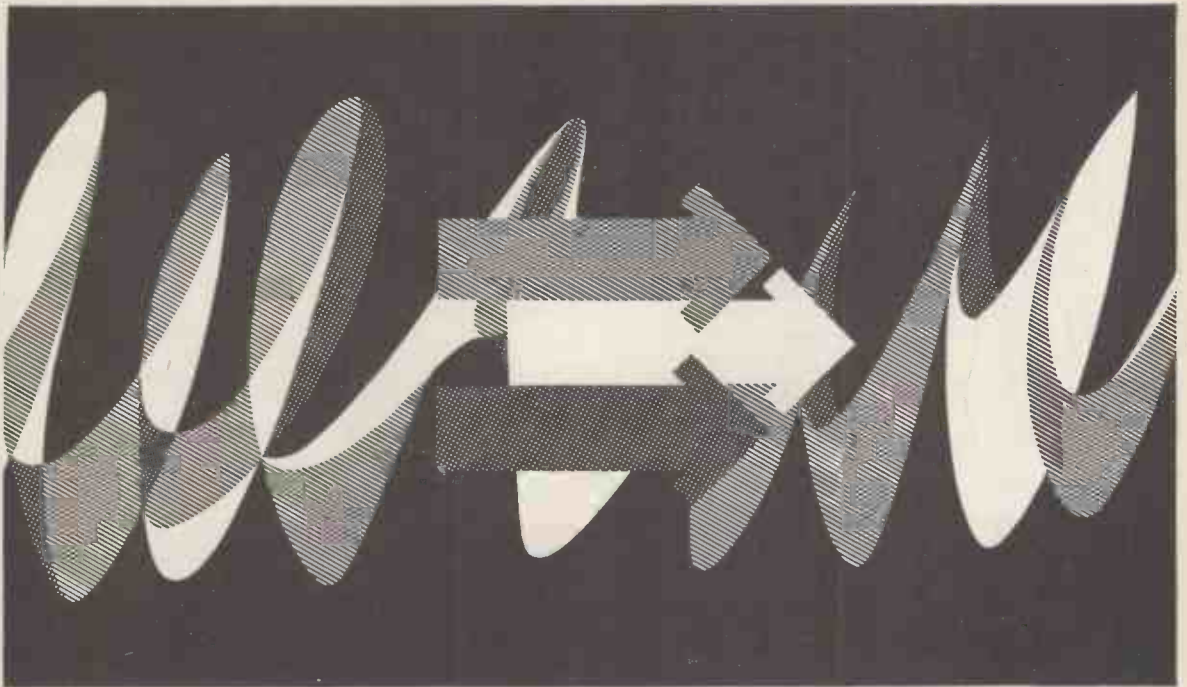
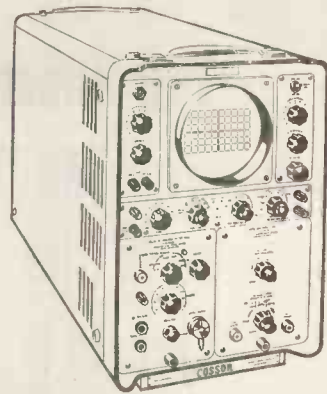


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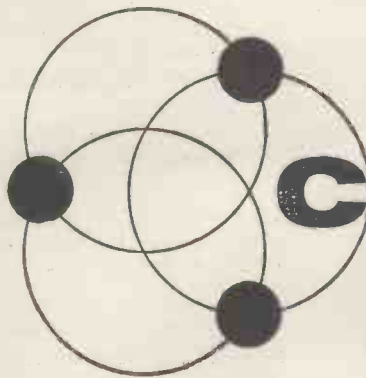
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40—20,000 c/s \pm 3dB at 15 ips
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40—13,000 c/s \pm 3dB at 3½ ips
40—7,000 c/s \pm 3dB at 1½ ips

Amplifier response 40-25,000 c/s \pm 3dB.
Superimposing and mixing facilities.

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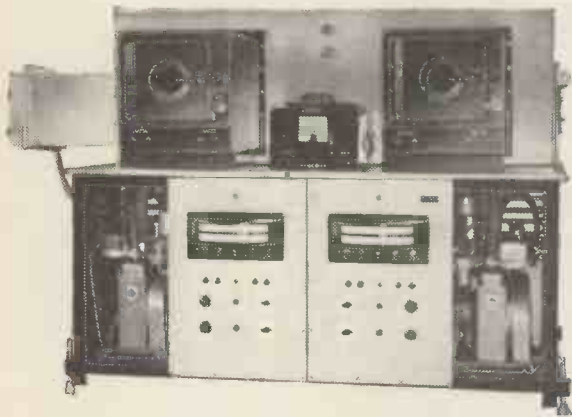
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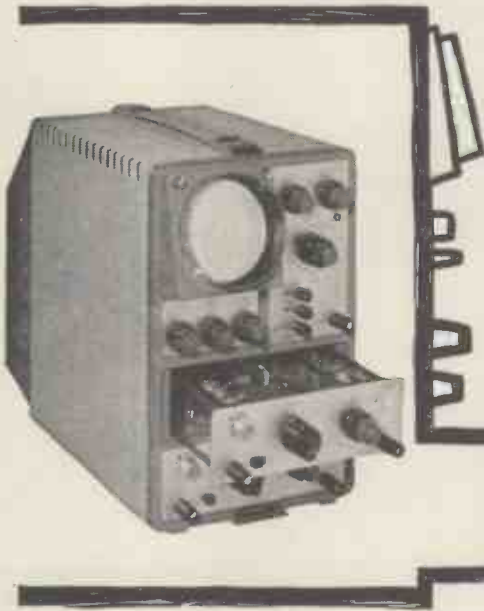


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A standard form of amplifier with a wide frequency response, and the additional facility of x10 sensitivity when needed over a limited bandwidth.

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Maximum sensitivity is as high as 100 uV/cm AC, frequency response 5 c/s to 150 Kc/s.



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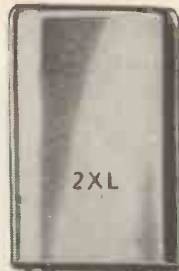
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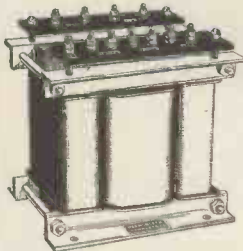


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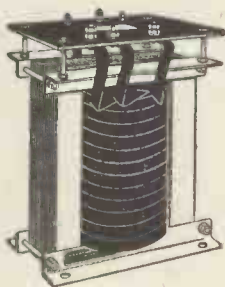
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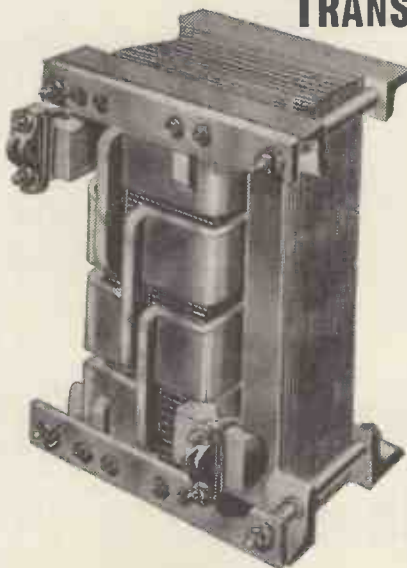
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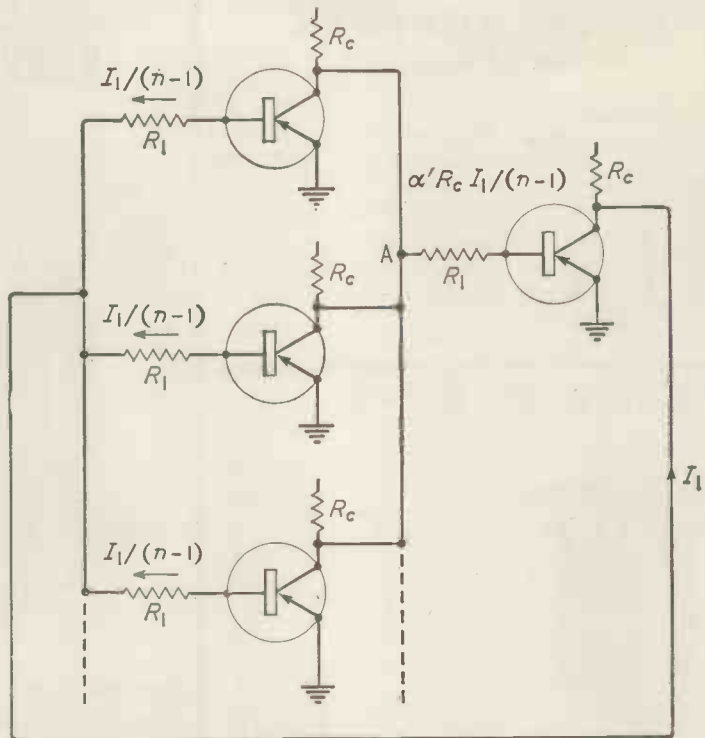


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Reversible Decimal Counters



In the current July issue of **ELECTRONIC TECHNOLOGY** one of the many interesting articles gives details of electronic counters, using transistor-circuit techniques, which reverse their direction of counting in response to external control signals. Design details are given for three basic circuit elements using junction transistors and diodes and it is shown how these three basic elements can be used to construct binary and bi-quinary counters.

ARTICLES IN THE AUGUST ISSUE INCLUDE:

COMMON-EMITTER AMPLIFIER

In this article the conditions are examined under which a simple equivalent circuit for a transistor may be applied with accuracy to an analysis of the common-emitter amplifier. The relationship between the voltage gain of the amplifier and the frequency is discussed in detail and it is shown that theoretical results compare favourably with experimental results. A formula is developed in terms of transistor parameters which enables the best transistor to be selected from a number of possible types when the maximum bandwidth is required at a specified zero-frequency voltage gain.

MAGNETIC RECORDING

A novel explanation for the magnetization of magnetic tape is given in this article and the role of a.c. bias is suggested. In spite of gross simplifications, several hitherto-unexplained phenomena can be accounted for on the basis of this analysis. A simple experiment is described which proves the salient points of the theory.

Electronic technology

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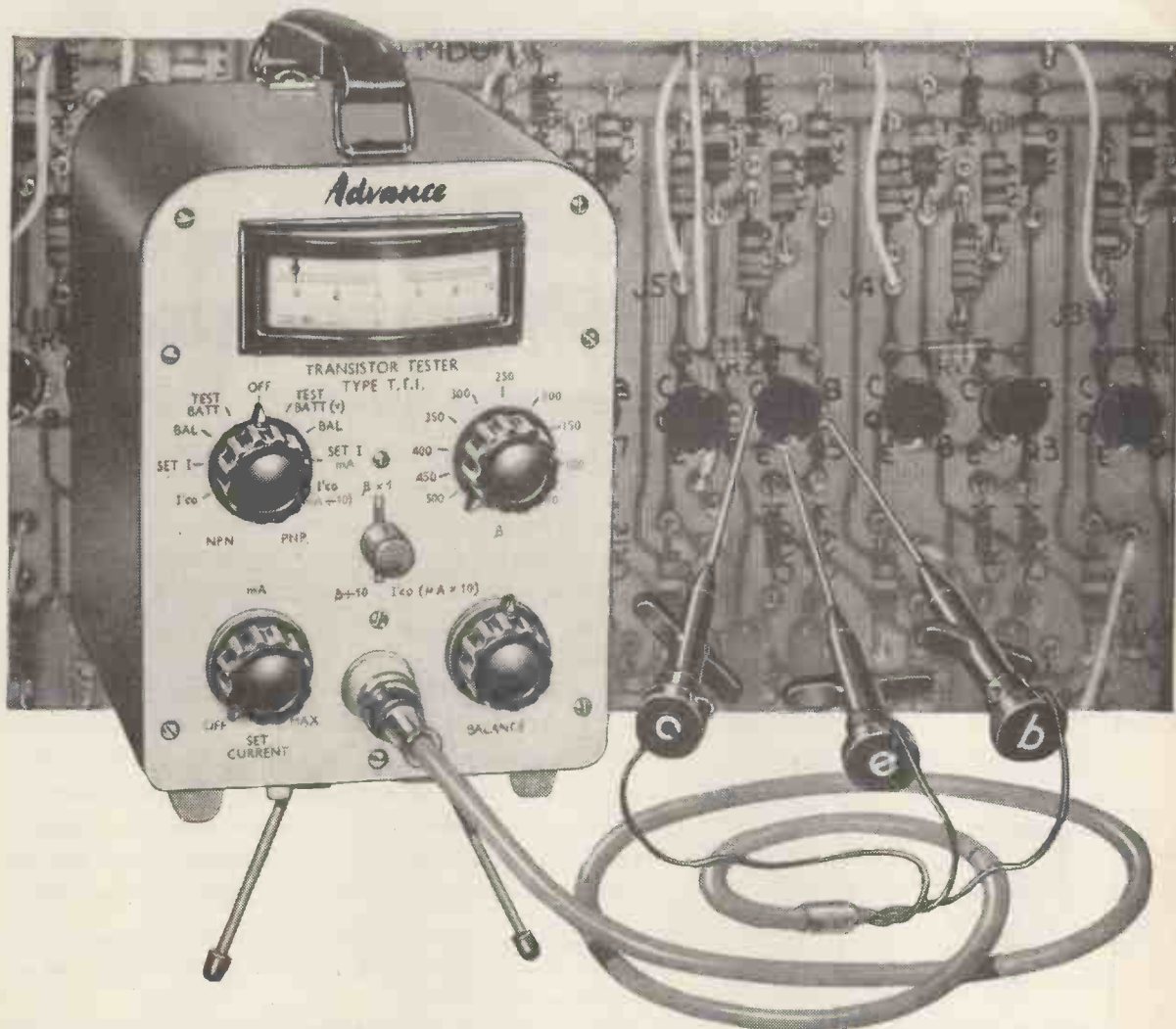
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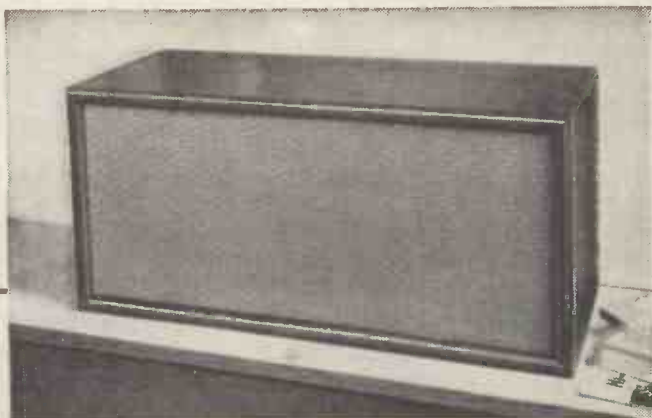
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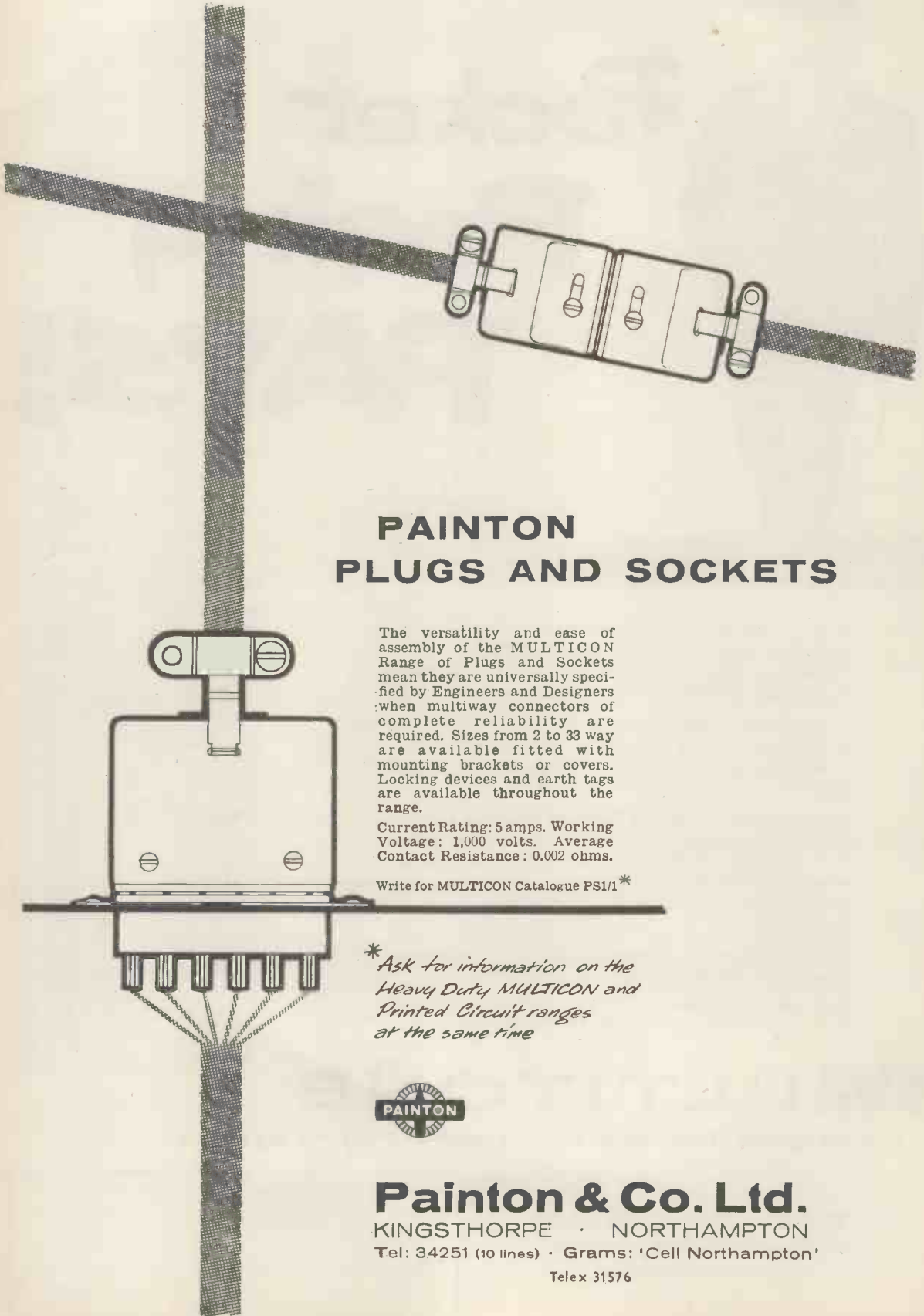
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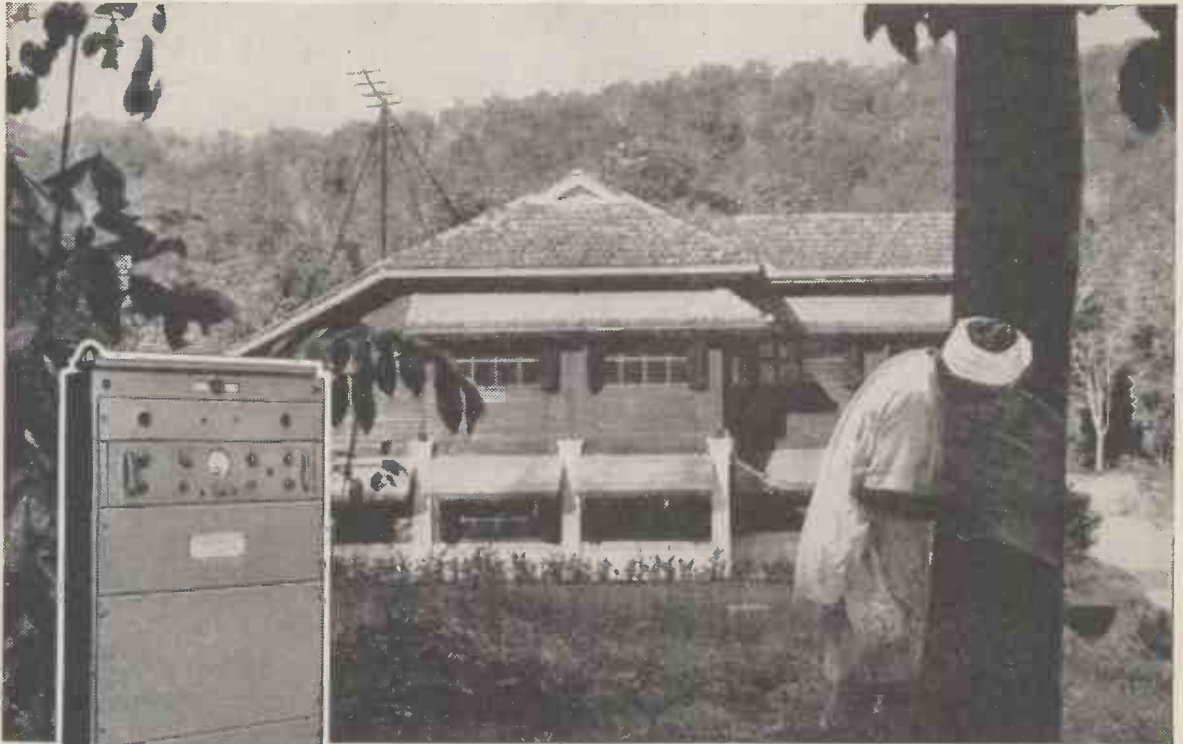
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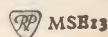
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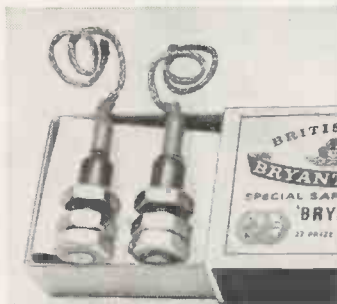
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Z5A.91F	9.1	2.0	670
Z5A.100F	10	2.0	610
Z5A.110F	11	2.1	520
Z5A.120F	12	2.1	490
Z5A.130F	13	2.1	460
Z5A.150F	15	2.1	410
Z5A.160F	16	2.1	370
Z5A.180F	18	2.1	340
Z5A.200F	20	2.1	310
Z5A.220F	22	2.2	275
Z5A.240F	24	2.3	245
Z5A.270F	27	2.5	225
Z5A.300F	30	3.0	205
Z5A.330F	33	3.4	190
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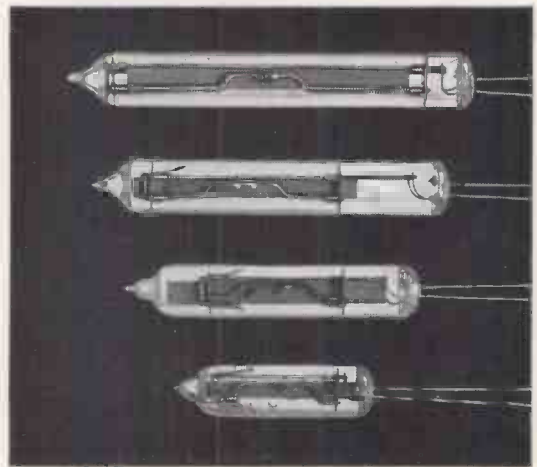
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Frequency Range Kc/s	STC Type	Maximum seated height		Volume		Lead Length	
		in.	cm	cu. in.	cu. cm	in.	cm
57-62.9	4432	2.83	7.19	0.36	5.90	1.5	3.8
63-71.9	4438	2.44	6.19	0.31	5.08	1.5	3.8
72-99.9	4437	2.04	5.18	0.26	4.26	1.5	3.8
100-150	4435	1.45	3.68	0.18	2.95	1.5	3.8

The new crystal units provide a saving in space of over 60%. They are ideal for horizontal mounting on transistorized printed circuits.

It is intended, in the near future, to extend the frequency range down to 10 kc/s to replace types using the present B7G mounting.

Write for further information to STC Quartz Crystal Division, Temple Field, Harlow, Essex.





LOW NOISE TWT EXTENDS RADAR RANGE

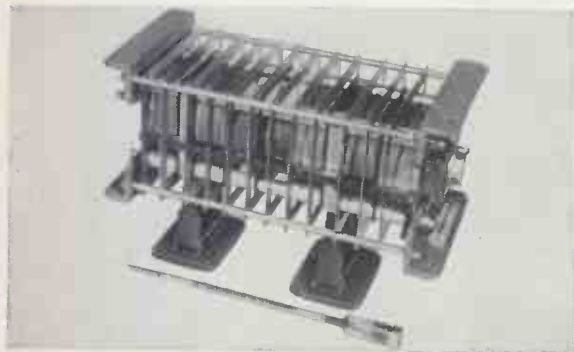
A limitation on the effective range of a radar equipment is the noise level in the receiver: the limiting range is reached when signal to noise ratio approaches unity. The signal to noise ratio in the equipment cannot be better than that in the first stage, therefore the use of a low noise amplifying tube in that stage is of paramount importance.

STC offers two tubes of eminently suitable design for use in S-band:

Type W9/2E for broadband coverage with a gain of 40 dB and noise factor of about 8.5 dB. It is intended for operation over the whole frequency range 2.5 to 4.1 Gc/s with fixed voltages. An aluminium foil mount is available with coaxial r.f. connectors.

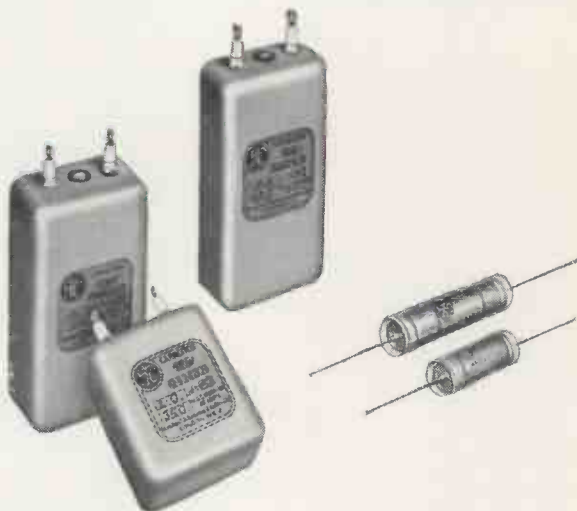
Type W10/3E for narrow band operation with about 23 dB gain and 6.5 dB noise factor with the grid voltages set for optimum noise factor at the appropriate centre frequency.

W10/3E has a frequency range 2.7 to 3.3 Gc/s in solenoid circuit 495—LVA—003 with waveguide r.f. connectors or frequency range 2.8 to 3.8 Gc/s in solenoid circuit 495—LVA 006 with coaxial r.f. connectors.



Apply to STC Valve Division, Footscray, Sidcup, Kent, for Brochure MS/113.

OIL-FILLED PAPER CAPACITORS



STC Oil-filled Paper Capacitors are manufactured with rectangular and tubular construction. Both types provide a range of capacitors offering a high stability of electrical characteristics over an extensive life at operating temperatures of from -40°C to 100°C .

Sintered glass compression type seals are used on the tubular types and the rectangular cases have Corundite sealing. The oil-filled construction renders the capacitors suitable for a.c. or d.c. applications and the design is such that the devices will withstand severe vibration conditions. The capacitors conform to Category H.1. of RCS131 and BS2131.

TUBULAR METAL CASES

Capacitance Range: $0.0033 \mu\text{F}$ to $1.50 \mu\text{F}$

Voltage Ranges: 100V to 350V d.c. 75V to 250V a.c.

Capacitance Tolerance (20°C):

Up to $0.01 \mu\text{F}$ $\pm 25\%$

Greater than $0.01 \mu\text{F}$ $\pm 15\%$

Insulance at 300V after 1 min: $5000 \Omega\text{F}$, or $25000 \text{M}\Omega$, whichever is less

D.C. test voltage: 3 times the rated working voltage at 70°C

RECTANGULAR METAL CASES

Capacitance Range: $0.25 \mu\text{F}$ to $10.0 \mu\text{F}$

Voltage Ranges: 150V to 1500V d.c. 75V to 750V a.c.

Capacitance Tolerance (20°C) $\pm 15\%$

Insulance at 300V after 1 min: $5000 \Omega\text{F}$, or $25000 \text{M}\Omega$, whichever is less

D.C. test voltage: 3 times the rated working voltage at 70°C

Write for Technical Data Sheets to STC Capacitor Division, Brixham Road, Paignton, Devon.



New Silicon Epitaxial Planar n-p-n Transistors

The Transistor Division is now producing the new silicon epitaxial planar transistors. This type of structure gives better saturation characteristics than the conventional mesa structure and represents a further landmark in the rapid advancement of STC semiconductors.

The initial range comprises four transistors for fast switching and high frequency oscillator applications. Brief data are given below.

For further information apply to STC Transistor Division, Footscray, Sidcup, Kent.

Characteristics	TK202A	TK203A	TK252A	TK253A	
f_T Common emitter gain-frequency product at $I_C=20\text{mA}$ $V_{CE}=9\text{V}$, $f=20\text{ Mc/s}$	50	100	50	100	Mc/s (min)
V_{CES} Collector-to-emitter saturation voltage at $I_C=100\text{mA}$ $I_C=200\text{mA}$	1.0 ($I_B=20\text{mA}$)	1.0 ($I_B=12.5\text{mA}$)	0.8 ($I_B=10\text{mA}$)	0.8 ($I_B=6\text{mA}$)	V (max) V (max)
I_{CBO} Collector-to-base leakage current at $V_{CB}=9\text{V}$, $I_E=0$	1.0	1.0	1.0	1.0	m μA (typ.)
Ratings					
V_{CBM} with emitter open circuited or reversed biased	40	40	40	40	V
V_{CEM} with base open circuited	20	20	20	20	V
V_{EBM} reverse direction	6	6	6	6	V
I_{CM} (mean)	0.5	0.5	0.5	0.5	A
P_{CM} unmounted in a heat sink	2.5 10	2.5 10	0.6	0.6	W
T_{JM}	150	150	150	150	$^{\circ}\text{C}$
JEDEC Outline	TO-3	TO-3	TO-9	TO-9	

STC High 'Q' Stanferite Pot Cores for Filter Coils, etc.

The range of STANFERITE air-gapped pot cores is provided with a minimum setting inductance adjustment of -3% or -5% to $+5\%$. This is achieved by rotating one half of the pot core relative to the other, and is produced by an asymmetric airgap resulting in a flux distortion. This is used primarily to compensate for the

spread in capacitor and other component tolerances associated with the inductor, without recourse to mechanical adjustment of the airgap, and in so doing enables a standard number of turns to be used.

Technical Data Sheets available from STC Magnetic Materials Dept., Edinburgh Way, Harlow, Essex.

TYPE	DIMENSIONS (Approx.)		INDUCTANCE RANGE (Nominal)	FREQUENCY RANGE (Nominal)	'Q' RANGE (Nominal)	EFFECTIVE PERMEABILITY		HYSTERESIS FACTOR MAXIMUM	
	Diameter in.	Height in.				With gap	Without gap	With gap	Without gap
PC1	0.25	0.16	$30\mu\text{H}$ to 9mH	—	—	—	> 400	—	3 000
PC1A	0.25	0.1	$30\mu\text{H}$ to 6mH	—	—	—	> 400	—	3 000
PC2	0.5	0.32	$30\mu\text{H}$ to 100mH	50c/s to 3Mc/s	30 to 300	25, 50, 100, 150	> 600	4.6 to 67	550
PC3	0.75	0.57	$30\mu\text{H}$ to 1H	200c/s to 3Mc/s	30 to 300	25, 50, 100, 150	> 900	4.1 to 60	890
PC4	1.0	0.68	$30\mu\text{H}$ to 5H	100c/s to 3Mc/s	30 to 600	25, 50, 100, 150	> 1 000	1.6 to 21.5	370
PC5	1.5	1.0	$30\mu\text{H}$ to 15H	50c/s to 2Mc/s	30 to 1 000	25, 50, 100, 150	> 1 200	0.97 to 15	340



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	ZT42	ZT43		ZT42	ZT43	Test Conditions
Collector Base Voltage	45	45 volts	Common Emitter D.C. Current gain h_{FE}	18-42	38-82	$V_{CE} = 6V$ $I_C = 10mA$
Collector Emitter Voltage	45	45 volts				
Emitter Base Voltage	6	6 volts	Common Emitter A.C. Current gain h_{FE}	30*	45*	$V_{CE} = 6V$ $I_C = 1mA$
Collector Current	50	50 mA				
Total Dissipation	300	300 mW	Collector Saturation Voltage. Max. $V_{CE sat.}$	1.0V	1.0V	$I_C = 10mA$ $I_B = 2mA$
Temp. Range operating and storage	-55 to +150°C		Gain Bandwidth Product. Min. f_T	50mc/s	50mc/s	$V_{CE} = 6V$ $I_C = 10mA$

* Typical values

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No. 3 IN THE SERIES

Technical Information for the Transistor Circuit Designer

Stability factor

The stabilisation of the operating point of transistors over a wide temperature range is vital in most applications and is normally achieved by the choice of the right biasing network. This network can take one of the forms shown in figure 1.

The stability factor S (i.e. the number of times the leakage current is amplified in the circuit) is given by:

Figure 1a.
$$S = \frac{\Delta I_C}{\Delta I_{CBO}} \approx \frac{1 + \frac{R_E}{R_B}}{\left(1 - \alpha + \frac{R_E}{R_B}\right)}$$
 where $R_B = \frac{R_1 R_2}{R_1 + R_2}$

Figure 1b.
$$S \approx \frac{1 + \frac{R_E}{R_F}}{\left(1 - \alpha + \frac{R_L + R_E}{R_F}\right)}$$

Figure 1c.
$$S \approx \frac{1 + \frac{R_F}{R_B'}}{\left(1 - \alpha + \frac{R_L + R_E}{R_F + R_B'}\right)}$$
 where $R_B' = \frac{R_F R_2}{R_F + R_2}$

The above are approximations because it is assumed that the external resistors R_E , R_1 , R_2 and R_F are of much higher value than the transistor's internal parameters r_e and r_b , of the T-equivalent circuit. It should be noted that a low value of S is desirable and that S can never be less than unity. The highest value of junction temperature in a particular circuit will determine a practical value for S , because $S \cdot I_{CBO}$ must be less than the desired value of I_C at the highest temperature.

In power output stages it is not always possible to tolerate the loss associated with the emitter resistor and the stability factor will suffer. The use of a temperature sensitive resistor can solve this problem and this will be discussed in No. 5 of this series.

($T_{amb} = 25^\circ\text{C}$ unless otherwise stated)

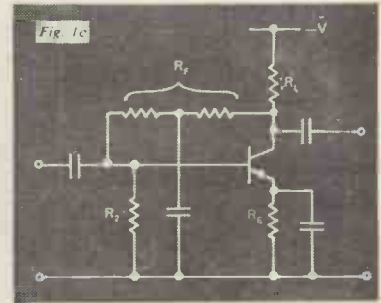
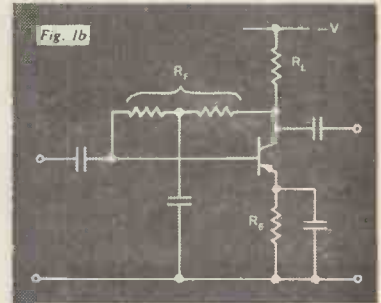
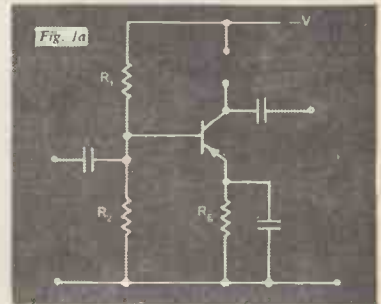


Fig. 1—A. C. Coupled Amplifier—Biasing Arrangements

Type	Description and Applications	h_{FE} measured at			V_C (V)	I_C (mA)	f_{hb} Typ. Mc/s	V_{CB} Max. (V)	V_{CE} Max. (V)	T_{junc} Max. ($^\circ\text{C}$)	P_c max at 25°C (mW)
		Min.	Typ.	Max.							
TK30C	GERMANIUM ALLOY JUNCTION TRANSISTORS P n p. Excellent switching performance at relatively high collector currents. Very low saturation resistance.	20	40	*85	-4.5	-1.0	6.0	-30	-10	75	200
TK31C	Similar to the TK30C, but with a cut-off frequency greater than 8 Mc/s.	20	60	150	-4.5	-1.0	11	-20	-5	75	200
TK41C	P n p. Particularly suitable for low power audio frequency amplifiers.	20	40	55	-12	-1.0	0.5 min.	-40	-20	75	200
TK42C	Similar to the TK41C, but giving greater current gain.	45	70	150	-12	-1.0	0.5 min.	-40	-15	75	200

*95% Limit.



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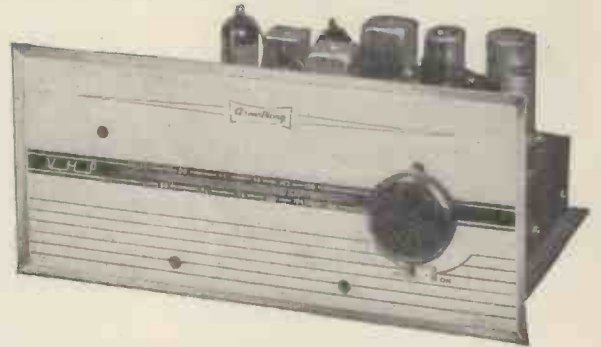
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7 x 3in.	37G	6500 g	20/6	6/7
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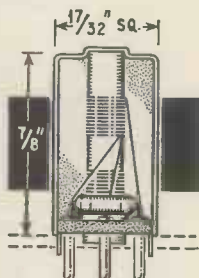
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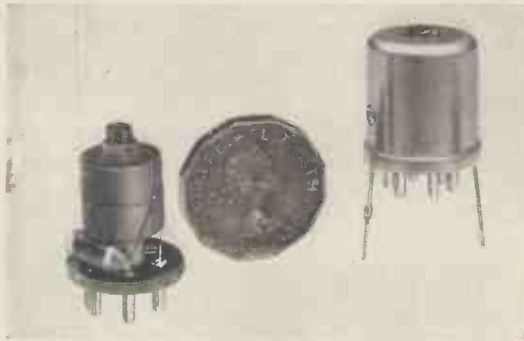
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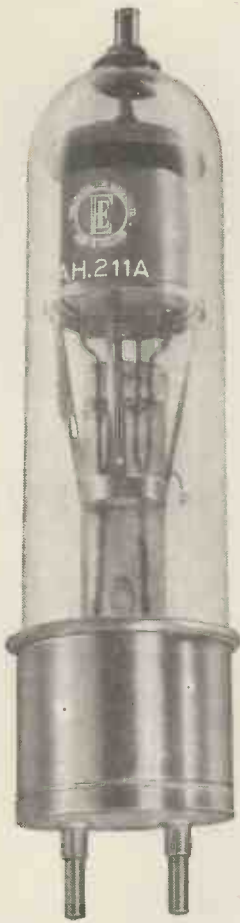
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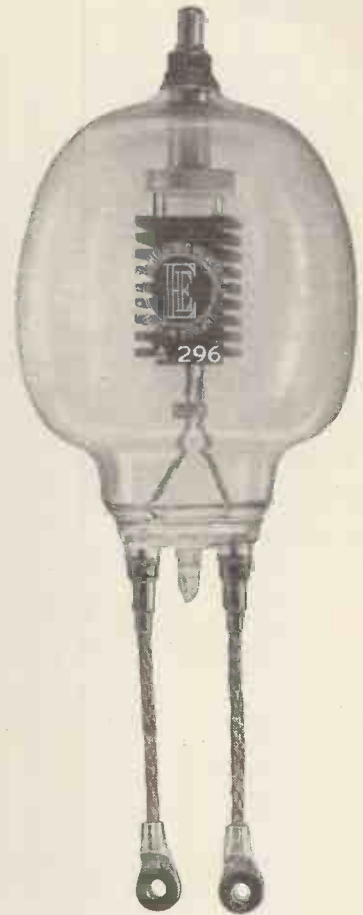
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					Peak (A)	Mean (A)
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	*A207	—	CV2160	45	1.1	0.35
	A235	2-25A	—	25	0.5	0.05
	*A237	—	CV482	65	1.5	0.25
	*A296	—	—	25	6.5	1.25
MERCURY VAPOUR	*869B	869B	—	20	10	2.5
	*872A	872A	CV1449 & CV642	10	5.0	1.25
	AH200	—	—	20	10	2.5
	*AH205/857B	857B	CV2673	22	40	10
	*AH211A	—	CV532	16	8.0	2.0
	AH213	—	CV2723	20	10	2.5
	*AH221	—	CV5 & CV1435	20	5.0	1.25
*AH238	—	CV1629	13	5.0	1.25	
XENON	†3B22	3B22	CV3815	0.725	†4.0	†0.5
	*3B28	3B28	CV1835	10	1.0	0.25
	*4B32	4B32	CV2518	10	5.0	1.25
	*AX228	—	CV2399	13	6.0	1.25

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† Full wave rectifier.

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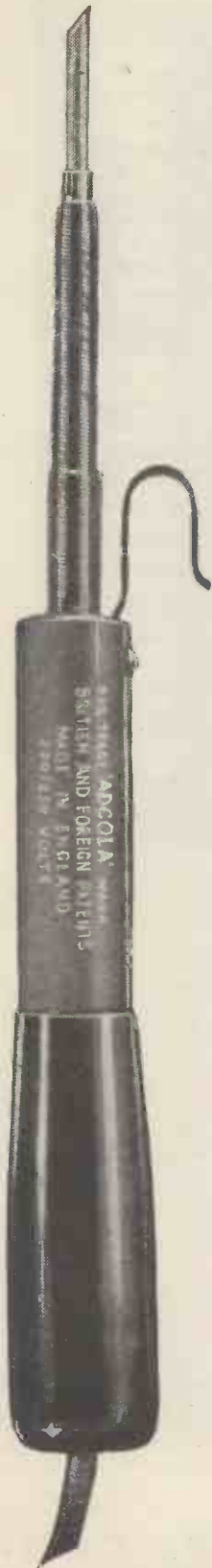
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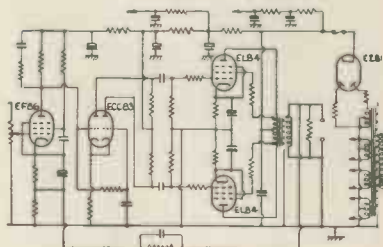
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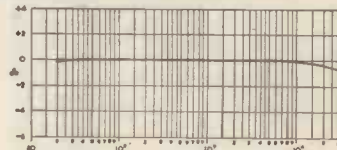
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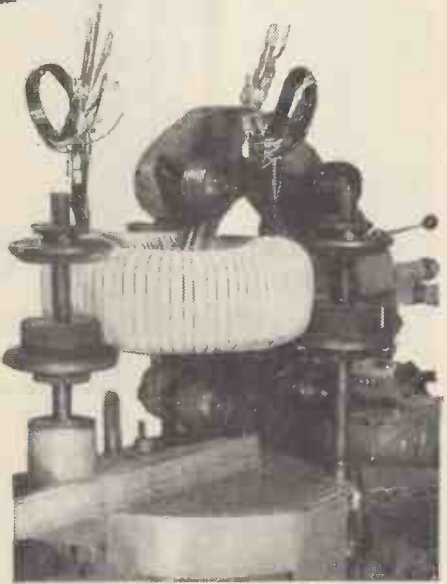
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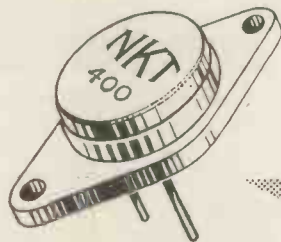
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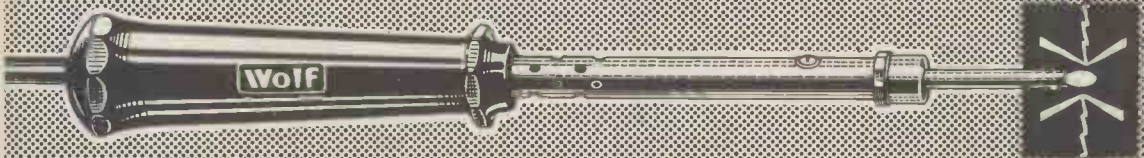
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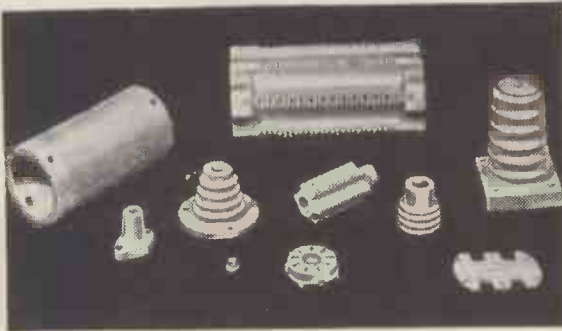
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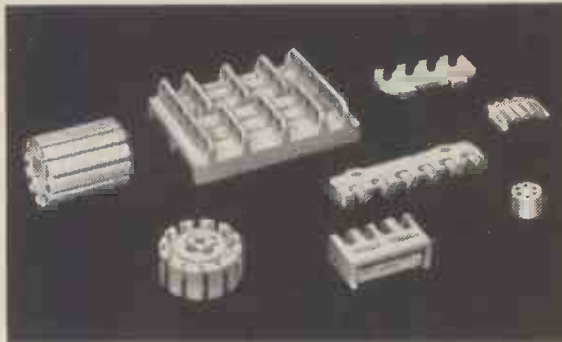
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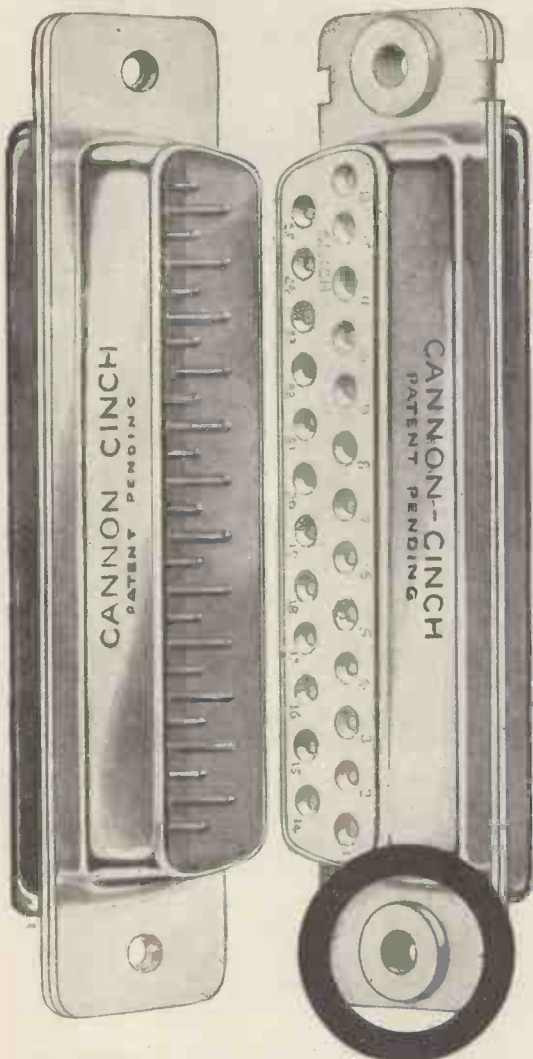
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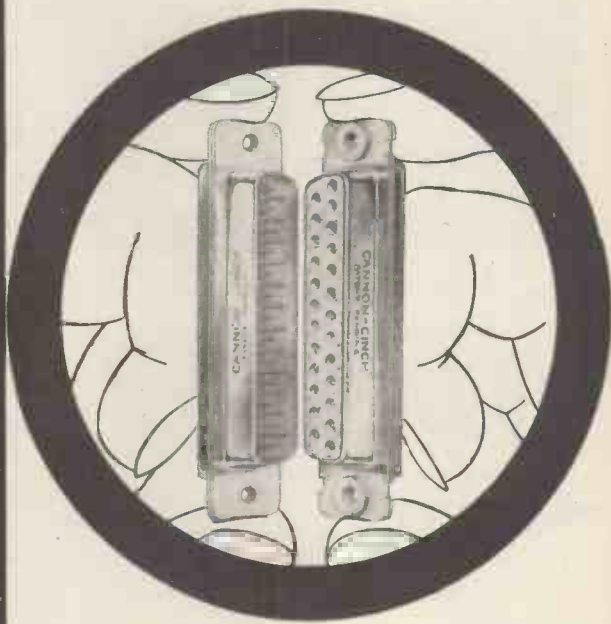


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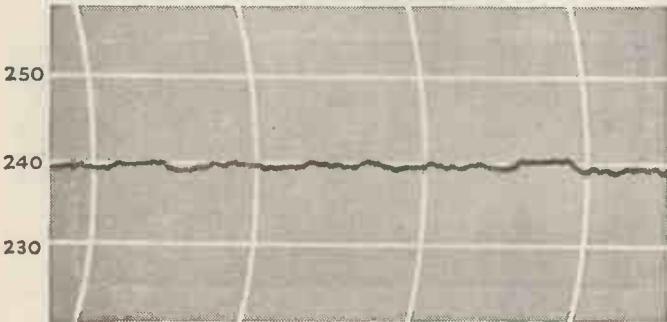
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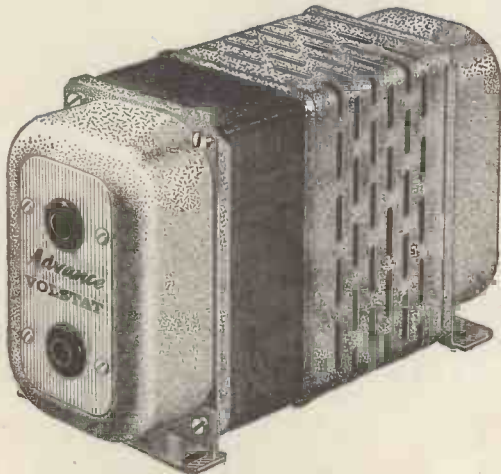


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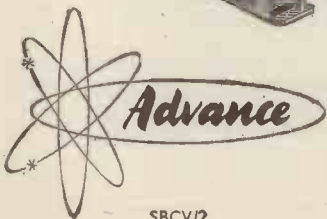


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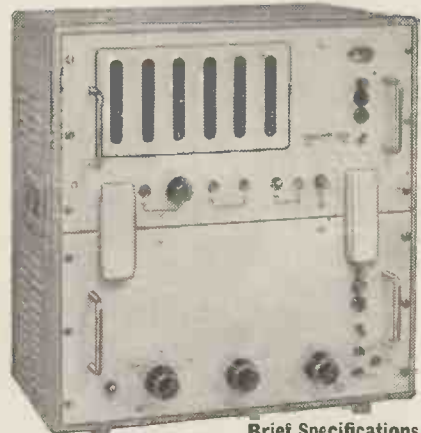
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After nearly 30 years of specialising solely in the production of Miniature Electric Lamps, we have accumulated a store of information that is freely available to the Electronics Industry. You are invited to write or phone us for any information you may require about Miniature or Sub Miniature Filament Lamps for use in existing or new projects.

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MINIATURE TRANSFORMERS, PICK-UP,
CLOCK AND INSTRUMENT COILS, ETC.
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CONTRACTORS TO G.P.O., M.O.S., L.E.B., ETC.
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Patent No. 748811

Safety first every time with these patented spring-loaded AVO prodclips.

Cleverly designed for use as insulated prods, they are invaluable for reaching and holding test points which are difficult of access.

Suitable for use with AvoMeter, Multiminor and Avo Electronic Test Meter Leads.

Post Free 15/- per pair

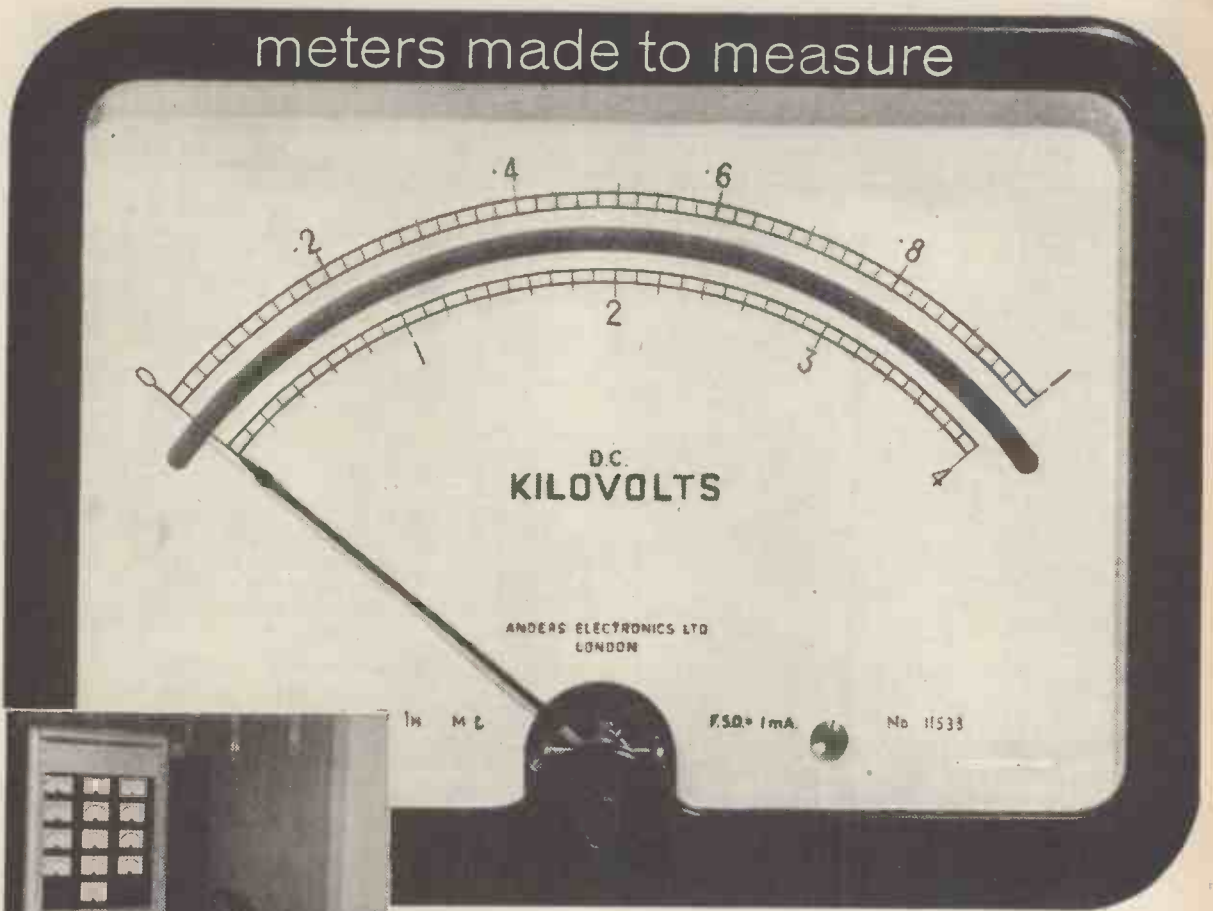
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VICTORIA 3404 (12 lines)

A MEMBER OF THE METAL INDUSTRIES GROUP OF COMPANIES

meters made to measure



special EHT meter rushed through for MO Valve Company

This Multi-range E.H.T. Series 705 meter is one of a number of instruments supplied to the M.O. Valve Company Ltd. by Anders Electronics at very short notice. These meters are used in the M.O. Valve Company Production Test Equipment for Travelling Wave Tubes shown here. Just the kind of work Anders excel in: special meters for very special equipment. Anders are indebted to the M.O. Valve Company for their kind permission to illustrate this test gear.

The Anders Instrument Centre is in a unique position to meet the most urgent, and the most unusual, meter requirements from production, development and research. Many standard meter ranges are available immediately from stock. Non-standard meters are calibrated, tested and normally ready within 10-14 days. All shapes; sizes from 1½" to the largest switchboard meters. All well-known makes and all types including moving coil, moving iron, thermocouples, electrostatic, dynamometers and full range of meter accessories. Anders would like to demonstrate the kind of service they can give you and look forward to your enquiries, by letter or by telephone.

ANDERS

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Ministry of Aviation approved.*

METERS, ELECTRONIC AND TEST EQUIPMENT TO INDIVIDUAL SPECIFICATIONS

WE SEND THE BEST OF BRITAIN'S HI-FI EVERYWHERE

NOW AT LARGER PREMISES

PLEASE NOTE—Prices quoted subject to alteration in accordance to those advertised by manufacturers at time of receipt of order.

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Vortexion W.V.A.	£93 13 0	\$268
Vortexion W.V.B.	£110 3 0	\$315
Brennell Mk. V	64 gns.	\$192
Brennell 3 Star Stereo...	89 gns.	\$267
Clarion Transistor	25 gns.	\$75
Cossor 1601 4 Tr.	37 gns.	\$111
Cossor 1602 4 Tr. 3 spd.	59 gns.	\$127
Ferroglyph 4AN	81 gns.	\$243
Ferroglyph 4AH	86 gns.	\$258
Ferroglyph 808 Stereo...	105 gns.	\$315
Grundig TK1	26 gns.	\$68
Grundig TK55 Stereo	92 gns.	\$276
Grundig TK20 with Mic.	42 gns.	\$126
Grundig TK24	55 gns.	\$165
Grundig TK30	65 gns.	\$195
Philips 4 Track EL 3542...	59 gns.	\$117
Philips 4 Track Stereo EL 3536	92 gns.	\$276
Philips 4 Track	34 gns.	\$102
Reflectograph "A" 4 Tr.	105 gns.	\$315
Reflectograph "B" 4 Tr.	115 gns.	\$345
Stuzzi Magnette	59 gns.	\$177
Stuzzi Tri-corder	63 gns.	\$189

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Wearite 4A mono.	£36 10 0	\$105
Wearite 4B	£41 10 0	\$119
Brenell Mk. V	28 gns.	\$84
Brenell Stereo Deck	£33 16 0	\$101
AKG. C12, Condenser...	£185 0 0	\$535
AKG. D.19, Dynamic ...	£19 10 0	\$56

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Wharfedale SFB/3	£39 10 0	\$113
Wharfedale Coaxial 12	£25 0 0	\$72
Wharfedale Golden 10	£8 14 11	\$20
Tannoy 12in. Monitor ...	£30 15 0	
Tannoy 15in. Monitor ...	£37 10 0	
WB. 1016	£7 12 3	\$16
Goodmans AL.120	£29 10 0	\$84
Goodmans AL.100	£23 10 0	\$67
Goodmans Triaxiom ...	£25 0 0	\$72
Goodmans 300	£11 5 9	\$32
Goodmans 400	£16 1 0	\$41
Kelly Ribbon Mk. II ...	£10 10 0	\$30

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Decca Stereo P.U. complete	£21 0 0	\$45
Lenco GL60 Trans. Unit	£27 12 6	\$60
Lenco GL58/R, Stereo P.U.	£24 5 7	\$53
Garrard 301	£22 7 3	\$49
Garrard 4HF/Stereo P.U.	£19 4 8	\$45
Connoisseur Motor Type "B"	£27 16 1	\$59
Connoisseur, 2 sp. Motor	£16 13 1	\$36
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Quad 22-Control Unit	£25 0 0	\$73
Quad II Amplifier	£22 10 0	\$65
Leak Stereo 20 Amp.	£30 9 0	\$87
Leak Point One Pre-Amp.	£21 0 0	\$60

Rogers Junior Stereo ...	£28 10 0	\$82
Rogers Master Stereo Unit	£35 0 0	\$100
Quad FM Tuner	£28 17 6	\$60
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Enquiries for all items by firms mentioned in this advertisement invited.

BINSON "ECHOREC" UNITS

BINSON STANDARD ECHOREC pre-amplifier unit enables echoes to be imposed on signals between microphone (or other source) and amplifier or recorder. 3 channels available, and timing of echoes is controllable. Details on request. 140 gns. \$420
Binson "Baby Echorec," similar to above, but for single-channel working. 100 gns. \$300

PROFESSIONAL AND TRADE DISCOUNTS.

● FULL OFFICIAL RATES OF EXCHANGE FOR PAYMENT IN ANY CURRENCY.

● MANY ITEMS FOR 110 VOLTS A.C.

● TRANSISTOR RADIOS.

● ACCESSORIES.

● LARGE AND UP-TO-DATE STOCKS.

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Carriage charged at cost.
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Mechanical Relay Latch

FOR P.O. TYPE 3000

This latching device enables the P.O. 3000 type relay to be held in the closed position when the coil is de-energised and until manually released.

Does not impair the versatility of the contact arrangements, nor affect the normal mounting position.

WILL TRIP AND HOLD ON A.C. OR D.C. IMPULSE



Illustrations show 3000 Type Relay fitted with "Remote" or "Local" release latch.

EITHER TYPE CAN BE FITTED TO YOUR EXISTING 3000 TYPE RELAYS IN A MATTER OF MINUTES.

Please send for illustrated leaflet.

A NEW ADDITION TO THE P.O. 3000 TYPE RANGE THE "REMANENCE RELAY" Details on request.

Jack Davis (Relays) Ltd.
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A wide range of LAMP HOLDERS for use in circuits up to 380v using NEON and FLUORESCENT neon lamps or low voltage filament lamps are available.



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SUPERB EQUIPMENT BY



**FOR STEREO
OR MONAURAL**



New Craftsman Speaker, MAJOR 8in. and 5in. speakers 30-15,000 cycles, £25/15/4 inc. Tax.

MINOR 5in. speaker £16/5/6 inc. Tax, finished Vynair plastic with medium walnut and matt black trim.



stereo Pickup Mark III
Designed to accept both monaural and stereo heads. Adjustable for heights of various turntables. Pickup head specification identical with the Type CS1. Arm only £3/19/11 inc. Tax. Stereo head £7/19/11 inc. tax.
Mark II Diamond head £8/13/3 inc. tax.
Mark II Sapphire head £4/13/3 inc. tax.



Stereo Pickup Type CS1
Pickup arm fitted with integral lifting device. The pickup head employs miniature ceramic units, frequency range 20-14,000 c.p.s., output 20mV with channel separation of 20-25 db. Downward pressure 3-4 grams. Diamond stylus. Will accept Mark II monaural heads. Pickup (complete as illustrated) £12/19/10 inc. tax. Pickup head £7/19/11 inc. tax. Pickup arm £4/19/11 inc. tax.



THE CRAFTSMAN

2-speed transcription motor finished in matt black and silver. Full 12in. heavy aluminium turntable. 2 speeds 33 $\frac{1}{3}$ and 45 r.p.m. Synchronous motor dynamically balanced, precision ground and lapped shaft; nylon adjustable bearings; neon on/off indicator. PRICE £18/13/1 inc. tax.



Stereo Amplifier and Control Unit Type 586.
Twin channel with ultra-linear output stage. Inputs for F.U. Tape and Radio, sensitivity being 6mV. Separate treble and bass controls. Pre-amp. £16/10/-.
Amp. £24/10/-.

Please write for Leaflets.

A R SUGDEN & CO(ENGINEERS) LTD.

MARKET STREET, BRIGHOUSE

TURN YOUR LIVING ROOM into a CONCERT HALL!

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ADD-ON

REVERBERATION UNIT

makes music as
LARGE AS LIFE

Added on to your radio, record player or tape recorder, the Bird Reverberation Unit gives concert hall acoustic dimensions to your room. It brings a startling new reality to monaural or stereo reproduction.



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NEW DIMENSION
to your music

19 Gns. Legs 30/- extra

ASK YOUR DEALER FOR A DEMONSTRATION

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AUTOMATIC COIL WINDING MACHINE

Type A1/1 (25/50 S.W.G.) Type A1/X (19/46 S.W.G.)

THESE MACHINES INCORPORATE THE FOLLOWING FEATURES:—

Infinitely variable wire gauge adjustment with easily read scale calibrated in .001in. Width of coil quickly adjusted within fine limits. Adjustable tailstock fitted with spring loaded live centre and quick release lever. Machines to stop automatically at a required number of turns can be supplied.

We will be pleased to send you an illustrated leaflet giving a full technical specification on request.

KOLECTRIC LTD 73 UXBRIDGE ROAD,
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A Compact SPEAKER SYSTEM WITH CLEAN BASS



MODEL W3 A 3-speaker system in which compactness has been achieved without sacrificing quality of reproduction and without introducing "small box" tonal character. It is ideal for use on a stereo or single channel input where room space is limited, as the cabinet is suitable for floor or shelf mounting. The sensitivity is high enough to give full domestic volume with any good commercial FM receiver with about 3 watts output.

BASS In this model LF output is produced by a 12" unit type WLS/12 fitted with a soft fibrous cone for smooth response. The special roll surround permits large distortion-free excursions with fundamental resonance below 25 c/s.

TREBLE The upper registers are handled by 5" and 3" units connected in parallel via a quarter section 1 kc/s dividing network, with an extra series capacitor to protect the smaller speaker. Two volume controls permit adjustment of midrange and treble to give tone control and facilitate balancing different speakers on stereo.

Cabinet size 28" x 14" x 12"
Weight 48 lb. complete
Impedance 15 ohms
Max input 15 watts

£39.10.0
complete, tax free

The elegant cabinet is available in a choice of walnut, oak or mahogany veneers. Also available in whitewood, price £36 10s. 0d. Tropical model made with resin-bonded plywood can be supplied at £2 0s. 0d. extra.

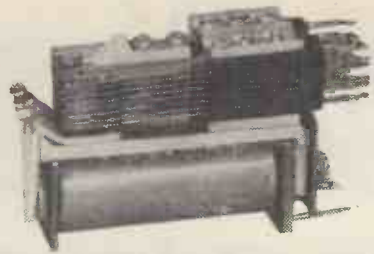
Wharfedale
WIRELESS WORKS LTD

Telephone: Idle 1235/6 Telegrams 'Wharfedel' Idle Bradford

FOR FULLY DESCRIPTIVE LEAFLET on Cabinet Models
POST THIS COUPON (Unsealed 2d. stamp) **TO**
WHARFEDALE WIRELESS WORKS LTD., IDLE, BRADFORD,
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ADDRESS.....
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DEPENDABLE ELECTRONIC CONTROL EQUIPMENT



... BUILT TO SPECIFICATION

Realistic delivery dates for all types of equipment including

- ★ HEAT CONTROL UNITS
- ★ POWER SUPPLY UNITS
- ★ RELAYS TO SPECIFICATION
- ★ PHOTO-ELECTRIC UNITS
- ★ BATCH AND PROCESS COUNTERS
- ★ ELECTRO-MAGNETIC COUNTERS
- ★ SECURITY DEVICES
- ★ TRANSISTOR RELAYS

CONTACT TYPE: For use with moving coil meters, contact thermometers etc.

VOLTAGE TYPE: (300 micro amps at 1.5vDC or 2-10 micro amps at 100-150 milli-volts) for photo-electric equipment, bridge circuitry etc.

Large stocks always available of the following:—

P.O. type 3,000 and type 600 relays, transistor relays, Siemens high speed relays, sealed relays by G.E.C., S.T.C. Siemens etc. Rotary transformers by Delco, Hoover etc.

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LINEAR

MODEL L10 HIGH FIDELITY 10 WATT AMPLIFIER

WITH SEPARATE PRE-AMPLIFIER

Supplied complete only (i.e. Main Amplifier and Pre-amp.) **15** Retail Price **GNS.**

Size of main amplifier 9in. x 7in. x 5in., Pre-amp 11in. x 4½in. x 2½in. Front Plate 12in. x 3½in. Stoved Gold hammered finished chassis. Front Plate Polychromatic Gold. Weight of main amplifier 10lb. Pre-amp. 3lb. For 50/60 c.p.s. A.C. mains 200-230-250 v. or to order for export.

The Following Outstanding Test Figures include Pre-amplifier.

Sensitivity (for 10 watts)

L.P. 25 m.v.
78 r.p.m. 20 m.v.
Radio, 35 m.v.
Microphone, 2.5 m.v.

Input Impedance
All inputs 500k. Plus 10pfd.

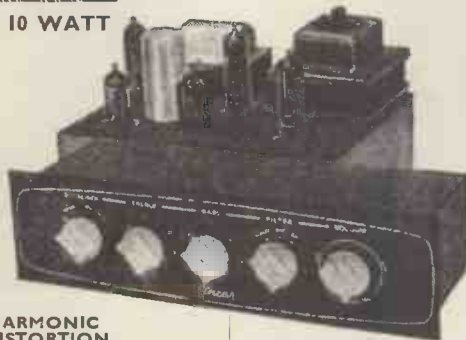
Frequency Response
±2 d.b. 30-25,000 c.p.s.

Power Consumption
90 watts.

Maximum Power Output
In excess of 12 watts.

Negative Feedback
Total 32 d.b.

HARMONIC DISTORTION
(Inc. Pre-amplifier)
0.09% measured at 10 watts.
Damping Factor 35
Bass Control
+9 d.b. to -9 d.b. at 50 c.p.s.
Treble Control
+9 d.b. to -9 d.b. at 12,000 c.p.s.
Hum Level
-70 d.b.
Filter
-7 d.b. at 9 Kc/s.
-10 d.b. at -5 Kc/s.



For **HIGH SENSITIVITY!**
HIGHEST FIDELITY!
MAXIMUM RELIABILITY!
REASONABLE COST!

Also Available

The L45. Compact High Quality 4-5 watt amplifier

Size approx. 7-5-5½in. high. Sensitivity is 28 millivolts so that the input socket can be used for either microphone or gram., tape, radio tuner, etc. B.V.A. valves used are: ECC83, EL84, EZ80. Controls are: Vol., Treble and Bass with mains switch. The Tone controls provide full compensation for long playing records. Output matching for 3 ohm loudspeaker. Retail price £5/19/6.

THE LT54 TAPE DECK AMPLIFIER. A complete unit (power pack and oscillator incorporated) ready for connection to A.C. mains. 3 ohm loudspeaker and practically any make of deck. Negative feedback equalization adjustment by multi-position switch for 1½, 3½ and 7½ per sec. Retail price 12 gns.

DIATONIC 10-14 WATT. High Fidelity amplifier with integral pre-amplifier. Retail 12 gns.

CONCORD 30 WATT. Hi-Fi amplifier with two separately controlled inputs. Retail 16 gns.

LS0 50 WATT AMPLIFIER. Size approx. 14x10x8in. Sensitivity 25 m.v. Outputs for 3 and 15 ohm speakers. Retail price 22 gns.

LS/5 STEREOPHONIC AMPLIFIER. Sensitivity 10 m.v. Output 5 watts on each channel. Retail 12 gns.

MULLARD VALVES:
EF86 (1); ECC83 (2); EL84 (2); EZ81 (1).

OUTPUT MATCHINGS
For 3 ohm and 15 ohm L/Speakers from high-grade sectionally wound output transformer.

RESERVE POWER SUPPLY (for Radio Tuner) 300 v. 30 m.a. smoothed and 6.3 v. 1.5 a. at 4-pin socket.

TRADE AND EXPORT ENQUIRIES TO:
LINEAR PRODUCTS LTD.

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ARMLEY, LEEDS.**

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(3 lines)

The
Superspeed
Soldering Iron
heats up from cold
in **6** seconds

Designed on an entirely new principle, this lightweight, versatile iron is eminently suitable for soldering operations in the radio, television, electronic and telecommunication industries. For test bench and maintenance work it is by far the most efficient and economical soldering iron ever designed.



Length, 10";
weight, 3½ ozs.

For best results
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use **ENTHOVEN
SUPERSPEED
CORED SOLDER
and ALUMINIUM
CORED SOLDER**

- * Activated by light thumb pressure on the switch ring. When pressure is released, current is automatically switched off—thus greatly reducing electricity consumption, wear on copper bit and carbon element.
- * Can be used on 2.5 to 6.3 volt supply (4 volt transformer normally supplied) or from a car battery.
- * More powerful than conventional 150-watt irons; equally suitable for light wiring work or heavy soldering on chassis.
- * Simple to operate; ideal for precision work.
- * Requires minimum maintenance—at negligible cost; shows lowest operating costs over a period.

LIST PRICES	
IRON	39/6
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SHADED POLE INDUCTION MOTORS, Brand new, B.T.H. Dual voltage 115/230 v. A.C., 2400 r.p.m. 8-watts. Silent running—no interference. Suitable for fan and model drive, tape recorders, mixers, etc. 27/8 (despatch 2/-).

SMALL GEARED MOTORS, large range of speed from 1 r.p.m. to 800 r.p.m. and torque up to 75 lbs./ins. Please write for our current net list GM. 361 giving full details.

CAPACITOR/INDUCTION MOTORS (B.T.H. & G.E.C.) 1/10th h.p., 2,850 r.p.m. 220/250 v. A.C. Length of body 6 in. dia. 3½ in., shaft prof. 1 in. Foot-mounted. With condenser, 57/6 (des. 2/6). Exceptionally fine offer.

EXTRACTOR FANS. New miniature model complete with outside cowling and indoor shutter, circular motor housing only 4½ in. diameter. Easily mounted in small window pane. Silent induction motor. 200/250 v. A.C. (no interference). 3,500 c.f.t./hour. Mounting instructions with each. Remarkable offer, 59/6 (despatch 3/6). We still supply our well-known 6 in. (24/12/6), 8 in. (25/5/-) and 10 in. (25/12/6) Extractors (des. any one 3/-). Details on request.

SYNCHRONOUS TIMER MOTORS (Sangamo). 200/250 v. 50 c/s. Self-starting, 2½ in. dia. by 1½ in. deep. 1 r.p.m., 1 r.p.h. and 12 r.p.h. Any one 37/6 (des. 1/-). Also high-torque model (G.E.C.) 6 r.p.m. 57/6 (des. 1/-). These are suitable for display turntables.

MINIATURE COOLING FANS. (200/250 v. A.C.) with open type induction motor. 3 in. by 2½ in. by 1½ in. and 4 in. 4-bladed metal impeller. Ideal for projector lamp cooling and convector heaters, etc., 28/6 (despatch 2/-).

SYNCHRONOUS ELECTRIC CLOCK MOVEMENTS. 200/250 v. 50 c/s. Fitted with spindles for hours, minutes and seconds hands. Self-starting, central hole fixing. Dia. 2½ in., depth behind dial only 1 in. Very latest model. With dust cover, 29/6 (despatch 1/6). Sets of three hands to fit in good style for 5/7 in. dial, 2/6 set, or 6/10 in. dial, 3/6 set.

AIR BLOWERS. Powered with BTH Cap./Ind. Motor. 230/250 v. A.C. Duty 190 CFM (free air) 90 CFM at 1.4 in. W.G. Overall length 11 in., height 8 in., width 5 in. Inlet 3½ in. dia. Outlet 3 in. dia. Very efficient units, complete with condenser, brand new, 28/10/- (despatch U.K. 6/6).

SYNCHRONOUS TIME SWITCHES. (Sangamo) for accurate pre-set switching operations on 200/250 v. 50 c/s. 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 4 in. dia., 3½ in. deep. With full instructions. 25/8/6 (despatch 2/6). Also Smith's Relvon Twin-circuit model 20-amp. switching, 27/8/- (des. 2/6).

COMPLETE SEWING MACHINE MOTOR OUTFITS. No better job obtainable 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 28/15/- (despatch 3/-).

SYNCHRONOUS TIMERS (by well-known British maker—brand new). Good news for those who applied too late for first supply—a limited new delivery now available 200/250 v. 50 c/s. Providing any "on" period between 5 mins. and 8 hours, switching "off" at the end of the set period. Made for electric cookers and suitable for many other purposes—tape recorders, immersion heaters, etc. Capacity 25 amps., fitted neon indicator. Housing 6 in. sq. by 3½ in. 24/12/6 (despatch 3/-).

M. R. SUPPLIES, Ltd., 68 New Oxford Street, London, W.C.1
(Telephone: MUSEum 2958)

BROOKES Crystals

mean
DEPENDABLE
frequency
control



Illustrated left is a Type M Crystal Unit from a range covering 8 Mc/s to 17 Mc/s.

- Frequency 12,500 kc/s.
- Hermetically sealed metal can.
- Frequency tolerance $\pm 0.01\%$ of nominal at 20°C., or better for special applications.

All Brook's Crystals are made to exacting standards and close tolerances. They are available with a variety of bases and in a wide range of frequencies. There is a Brook's Crystal to suit your purpose—let us have your enquiry now.



Brookes Crystals Ltd.,

Suppliers to Ministry of Supply, Home Office, B.B.C., etc.

LASSELL STREET, GREENWICH, S.E.10

Telephone: GREENwich 1828

Grams: Xtals, London, S.E.10. Cables: Xtals, London

S.G. Brown

... for faultless performance in any sphere!



SUPER **K** HEADPHONES

FIST MICROPHONE

Moulded in Nylon, this attractively designed unit is weather-proof and almost indestructible under the most adverse conditions. It has a positive action Double Pole changeover switch, and is available with either Carbon or Electro-magnetic Transmitter. When fitted with the H/M Inset it also operates as a receiver. For use on Mobile Radio, Walkie-Talkie, Police Motor Cycle Wireless, etc.



UNIVERSAL HANDSET



Moulded in Cyclocac—one of the toughest plastic materials ever produced, this beautifully styled, robust and lightweight instrument is designed to accommodate any known Transmitter or Receiver Inset. Built-in Double Pole changeover switch is also available. Standard Insets: Moving Coil, Electro-magnetic, Single Carbon and Double Button Carbon. For use on Radio Stations, Mobile Radio, Walkie-Talkie, Police Car-Radio, etc.

The "Super K" Headphones are the newest product of S. G. Brown Ltd., and are designed especially for High Fidelity Stereo requirements. They are attractive in appearance, extremely comfortable to wear and incorporate plastic head band and earpieces.

Write for full details to:-



**HAWKER
SIDDELEY
GROUP**

Shakespeare Street

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Telephone: Watford 27241

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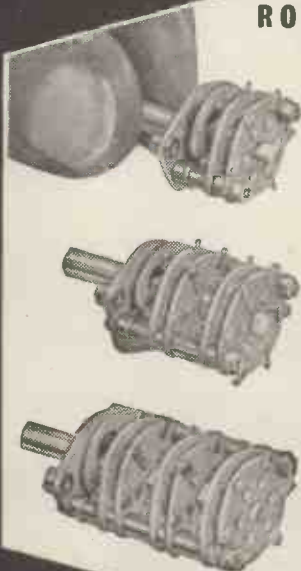
Miniature

ARDENTE

ROTARY SWITCHES TYPE S.1450

SRDE type approved

Laboratory kits available



TYPICAL SPECIFICATION

Initial contact resistance	5 mΩ maximum.
After 10,000 operations	10 mΩ maximum.
Insulation resistance:	
Between contacts	} Greater than 5,000 MΩ at 500v DC.
Between contacts and spindle	
Contact rating	50 mA at 300v DC or AC. 500 mA at 30v DC or AC.
Capacity between contacts or contacts and spindle	0.5 pF approx.
Indexing interval	60°.
Turning torque	5 to 20 oz.ins., 360 to 1440 g.cms.
Maximum end stop torque	8 lb.ins., 9200 g.cms.
Weight:	
Single bank switch	0.26 oz., 7.35 g.
Each additional bank	0.08 oz., 2.27 g.

ARDENTE

full technical data on request

ARDENTE ACOUSTIC LABORATORIES LTD

8-12 Minerva Road • North Acton • NW10

Tel: ELGAR 3923

MINIATURE
COMPONENTS

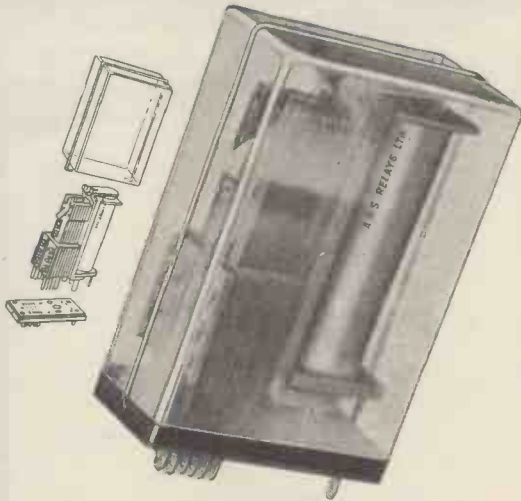
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GROUP OF COMPANIES

FULLY TYPE APPROVED
TO A.I.D., A.R.B., & ADMIRALTY

Still **THE MOST RELIABLE**
K 3,000 type RELAY



"PLUG-IN"
3,000 type RELAY
with **TRANSPARENT DUST COVER**
and **PLUG-IN BASE**
as used exclusively in
BERKELEY POWER STATION



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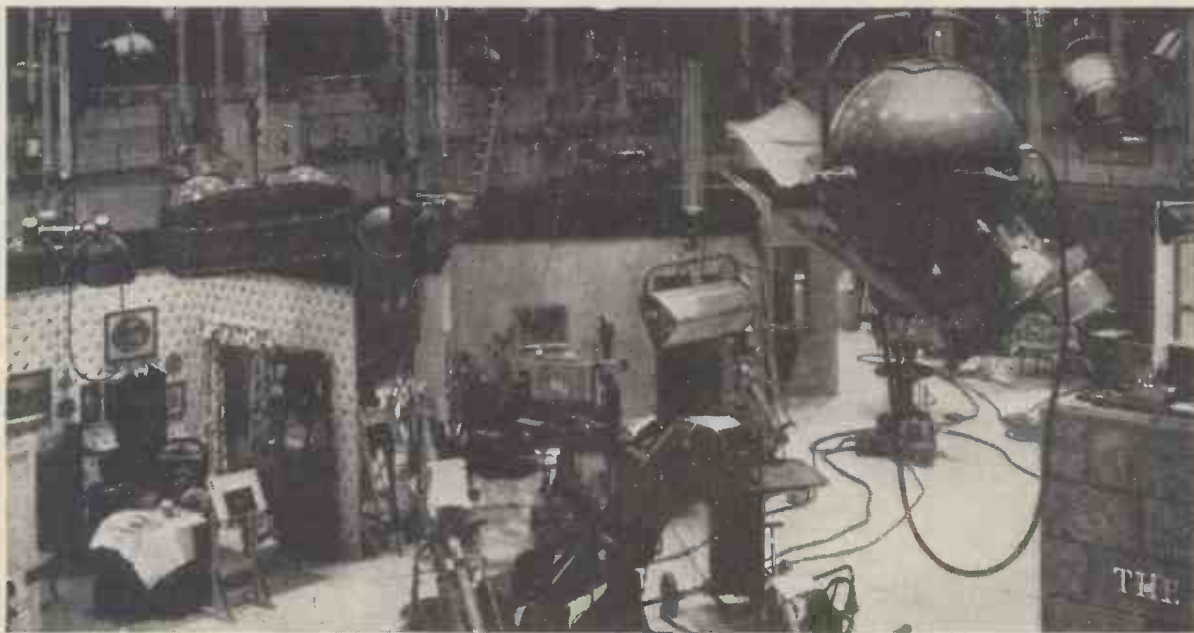
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"BELLING-LEE" NOTES

No. 31 of a Series:

Some mechanical aspects of design, part 4.

Last month we outlined the unique properties of beryllium-copper, which render it such an excellent material for making resilient electrical contacts, amongst other things. Unfortunately it is not a cheap material if compared with copper, brass and steel. This is because beryllium is comparatively rare, i.e., it does not occur very abundantly in nature, nor is it easily extracted from its ores, and, since it forms only about 2% of the content of the most important of the commercial beryllium-copper alloys, very close control of alloying is necessary. Beryllium-copper is consequently sufficiently expensive for its use to be confined to applications in which one or more of its properties can be usefully exploited. In this connection, it should be borne in mind that high basic cost does not necessarily mean that the material is uncompetitive with cheaper metals, for in many cases this may be largely offset by simpler and cheaper processing routines, coupled with a lower reject rate.

Now what of the finish required for electrical work? We have already said that the alloys possess good anti-corrosion properties; in this they are comparable with copper, and better than most ordinary steels. They are attacked by sulphur and certain of its compounds, particularly those which are gaseous, and lubricants containing this element should be avoided. Under oxidising conditions the film of beryllium oxide, which forms very quickly on the surface, is protective (i.e., anti-progressive) and for ordinary applications beryllium-copper may therefore be used untreated, as we do in our Unitor sockets; the thin oxide film is broken down mechanically in the action of insertion, after which the points of contact are protected, of course. It has a lower contact resistance than brass, and although the brass plug pins would also be cleaned on insertion, it is normal to plate them to improve the overall contact resistance.

However, good as clean beryllium-copper is, in order to achieve really low contact resistance at very low circuit voltages, plating is desirable. This applies for instance, in transistorised circuits, e.g., in printed circuitry for computers. Of the many different plated finishes that can be used, exhaustive tests by various authorities have proved that gold is the best, despite its high price, and if the surface area to be treated is kept reasonably small the cost need not be prohibitive. But now we meet a number of conflicting

factors. To ensure that the voltage at which the resistance will remain low over long periods without disturbance is kept to a minimum, contact pressures must be high. However this in turn leads to excessive wear and limits the number of insertions and withdrawals that can be made before the gold becomes seriously displaced. Use of a hard gold* produces an improvement, but very hard gold is liable to craze on flexing, and then corrosion can take place through the cracks. A table can be made showing the number of satisfactory insertions that can be achieved with different contact pressures, and the optimum value must be chosen in relation to the range of applications envisaged. For "Belling-Lee" printed circuit edge connectors a value has been selected which gives an expectation of reliable performance in excess of 25,000 insertions and withdrawals.

The effectiveness of plating is measured by the thickness and uniformity of the coating, and its adhesion to the under-surface. Good adhesion calls for careful preparation to achieve scrupulous cleanliness of the piece parts, including freedom from beryllium oxide. The oxide scale formed during heat treatment can be removed by pickling in a solution of sulphuric acid (20% by volume), preferably used hot, but care must be taken not to overdo this otherwise the surface may become unduly roughened, with obvious detrimental effects, and deterioration of the mechanical properties particularly under conditions inducing fatigue. If the parts have already been de-scaled and stored, there will be a film of oxide (perhaps invisible) on the surface, which must be eliminated immediately prior to plating, and this may be done by any of the different dipping processes which are applicable.

The quality of the plating is maintained by regular chemical analysis of the solution in the bath, and monitoring the plating current by means of a watt-hour meter. Each individual contact has its contact resistance measured, while continual checking of the plating thickness is carried out by measurement of micro-sections.

**Pure gold is soft, but it may be hardened by alloying it with small quantities of silver, nickel, etc., which also act like "sand on the rails."*

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Aspects of design

37

SWITCHING PROBLEMS
IN COMBINED
TELEVISION AND FM
RADIO RECEIVERS

This is No. 37 in the series of articles dealing with advanced problems in circuit design published by The Ediswan Mazda Applications Laboratory. No. 38 will appear next month. We shall be pleased to answer queries arising from this or other articles.

INTRODUCTION

The design of a receiver to combine satisfactorily the functions of a television-set for signals on Bands I and III and a radio set for FM signals on Band II poses several problems in the internal switching arrangements. A multiple switch, generally coupled to the tuner channel changing mechanism, is connected to perform functions associated with the following requirements:—

- Valve heater series chain modification
- HT line switching and load compensation
- Removing sound channel interference generated by scanning circuits
- Sound IF amplifier, detector and AGC circuit modifications.

The use of such a combined receiver is likely to be at least as much for radio reception as for television reception. Thus it is desirable that the switching arrangements should ensure that the performance and life of the valves and cathode ray tube used only for television should not be significantly affected either by transient surges during switching or by working conditions during radio use.

SERIES HEATER CHAIN SWITCHING

It is always advisable to switch off the heater of the cathode ray tube during radio use. This avoids unnecessary loss of emission life in the most expensive single replacement item in the set.

The simplest method of conserving the life of valves not used for radio reception is to switch off their heaters and substitute a suitable series resistance. This generally includes valves in the vision IF amplifier, video amplifier, synchronising, line scan and field scan circuits. However, when switching back to television reception, the low heater resistance of these cold valves would result in a large and probably damaging current surge in the remaining valve heaters which are already hot, unless a protective device is used. Surge protection may be provided by incorporating a suitable thermistor in series with the part of the valve chain which is switched off for television.

The resulting slow warm-up with this method gives the disadvantage of a particularly long delay before the appearance of a picture when switching over from radio to television reception. The need for a protective thermistor can only be avoided if not more than one or two selected valve heaters, in addition to the cathode ray tube heater, are switched off for radio reception. The maximum permissible surge current in valves already running at their nominal heater current of 0.3A has been determined as approximately 0.35A for satisfactory life, when due allowance is made for mains voltage and component variations. With this limit, it can be calculated that the total nominal heater voltage of the switched valves and cathode ray tube should not exceed 33 V without using thermistor protection in a receiver designed for a minimum nominal mains voltage of 200 V.

HT LINE SWITCHING

In conjunction with the first method of heater chain switching described, it is also desirable to switch off the HT supply to the unused valves for radio reception. This avoids the full current being drawn as the cathodes cool down, which may cause deterioration of emission life performance, particularly in the higher power valves. Some additional series or shunt resistance load should be added to maintain a consistent HT line voltage, as otherwise electrode dissipation and voltage ratings may be exceeded on radio reception.

In the alternative method, where only the cathode ray tube heater is switched off for radio reception, the HT supply to the unused valves should not be maintained at its full level. This is both to conserve their life and to reduce the noise and HT voltage ripple from the scanning stages which are likely to interfere with the quality of the sound reproduction of Band II signals.

On the other hand, it is not desirable to completely disconnect the HT supply from these valves. Many types of valve, when run with normal heater voltage but no significant cathode current, develop changes in the cathode emitting characteristics that result in a deterioration of performance when used normally. This deterioration is such that the life of valves in many of the television applications in these combined receivers is likely to be less than their life when run continuously at their normal cathode currents.

This effect can be obviated by running unused valves on radio reception at low cathode currents of the order of 10% of their normal values. There is then no significant deterioration of normal performance on television, even when run for long periods at this low current. On switching to radio reception, a suitable resistance may be connected in series with the HT supply to these valves, in addition to the extra shunt or series resistance load to maintain a consistent HT voltage to the rest of the receiver.

There are, of course, several variations and combinations of the two main methods of heater chain and HT line switching described, but the same considerations of surge protection and life still apply.

OTHER SWITCHING TRANSIENT CONSIDERATIONS

In receivers for television only, precautions are normally taken to avoid the appearance of an excessively bright focused spot on the cathode ray tube screen when switching off. These precautions usually aim to discharge the EHT voltage before complete collapse of the scan by including a long time constant in the first anode voltage supply or a voltage dependent resistor in the grid bias circuit or across the EHT supply. In combined radio and television receivers, where the HT supply is disconnected from the scanning valves for radio reception, the scan will collapse much more rapidly since there is no reservoir capacity to maintain the voltage on switching over to radio. The protection against the bright focused spot therefore needs further consideration of its adequacy in these receivers. Since the details of individual circuit designs affect this, the subject is beyond the scope of this brief article.

On many combined receivers, it is possible to switch through the Band II channels in changing from one television channel to another. This does not generally result in dangerous transients if the previous recommendations have been complied with in the design, as long as the operation is performed without much delay. Switching from television to radio and then back within the period between approximately five seconds and one minute should, however, be avoided. Repeated operation with this interval could damage valves or cathode ray tube by large heater surges in series heater chains using a thermistor. The differing cooling rates of certain valves, the cathode ray tube and the thermistor can give rise to conditions where the thermistor cannot give adequate protection against these large transients.

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The 6F28 is a screened high slope frame grid beam tetrode for use in television video output stages. High peak current is available, enabling adequate video drive to be provided for the cathode ray tube with anode loads down to 4700 ohms; this low value of load eases the problem of HF video compensation.

This type has identical characteristics to the tetrode in the 30FL12 triode-tetrode combination.

Heater Voltage (volts)	.. ..	V_h	6.3
Heater Current (amps)	.. ..	I_h	0.3

TENTATIVE RATINGS AND DATA

Maximum Design Centre Ranges

Anode Dissipation (watts)	.. ..	$P_a(max)$	2.5
Screen Grid Dissipation (watts)	.. ..	$P_{g2(max)}$	1.3
Anode Voltage (volts)	.. ..	$V_a(max)$	250
Screen Grid Voltage (volts)	.. ..	$V_{g2(max)}$	250
Heater to Cathode Voltage (volts rms)	.. ..	$V_{h-k(max) rms}$	150*

*Measured with respect to the higher potential heater pin.

Inter-Electrode Capacitances†(pF)

Input	.. ..	C_{in}	8
Output	.. ..	C_{out}	2.5
Control Grid to Anode	.. ..	C_{g1-a}	0.03

†Measured in fully shielded socket without can.

CHARACTERISTICS

Anode Voltage (volts)	.. ..	V_a	180
Screen Grid Voltage (volts)	.. ..	V_{g2}	180
Anode Current (mA)	.. ..	I_a	10
Mutual Conductance (mA/V)	.. ..	g_m	12.5

TYPICAL OPERATION AS VIDEO AMPLIFIER

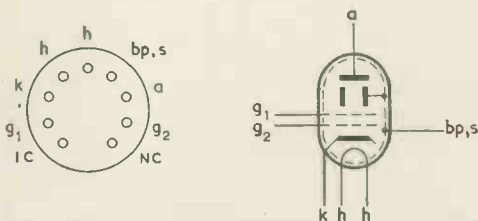
Allowance must be made in circuit design, not only for component variation, but also for valve spread and deterioration during life. Values of peak anode current, for an average valve when new and at the assumed end of life point for any valve, are as follows:—

	V_a (V)	V_{g2} (V)	V_{g1} (V)	I_a (mA)	
Average New Valve	70	180	-1	40
Assumed End of Life Condition	60	180	-1	25

Mounting Position: Unrestricted

Base: B9A (Noval)

Connections

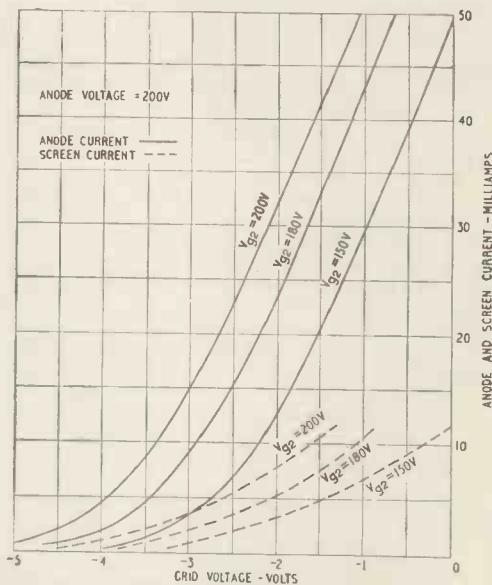
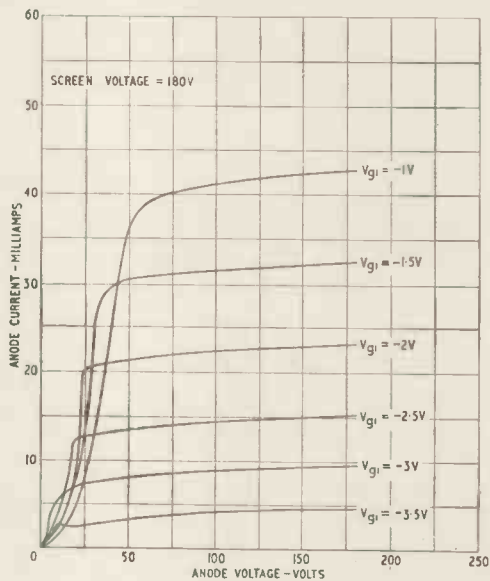


MAXIMUM DIMENSIONS (mm)

Overall Length	.. ..	56
Seated Height	.. ..	49
Diameter	22.2



Tentative Characteristic Curves of Ediswan Mazda Valve Type 6F28



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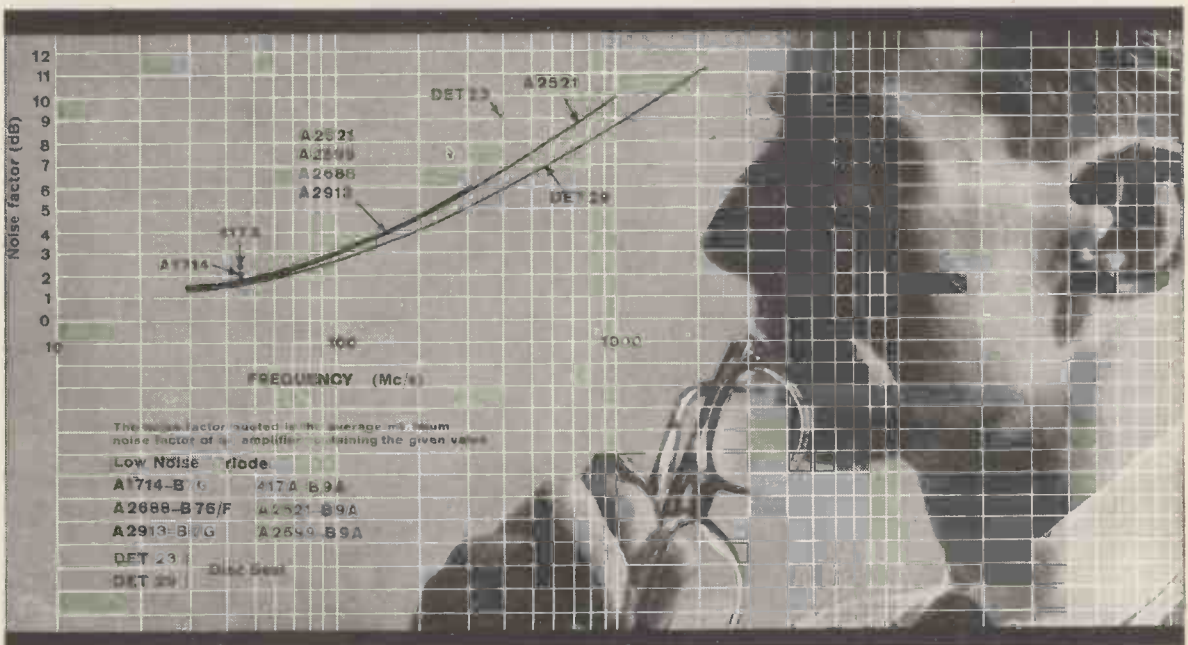
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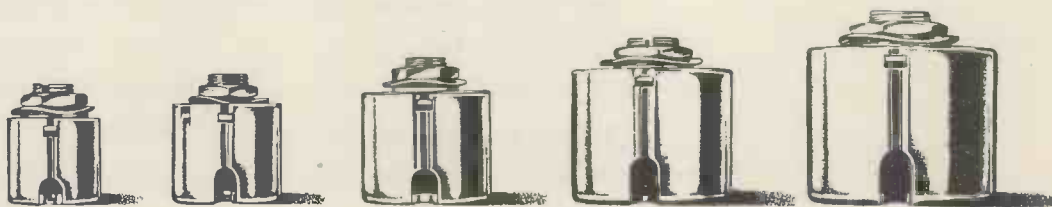
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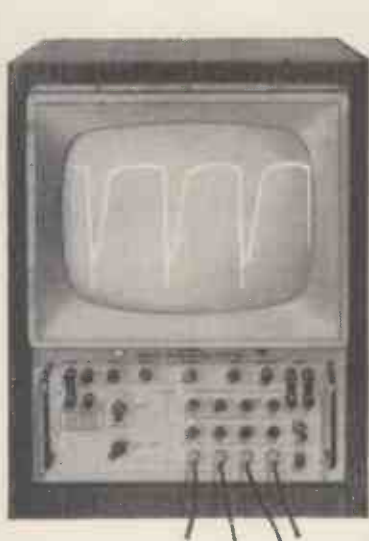
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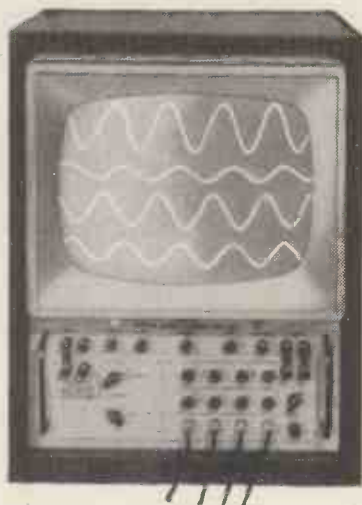
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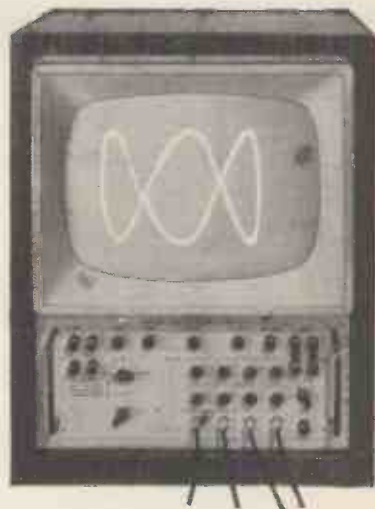


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It is available in our standard steel case with Baxendale tone controls and up to 4 mixed inputs, which may be balanced line 30 ohm microphones or equalised P.U.s to choice.

ELECTRONIC MIXER/AMPLIFIER

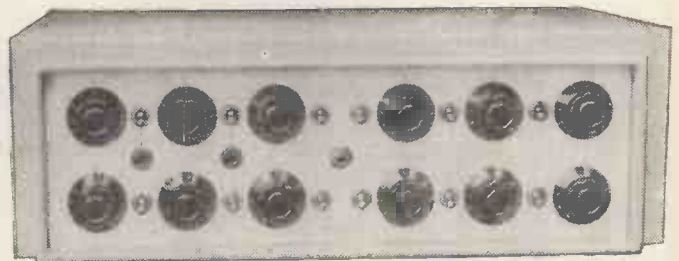
This high fidelity 10/15 watt Ultra Linear Amplifier has a built-in mixer and Baxendale tone controls. The standard model has 4 inputs, two for balanced 30 ohm microphones, one for pick-up C.C.I.R. compensated and one for tape or radio input. Alternative or additional inputs are available to special order. A feed direct out from the mixer is standard and output impedances of 4-8-16 ohms or 100 volt line are to choice. All inputs and outputs are at the rear and it has been designed for cool continuous operation either on 19 x 7in. rack panel form or in standard ventilated steel case.

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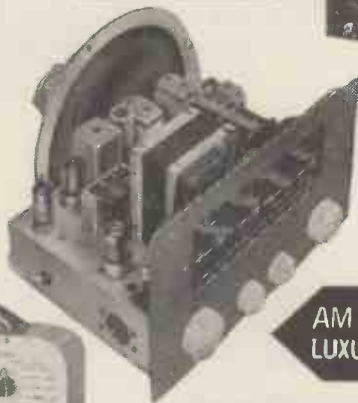
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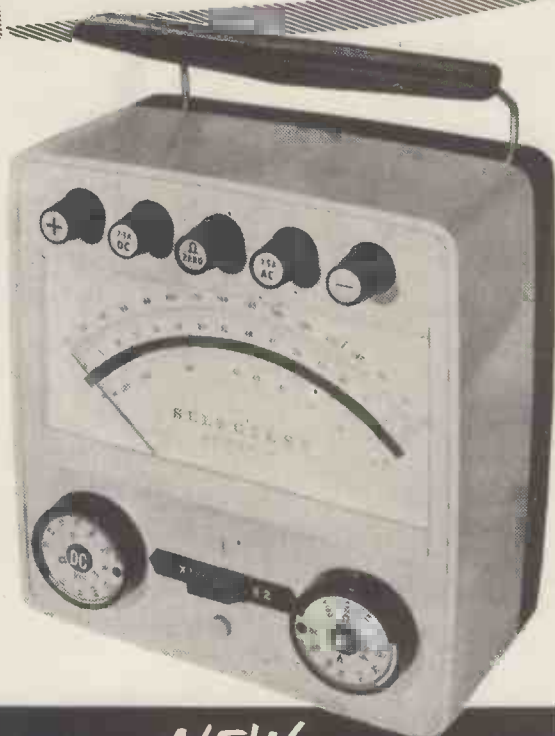
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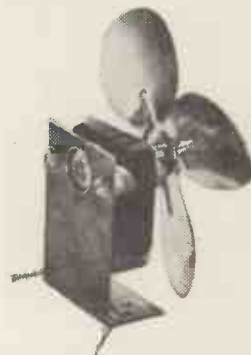
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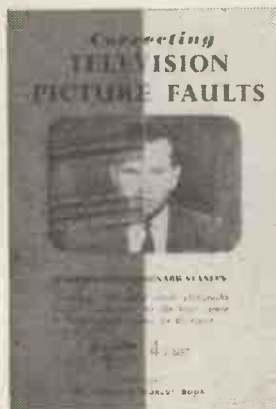
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Remanence, Brem, from saturation (gauss)	5 000	4 700	10 000	11 000	3 500	
Coercivity, Hc. (oersteds)	0.01	0.04	0.15	0.04	0.30	
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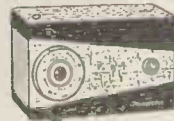
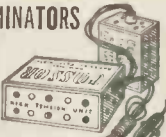
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5Y3G	5/9	*6S87	4/6	618PT	11/-	ECH21	12/6	PC88	19/-	U309	7/-
5Y3GT	6/-	6U4GT	10/6	188BT	18/-	ECH35	9/6	PC89	13/6	U329	7/-
5Z3	6/6	*6V62	6/6	80T(4)	5/6	ECH42	8/6	PCF80	7/6	U329	7/-
5Z4G	9/6	6V6GT	6/6	80T(8)	3/9	ECH81	7/-	PCF82	7/3	U339	11/-
5Z4GT	11/-	6V6G	5/9	955	3/9	ECHO80	7/-	PCF84	16/-	U403	9/6
6A6	8/-	6X4	5/-	956	2/6	ECL82	9/6	PCL82	7/6	U801	19/-
6A8G	9/6	6X5G	5/-	9001	4/-	ECL83	12/-	PCL83	10/8	UAB20	8/6
6AC7	4/3	6X5GT	5/6	9003	4/-	EP22	7/-	PCL84	7/6	UBC41	7/6
6AG5	3/6	6Y8	7/-	ATP4	6/9	*EP25	4/3	*PEN25	4/6	UBF80	8/6
6AG7	7/9	7B7	7/9	AZ31	9/-	*EP80	4/9	*PEN45	7/3	UBF89	7/9
6AK5	6/6	*7C5	7/3	*B39	3/6	EP85	6/6	*PEN45	5/3	UCL21	14/6
*6AL5	3/6	7C6	7/3	B65	4/6	EP86	9/-	*PL53	8/3	UCL21	12/6
*6AM6	3/-	7E7	7/8	C10	8/8	EP89	6/9	PL36	10/6	UCH42	7/6
6AQ5	6/-	7E7	7/8	CL31	21/-	*EP81	3/-	PL38	16/6	UCH81	8/6
6AT8	6/-	7Y4	7/-	*CCH35	14/-	*EP82	4/6	PL81	8/9	UCL82	11/3
6AU6	7/6	10C1	11/-	CL33	11/8	EL22	12/6	PL82	6/9	UCL83	11/3
6B8G	3/6	10C2	13/6	CY31	9/9	EL32	4/6	PL83	6/9	UCL83	11/3
6BA6	6/-	*10F1	5/9	D63	1/8	*EL33	8/-	PL84	9/-	UP41	8/6
6BE8	5/9	10LD11	14/8	DA90	2/6	EL35	7/-	PY31	7/9	UP42	5/6
6BGG	12/9	10P13	8/-	DACC2	9/9	EL37	11/8	PY32	10/-	UP80	7/6
6BW6	7/9	*10P14	9/-	DAF91	4/9	*EL38	12/6	PY90	7/-	UP85	8/9
6BW7	5/9	12AH7	6/9	DAF96	7/3	EL41	8/-	PY81	6/-	UP86	14/6
*6C4	3/8	12AH8	9/9	DF33	3/9	EL42	9/-	PY82	6/3	UP89	7/-
6C6	4/9	12AT6	7/6	*DF91	3/9	EL44	7/-	PY83	7/6	UL41	7/-
6C9	8/9	12AT7	5/6	DF96	7/3	*EL91	4/6	PZ20	9/6	UL44	11/-
6C86G	21/-	12Q7GT	5/-	*DH77	6/-	EM34	8/8	R18	11/-	UL46	9/9
*6C8	8/3	12AX7	6/9	DH81	8/6	EM80	8/6	R19	11/-	UL84	7/6
6D6	4/9	12J6GT	6/6	DK32	11/3	EM81	8/9	*T41	7/6	UL80	9/6
*6H1	4/9	12K7GT	5/-	DK91	5/6	EM84	9/9	TDD4	7/6	UU6	12/6
6H8G	6/3	12K8GT	6/6	DK92	7/8	EM85	10/6	U14	8/-	UU7	9/6
*6H2	3/6	11/-	DK96	7/6	EN31	16/-	U18	8/-	UY1N	11/-	
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6H4	9/8	12SK7	4/3	EL35	9/8	EM80	8/6	U24	15/-	UY85	6/6
6H5	8/8	12SK7GT	6/6	DL91	8/-	EY86	8/-	U25	12/6	VR105/30	5/6
*6H6	2/-	4/9	DL92	6/6	EZ40	6/6	U26	9/9	U31	7/9	
*6H7	2/9	128N7GT	DL93	4/9	EZ41	7/-	U31	7/9	U31	7/9	
6J5GT	3/9	13D3	8/8	DL94	6/9	EZ80	6/-	U33	14/-	U33	14/-
*6J7G	5/-	1487	22/6	DL95	7/3	EZ81	6/6	U35	11/-	X63	9/8
6K6GT	6/6	19BGG	EL91	9/8	EAB80	8/6	GZ30	11/-	U37	28/-	
*6K7G	2/3	15/-	EAB80	7/6	EAF42	8/6	GZ32	8/6	U50	5/9	
6K7GT	4/9	20D1	8/6	*EB34	1/6	HBC90	7/8	U70	5/6	X78	14/6
*6K8G	5/6	*20F2	8/6	*EB41	7/6	HBC90	7/8	U71	8/-	X79	16/6
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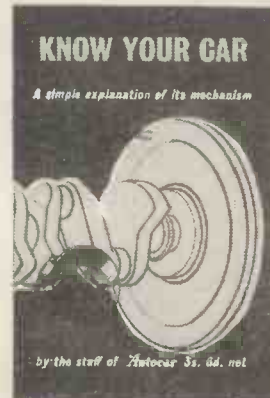
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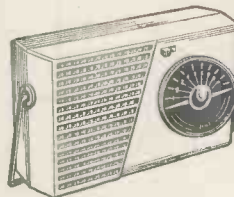
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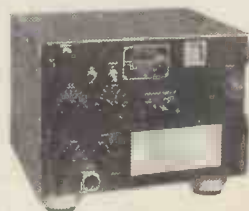


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300 mv	15 v.	3 ma.	150 ma.
1.5 v.	75 v.	15 ma.	750 ma.
3 v	150 v.	30 ma.	1.5 amp.
15 v.	300 v.	150 ma.	7.5 amp.
30 v.	600 v.	300 ma.	15 amp.
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750 v.		15 amp.	100 k. ohms
1,500 v.		30 amp.	1 megohm

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| 6½in...3 ohm...17/6 | 8 x 2½in.3 ohm.17/6 |
| 8in...3 ohm...19/6 | 8 x 6in..3 ohm.17/6 |
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Primary 230 volts. Secondary adjustable from 185 to 250 volts at 24 amps. Can also be used in reverse. £12/10/- each Carriage 10/-.

1 MEGOHM 1% WIREWOUND RESISTORS

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| 12/18v. 6 amp....13/6 | 36/48v. 6 amp....32/6 |
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All primaries tapped 200/250 volts.

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| 3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30 volts 4 amp.....27/6 |
- Please add postage

PAINTON MINIATURE JONES PLUGS AND SOCKETS

- | | |
|-------------------|---------------------|
| 2 pin.....2/6 pr. | 12 pin..... 5/6 pr |
| 4 pin.....3/6 pr. | 18 pin..... 7/6 pr |
| 6 pin.....4/- pr. | 24 pin..... 6/6 pr. |
| 8 pin.....4/6 pr. | 33 pin.....10/6 pr. |
- All new and unused. Please add postage.

PARMEKO TABLE TOP TRANSFORMERS

Input 230 volts 50 cycles. Output 620/550/375/0/375/550/620 volts 250 mA. 5 volt 3 amp., 5 volt 3 amp. Size 6½ x 6½ x 5½in. Brand new, boxed 45/- each. Carriage 3/6.

SPARES KITS FOR CR.100 RECEIVERS

Contains 15 valves. 2-DH63, 2-KT63, 2-X66, 2-U50, 7-KTW61. Condenser and resistor packs, pots, toggle switch output transformer, etc. All brand new, 59/6 each. P/P 3/6.

MARCONI TF-373 UNIVERSAL IMPEDANCE BRIDGES

Reconditioned to maker's specification. 0-100 H., 0-100 mfd., 0-1 megohm, 0-100 Q each on 5 ranges at 1,000 c/s. £35 each

AMERICAN ARB RECEIVERS

Frequency coverage on 4 bands 195 kc/s to 9.05 mc/s. Precision vernier drive. Valve line-up: 12SA7, 4-12SF7, 12A6 and 991. Operation 24 volts D.C. Supplied fully tested and checked, £6/19/6 each. Carriage 7/6.

PHOTO VOLTAGE AMPLIFIERS

These special units contain a 1 microamp Tinsley mirror galvanometer, twin selenium photo cell, 12 v. lamp, lamp housing and focusing unit. Brand new, boxed, £9/19/6 each. Carriage 7/6.

AVOMETERS MODEL 7



VOLTAGE		CURRENT	
50mV D.C. only		1mA D.C. only	
100 " " "		2 " " "	
500 " " "		5 " A.C. & D.C.	
1V " " "		10 " " "	
5 " A.C. & D.C.		50 " " "	
10 " " "		100 " " "	
50 " " "		500 " " "	
100 " " "		1A " " "	
200 " " "		5 " " "	
400 " " "		10 " " "	
500 " " "		CAPACITY 0.01-20 mFds.	
1,000 " " "			

RESISTANCE

10,000 ohms	} using internal 1½ volt cell
100,000	
1 Megohm	
10 Megohms	

} using internal 9 volt battery
} using external source of A.C. or D.C. voltage.

POWER AND DECIBELS

Impedance	Power	Decibels
500 ohms	200 mW	0 = 50W.
5,000 ohms	2W	-25 to + 6
50,000 ohms	200 mW	-15 to + 18
		-25 to + 6

Fitted with automatic cut-out. Supplied reconditioned as new, complete with batteries and leads, £12 each. P&P 3/6.

TRANSISTORS AND COMPONENTS

- | | | |
|------------------------------|---------------------------|---|
| Transistors | Diodes | Personal Earphones |
| Green spot 1½v. L.F. .2/- | General purpose...6d. ea. | Complete with cord and midget plug and jack. |
| Yellow spot 6v. L.F. .2/3 | Yellow spot= OA81.2/- ea. | Available high or low impedance 7/- ea. |
| Red spot=OC71 L.F. .3/6 | MuBard OA81... 3/- ea. | Midget Resistors |
| White spot=OC45 R.F. .3/6 | GEX34, 4/- GEX36 .9/- | All sizes 3d. ea. |
| Blue spot=OC44 R.F. .4/6 | Transformers | Midget condensers |
| Yellow/green=OC72 L.F. .3/6 | Sub-miniature size. | All sizes to .01.....6d. ea. |
| Set of 8 Mullard transistors | Push-pull inter stage | .01 to 1mfd..... 8d. ea. |
| 1.....OC44 | 4.5:1 .....4/9 | Matched to 3 ohms...4/9 |
| 1.....OC45 | Push-pull output 20:1 | Miniature Electrolytics |
| 1.....OC45 | .25 and .5mfd.....1/- ea. | Variable Condensers |
| 1.....OC81D | All sizes available | Jackson "OO" gang 8/6 ea. |
| 2.....OC81 | 1mfd.-100mfd. | Solid dielectric variables |
| Complete set only 39/6 | 3-12v. wkg..... 1/9 ea. | 100, 300 or 500pf... 4/- ea. |
| Transistor holders 8d. ea. | | |
- Please add postage.

G.W. SMITH & CO (RADIO) LIMITED

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

Each Model incorporates the highly successful HT/TR3 Amplifier (described below), thus ensuring truly "Hi-Fi" record and playback facilities.

All prices quoted provide for the COMPLETE RECORDER including CRYSTAL MICROPHONE and 1,200ft. Spool of Tape.

There are no "better value for money" Tape Recorders on the market—if you can't call and hear them send S.A.E. for fully descriptive leaflets.



Stern's "fidelity" TAPE RECORDERS

BEFORE YOU BUY—YOU SHOULD HEAR THESE RECORDERS—THEY ARE COMPARABLE TO THE MUCH HIGHER PRICED MODELS

MODEL CR3/S. Incorporates the Collaro "STUDIO" TWIN TRACK 3-speed Deck operating at 1 1/2 in., 3 1/2 in. and 7 1/2 in. speeds. **£39.10.0**
H.P. Terms: Deposit £7/18/- and 12 months of £2/17/11.

MODEL TR3/Mk. VI. Incorporates the New TRUVOX Mk. VI TWIN TRACK 2-speed Tape Deck operating at 3 1/2 in. and 7 1/2 in. speeds. **£49.10.0**
H.P. Terms: Deposit £9/18/- and 12 months of £3/12/7.

TAPE AMPLIFIERS and PREAMPLIFIERS presented from MULLARD DESIGNS

MULLARD TYPE "C" TAPE-PREAMPLIFIER ERASE UNIT

The "Hi-Fi" link to add full tape recording facilities to High Fidelity home installations. Incorporates FERROXUCUBE POT CORE PUSH-FULL OSCILLATOR and 3-speed treble equalisation by FERROXUCUBE POT CORE INDUCTOR. FOR WEARITE—COLLARO—TRUVOX or BRENNEL TAPE DECKS. (STATE which when ordering.) Includes separate Power Supply Unit. **£14.0.0** or ASSEMBLED **£17.0.0**
H.P. £3/8/- Deposit and 12 months at £1/4/11.
(Excluding Power Unit £11/15/- and £14/10/- respectively.)



MODEL HF/TR3 Mk. II TAPE AMPLIFIER (Mullard Type "A" design)

A very high quality Amplifier incorporating 3-speed treble equalisation, by the latest FERROXUCUBE POT CORE INDUCTOR. FOR COLLARO-TRUVOX-BRENNEL or WEARITE Tape Decks (STATE which when ordering), has GILSON Output Transformer. Includes separate Power Supply Unit. **£13.13.0** or ASSEMBLED **£17.0.0**
KIT OF PARTS. H.P. £3/8/- Deposit and 12 months at £1/4/11.



FOR THE HOME CONSTRUCTOR SPECIAL "COMBINED ORDER" PRICES

- (a) The COLLARO "STUDIO" TAPE DECK and our Mullard Type "C" PRE-AMPLIFIER and Power Unit assembled and tested **£29.10.0**
H.P. Terms: Deposit £5/18/- and 12 months at £2/3/3.
- (b) As above but Type "C" PRE-AMPLIFIER supplied as complete Kit of Parts **£26.10.0**
- (c) The TRUVOX Mk. VI TAPE DECK and the assembled Type "C" PRE-AMPLIFIER and Power Unit. **£40.0.0**
H.P. Deposit £8 and 12 months £2/18/8.
- (d) As above but the Type "C" supplied as complete Kit of Parts **£36.10.0**
- (e) The BRENNEL Mk. V Deck and the assembled Type "C" PRE-AMPLIFIER and Power Unit. **£46.0.0**
H.P. Deposit £9/4/- and 12 months at £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/- and 12 monthly £4/2/1.

- (a) COMPLETE KIT to build the HF/TR3 Amplifier, together with the COLLARO "STUDIO" DECK **£26.0.0**
 - (b) As above, but HF/TR3 ASSEMBLED and TESTED H.P. Terms: Deposit £5/18/-, 12 months of £2/3/3. **£29.10.0**
 - (c) COMPLETE KIT to build the HF/TR3 together with the NEW TRUVOX Mk. VI TAPE DECK. **£36.10.0**
 - (d) As above but HF/TR3 ASSEMBLED and TESTED H.P. Terms: Deposit £8, 12 months of £2/18/8. **£40.0.0**
 - (e) COMPLETE KIT to build the HF/TR3 AMPLIFIER with the BRENNEL Mk. V TAPE DECK. **£42.0.0**
 - (f) As above but HF/TR3 ASSEMBLED and TESTED H.P. Terms: Deposit £9/2/-, 12 months of £3/6/9. **£45.10.0**
 - (g) THE ASSEMBLED and TESTED HF/TR3 AMPLIFIER with the WEARITE MODEL 4A DECK, incorporates Wearite Head Lift Transformer, etc. **£55.0.0**
H.P. Terms: Deposit £11, 12 months of £4/0/8.
(Carriage and insurance on each above is 10/- extra.)
- Attractive PORTABLE CASE is available to accommodate the TRUVOX or COLLARO TAPE DECKS and we offer it together with ROLA/CELESTION 10 x 6in. LOUDSPEAKER—ACOS CRYSTAL MICROPHONE—and 1,200ft. SPOOL TAPE—ALL FOR **£9.0.0**
(Carriage and Insurance 5/- extra.)

EACH OF ABOVE CAN BE SUPPLIED IN PORTABLE CASE FOR £5/10/- extra. THUS FORMING A COMPLETE PORTABLE PRE-AMPLIFIER. SEND FOR DETAILS.

SPECIAL OFFER OF TAPE	225ft. on 3in. Spool	5/9
P.V.C. base on latest type plastic	900ft. on 5in. Spool	18/6
Spools. New, Boxed and Guaranteed.	1,200ft. on 5 1/2 in. Spool	21/-
	1,200ft. on 7in. Spool	21/-
	1,800ft. on 7in. Spool	32/6

A LARGE PURCHASE OF BRAND NEW and FULLY GUARANTEED GARRARD TAPE EQUIPMENT ENABLES THESE OUTSTANDING PRICE REDUCTIONS



THE "MODEL HF/G2R" PORTABLE TAPE RECORDER (Original Price £33/0/0)

FOR 22 GNS. H.P. Dep. £4/14/-, 12 months £1/13/9. (Carriage and Ins. 10/- extra.) ONLY

INCORPORATES THE LATEST GARRARD "MAGAZINE" TAPE DECK and MATCHING AMPLIFIER. Based on the successful MULLARD TYPE "A" DESIGN and specifically developed to operate the GARRARD TAPE MAGAZINE and 4in. SPOOL OF DOUBLE PLAY TAPE. A Twin Track Recorder operating at 3 1/2 in./sec. providing up to 1 hour 10 mins. playing time. The outstanding features being excellent performance and simplicity of operation. Incorporates EXT. SPEAKER SOCKET, also operates as independent amplifier for direct reproduction

from P.U., mike or Radio tuner. Weighs only 22lb. WE ALSO OFFER DECK and AMPLIFIER CONNECTED. TESTED FOR IMMEDIATE OPERATION, 19 gns. H.P. Dep. £4 and 12 months £1/9/4. Carriage and Ins. 10/- ex. INCLUDES SPEAKER, tape Magazine and 4in. Spool of Double Play Tape. Comprises a complete tape recorder chassis ready for easy fitting into cabinet.

THE "ADD-A-DECK"

INCORPORATING GARRARD "MAGAZINE" TAPE DECK and the MATCHED MODEL HF/G2P PREAMPLIFIER. Supplied on ONE CHASSIS (as illustrated) READY FOR USE.

PRICE: Including GARRARD MAGAZINE and a 4in. SPOOL DOUBLE PLAY TAPE (Carr. & Ins. 10/- extra). H.P. Deposit £3/16/- and 12 18 Gns. months of £1/7/8. Provides complete tape recording facilities and designed to operate through the pick-up sockets of the standard type of RADIO RECEIVER, or an AMPLIFIER, from which really first class reproduction is obtained.



It consists of a Twin Track Deck connected to the Pre-amplifier and operates at 3 1/2 in./sec. speed, providing up to 1 hour 10 mins. playing time. Only needs connecting to the mains supply and pick-up sockets. Very simple to operate and easily installed in a cabinet, only four fixing screws being required.

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

FULLY DESCRIPTIVE LEAFLETS ON ALL OF ABOVE ARE AVAILABLE—BUT PLEASE ENCLOSE S.A.E.

STERN'S MULLARD DESIGNS

COMPLETE KIT OF PARTS

Designed by MULLARD—presented by STERNS strictly to specification

MULLARD "5-10" MAIN AMPLIFIER

For use with the MULLARD 2-stage pre-amplifier with which an undistorted power output of up to 10 watts is obtained. We supply SPECIFIED COMPONENTS and NEW MULLARD VALVES including PARMEKO MAINS TRANSFORMER and choice of the latest Ultra-linear PARMEKO or the PARTRIDGE Output Transformer.

Price: COMPLETE KIT (Parmeko Output Trans.) **£10.00**
 Alternatively we supply ASSEMBLED AND TESTED **£11.10**

ABOVE INCORPORATING PARTRIDGE OUTPUT TRANSFORMER £1/6/- extra.

MULLARD'S 2-VALVE PRE-AMPLIFIER TONE CONTROL UNIT

Employing two EF86 valves and designed to operate with the Mullard MAIN AMPLIFIER but also perfectly suitable for other makes.

Supplied strictly to MULLARD SPECIFICATION and incorporating

- Equalisation for the latest R.I.A.A. characteristics.
- Input for Crystal Pick-ups and variable reluctance magnetic types.
- Input (a) Direct from High Imp. Tape Head. (b) From a Tape Amplifier or Pre-Amplifier
- Sensitive Microphone Channel. ● Wide range BASS and TREBLE Controls.

Price: COMPLETE KIT OF PARTS **£6.60**

ASSEMBLED AND TESTED **£8.00**



COMPLETE MULLARD 5-10 AMPLIFIER

The popular and very successful complete "5-10" incorporating Control Unit providing up to 10 watts high quality reproduction.

Specified components and new MULLARD VALVES are supplied including PARMEKO MAINS TRANSFORMERS and choice of the latest PARMEKO or PARTRIDGE ULTRA Linear Output Transformers.

Price: COMPLETE KIT, Parmeko Transformer **£11.10**

Alternatively we supply ASSEMBLED AND TESTED **£13.10**

Hire Purchase (Assembled Amp. only). Deposit £2/14/- 12 months at 19/10. ABOVE incorporating PARTRIDGE OUTPUT TRANSFORMER £1/6/- extra.



COMPLETE MULLARD 3-3

A VERY HIGH QUALITY AMPLIFIER DEVELOPED FROM THE VERY POPULAR 3-VALVE 3-WATT AMPLIFIER DESIGNED IN THE MULLARD LABORATORIES.

Price for COMPLETE KIT OR PARTS **£7.10**

(Plus 6/6 carriage and insurance).

Alternatively supplied ASSEMBLED AND FULLY TESTED (Plus 6/6 carriage and insurance) .. **£8.19.6**

H.P. TERMS: Deposit £2 and 8 monthly payments of £1

of specified components, valves and PARMEKO OUTPUT TRANSFORMER. We also include switches and PARMEKO OUTPUT TRANSFORMER. We also drive a Radio Tuning Unit is also available. Extra power to

COMPLETE STEREO AMPLIFIER

Meets the many requests for a low priced but good quality Stereophonic Amplifier. Output power is 4 watts. Inputs for Crystal Pick-ups and Radio Tuner.

KIT OF PARTS **£8.10.0** or ASSEMBLED **£10.10.0**

Mk. II "Fidelity" FM TUNING UNIT

An attractively presented Unit incorporating MULLARD PERMEABILITY TUNING HEART and corresponding Mullard valve line-up. Very suitable to operate with our Mullard Amplifiers.

Price: COMPLETE KIT **£10.10.0** or ASSEMBLED **£14.5.0**

SPECIAL CASH ONLY OFFER !!

The very attractive PORTABLE AMPLIFIER CASE together with a good quality GRAM AMPLIFIER and a matched P.M. SPEAKER. ALL FOR ONLY Pts 7/6 (car. 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) 6 1/2 in. P.M. SPEAKER **18 9**

£8.7.6

(Carriage and Insurance 4/- extra).



STERN'S INTER-COMM or BABY ALARM

A small versatile Unit employing the new MULLARD ECL86 valve and designed to provide two (or three) way communication up to extreme distances. Operates from A.C. mains 200 to 250 volts and as in all our designs only new high-grade and guaranteed components are incorporated. PRICES—MASTER UNIT and ONE EXTENSION KIT OF PARTS £6/17/6. ASSEMBLED AND TESTED £8.

(Available in August) (Available mid-July)

The equipment consists of a MASTER UNIT, size only 9 1/2 in. x 5 1/2 in. x 6 in. and ONE EXTENSION (a second extension may be added at any time). The Master Unit incorporates switching and power supply and with the chassis completely isolated from the mains is operated in absolute safety. Attractively presented in cases covered in quality leatherette.

"Hi-Fi" LOUDSPEAKERS WE HAVE IN STOCK A COMPLETE RANGE BY

GOODMANS—WHARFEDALE—W.B.

ILLUSTRATED AND PRICED LEAFLETS ON REQUEST

STEREO PRE-ANNOUNCEMENT

To meet the increasing demand for stereophonic sound equipment our Design Engineers are producing

STEREO TAPE PRE-AMPLIFIER

for operation with the latest MINIFLUX and COLLARO 4 track tape heads. The Unit incorporates the latest circuitry, the design being based on the very popular MULLARD TYPE "C" Unit, and employs a sensitive meter for accurately setting the record level. High grade Tape Decks incorporating the MINIFLUX Heads will be available and in keeping with our normal practice will be offered with the Pre-amplifier. Full details and the assembled Pre-amplifier will be available in September.

PRICE REDUCTIONS

(a) The COMPLETE KIT OF PARTS to build both the "5-10" Main Amplifier and the 2-Stage Pre-Amplifier Control Unit **£15.15.0**

(b) The "5-10" and the 2-Stage Pre-Amplifier both Assembled and Tested **£18.18.0**
 H.P. TERMS: Deposit £3/16/- and 12 months of £1/7/8

(c) The COMPLETE KIT OF PARTS to build the Dual Channel "3-3" Amplifier and the Dual Channel Pre-Amplifier Control Unit **£21.10.0**

(d) The Dual Channel "3-3" Amplifier and the Dual Channel Pre-Amplifier Control Unit both Assembled and Tested **£25.0.0**
 H.P. TERMS: Deposit £5 and 12 months of £1/16/8.

(e) The COMPLETE KIT OF PARTS to build one "5-10" Main Amplifier (Parmeko Transformer) and the Dual Channel Pre-Amplifier Control Unit **£21.10.0**

(f) One "5-10" Amplifier (Parmeko Transformer) and the Dual Channel Pre-Amplifier both Assembled and Tested **£25.0.0**
 H.P. TERMS: Deposit £5 and 12 months of £1/16/8.

(g) COMPLETE KIT OF PARTS to build Two "5-10" Main Amplifiers (incorporating Parmeko Output Transformers) and the Dual Channel Pre-Amplifier Control Unit **£31.0.0**

(h) Two "5-10" Amplifiers (Parmeko Output Transformers) and the Dual Channel Pre-Amplifier Control Unit both Assembled and Tested **£36.0.0**
 H.P. TERMS: Deposit £7/4/- and 12 months of £2/12/-.
 Carriage and Insurance 7/6 extra.

Prices quoted are subject to £1/6/- extra for Partridge Trans.

MULLARD FOUR CHANNEL MIXING UNIT

Self powered Cathode follower output. Incorporates Two inputs for CRYSTAL MICROPHONES, one for CRYSTAL PICK UPS and a Fourth for Radio or Tape. KIT OF PARTS **£8.8.0** ASSEMBLED AND TESTED **£10.0.0**
 Terms: Deposit £2 and 12 months at 15/- Model I.L. one microphone input matched for moving coil or ribbon mike £1/17/- extra.



STEREO DUAL CHANNEL PRE-AMPLIFIER

This model incorporates two 2-valve Pre-Amplifiers (described above) combined into a Single Unit enabling it to be used for both STEREOPHONIC and MONAURAL operation. It is designed primarily to operate with our range of MULLARD MAIN AMPLIFIERS but will also operate equally well with any make of Amplifiers requiring an Input of 250 mV.



Price: COMPLETE KIT OF PARTS **£12.10.0** Alternatively ASSEMBLED AND TESTED **£15.0.0**
 H.P. Terms on assembled unit: £3 Deposit and 12 months of £1/2/-.

STEREO "3-3" MAIN AMPLIFIER

Comprises Two MULLARD 3-3 Main Amplifiers on one chassis. Operates with above MULLARD STEREO PRE-AMPLIFIER. Output power 6 watts. Inputs for Crystal Pick-up and Radio Tuner

KIT OF PARTS **£10.0.0** or ASSEMBLED **£11.15.0**

RECORD PLAYERS Many at REDUCED PRICES !!!

Send S.A.E. for ILLUSTRATED LEAFLET

- THE EMI 4-speed single record player with separate crystal pick-up **4 gns**
- B.S.R. MONARCH UA8 4-speed Mixer Autochanger with Crystal Pick-up **£6.19.6**
- THE NEW COLLARO "C 60" 4-speed autochanger unit with Studio "Q" pickup **£7.19.6**
- THE NEW COLLARO Model RP594, 4-speed Single Record Player. Studio Cartridge **£9.16.6**
- THE E.M.I. 4-speed Single Record Player, incorporating a high output crystal pick-up **£6.9.6**
- B.S.R. MODELS UA12 and UA14. Each a 4-speed Mixer Autochanger with Crystal Pick-up **£7.19.6**
- Both available incorporating the B.S.R. STEREO Pick-up, plays L.P. and 78 records **£10.10.0**
- GARRARD RC209 4-speed Autochanger fitted with latest Crystal Pick-up **£8.19.6**
- The latest GARRARD TRANSCRIPTION MOTOR "301" **£22.7.3**
- The new GARRARD Model 4HF High Quality Single Record Player fitted with the latest T.P.A. 12 Pick-up arm and G.C.S. Crystal Cartridge **£18.7.6**
- GARRARD Model TA/Mk. II Single Record Player fitted with high output Crystal Pick-up, detachable head **£8.10.0**

HIRE PURCHASE TERMS available on all units £3/19/6 and over Carriage and Insurance on each above 5/- 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, Pre-amplifiers, Tuning Units, Record Players, etc. All models are very easily assembled, in fact only a screwdriver is required. Fully illustrated leaflets are available, including complete specifications of the various STENTORIAN LOUDSPEAKERS. Please enclose S.A.E.

H.P. TERMS ARE AVAILABLE ON ALL EQUIPMENT OVER £9. FULLY DESCRIPTIVE LEAFLETS ARE AVAILABLE FOR ALL EQUIPMENT, BUT PLEASE SEND S.A.E.

DEPT. W. 109 FLEET ST., LONDON, E.C.4

STERN RADIO LTD.

Telephone: FLEET STREET 3812/3/4

LASKY'S RADIO

4-SPD. AUTO-CHANGER

New and Unused in Maker's Cartons



- B.S.R. UA12, stereo ... £7 19 6
 - B.S.R. type UA8 ... £6 19 6
 - B.S.R. UA8, stereo ... £7 19 6
 - B.S.R. Type UA14 ... £7 19 6
 - COLLARO Studio C60 wired for stereo, with monaural p.u. £7 19 6
- Post on all above 5/-

GARRARD

- Model 120 ... £8 8 0
- Model 121 ... £9 9 0
- Model 209 ... £9 19 6
- Mdl. 210, Stereo ... £11 0 0
- Mdl. 210 with monaural and stereo heads ... £12 10 0
- RC.88 ... £12 19 6
- RC.88 STEREO ... £13 10 0
- RC.98 ... £14 19 6

SINGLE PLAYERS

- Auto start and stop. Complete with pick-up and crystal cartridge. GARRARD 4SP ... £6 19 6
 - GARRARD TA Mk. II wired for STEREO, plug-in head £8 9 0
 - E.M.I. 4-sp., wired for STEREO and fitted mono cartridge ... £5 19 6
 - As above, STEREO ... £6 19 6
- Post on all above 5/-

- COLLARO JUNIOR 4-speed motor and separate pick-up ... 75/-
 - B.S.R. TU9, non-auto Turntable and separate pick-up ... 79/6
- Post free.

PICK-UP CARTRIDGES

- ACOS, G.P.67 turn over crystal cartridge with L.P. and standard styl. List 39/7.
- Lasky's Price 18/- post free.

- ACOS 73-1A STEREO. List 52/6.
- Lasky's Price 29/6 post free.

ALL TYPES OF CHASSIS

- ARMSTRONG, DULCI, EMPRESS, etc. A.M. (1, m, s.) from... 7 Gns.
- A.M./F.M. from ... 14 Gns.
- A.M./F.M. STEREO from 22 Gns.

'SUPER 60' 6-TRANSISTOR TABLE RADIO



Printed circuit construction using 6 Mullard matched transistors, including two OC81 in push-pull, plus 1 diode, giving 1 watt undistorted output. I.F. 470 Mc/s. Med. and long wave, Ferrite rod aerial, high flux 7x4 Speaker Hand-some walnut veneer Cabinet. 18x18½x5in.

CAN BE BUILT FOR £9/15/- POST 4/6

Circuit diagram and full data supplied. Every component available separately.

SAVE POUNDS! ORDER BY POST IF YOU CANNOT CALL

NEW TAPE RECORDER SCOOP!

THE "WALTER" MAINS/BATTERY FULLY TRANSISTORISED

Twin-track Recorder using 7 transistors. Full size and operates anywhere on either three PP9 batteries or mains voltage 100/250 v. 50 cycles.

NOTE THESE STAR FEATURES:—

- ★ 2½ watts output.
- ★ Frequency response: 50-9,000 c.p.s. overall; 50-15,000 c.p.s. straight through.
- ★ Signal-to-noise ratio better than -40 db.
- ★ 2 outputs: extension loudspeaker and external amplifier.
- ★ 5½in. reels giving maximum playing time of 3 hours.
- ★ Single master control.
- ★ Magic eye level indicator.
- ★ Revolution counter.
- ★ Monitor and tone control.
- ★ Superimposing and mixing facilities.
- ★ Very low battery consumption.
- ★ Handsome black/grey finish.
- ★ Overall dimensions: 14 x 13½ x 5½in. Detachable lid. Carrying handle.



Brand New in maker's cartons full Guaranteed.

LISTED AT £57 . 15 . 0

LASKY'S PRICE INCLUDING MIKE, REEL OF TAPE, AND EMPTY SPOOL

27 gns

Carr. & Ins. 15/- Batteries extra Price 3/- each



The LATEST COLLARO STUDIO TAPE TRANSCRIPTION. 3 motors, 3-speed 1½, 3½, 7½ i.p.s., takes 7in. spools. Push-button controls. Digital counter. Lasky's Price complete with Spool, Carr. & Ins. 12/6. £10/19/6

TAPE PRE-AMPLIFIER

For use with any Tape Deck including Collaro, Motek, etc. Full recording facilities for 1½, 3½ and 7½ i.p.s., multi-position switch gives automatic equalisation by negative feed-back to each speed. 4 valves including magic eye level indicator. Overall dim.: 12 x 4 x 5in. Front panel: 12½ x 3½in. Attractive gold hammered finish.

LASKY'S PRICE 9 GNS. Post 3/6.

MOTEK K10 3-speed Deck. Lasky's Price £9/19/6. Carr. & Ins. 7/6.

PLASTIC TAPE SPOOLS

3in.	5in.	5½in.	7in.	8½in.
1/8	2/6	2/8	2/6	5/6

Post extra.



"CLARION" TRANSISTOR BATTERY TAPE RECORDER

Capstan drive, push-button controls. Constant speed 3½ i.p.s., uses 3in. spools. High impact plastic case with transparent upper. Size 9½ x 5 x 3½in. List 25 Gns.

Lasky's Price, 16½ GNS.

with Mike and Tape. Carr. 7/6.

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Famous make, P.V.C. base on latest type plastic spools. Brand new, perfect, boxed, guaranteed.

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1,800ft. on 7in. spool	32/6
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225ft. on 3in. spool	6/6

Post free.

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Leading make, new and unused. Upper or lower track. RECORD/PLAYBACK, high impedance. Double wound and will reproduce up to 12,000 c.p.c. at 7½ i.p.s. Azimuth adjustments. Output 5 millivolts at 1 Kc. at 7½ i.p.s. ERASE, low impedance. LIST £4 PAIR.

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Please specify upper or lower track. SPECIAL OFFER. Set of 4 Heads (upper and lower). 49/6

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SONYO 6, m/long	17 Gns.
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CAN BE BUILT FOR **£9.19.6**
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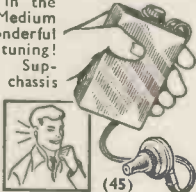
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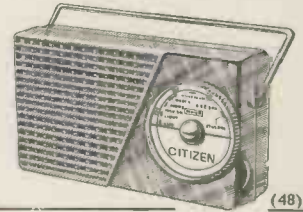


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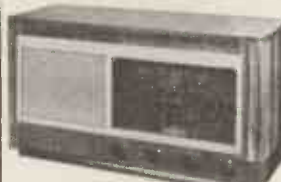
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Covers local medium wave stations variably tuned. Compact self-contained unit requiring only connection to aerial (no power supplies reqd.) for 1st class reception when used in conjunction with your tape recorder or high gain amplifier. All necessary parts available at a special inclusive price of **only 19/6**. P. & P. 1/6.

FRUSTRATED EXPORT. Not repeatable! L, M and S.W. **SUPERHET RECEIVER.** Manufactured by McCarthy for export. At present for operation on 6 volts, but conversion details supplied free.



Valve line-up: 6K8G, 6K7G, 6Q7C, 6F6G, 6X5G and 6 volt 4-pin non-synchronous vibrator. 8in. P.M. Speaker, 4 watts output, P.U. socket. Ext. L.S. socket etc. Tone control. Fitted in polished wood cabinet, size 2 1/2in. x 10 1/2in. x 10 1/2in. These cabinets are slightly soiled owing to storage, but each is guaranteed unused, in serviceable condition, tested prior to despatch. Price **£5/19/6** only plus P. & P. 7/6, plus 27/6 for A.C. Mains Conversion Components if required. **OUTSTANDING BUY!**

12in. BAKERS SELHURST LOUDSPEAKER. 15 ohms, 15 watt 30-14,000 cps. Brand new, £4/10/- P. & P. 3/6.

12in. RICHARD ALLAN P.M. LOUDSPEAKER. 3 ohm speech coil. Brand new. **ONLY 32/6** plus 2/6 P. & P.

SUPER MAGNETIC RECORDING TAPE SPECIAL!!!
 Famous American Ferrodynamics "BRAND FIVE"
 An enthusiast's "must." Brand new (NOT SUB-STANDARD) High grade Acetate Base.
 5in. 600ft. 16/-, 5in. 900ft. 18/6, 5 1/2in. 1,200ft. 23/6, 7in. 1,200ft. 25/-, 7in. 1,800ft. 35/-. Extra quality Mylar Dupont, 3in. 300ft. 13/-, 5in. 1,200ft. 37/6, 7in. 1,800ft. 44/-, 7in. 2,400ft. 60/-. Each on plastic spool. All Post free. Trade enquiries invited

DECCA PORTABLE AMPLIFIER. As supplied in famous DECCAMATIC III. Complete with small cream knobs. Full range tone and volume controls. Employs ECL82 valve. Size 3 x 3 1/2 x 8 1/2in. Only 59/6 plus 2/6 P. & P.

SPECIAL CELESTION 8 x 6in. exceptional high flux loudspeaker 30/- plus 1/- P. & P. to fit.

VERY ATTRACTIVE PORTABLE CABINET in two-tone reline covering for accommodating the above items and ancillary equipment 75/- plus 5/- P. & P. Note, if the above three items are purchased together they will be supplied at the special inclusive price of **£72/6** plus 6/6 P. & P.

LOUDSPEAKERS, EX. CHASSIS. As new guaranteed perfect, by leading manufacturers. 6in. 9/6; 8 1/2in. 10/6; 7in. x 4in. 10/6; 8in. 13/6; also 10in. with 6/P transformer (5,000 ohms), 17/6. All 8 ohm speech coils, also 8in. available, in attractive cloth covered cabinet, ideal for extension speaker 22/6. Each item plus 1/6 P. & P. Large selection of Brand New Speakers. Full list on request.

EXTENSION CABINETS. Light oak. Attractive appearance, for 6 1/2in. or 8in. at 22/6. For 10in. 25/- each plus 1/6 P. & P.

THE CRY (19) BABY ALARM



This highly efficient unit is simple to assemble, extremely sensitive and may be installed in a matter of minutes. Completely **SAFE** employing a double wound mains transformer. Attractively finished in Red and Grey (washable) "Lionide" with cream plastic escutcheon. Size only 7 1/2in x 3 1/2in. x 6 1/2in. Supplied in kit form complete with mike at **ONLY 72/6** plus 2/6 p. & p. or assembled and tested 89/6 p.&p 1/6. Suitable mike flex available at 3d. a yard. Instruction book and price list separately 1/- post free. A.C. 200-250 v.



★ TAPE RECORDER CONSTRUCTORS ★

TELEPHONE PICK-UP COIL. Designed to feed into the microphone input of either a tape recorder or any high gain amplifier. Easily attached to telephone by rubber suction attachment. The coil is electrostatically shielded to minimise hum pick-up. When positioned on telephone this model is more than adequate for a fully modulated tape recording. Brand new complete with 5ft. shielded cable. **ONLY 14/-**. P. & P. 1/6.

COLLARO TAPE PRE-AMPLIFIER AND BIAS OSCILLATOR. Complete with power pack for use with Collaro Mk. IV deck. 4 valve plus EM81 magic eye. 110-240 v. A.C. Input sensitivity: microphone socket 5 m/v., auxiliary socket 500 m/v. Speed equalisation switch gives compensation at all 3 speeds. Full wiring instructions included. List price £21. Limited quantity only at **£15/19/6**. P. & P. 5/-.

LATEST COLLARO STUDIO TAPE TRANSCRIBTOR. Latest type incorporating Record, Interlock, Lever, Button, 3 motors, 3 speeds, 1 1/2, 3 1/2, 7 1/2 i.p.s., takes 7in. spools. Push-button controls. **£12/19/6** plus 5/- P. & P. Usual H.P. facilities.

LATEST B.S.R. "MONARDECK." Single speed Tape Deck. Takes 5 1/2in. spools—3 1/2 i.p.s. At only **£8/5/-** plus 5/- P. & P.

TAPE RECORDER AMPLIFIER. Suitable for use with either of the above Tape Decks, and most other types. For A.C. mains, 4 watts output. 40-12,000 CPS at 7 1/2 i.p.s. ± 3 db. Facilities for superimpose. Valves: 6BW6, ECL82, 12AX7, 6EM8, and contact cooled metal rectifier. Radiogram input, microphone input, monitor facilities (can be used as straight through amplifier), volume control and separate treble and bass controls. Chassis measurement 1 1/2 x 3 x 4 1/2in. Supplied complete with attractive grey/blue escutcheon plate finished in black and gold. Circuit diagram and connecting instructions included. Price **£11/5/-** only, plus 3/6 P. & P. If purchased with either of the above decks, both items post free!

ATTRACTIVE TWO-TONE PORTABLE CARRYING CASE. Suitable for above amplifier and Collaro Studio deck. Limited quantity only at **79/6** plus 3/6 P. & P.

MIC 45-1. Acos latest flat pistol-grip crystal microphone. Attractive black and gold finish. **OUR PRICE 29/6** plus 1/- P. & P. **ACOS MIC 39-1.** Crystal stick microphone. List price 5 gns. Our price 39/6 plus 1/6 P. & P. **MIC 40.** General-purpose crystal microphone with desk stand. Our price **22/6** only plus 1/6 P. & P. **M.C. 24.** Imported, crystal, attractive streamlined polished metal case, incorporates muting switch. List price 64/- **OUR PRICE 32/6** only. 1/- P. & P.

TELEPHONES!!!

The Best value yet offered!

LIMITED QUANTITY

Attractive appearance. Operate from 6-volt battery. Ideal for Home, Office, Factory etc. Simply turn handle and bell rings at other end. Any twin lighting type flex required for connection. Not new but good condition. Tested before despatch.

5 GNS. Per pair complete with batteries, plus C. & P. 7/6. Suitable twin P.V.C. clear plastic flex 3d. per yard or 20/- per 100 yards.



CLYNE RADIO LTD.



18 Tottenham Court Road, London, W.1.
 162 Holloway Road, London, N.7.
 9 Camberwell Church St., S.E.5.

THE COMPONENT SPECIALISTS

VALVES

Brand new, individually checked and guaranteed

AC5PENNDD 4/-	EBC90 5/-	EZ81 6/9	Q595/10 6/9	IT4 4/-	6L6 9/-	12SJ7 6/-	954 2/-
AL60 6/-	EC52 3/-	FV4/500 6/6	QS108/45 6/9	2A3 8/-	6L6G 6/6	12SK7 4/-	956 2/-
AP4 4/-	EC90 10/-	GL450 10/-	QS150/15 6/9	2A5 8/-	6L34 6/6	12SL7 7/-	958A 5/-
AR8 5/-	ECC81 5/6	GZ32 9/-	QVO4/7 12/6	2A6 7/-	6N7G 5/9	12SN7 8/-	1616 3/-
ARDD5 2/-	ECC82 6/6	HL23 6/-	R3 8/-	2C34 2/6	6N7GT 6/-	12SR7 6/-	1619 5/-
ARP 3/-	ECC83 7/-	HL23DD 6/-	R10 12/6	2D4A 4/-	6Q7G 6/-	15D2 6/-	1625 6/-
ARP4 3/6	ECC84 7/-	HL41DD 8/-	REL21 25/-	2X2 4/-	6R7G 6/-	15E 8/-	1626 4/6
ARP12 2/9	ECC85 8/-	KRN2A 19/-	RK34 2/6	3A4 5/-	6R7GT 8/-	15R 7/6	1629 4/6
ARP21 5/6	ECC91 4/-	KT2 4/-	RX235 10/-	3B7 5/-	6SA7 6/-	20A2 7/6	6120 4/-
ARP24 3/6	ECF82 8/-	KT31 8/-	SP2 4/-	3B24 8/-	6SC7G 5/6	21B6 9/-	7193 1/9
ARP34 4/6	ECH42 7/6	KT32 8/-	SPI3C 4/6	3E29 4/-	6SCTGT 6/-	30 5/-	7475 5/-
ARTH2 7/-	ECH81 7/9	KT33c 4/9	SP41 2/6	(829B) 60/-	6SG7 5/6	35L6GT 8/-	8013A 25/-
ATP4 2/9	ECL80 8/-	KT44 6/3	SP61 2/-	3Q5GT 9/-	6SH7 4/6	35T 30/-	8020 6/-
ATP7 5/6	ECL82 9/-	KT76 10/-	SU2150A 4/9	3S4 5/-	6SJ7 6/6	35Z4GT 7/-	9001 4/6
AU1 5/-	EF22 7/3	KTW62 7/6	T4 7/9	3V4 7/3	6SFS 8/-	37 4/-	9002 5/6
AU4 5/-	EF32 5/-	KTW63 6/6	TP25 15/-	5T4 9/-	6SJ7G 5/9	38 4/-	9004 4/-
AW3 4/-	EF36 3/6	M4 4/-	TT11 3/-	5U4G 5/-	6SK7 5/3	58 6/-	9006 4/-
AZ31 8/-	EF37A 8/-	MH4 3/6	TZ20 16/-	5Y3GT 6/-	6SL7GT 6/6	59 6/-	Cathode Ray
BL63 6/-	EF39 4/6	MH41 5/-	U17 5/-	5Z3 8/6	6SN7GT 6/6	75 8/-	Tubes:
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BT45 25/-	EF54 3/3	MS/PEN 6/-	U27 8/-	6AB7 4/-	6SR7 6/6	77 6/-	(O9) 55/-
BT9B 25/-	EF55 6/-	(4033A) 10/-	U52 5/-	6AC7 3/-	6SS7 6/-	78 7/-	5BP1 35/-
BT83 22/6	EF70 4/-	OD3 5/-	UBC41 7/6	6AG5 3/6	6U6G 5/6	80 6/3	5CP1 42/6
CV31 7/6	EF73 6/-	OZ4 5/-	UCH42 7/6	6AG7 6/-	6V6GT 6/-	82 8/-	5FP7 45/-
D41 3/3	EF80 5/6	PCC84 7/-	UL41 4/3	6A7 7/3	6X4 4/3	83V 12/-	7BP7 40/-
D77 4/3	EF85 6/10	PCC85 8/-	UL84 7/6	6A7 7/3	6AK5 5/-	84 8/-	12DPR 15/-
DA30 12/6	EF86 9/-	PCF80 7/-	UL85 7/6	6A7 7/3	6AK7 8/-	85A1 12/-	VCR97 15/-
DAF91 6/-	EF89 7/9	PCF82 8/-	UU9 5/6	6AM5 5/-	6AM6 5/-	89 6/-	VCR9258 (with scanning coil) 45/-
DAF96 8/-	EF91 3/6	PCF82 8/-	UY41 6/-	6AM6 5/-	6AT 5/-	7H7 7/3	VCR138 30/-
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DETS 15/-	EF95 7/6	PEN25 4/6	VP23 3/6	6B8G 2/6	6C4 3/6	7C7 6/6	Photo Tubes:
DF72 7/6	EK32 7/-	PEN46 5/-	VP41 5/6	6C5 6/-	6C5 6/-	7Q7 7/6	CMG8 9/-
DF91 3/3	EL32 3/9	PEN65 6/6	VR78 4/6	6C6G 4/3	6C6G 4/3	7Y4 6/-	CMG25 8/-
DF96 8/-	EL33 8/-	PEN220A 3/-	VR99 9/-	6C8B 5/-	6C8B 5/-	7Z4 2/6	GS16 12/6
DK96 7/3	EL35 8/3	PENDD/1360 9/6	VR105/30 7/6	6D6 4/6	6D6 4/6	8D2 6/6	931A 50/-
DL92 6/-	EL41 8/3	PG7/5 15/-	VR150/30 7/3	6E5 5/-	6E5 5/-	9D2 3/-	Special Valves:
DL94 6/-	EL42 9/-	PL36 10/6	VU39 3/6	6F6G 4/6	6F6G 4/6	12A6 5/-	2J31 45/-
DL96 8/-	EL84 7/6	PL81 8/-	VU111 3/-	6F8G 6/6	6F8G 6/6	12A7 7/6	3A/1481 45/-
DX25 9/-	EL85 10/-	PL82 8/-	WX3138 12/-	6F12 4/6	6F12 4/6	12A7 7/6	3J/170E 35/-
EBC21 8/-	EL91 7/6	PL83 7/9	Y63 5/-	6F17 7/6	6F17 7/6	12AU6 9/-	3J192/E 37/10
EBC91 3/9	EM80 8/-	PT25H 7/6	Y66 8/-	6G6G 3/-	6G6G 3/-	12AU7 6/-	807BP 6/-
E1232 5/6	EN31 22/6	PX4 19/-	Z31 6/-	6H6M 2/-	6H6M 2/-	12AX7 7/-	810 80/-
E1524 6/6	EN32 7/6	PY80 9/-	IA3 3/-	6J5 3/6	6J5 3/6	12C8 3/-	813 67/6
EA50 1/6	ESU208 8/-	PY81 7/-	IA5GT 7/6	6J5G 3/-	6J5G 3/-	12E1 22/6	815 40/-
EABC80 7/3	EY86 8/-	PY82 8/-	IC5GT 5/6	6J6 4/3	6J6 4/3	12H6 2/-	816 30/-
EAC91 4/6	EY91 3/6	PY83 7/3	ID8GT 6/-	6J7G 5/-	6J7G 5/-	12K7GT 4/6	826 10/-
EB34 1/6	EZ40 7/-	QP21 6/-	IE7GT 7/6	6K6GT 3/6	6K6GT 3/6	12K8M 9/-	829A 30/-
EB91 3/9	EZ41 6/9	QP25 5/3	IG6GT 12/6	6K7G 2/3	6K7G 2/3	12Q5GT 3/6	832 15/-
EBC91 7/9	EZ80 6/6	QS75/20 6/9	IL4 3/6	6K7GT 4/9	6K7GT 4/9	12TGT 4/6	832A 35/-
			ILD5 3/6	6K8G 5/9	6K8G 5/9	12SA7 7/6	843 7/4
			ILN5 4/9	6K8GT 5/3	6K8GT 5/3	12SC7 4/6	866A 10/-
			IR5 5/3	6K8M 8/6	6K8M 8/6	12SG7 6/6	872A 35/-
			IS5 5/9	6L5G 6/-	6L5G 6/-	12SH7 3/-	930 8/-

AND MANY OTHERS IN STOCK including Cathode Ray Tubes and Special Valves. All U.K. orders below 10/- P. & P. 1/-; over 10/- 1/6; orders over £3 P. & P. free. C.O.D. 2/- extra. Overseas Postage extra at cost.

MARCONI SIGNAL GENERATOR. TF 144G, 85 Kcs—25 Mc/s. Made up to new standards, £70. Delivered free.

TELEPHONE HANDETS. Standard G.P.O. type new, 12/- P. & P. 1/6.

FIELD TELEPHONES TYPE "L." Excellent guaranteed condition £5/5/- per pair, carriage paid.

TRANS-RECEIVER No. 22. 2 megacycles to 8 Mc/s. Built almost exactly as Number 19. Set much more economical in battery consumption. Complete in fully working condition with power pack for 12 volts, head-gear and microphone assembly, key. £9/9/6. Carriage 15/-.

U.H.F. SIGNAL GENERATOR TYPE TS14 3,200-3,370 mc/s., power measuring range 20-200 mW., R.F. output power -20 to -100 dbm below 1 mW. Power supply 115 w. A.C. Price £15. Carriage 15/-.

H.T. CHOKES made by Bendix Radio (U.S.A.) 3 henrys .600A D.C. 25 ohms D.C. resistance, 18 volts R.M.S. 60 cycle test, £1/12/6. P & P 6/-. Ditto 10 henrys 250 amps. D.C. 90 ohms D.C., resistance 1500 R.M.S. 60 cycle test 16/6. P & P 3/6.

B.P.5 TRANSCEIVERS. Specially built for Parachutists during the war. Receiver Superhet Transmitter crystal controlled CW and phone. 2-8 Mc/s., 829 valve as output. 60 w. on CW, 15 w. on microphone, together with mains power pack 120/220 v., two rotary converters to work from 12 v. battery, microphone, key and dipole aerial. Price £15. Carriage 30/-.

CARBON INSET MICROPHONE, G.P.O. type, 2/6. P. & P. 1/-.

SPECIALLY BUILT POWER PACK for TCS receivers, 230 volts A.C. mains, including 6X5GT valve, £3/10/- Carriage 5/-.

SUPPLY UNIT RECTIFIER No. 21. Fully sealed enabling all sets built for 6 v. (R209, R109, etc.) to work from A.C. mains. Input 90 v.-260 v. A.C. (taps at 10 v. intervals); output excellently smoothed up to 10 amps with meter indicating exact output voltage. Measurements 12 x 9 x 10in. Price £8. Carriage and packing 15/-.

VACUUM CONDENSER. 32,000 v., 50 p.F., 12/6. P. & P. 3/-.

FREQUENCY METER BC221 TECHNICAL MANUAL 22/6.

BRAND NEW ORIGINAL SPARE PARTS FOR AR88 RECEIVERS.

I.F. TRANSFORMERS. 1st, 2nd, 3rd, 4th (for type D), 12/6 each, or complete set of 6, 60/-.

I.F. Transformers. Crystal Load, 12/6 each. Plates escutcheons (for D and LF), 15/- each. Dials (for type D), 10/- each.

Logging dial (for D and LF), 10/- each.
Filter Chokes (for D and LF), 22/6 each.

Output Transformers (for LF), 30/- each.
Antenna Trimmers (LF and D), 2/6 each.
Filter Condenser 3 x 4uF, £2/10/-.

Condensers, 3 x .25uF (D and LF), 2/6 each;
3 x .01uF (D and LF), 2/6 each.

RF Antenna Inductors (D and LF), 7/6 each.
Mains Transformers (LF), £3 each.
Small Mica Condensers, various values, 1/6 each.

Small Trimming Tool, 7/6.
Instruction Manual for AR88D, £1.

MARCONI CR-100 COMMUNICATIONS RECEIVER. 60 Kcs-30 Mc/s, with noise limiter. Completely reconditioned, £25. Carr. 25/-.

RECEIVER TYPE BC 341. 110 v. A.C. 1.5-18 mcs. £22/10/- Carriage 30/-.

RECEIVER TYPE BC 312. As above but 12 v. battery. £22/10/- Carriage 30/-.

P. C. RADIO LTD.
170, GOLDHAWK RD.,
W.12 SHEpherds Bush 4946

R209 RECEPTION SET. A 10-valve high-grade Super Heterodyne Receiver with facilities for Receiving R/T (A.M. or F.M.) and C.V. frequency 1 Mc/s-20 Mc/s. Hermetically sealed. Built on miniature valves and incorporating its own battery power supply unit driven by a 6 v. vibrator (2-point connector included). The set provides for reception from rod, open-wire or dipole aerial with built-in loudspeaker or phone output. Overall measurements: Length 12in., weight 8in., depth 9in. Weight 23 lb. In as new, tested and guaranteed condition, £23/10/-, including special headphone and supply leads. Carriage £1.

19-SET OWNERS. To increase output of your set six to ten times use RF AMPLIFIER No. 2 with built-in rotary converter for 12 v. input. Four 807 valves output. Simple connection with transmitter. Fully tested condition, £9/15/- including necessary connectors and instructions. Carriage and packing 15/-.

AR 88's. Completely rebuilt with new PVC wiring. Type "D", £75; Type "LF", £70.

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.

RADIO COMMUNICATION TRANS-CEIVER TYPE A.R.II. Very compact, external dimensions 12 x 8 1/2 x 5in. Total weight 18lbs. CW 4.4-16.3 Mc/s. 110/220 v. Power output about 10 w. Crystal controlled Receiver superhet. Price £12. Carriage 20/-.

TCS RECEIVERS made by Collins of U.S.A., in fully guaranteed working condition. 1.5-12 Mc/s. Line-up: 12S7 (1), 12SQ7 (1), 12A6 (2), 12SK7 (3), power requirements 12 volts L.T., 225 volts H.T., £11/10/- Carriage 12/6.

VARIOMETERS var W/S No. 9. Fully tested and working, 12/6. P. & P. 2/6.

PERSONAL CALLERS WELCOME



MAINS POWER SUPPLY UNITS.

Potted and sealed transformer and choke by famous maker. Mounted on metal chassis 6½ x 7½ in., complete with 5Z4 rectifier valve and full smoothing.

Input tapped 220-230-240 volts.
Output: 300 V. D.C. at 100 mA.
6.3 V. A.C. at 4.5 amp.
6.3 V. A.C. at 2 amp.
Rectifier supply 5 V. A.C. at 3 amp. Very conservatively rated. Price 47/6 plus P. & P. 8/-.

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

MULLARD TRANSISTORS. OC 170, 70 to 100 Mc/s., 13/6 each. OC 171, 100 to 200 Mc/s., 14/6.
Set of six 1 x OC 44: 2 x OC 45: 1 x OC 81D: 2 x OC 81. Six for 39/6.

S.T.C. RECTIFIER. 36 plates by 120 mm. Bridge connected. Maximum A.C. input 60 volt. D.C. output 15 amp. New, perfect. Price 60/-. P. & P. 3/6.

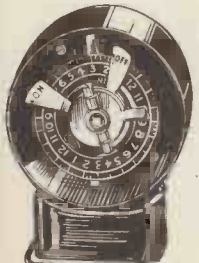
S.T.C. BRIDGE RECTIFIER. New, perfect. 8 plates each 115 mm. Maximum A.C. input 36 v. D.C. output 5 ampere, 24 volt. Price 20/- P. & P. 2/-.

W. W. RHEOSTAT. New. 3.5K or 5K 25 watts. Price 7/6. P. & P. 1/6.

AUTO TRANSFORMERS. Step up, step down. 110-200-220-240 v. Fully shrouded. New. 300 watt type £2/2/- each. P. & P. 2/6. 500 watt type £3/3/- each. P. & P. 3/9. 1,000 watt type £4/4/- each. P. & P. 6/6.

HEAVY DUTY L.T. TRANSFORMER. Very conservatively rated for continuous duty. New, in manufacturer's cases. Input 110-260 volt multi-tapped. 50 cycles, single phase. Output 28-29-30-31 volts at 21 ampere. Price £6/15/-, carriage 10/-.

ROTARY SWITCH REGULATOR. 25 ohms, very conservatively rated at 4 amp., will handle 8 amp. Overall size 7 x 8 x 6 in. Price 15/- P. & P. 2/6.



28-day clockwork TIME SWITCH

Contacts 2½ amp., 230 volt, 24 hour phase, ¼ hour divisions, allow setting for one make and one break to be made every 24 hours, complete with key. Used but guaranteed perfect. Price 27/6 each. P. & P. 2/-.

EX P.O. MAGNETIC COUNTER. 3 ohm type for 6 V. D.C. operation. 4 figures to 9,999. Price 8/6. & P. P. 1/3.

TANNOY P.A. LOUDSPEAKER. For outdoor use, metal exponential horn with 20 in. square flare. Overall length 30 in. Speech coil 15 ohms. Guaranteed in working order and good condition. Price £7/10/-. Carriage 10/-.

20-WAY STRIP. Containing standard Post Office telephone Jack Sockets, overall size 11 x 3½ x ½ in. New. Price 15/- each. P. & P. 1/6.

10-WAY STRIP standard Post Office telephone Jack Sockets, spacing allowing Igranite Jack Plugs. New. Price 10/-. P. & P. 1/6.



MOULDED CABINET suitable for Transistor Set. Dual colour red/black. Size 5½ in. x 3½ in. x 1½ in. Gold metal dial. Price 7/6. P. & P. 1/6.

AVO METER MODEL 7. Individually tested on all ranges and guaranteed. Inclusive of Test Leads. £12/10/- each. P. & P. 5/-.

G.E.C. SEALED RELAYS TYPE M1095. 24 volt 760 ohms. 2 make 2 break. Unused. Price 12/- each. P. & P. 1/-.

G.E.C. SEALED RELAYS TYPE M1494. 24 volt 670 ohms coil. 2 pole C.O. Brand New. Price 10/- P. & P. 1/-.

NEW P.O. RELAYS TYPE 3000. 2,000 ohm coil. 4 make 4 break, 12/6 each. P. & P. 1/-.

NEW RHEOSTAT 1,750 ohms 100 watt. Wound on ceramic former. In metal case with 1 in. x ½ in. spindle. New in maker's packing, 32/6 each. P. & P. 2/6.

SUPERIOR BRAND NEW RELAY. 7,000 ohms coil. Will pull in at 750 microamps, and out at 450 microamps. Change-over, platinum contacts. Vacuum sealed, will therefore not be affected by oil, moisture or water and never needs adjusting. Weight 2½ oz. Price 18/6. P. & P. 1/-.

MINIATURE MOVING COIL DIFFERENTIAL RELAY. Two coils 350 ohms each.

Operating current minimum 140 microamp., nominal 400 microamp., maximum 8 milliamp. One pole two way, or centre stable. Two way contact current 100 mA at 50 V. A.C. or D.C. Size 1¼ x ¾ x ¾ in. Price 22/6 each.

PACKARD BELL BRAND NEW RELAYS, 2 pole C/O. 6 volt 80 ohms. 7/6 each. P. & P. 6d.

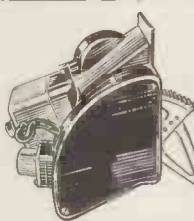
MINIATURE RELAYS 250 ohms. Two makes. For operation on 4.5-9 volt. Ideal for transistor circuits. Weight just over 1 oz. Price 12/6 each.

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

SOLENOID OPERATED MAGNETIC RELAY. Type 5CW/3945, 4 pole changeover, 10 A contacts 24 v. operation. Brand new 13/6. P. & P. 1/6.

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

CROMPTON PARKINSON BRAND NEW ½ H.P. MOTORS 230/250 VOLT A.C. 1440 R.P.M. Complete with 2 in. SPINDLE. Price £3/15/0. Carriage 8/6.



SPECIAL REVERSING 24-VOLT D.C. MOTOR 2 AMPERE. Quadrant moves 90 degrees with limit switches. Ideal for opening doors etc. Price 22/6. P. & P. 2/-.

CONSTANT SPEED, PRECISION MADE, BATTERY DRIVEN D.C. GOVERNED MOTOR (Elliott Bros.). Commutator/brush incorporating loading ballast resistor 2,470 r.p.m. ± 2% at 12 volt. Loss on 8.5 volt only 4%. Size 1½ in. dia. x 2½ in. long. Spindle .77 in. long x .15575 in. dia. Weight 4 oz. New. Price 25/-, plus 1/- P. & P. Ideal for portable tape recorders.



DESK TELEPHONE HANDSETS



Used but perfect. Complete with two-way calling system (buzzer), internal battery. All ready for simple two-wire connection. Price £3/2/6 each or £6 the pair. P. & P. 3/6 each handset.

DESK TELEPHONE SETS, similar to G.P.O. extension telephones. Each complete with automatic dial, internal bell and long connection core and junction box. Used but in perfect working order. Price £2/17/6 each. P. & P. 3/6.

DIALS ONLY FOR AUTOMATIC TELEPHONES. Used but in good condition. Price 12/6. P. & P. 1/6.

NEW BALANCED ARMATURE HEADPHONES, TYPE DLRS. Guaranteed perfect. Price 12/6 each. P. & P. 2/-.

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Miniature latest type moving coil 0-5 milli-amp meter, 1½ in. diameter, flush fitting, complete with fixing clip. Price 17/6. P. & P. 1/-.

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£4.10.0

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VELODYNE REVERSING MOTOR GENERATORS

Type 74 Motor armature 5 amps. Field 80 mA. Generator armature 56 volts d.c. Field 24 volts d.c. Size: 8 x 3½ in. Spindle dia. ¼ in. Unused.



35/- Carriage 2/6.

3cm. SIGNAL GENERATOR

TS 13AP "X" band Signal Generator with integral checking wavemeter covering 9305-9455 Mc/s and providing pulse, square wave, or FM modulation. Pulse width and shift variable: FM from external sawtooth supply. Metered power output of 5 microwatts minimum on CW or pulse into calibrated attenuator. P.R.F. plus or minus 1 kc/s on self-sync. operation on 350 c/s-4 kc/s triggered. Valves: 723 A/B, 2x6AC7, 3x6SN7GT, 6S6, 5U4G, 5Y3, and 3xVR105/30 stabilisers. In black crackle case containing leads. Size: 20x10x11½ in. deep. Complete with diagrams and handbook.



£25

Carriage £1

MEGISTORS, 125, 1,000 or 10,000 MEGohms
Glass encapsulated. Tolerance: 10%. One of each value plus any chosen two, only

5 for 10/- Post paid.



TRANSMITTER/RECEIVER APN-1

A complete 14-valve radar set covering 420-460 Mc/s., ideal for conversion to radio control of models or 70 cm. work. Brand new and complete with all valves, but less dynamotor.

£2

Carriage 7/6.

GEIGER COUNTER TUBES

Low voltage, Halogen quenched Geiger Mueller tubes by a famous British manufacturer. Working voltage 400-450. Highly sensitive: effective length 11.8 cm. Background 90 counts/min.—max. response 30,000 counts/min. Plateau 80 volts. Stainless iron electrode. Similar to tubes fitted in high-grade instruments and used in demonstration counters on B.B.C. and I.T.V. programmes. IDEALLY SUITED FOR HOME-BUILT GEIGER COUNTERS, BASIC EXPERIMENTATION, AND INSTRUCTION AS WELL AS SERIOUS WORK. Circuits of simple, all-transistor and conventional valve counters supplied on request. Brand new

25/- Postage 2/6.

PRESSURE SENSING INDUCTANCE

Highly sensitive device consisting of ferrite encapsulated 160 kc/s. coil unit and aneroid capsule which changes frequency with changes of pressure. Coil Q43; capacitance 870 pf. In ½ in. square aluminium can on 2½ in. diameter lightweight plug-in unit.

22/6 Carriage 2/6.

CENTRE SCALE COUNTERS

Ex-R.A.F. camera film footage indicators. Consists of really compact lever solenoid which actuates a pawl on a ratchet wheel to move a pointer progressively round a circular dial. Works on either 12 or 24 volts d.c. and records 125 counts per revolution. Can be used as a lap marker for "Scalextric" car sets, mechanical counting, display, etc. In diecast case with centre toggle switch and reset button. Stick-on dial graduated 0-125 supplied. Size: 3½ x 1½ in.



Carriage 3/-

7/6

MASTER AND REMOTE CONTACTORS

MASTER CONTACTOR is a robust, high quality, spring driven clock with balanced escapement driving a low friction pair of contacts that "make" every half-second. Mechanism enclosed in sorbo-rubber lined box size 6 x 6 x 6 in. REMOTE CONTACTOR is a solenoid-operated ratchet mechanism which is energised by the half-second impulses from the Master Contactor to turn a pointer at one rev. per minute over a 2 in. dial with adjustable zero and quarter divisions. In first-class guaranteed condition.

30/- Carriage 5/-.

COLD CATHODE TRIGGER TUBES

Sub-miniature cold cathode valve developed by Ericsson primarily for computer work. Anode-cathode running voltage of 95 to 140 at 4.5 mA, and at 290 anode volts require a trigger current of only 250 microamps to cause the anode to take over the discharge. Typical ionization time: 90 microseconds. Will withstand up to 310 volts with zero trigger voltage without self-igniting. Complete with full performance data in original packs of 100 at the special price of

£5.0.0

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Post paid.

ELECTRIC ACTUATORS

Special offer of aircraft quality, precision engineered rotary actuators by leading British manufacturers. In new or first-class used condition. For 24 volt operation.



TYPE 2

Split field, series wound, reversible motor fitted with electro-magnetic brake. Max. load 50/60 lb./in. Output 0.02 h.p. at 13,000 r.p.m. Reduction gear ratio 2,957 to 1. Length 7 in. Weight 2½ lb. Fitted with adjustable limit switches.

75/- Post paid.

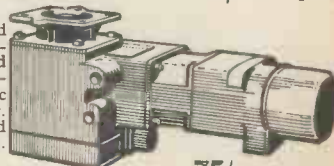
TYPE 3

Similar in appearance to above. Designed for operation of 3-position-type valves in which actuator gives wide variety of angular settings determined by position of limit switches. Max. load 50 lb./in. Output 0.017 h.p. at 17,000 r.p.m. Full range travel: 140 deg. in 2 seconds. Weight 3.25 lb.

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TYPE 5

Two-pole, split series wound motor. Fitted with double-plate friction clutch. Speed of motor 11,000 r.p.m.—reduced through epicyclic and worm gears to 60 deg. rotation of right-angled drive shaft in 3 seconds. Consumption 3 amps.



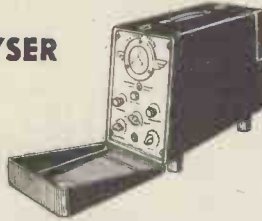
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- VCR139 (Cossor 23D equivalent) 2½ in. cathode ray tube 15/- Postage 2/6.
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- Double pole knife changeover switch on porcelain base, 2 for 4/- Postage 1/-.
- Pyrex aerial insulators, four 3 in. OR one 7 in., 6/- Postage 1/6.
- Neons, ten 115 volt for 19/- Postage 2/6. Six 80 volts for 6/- Postage 1/6.
- G.P.O. electro-mechanical relays 0-9999, 5/- Postage 2/6.
- Bulgin type "M" microswitches, 4 for 10/- Postage 1/6.
- Metal rectifiers: selenium 6-12 volt 1½ amp., 9/6. 2½ amp., 9/6. 4 amp., 16/6.
- Charging transformers: Pri. 200/250 volts, Sec. 3½, 9 and 17 volts, at 4 amp., 18/6. Postage 3/-.

ELECTRONIC IGNITION ANALYSER

Versatile, portable equipment specially designed for the critical analysis of aero-engine ignition systems. Displays entire performance of ignition system on a cathode ray screen while engine is running—simultaneously showing each plug firing in a side by side comparison. Reveals excessive carbon formation, faulty condenser, leaking cables, incorrect plug or contact breaker gap, worn cams, etc. Ten-step loading switch absorbs energy from system and thus accentuates test to show-up deterioration in coil primary, secondary winding, condenser, cables, etc. Straightforward connection to system. Power supply can be switched to either 230/250 volts A.C. mains, or 6, 12 or 24 volts D.C. In attractive metal case 9x13½x17½in. deep. Complete with circuit, instructions and good and faulty trace drawings. Guaranteed serviceable.



£15.0.0 Carriage 10/-

TELEVISION OSCILLOSCOPE

Release of a small quantity of the latest version of the well known APN-4 Indicator Unit from the American Loran Airborne radio navigation system. This provides a golden opportunity to make a serious television servicing and development tool as described in "Wireless World." Steel, double-deck, chassis with fully screened 5CP1 tube in the centre, all high-grade capacitors and resistors, separate tag boards and layout diagrams for individual sections, etc. Modern circuit technique centred around one type of valve (14 of 6SN7 double-triodes and 8 of 6H6, plus three 6SL7 and one 6SJ7), and RCA. 100 kc/s Crystal. Brand New with W.W. Circuit for conversion.

£6.10
Carriage 10/-

Modern light-alloy cased. Drive unit type 114 containing a robust 8½in. induction sustained 25 c/s tuning fork with attendant induction pick-ups and waveform amplifier comprising 2 DF50, CV1092 diode and 6L6 output. 5U4G rectifier and VS11Q stabiliser in power supply derived from high-cycle transformer—easily replaced by standard mains type. High grade components throughout. Easily removed, flexibly mounted tuning fork assembly energised by 6.3 volts A.C. only. Case size: 8½x7½x10½.

APNI TRANSDUCER

Consists of magnet and coil which is attached to an aluminium diaphragm suspended freely and perforated to prevent air damping. A metal-coated ceramic cover is located over diaphragm to form 2-gang capacitor having swing of 10-50 p.f. Widely used in wobblator circuits, etc.

6/-
Postage 1/6.

INVERTORS

28 volt DC to 115v. 3 phase 400 c/s AC. Type 102A. Output 625VA. Brand new and complete with type 34(5UC/5820) voltage and frequency control unit. **£15.0.0** Carriage 10/-.

28 VOLT DC to 115v. 1 phase AC. Self contained motor generator unit with complementary carbon pile voltage regulator, contactor and associated rectifier in separate compartment on same base. Continuously rated for 25/28 volts D.C. input with 360 VA output at 115 volts single phase A.C. at 1,600 cycles with a power factor of 1.0. Fan cooled with end plate for blast or internal cooling as required. Type 200. Ref. 5UB/5083. In first class condition.

£4.10.0 Carriage 7/6.

200/220 Volt D.C. to 200/250v. 1 phase 50 c/s AC. Output 260 watts. New, in sound-proof cabinet.

£9.0.0 Carriage 10/-.

24 volt DC to 26v. 1 phase 400 c/s AC. Output 6VA. Size 2½in. dia. 4in. long 1½in. high pedestal base. Instrument quality.

AS NEW **27/6** Carriage paid.

28 volt DC to 115 volts 1 phase 400 c/s AC. Output 50VA. Size 7x4x5½in. high. In black crackle case on anti-vibration mounted pedestal base containing condenser filter. Fan cooled.

As new. **£4.10.0** Carriage 5/-.

PRECISION POTENTIOMETER

Magnificent ball-bearing mounted, 25k, 10 watt, precision wire-wound potentiometer by Colvern. Brand new in original carton with test certificate and 10-position calibration check readings. Extra long spindle.

10/-, postage 2/6.

LOW VOLTAGE PRECISION RELAY

Actuates heavy-duty, silver contact, 2-pole changeover switch rated at 25 amps and mounted on low loss base. Input 24 volts 5 watts. Changeover occurs at 16-17 volts and reverse changeover when voltage drops by one-third of energising value. Manufactured to RAE Spec.: DES 1 to withstand 200 vibrations per second with unimpaird performance. Size: 2½ x 2 x 1½. Weight 9 ozs. Dust cover protected. New in original packing. **7/6** Postage & Packing 2/-.

SCOPE UNIT T.S. 74

A basic scope with brilliance and focus controls on front panel which also contains X-plate terminals, gain control and two-speed timebase switch. Immediately behind the panel is a separate screened compartment that houses two VR65 and a VR92 (tunable input receiver-converts to input and amplifier) and a signal generator (3 VR65 and VR135) modulated at two frequencies over its 155 to 255 mc/s range. Substantial EHT and HT power pack (VU120 and 5Z4G) at rear, plenty of free room, four high-voltage pre-set pots two full-length tag boards, 12 valves plus VCRI39A. Complete with circuits and full instructions for modification.

£3-10-0 Carriage 15/-.

25 c/s Tuning Fork Drive 60/- AMPLIFIER



Modern light-alloy cased. Drive unit type 114 containing a robust 8½in. induction sustained 25 c/s tuning fork with attendant induction pick-ups and waveform amplifier comprising 2 DF50, CV1092 diode and 6L6 output. 5U4G rectifier and VS11Q stabiliser in power supply derived from high-cycle transformer—easily replaced by standard mains type. High grade components throughout. Easily removed, flexibly mounted tuning fork assembly energised by 6.3 volts A.C. only. Case size: 8½x7½x10½.

RECEIVER TYPE 88 (R1475)

Highly stable, specially accurately calibrated, Marconi design, RAF communications receiver covering 2-20 Mc/s in 4 bands with built-in 600 kc/s Xtal reference, oscillator for checking dial which can be reset by special panel trimmer control. 11 Valves: 3 6K7, 6K8, 6J5, 3x6Q7, 6H6, Y63 tuning indicator and VR150-30 voltage regulator. Two stage IF with 8 tuned circuits, Xtal controlled B.F.O. Four position selectivity with audio filters for narrow bandwidth C.W. Fast and slow AVC, high and low noise suppression. A plug-in unit with additional mixer provides a "listening through" guard channel of either 2-4 or 4-7½ Mc/s. Receiver 16½x9x11in. Power pack 8x9x11in. Complete with 200-250 volt AC (or 12v. D.C.). Power pack type 360, and operating and alignment instructions. Used, but in very good condition. Guaranteed serviceable. A sound buy indeed at **£13.10.0** carriage paid.

ANTENNA BEAM ROTATING MOTOR



Powerful British series-wound split field 24-volt motor with a 600-1 epicyclic reduction gear turning a ¾in. long, ½in. diameter splined drive at 12-15 r.p.m. Removal of the easily detachable (24 volt) magnetic brake housed in a separate rear casing permits operation from either A.C. or D.C. at any voltage between 6 and 30 with corresponding variable speed. Limit switches operate after approximately 3 turns in either direction, but these can be shorted out for continuous running. Designed for external use, easily waterproofed. Consumption 4-6 amps. **55/-** plus 7/6 carriage.

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Remote indication to within 1° on precision instrument type flush fitting black crackle indicator with 3in. dial calibrated in 2° steps plus the four cardinals. Simple D.C. wiring (6-30 volt) from specially wound potentiometer in sealed die-cast housing with ½in. drilled spindle transmits accurate signal of horizontal or vertical bearing. Brand New. Post free Carriage 5/- **30/-**

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Build a high quality recorder in the £70 class for only

25 1/2 GNS. OR DEPOSIT £5/7/6 and 12 monthly payments of 42/- Cash price if settled in 3 months.

Can be assembled in 1/2 hour.

INCORPORATING THE LATEST COLLARO STUDIO TAPE TRANSCRIBER. THE LINEAR LT45X HIGH QUALITY TAPE AMPLIFIER. A HIGH FLUX 7 x 4in. LOUDSPEAKER. Reel of Best Quality TAPE, Spare Tape Spools, a Portable Cabinet, size approx. 16 x 13 x 9in., finished in durable and attractive du-tone Polycrome and connection diagram for wiring amplifier to transcriber.

FEATURES INCLUDE:
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 Full descriptive leaflet supplied on receipt of S.A.E.



HI-FI 10 WATT AMPLIFIERS

BRAND NEW CARTONED MANUFACTURERS DISCONTINUED £6.19.9

MODEL A REMARKABLE OPPORTUNITY. Carr. 7/6. Push-pull output. Latest high efficiency Mullard valves. Dual separately controlled inputs, for mike and gram. Separate bass and treble controls. High sensitivity. Output for 3 ohm or 16 ohm loudspeaker. Guaranteed, tested and in perfect working order. Please state speaker matching required when ordering.

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 Design of a high quality Radio Tuner Unit (specially suitable for use with any of our Amplifiers). A Triode Heptode F/Changer is used. Pentode I.F. and double Diode Second Detector delayed A.V.C. is arranged so that A.V.C. distortion is avoided. The W. Ch. Sw. incorporates Gram-position. Controls are Tuning, W. Ch. and Vol. Output will load most Amplifiers requiring 500 mV input depending on Ac location. Only 250 v. 16 mA H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-7in. high. Send S.A.E. for illustrated leaflet. Total building cost is £4/15/-. Point-to-Point wiring diagrams and instructions 2/6.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS

HF1012, 10 watts, 15 ohm (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. £4/10/9. Please state whether 3 ohm or 15 ohm required.

BASS REFLEX CABINET. Specially designed for above speaker. Acoustically lined and ported. Polished walnut veneer finish. Size 18 x 12 x 10in. Strongly made. Handsome appearance. Ensure superb reproduction for only £3/19/6.

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 EAGLE. A.C. and D.C. 10,000 ohms per volt. £5/19/6

ACOS HI-FI CRYSTAL 'MIKES'
 Mic 40 Hand or Desk type
 27/9 (Listed) (45/-)
 39-1 Stick type
 39/6 (Listed) (5 Gns.)
 Limited number.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all-dry battery eliminator. Size 6 1/2 x 4 1/2 x 2in. approx. Completely replaces batteries supply 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s is available. Suitable for all battery portable receivers requiring 1.4 v. and 90 v. This includes latest low consumption types. Complete kit with diagram 39/9 or ready to use 46/9.
 Type BM2. Size 8 x 5 1/2 x 2 1/2in. Supplies 120 v. 90 v. and 60 v., 40 mA and 2 v. 0.4 a. to 1 amp., fully smoothed, THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND L.T. 2 v. ACCUMULATORS when connected to A.C. mains supply 200-250 v. 50 c/s. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator.
 Complete kit with diagrams and instructions. 49/9 or ready to use 59/6.



POWER PACK KITS. Only 19/11. Fully smoothed H.T. output of 250 v. 60 mA and L.T. supply of 6.3 v. 1.6 amp. Consisting of Double Wound Mains Transformer 230/250 v. 50 c.p.s. A.C. primary. Selenium Rectifier. Smoothing Choke, Double Electrolytic Condenser, Aluminium Chassis and Circuit.

R.S.C. A12 STEREO 4 GNS. AMPLIFIER KIT

A complete kit of parts to construct a good quality 3 + 3 watt (total 6 watt) stereo amplifier providing really life-like reproduction. Suitable for use with all stereo pick-up heads at present available. Ganged volume and tone controls. Preset balance control. Outputs for matched 2-3 ohm speakers. For 200-250 v. A.C. mains. Astonishing value.

R.S.C. STEREO/TEN HIGH QUALITY AMPLIFIER KIT

Valves EZ81, EOC 83, ECC83, EL64, EL84. Separate bass and treble controls giving "cut" and "boost." Sensitivity 50 mV. 5 watts high quality output on each channel. Can be used as straight 10 watt amplifier. Controls: Stereo/Monaural switch, ganged volume, ganged treble, ganged bass, and balance. Outputs for 3 ohm speakers. Point-to-point wiring diagrams and instructions. Illustration full wiring details and priced parts list, 1/9. Assembled and tested 59/6 extra.

POCKET PORTABLE TRANSISTOR RADIO DESIGN

Employing 2 Brimar R.F. Transistors, 1 output Transistor, and crystal diode, Ferrite Rod Aerial, Miniature Speaker Unit. Handsome Plastic Case. Constructional Envelope 1/6. Total building cost 49/9.

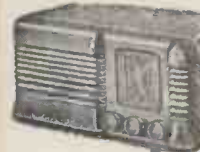
R.S.C. MINIATURE 3 WATT GRAM AMPLIFIER KIT

All parts to construct a very compact, highly sensitive amplifier suitable for any type of single or autochange player. Size 12 x 2 1/2 x 2 1/2in. Chassis is mains transformer isolated. For 200-250 v. A.C. mains. Output for 2-3 ohm speaker. Volume and tone control with mains switch. ONLY 39/6

SELENIUM RECTIFIERS

L.T. Types	H.T. Types H.W.
2/6 v. 1 a. H.W. ... 1/9	120 v. 40 mA. 3/9
6/12 v. 1 a. H.W. (Bridge) ... 2/9	250 v. 50 mA. 3/11
Following F.W. (Bridge)	250 v. 60 mA. 4/11
6/12 v. 1 a. 3/11	250 v. 80 mA. 6/11
6/12 v. 2 a. 6/11	250 v. 250 mA. 12/9
6/12 v. 3 a. 9/9	Contact Cooled
6/12 v. 4 a. 12/3	250 v. 80 mA. 6/11
6/12 v. 5 a. 14/6	250 v. 50 mA F.W.
6/12 v. 6 a. 15/6	..... (Bridge)
6/12 v. 10 a. 25/9	250 v. 75 mA F.W.
6/12 v. 15 a. 35/9	..... (Bridge)
	..... 10/11

THE SKY FOUR T.R.F. RECEIVER



A design of a 3 valve 200-250 v. A.C. mains L. and M. wave T.R.F. receiver with selenium rectifier. For inclusion in cabinet illustrated or walnut veneered type. It employs valves 6K7, 6P6L, 6R6 and is specially

designed for simplicity in wiring. Sensitivity and quality are well up to standard. Point-to-point wiring diagram, instructions and parts list 1/9. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite or veneered walnut.

VARLEY 2 v. 14 A.H. ACCUMULATORS.

New ex Govt. 5 x 3 1/2 in. 5/9 each. 3 for 15/-
JASON F.M. TUNER. Type FM.T1. All parts including Dial, Punched Chassis and Valves. Power supply required 180 v. 25 mA and 6.3 v. 1.5 a. £6/19/6

EX GOVT. SMOOTHING CHOKES

60 mA 10 h. 400 ohms	3/11
80 mA 20 h. 900 ohms	5/11
100 mA 5 h. 100 ohms	3/11
100 mA 10 h. 100 ohms	6/9
120 mA 10 h. 100 ohms	10/11
150 mA 12 h. 100 ohms	9/9
200 mA 5-10 h. 100 ohms	11/9
250 mA 5 h. 50 ohms	10/9

MICRO-AMMETERS

0-50 micro-amp. Diameter 2 1/2in approx. Sealed 0-100 Flush mounting, 29/6.

EX GOVT. MAINS TRANSFORMERS

Primary 0-110-200-230-250 v. 275-0-275 v. 100 mA. 6.3 v. 7a. 5 v. 3a. 22/9
 Input 200-250 v. 50 c.p.s. 250 v. 60 mA 6.3 v. 2a. 10/11
 Primary 200-250 v. Sec. 12 v. 20 a. 49/9
 Primary 230 v. 400-0-400 v. 200 mA. 29/9
 Primary 200-240 v. Sec. 3,500 v. 5 mA 2 v. 2 a. 39/9
 50 watts, 0-110/120-230/250 v. 8/11

HEAVY DUTY KIT

6/12 v. variable charge rate up to 6 amps. Consisting of Mains Trans., F.W. (Bridge) Selenium Rectifier, 0-7 amp. meter. Variable Charge Selector. Fuses, fuse-holders, panels, plugs and circuit. Only 59/6. Post 4/6.

CHARGER TRANSFORMERS

200-230-250 v. 50 c/s.	
0-9-15 v. 1 1/2 a.	12/9
0-9-15 v. 2 1/2 a.	15/9
0-9-15 v. 3 a.	16/9
0-9-15 v. 5 a.	19/9
0-9-15 v. 6 a.	23/9

Battery Chargers and Kits for 200-230-250 v. 50 c/s. A/C. Mains

BATTERY CHARGER KITS

Consisting of Mains Transformer, F.W. Bridge, Metal Rectifier, well ventilated steel case. Fuses, fuse-holders, grommets, panels and circuit. Carr. 2/9 extra.

6 v. or 12 v. 1 amp.	24/9
As above, with ammeter ...	32/9
6 v. 2 amps.	25/9
6 v. or 12 v. 2 amps.	31/6
6 v. or 12 v. 2 amps.	42/9
(inclusive of ammeter)	
6/12 v. 4 amps.	49/9
6 v. or 12 v. 4 amps., with variable charge rate selector and ammeter	59/9

ASSEMBLED CHARGER

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

ASSEMBLED 6 v. or 12 v. 4 amps.

Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish. Ready for use with mains and output leads. Carr. 5/- Or Deposit 13/3 and 5 monthly payments of 13/3. As above, but for 6 amp. charging, 4 GNS. Carr. 5/- Or Deposit 16/- and 5 monthly payments of 16/-.

D.O. SUPPLY KITS. Suitable for electric trains. Consist of mains trans. 200-250 v. 50 c.p.s. 12 v. 1 amp. selenium rect. (F.W. Bridge); 2 fuseholders, 2 fuses, change direction switch, variable speed regulator, partially drilled steel case and circuit. Very limited number, 33/9.

HEAVY DUTY EX GOVT. SELENIUM RECTIFIERS
 With large square aluminium cooling fins 12 v. 15 amp. F.W. (Bridge). Limited number. 19/6.

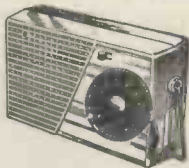
VALVES! Full range at really competitive prices.

EX GOVT. CASES
 Well ventilated, black crackle finished, undrilled cover Size 14 x 10 x 8 1/2in. IDEAL FOR BATTERY CHARGER OR INSTRUMENT CASE. COVER COULD BE USED FOR AMPLIFIER. Only 9/9, plus 2/9 post.

RELAYS. Carpenter Type Polarised, 2 x 9,600 turns at 1,855 ohms. 13/9. Miniature type G.E.C. 670 M1092 sealed wire ends 4 c/overs platinum, 12/9.

★'PW' 6-TRANSISTOR★

MEDIUM AND LONG WAVE POCKET SUPERHET (as described November P.W.)



- A sensitive superhet with 150mW push-pull output on 2 $\frac{1}{2}$ in. speaker. Uses 6 first-grade Mullard transistors and printed circuit. Moulded cabinet. Red, Blue or Cream.
- All parts sold separately. Send for list. Illustrated Building Plans 1/6 plus post. Size 5 $\frac{1}{2}$ x 3 x 1 $\frac{1}{2}$ in.

ALL PARTS REQUIRED £8.19.6

★ NO EXTRAS TO BUY—EVERYTHING SUPPLIED ★

TRANSISTOR FM TUNER

Fully tunable with A.F.C., A.G.C. Incorporating 5 Transistors and Printed Circuit Pre-assembled units.

- 2-OC171 and 3-OC170 Selected Transistors.
 - Fully Tunable 85 to 108 Mc/s.
 - 10.7 Mc/s. I.F.
- A new design for Hi-Fi to feed quality valve or transistor amplifiers.



All Parts 18 gns. P.P. 3/-

Fully Illustrated Book 3/6

MORE THAN 50% PRICE REDUCTION MULLARD and EDISWAN TRANSISTORS

SEND FOR FULL DETAILS. WE CAN SUPPLY OVER 200 TYPES OF TRANSISTOR AND SEMI-CONDUCTOR DEVICE—EVEN TUNNEL DIODES

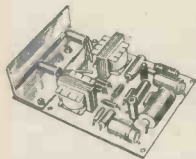
PRACTICAL TRANSISTOR CIRCUITS

Contains easy-to-follow plans of 40 all-transistor units, including light-operated switches, amplifiers, transmitters, receivers, test oscillators, signal tracers, hearing aids, radio control, etc. All parts available separately. POST FREE 3/6

750mW 4-TRANSISTOR

PUSH-PULL AMPLIFIER

- (over 1 watt peak output)
- Uses OC71/OC81D, 2—OC81.
- ± 3 dB 70 c/s to 12 kc/s.
- Overall size 3 x 2 $\frac{1}{2}$ x $\frac{1}{2}$ in.
- Built on printed circuit.



BUILT AND TESTED 69/6 p.p. 1/6 OR COMPLETE KIT 62/6 p.p. 1/6
Ideal for Record Player, Interm. Baby Alarm, for Tuners, etc.

- 3 ohm output, fully guaranteed, 9 volt operated. Descriptive leaflet with uses FREE on request.

★ TO BUILD YOURSELF ★

DETAILS ON REQUEST

- MINI-4, medium and long 6-stage pocket superhet. 4 Mullard transistors. All parts £6/19/6. Details on request.
- Ranger-2. 2-transistor version of Ranger-3 (see above). Very sensitive. Pictorial diagrams free. No extras to buy. 59/6. P. & P. 1/6.
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- 7-transistor medium, long and short wave superhet. Pre-built units. Full plans and details. 2/6 plus post.
- 4 Mullard Transistors for 1 watt amplifier 1—OC71, 1—OC81D, 2—OC81 with Cooling Clips only 27/6 per set.
- Transformers 25/- per pair.

6-TRANSISTOR RADIO



Fidelity "Coronet"

6-TRANSISTOR MEDIUM AND LONG WAVE POCKET RADIO

- Size 2 $\frac{1}{2}$ x 4 $\frac{1}{2}$ x 1 $\frac{1}{2}$ in.
- Quality Push-Pull Speaker Output.
- Guaranteed for 12 months.
- Phone and Tape Socket.

ALL BRITISH DESIGN AND CONSTRUCTION



9 $\frac{1}{2}$ gns. (Incl. Battery) Reg. Post 2/6.



★ RANGER-3 ★

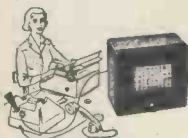
NO EXTERNAL AERIAL OR EARTH 3-TRANSISTOR AND 2 DIODES

PERSONAL POCKET RADIO Size 4 $\frac{1}{2}$ x 3 x 1 $\frac{1}{2}$ in. with 5 stages giving clear reception on medium wave, amateur top band and shipping. Only first grade components used throughout. As described in March R.C.

ALL COMPONENTS 79/6 P.P. 1/6
NO EXTRAS TO BUY
Everything Supplied.

- Easy to follow instructions with pictorial layout.
 - Reception of Radio Luxembourg guaranteed (most areas).
- Free Instructions and Price List on request. Easy to build.

● AFTER SALES SERVICE. GUARANTEED SUCCESS ●



ALL TRANSISTOR TIME SAVER

OFFICE OR HOME TELEPHONE PICK-UP AMPLIFIER

- No more "Holding Up" wasting time waiting for your call to come through. When it does the amplifier can be switched off if required.
- No connections, just Sello tape the pick-up coil to back of phone as above.

BUILT, TESTED, READY TO USE
£5. 10. 0 P.P. 2/6
● 5-inch speaker ; 3 months' battery life. Now with 400mW output.

ALSO 'BABY ALARM' £5.10.0 p.p. 2/6.

● CONTESSA ● COMBINED PORTABLE AND CAR RADIO



5-TRANSISTOR MEDIUM AND LONG WAVE SUPERHET TERRIFIC SENSITIVITY UNBEATABLE IN PERFORMANCE AND APPEARANCE

SPECIFICATION

- 425mW Push-Pull Output.
- 6" Top Grade "Ediswan Transistors.
- New Type Printed Circuit with all Components marked.
- Full Medium and Long Wave Tuning.
- High "C" Internal Ferrite Aerial.
- Car Radio Adaptation and AVC.
- Slow Motion Fingertip Tuning with Station Names.
- "Hi-Fi" Quality Speaker.
- Attractive Rexine Covered Cabinet.

TOTAL COST OF ALL PARTS £10.19.6 P.P. 3/6.

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NOW REDUCED IN PRICE EVEN BETTER VALUE FOR MONEY ● CALL FOR DEMONSTRATION ●

Descriptive Leaflet on Request.

6 MULLARD TRANSISTORS and Diode

ONLY 50/- PER SET
(Other matched sets in stock.)

- 1—OC44
 - 2—OC45
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 - 1—OA81
- Sub-miniature Jack Plug and Socket, 3/6 complete.
 - Mullard LA4 Pot Core complete 12/6. LA10 complete 17/6.
 - Sub-miniature 27 Mc/s 3rd Overtone Xtal for model control 30/-.
 - Personal Earphones used with RANGER 2 and 3. British made, 12/6.
 - 2 $\frac{1}{2}$ in. round $\frac{1}{8}$ deep 3 ohm speaker, 17/6.
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 - 208 + 176pF Transistor Tuner, 9/6.
 - 600 ohm Personal Ear Phone with Jack and Socket, 10/6. P.P. 9d.
 - Acos 40 Desk Mic., 19/6. P.P. 1/6.
 - 1 Watt Push-Pull Transformers for OC81 Transistors, 3 ohm, 23/- pair.
 - OA70, OA81, OA79, OA85 Diodes, 3/- each. OA91, OA95, 3/6.
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 - Crystal Lapel Microphone, ideal for portable tape recording 18/6. P.P. 1/-.


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FOR TRANSMITTING, RADIO CONTROL, OSCILLATORS, ETC.

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Crystal controlled variable frequency—Vernier Scale. As new, complete with handbook. 59/6 P.P. 2/6

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£17.10.0, Reg. P.P. 5/-

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Complete with 5 valves. In new condition. These sets are sold without guarantee but are serviceable.

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Headphones 7/6 pair. Junction Box 2/6. Throat Mike 4/6. Aerial Rod 2/6.

★ **BC221 FREQUENCY METER** ★

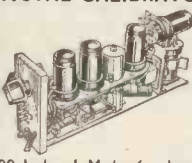
125 Kc/s to 20 Mc/s. Three valve crystal control oscillator. Used in new condition.

£16 CARRIAGE PAID

Complete with calibration charts and handbook.

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With handbook (New Condition).

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EX 1520, 1985, 1986, 1987 2-METRE MULTI-CHANNEL AIRBORNE EQUIPMENT

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FULL CIRCUIT DIAGRAMS 1/9. POST FREE

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Send today for full details of this entirely new construction system—the system which permits you to make frameworks in any size from 4 1/4" cube upwards and with a unique choice in the finished appearance.



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can be used for a multitude of purposes including chassis framework, component and instrument housing, display fittings and shelving, showcases, etc.

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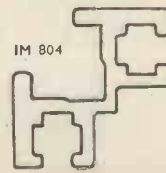
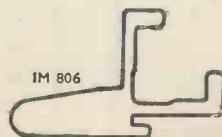
uses the established principles of the IMLOK Construction System, with die-cast aluminium connectors and a wide variety of interlocking aluminium extrusions.

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because of its range of extrusions, allows the widest possible choice of constructional methods and finishes, with extrusions for recessed panels, extrusions for glass and door frame extrusions.

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SONIC MASTER 4-TRACK TAPE RECORDER BARGAIN!!!

Complete Tape Amplifier (pre-amplifier, output stage 3 watts, oscillator and power pack).

9 x 5in. high flux density loudspeaker. Superimposing facilities, 4-track change-over switch, recording level indicator. Separate independent mic. and radio/gram inputs with mixing facilities.

Separate bass and treble controls . . . 8 gns.
Extra speaker if required (9 x 5in. high flux density) 1½ gns.

De luxe Cabinet
(to take two 9 x 5in. loudspeakers) 8 gns.

Standard Cabinet
(takes one 9 x 5in. loudspeaker) . . . 4 gns.

Latest Collaro Studio 4-track 3-speed transcripator with pause and digital counter 13 gns.

Microphone, recording leads, 1,200ft. 7in. spool and spare 7in. spool . . . 3 gns.

Complete kit, de luxe cabinet with two 9 x 5in. speakers 29 gns.

Or deposit of £10 and 12 monthly payments of £1/15/6.

Complete kit, standard cabinet with one 9 x 5in. speaker 25 gns.

Or deposit of £10 and 12 monthly payments of £1/10/6.
Post and packing extra.

TRANSISTOR TRAVELLING SUPERHET "TRABANT 6"

Transistor Travelling Superhet "Trabant T 6" Technical Data: Power supply 2 flat batteries 4.5 volts—Working voltage 9 volts max. Power consumption ca. 12.5 mA at 8 volts without modulation—Semi-conductor equipment 7 transistors, 2 germanium diodes—Receiving ranges short, medium, long wave—Station tuning planetary drive with dial scale—Circuits 7, 2 of them variable—Intermediate frequency 460 kilocycles—AVC acting on the first intermediate frequency transistor, additional attenuating diode in parallel with the first intermediate frequency circuit—LF final stage ≥ 300 mW—Loudspeaker permanent dynamic oval speaker 1 VA—Aerials ferrite aerial for medium and long wave, telescopic aerial for short wave—Housing unbreakable wooden housing coated with coloured material—Dimensions 10½in. x 7in. x 3½in. Weight with batteries approx. 5 lb. £25 only—limited quantity.



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MINIATURE LEAD ACID ACCUMULATORS

2 v. 1.5 A.H. Size 4 x 1½ x 1in. Wt. approx. ½lb., 6/6.



12 v. 0.75 A.H. Size 4 x 3 x 1½in Wt. approx. 2lb. 22/6.
BRAND NEW AND UNUSED



NEW AND UNUSED ACCUMULATORS

12 v. 75 A.H., 15 x 8 x 11in., £4/10/-. Carr. 8/6.

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12 v. 100 A.H., with carrying handle. Size 6½ x 6½ x 3½in., 15/- each. Carr. 3/6.

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6 v. 20 A.H. (as illus.), comprising three 2 v. celluloid-cased cells in wooden case. Overall size 5 x 5 x 7½in., 17/6. P. & P. 3/6.



HELLERMAN TOOL KIT. Type T.K.3. Contains sleeve expanding tool, wire stripper, 250 sleeves of assorted sizes. A must for every workshop, etc. 32/6. P. & P. 1/-.

QUALITY TEST EQUIPMENT



WAVEMETER CLASS D. Freq. band 1,900 Kc/s. to 8,000 Kc/s. (158-37.5 metres) in two ranges. 1,900 Kc/s.-4,000 Kc/s., also 4,000 Kc/s. 8,000 Kc/s. Supply 6 v. D.C. input. Complete with twin crystal, spare vibrator head phones, original instruction manual and transit case. As new £5/5/-.

UNREPEATABLE OFFER OF THE POPULAR TAYLOR VALVE TESTER Model 45A. Input 200-250 v. A.C. Will test English and American valves with filaments from 1.4 v. to 117 v. Perfect condition. Complete with full instruction manual. £10. Carr. 5/-.
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MARCONI SIGNAL GENERATOR TYPE TFS17-F/1. Covering 10-18 Mc/s., 33-58 Mc/s., 150-300 Mc/s. In very good condition. Complete with full technical data and instructions. Unrepeatable at only £12/10/-. Carr. 20/-.



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MULLARD BRIDGE. Type GM. 4140/1. Mains operated from 100-250 v. A.C. Will test resistances from 0.1 ohm to 10 megohms and condensers from 10pF to 10mfd. Good condition and complete with instruction booklet. £6/19/6. P. & P. 2/6.

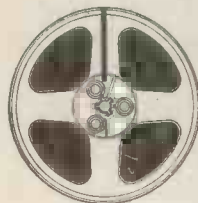
ROTARY CONVERTERS. 24 v. D.C. input. 230 v. A.C. output at 250 watts. With starting switch. New and unused £15. Carr. 7/6.

ROTARY CONVERTER. 24 v. D.C. to 230 v. A.C. 50 c/s, 150 watts. New and unused. £8/10/-. Carr. 7/6. Ditto, 100 watts £6/19/6. Carr. 7/6.

ROTARY CONVERTER. 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/-.

R.C.A. AR88-D RECEIVER Mint condition Freq. coverage 540 Kc/s., 32 Mc/s. £50. Carr. 20/-. Also L.F.s available. Freq. coverage 75-550 Kc/s., 1.5-30 Mc/s. £45. Carr. 20/-.

JUST ARRIVED! SUPER QUALITY AMERICAN "CBS" TAPES



BRAND NEW & GUARANTEED

CIP-6	600ft. 5in.	Std. Play	13/-
LP-9	900ft. 5in.	Long Play	17/6
CMXP-12	1,200ft. 5in.	Dble. Play	32/-
CIP-9	900ft. 5 1/2 in.	Std. Play	16/-
LP-12	1,200ft. 5 1/2 in.	Long Play	19/6
CMXP-18	1,800ft. 5 1/2 in.	Dble. Play	37/-
CIP-12	1,200ft. 7in.	Std. Play	21/-
LP-18	1,800ft. 7in.	Long Play	28/6
CMXP-24	2,400ft. 7in.	Dble. Play	47/-

MSS 3in. D.P. message tape 400ft. with spare spool 10/-.

Also 3in. 275ft. extra play 5/3. Limited quantity.

Many other types available including "Scotch," "EMI," "Tricon," "Syn-crotape," etc. Send s.a.e. for our huge money-saving literature on Tapes and Accessories. **ALL TAPE ORDERS BY RETURN OF POST.**

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(Ex-Govt.)

Heavy Duty 20 watts all-metal. 15 ohms. Diameter 15in., length 15in. (approx.), good cond., £6/10/- Carr. 10/- Ditto. Brand new, £8. Carr. 10/-.

SMALL MOBILE RE-ENTRANT LOUD HAILER. 15 watts, 15 ohms. Approx. 7" dia, 7" long. As new £5. Carr. 5/-.

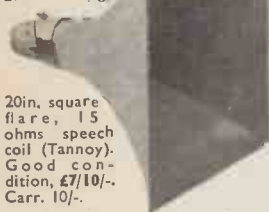
12 VOLT D.C. AMPLIFIER (Parmeko). As new, 15 watt push-pull output Mike and gram. inputs, tapped output transformer, £9/19/6. Carr. 10/6. (Hand microphone for above 30/- extra.)

TRUVOX/TANNOY LOUD-HAILERS

With 180 ohm line transformer and condenser. Impedance 7 1/2 ohms, handling capacity 8 watts. Complete in slope-front wooden case. Brand new 27/6. Carr. 4/6.

EXPONENTIAL HORNS

by famous manufacturer of P.A. systems, 15watts, 25in long.



20in. square flare, 15 ohms speech coil (Tannoy). Good condition, £7/10/- Carr. 10/-.

N&W P.M. HEAVY DUTY SPEAKERS. Complete with O.P. trans., in all steel blue-grey double grilled cabinet. 6in. 30/- Carr. 3/6 ea.

Send S.A.E. for comprehensive list of P.A. equipment for outdoor and indoor use.

50-WATT EX-GOVT. AMPLIFIER. Type III with 4KT66's in paralleled push-pull. Stannard 200-250 v. A.C. input Output imp. 600 ohms line. High imp. gram. and mike input. Bass boost control fitted. Quality amplifier housed in strong metal case ready for use. Terrific performance, £25. Carr. £1.

TELEFUNKEN STEREO HI-FI AMPLIFIER

110/250 v. A.C. input, 5 watt undistorted output (10 watts nominal) size 12 x 9 x 2in., weight 9lb. Illustrated leaflet available, our price 12/12/- carr. 5/-.

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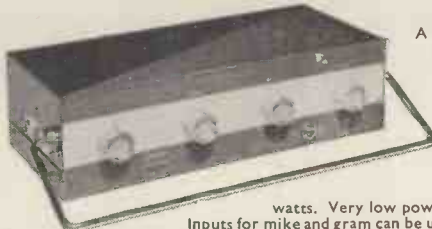
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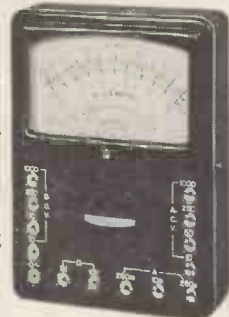
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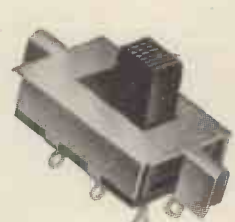
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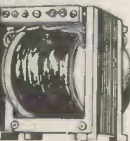




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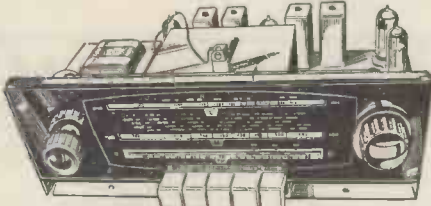
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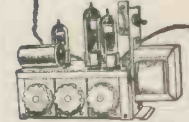


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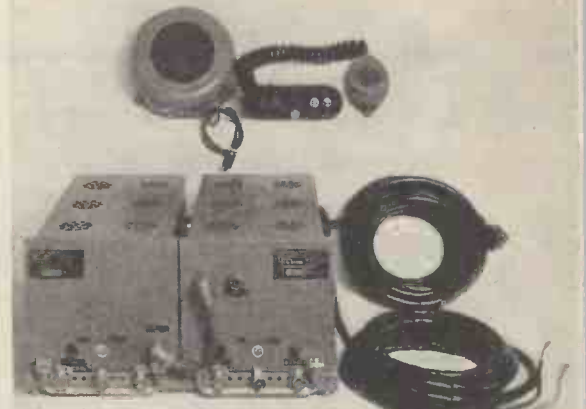
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THE NEW VERDIK SUPER TAPE RECORDING EQUIPMENT

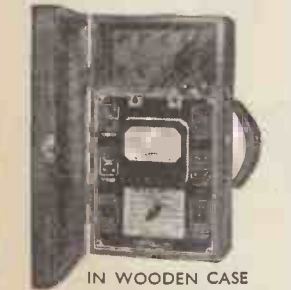
The Tape Deck using 3 motors, separate power pack included, 3 heads, 2 speed 3 1/2 and 7 1/2 I.P.S. wow and flutter better



than 2% at 7 1/2 I.P.S., integrated. 6 Valve record amplifier and playback pre-amp., magle eye level indicator, finished in grey and white stove enamel. Specially designed to feed into any HI-FI system. COMPLETE including 1,200ft. Tape and 7in. Take-up Spool, £35. S.A.E. for Detailed Specification.

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The Weston Model 779 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



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JTV2 Tuner completely assembled ready for use. £25/7/-.
FMT2. In kit form with free standing case with power pack. Including valves, £8/19/6.
FMT3. Variable tuner 58-108 mc/s. Variable AFC control dual limiters, approx. 80 mile range. Including valves, £10/19/6.
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2/6 post and pkg. on all the above. S.A.E. for details.
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10 watt push-pull ultra linear Hi-Fi amplifier with pre-amp control unit. Amplifier Valves EF86, ECC83, 2-EL84, EZ81. Sensitivity 40 M/V for 10 watts, output impedance, 4, 8 and 16 ohms, spare supply for tuner, 200/250 V., A.C. Pre-Amp. valve EF86. INPUTS Radio 100 M/V., tape 100 M/V. GRAM LP 50 M/V, 78 60 M/V. MIC 10 M/V., output socket for recording direct to tape recorder. Treble between -10 DB and +12 DB at 10 KC/S. BASS between -10 DB and +12 DB at 20 C/S. Finished in grey, green, stone enamel, control panel in gold lettering, fully guaranteed. Original price 20 gns.

OUR PRICE £14/19/6 P. & P. 7/6

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The "Fleet 6," a wow of a transistor set that really gets the stations. New design 6-transistor superhet pocket receiver, using 6 guaranteed first grade transistors plus sensitive diode, push-pull output, medium and long wave bands, new type printed circuit, high Q internal ferrite rod aerial, 2 1/2 in. high flux speaker, provision for car aerial, overall size 6 1/2 x 4 1/2 x 1 1/2. Simple to follow instructions. All components guaranteed, service after sales. This is equal to many manufactured sets at double the price. All components including cabinet, transistors, speaker, circuit, etc., only £8/19/6, complete. Post and pkg. 3/6. PP4 Battery 2/- extra. All components sold separately. Send S.A.E. for details. Circuit and Instructions 2/6 post free.



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A twin channel pre-amp. control unit, has 6 inputs for each channel. INPUT SENSITIVITY for 250 M/V or 1.5 V. output. TUNER 100 and 250 M/V. Tape 100 M/V hats 250 M/V. PICK-UP 5 and 50 M/V. Frequency response: 40 c/s. to 15 Kc/s. TAPE OUTPUT 60 M/V; continuously variable bass and treble control, loudness control and stereo balance control. Power required 6.3 V. at 1.3 amp. A.C. 350 v. at 6 M/A D.C. Will match any hi-fi amplifier. Manufacturer's price £28/10/-. OUR PRICE now £16/10/6. Carr. and packing 10/-.

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STEP 11 stereo pick up pre-amp. unit, 84/- P. & P. 2/6.
STEP 21 type pre-amp. unit, also 84/- P. & P. 2/6.



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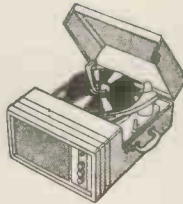
EXTENSION SPEAKERS 19'9



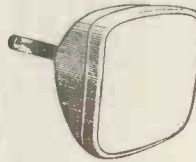
8in. P.M. Speakers fitted into polished cabinets. Complete with switch and flex. P. & P. 3/9.

RECORD PLAYER CABINET (RP4) 69'6

Luxury cabinet in two tone coffee colour. Size 15½ x 17 x 9½in. Takes all popular record player units and amplifiers. Position for 8in. speaker. Detachable lid for Stereo conversion. P. & P. 4/6d.



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15, 14, 12 in. - 70/-

1 EXTRA WITHOUT OLD BOWL, REFUNDABLE IF SAME RECEIVED WITHIN 14 DAYS.

14in. TUBES 36'24 35/-
SALVAGE PURCHASE OF GUARANTEED REPLACEMENT TUBES. Carriage 5/-.

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£7.19.6



Compact, well designed 5 valve amplifier. Output 3.5 watts. Input for Microphone, Radio and gram. Size 8½ x 3 x 4½in. Ins. Carr 4/6. 12 months guarantee. Terms available. EXTRAS:—Dial plate incl. sockets and super-impose switch, 3/6. Knobs 2/6.

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MIDGET, 220 v. 45 mA., 6.3 v. 2 a.	15/6
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7 in. x 4 in. Plessey 18/6. 10 in. x 6 in. Goodmans 27/6. 8 in. Plessey 19/6. 6 in. Rola 18/6. 8 in. Rola 21/-.

10 in. R.A. 30/-.

H.F. TWEETERS. 4 in. 25/-.

12 in. Plessey 30/-.

Plessey 15 ohms 45/-.

12 in. Baker 15 w. I.W.R. I.vart, 3 or 15 ohms, 90/-.

12 in. Baker ditto, foam suspension, 15 ohms, 26.

12 in. Baker Ultra Twelve 17/10. 20 c.p.s. to 25 k.c.s.

I.F. TRANSFORMERS 7/6 pair

495 kcs. slug tuning miniature can 1 1/2 x 1 x 1 in. High Q and good bandwidth. Data sheet supplied.

CRYSTAL DIODE G.E.C. 2/-.

GEX34 4/-. 40 Circuits 3/-.

H.E. HEADPHONES. 4,000 ohms, brand new, 15/- pair.

SWITCH CLEANER. Fluid, squirt, spout, 4/3.

TWIN GANG CONDENSERS. 365 pf. Standard with trimmers, 9/-.

Midget 7/6 with trimmers 9/-.

Single 50 pf., 80 pf., 100 pf., 150 pf., 5/6.

Solid dielectric 100, 300, 500 pf., 3/6.

VALVE HOLDERS. E.A.50, 6d. B12A, CRT, 1/3. Eng. and Amer. 4, 5, 6, 7 pin, 1/-.

MOULDED Mazds or Int. Oct. 6d.; B7G, B8A, B9C, B9A, 9d.

B7G with can, 1/6; B12A, 1/3; B9A with can, 1/9.

CERAMIC, EF90, B7G, B9A, Oct., 1/-; B7G, B9A cans, 1/-.

TELEVISION REPLACEMENT

Line Output Transformers from 45/- each, NEW stock and other timebase components

Most makes available. S.A.E. with all enquiries.

WAVECHANGE SWITCHES

2 p. 2-way, or 3 p. 2-way; short spindle 2/6

6 p. 4-way, 2 waffer, or 3 p. 11-w. 3 waffer, long spindle 6/6

2 p. 6-way, or 4 p. 2-way, or 4 p. 3-way, long spindle 3/6

3 p. 4-way or 1 p. 12-way, long spindle 3/6

Wave change "MAKITS" 1 waffer, 8/6; 2 waffer, 12/6; 3 waffer, 18/-.

Additional wafers up to 14, 3/6 each extra.

TOGGLE SWITCHES. 8.P. 2/-; D.P. 3/6; D.P.D.T. 4/-.

MORSE KEYS. good quality, with morse code, 2/6

FULL WAVE BRIDGE SELENIUM RECTIFIERS. 2, 6 or 12 v. 1 amp., 8/9; 2 a. 1/13; 4 a. 17/6; 8 a. 22/6.

CHARGER TRANSFORMERS. Tapped input 200/250 v. for charging at 2, 6 or 12 v., 1 1/2 a., 15/6; 2 a., 17/6; 4 a., 22/6.

Charger circuit free. **AMMETERS,** 4 a. and 5 a., 13/6.

THE HI-GAIN BAND 3 PRE-AMP

Cascade circuit using Valve ECC84. 17db gain. Kit 29/6 less power; or 49/6 with power pack. Plans only 6d.

Also Band 1 version same prices. (PCC84 Valve if preferred)

"REGENT" 4 VALVE

"96" RANGE VALVES

KIT PRICE £6. 6. 6.

Carr. 4/-



PRINTED CIRCUIT BATTERY PORTABLE KIT

Medium and long wave. Powerful 7 x 4 in. high Flux Speaker. T.C.C. Printed Circuit and condensers. Components of finest quality clearly identified with assembly instructions. Osmore Ferrite Aerial Coils. Resine covered attache case cabinet. Size 12 in. x 8 in. x 4 in. Batteries used B126 (L5512) and AD35 (L5040), 10/- extra. Instructions 9d. (free with kit). Mains Unit ready made for above, 39/6. Sold separately.

MONARCH RECORD PLAYER

SAVE POUNDS



BUILD IT YOURSELF USING 4-SPEED BSR MONARCH AUTOCHANGER U.A.S.

READY BUILT 3W. AMPLIFIER, HANDSOME PORTABLE CASE. HIGH FLUX 8in. LOUDSPEAKER.

FULL INSTRUCTIONS SUPPLIED.

Total Price **£12. 10. 0**

Carr. and ins. 5/-.

RECORD PLAYER BARGAINS

4 Speed Autochangers, BSR, U.A.S. £6 15 0

Collaro Autochanger £7 19 6

Garrard RC121 Mk. II £8 15 0

Garrard 209 or 210 £10 10 0

4 speed Single Players:

EMI Monaural. £6/5/- Stereo £6 19 6

Garrard TA Mk. II £8 8 0

Garrard 4 HF Transcription £17 19 6

Garrard Stereo Heads £2 extra.

Monarch

World's finest designed Autochanger



AUTOCHANGER ACCESSORIES

Suitable player cabinets (circuit boards) 49/6

Amplifier player cabinets with cut boards 63/-

2-valve amplifier and 6 1/2 in. speaker for above 79/6

Ready mounted on baffle 12 in. x 7 in., 3 in. deep.

All Sapphire styli available from 6/- each.

NEW MULLARD TRANSISTORS

Audio OCT1 6/-; OCT2 8/6; RF OC44 10/6; OC45 9/6.

"P.W." pocket size transistor kit, all parts, printed circuit and cabinet, £8/15/-.

Weyrad Printed Circuit Components in Stock. 7 x 4 in. Speaker 35d 25/-.

495 Kcs. SIGNAL GENERATOR. Total cost 15/-.

Uses B.F.O. Unit ZA 30088 ready made.

POCKET SIZE 2 1/2 x 4 x 1 in.

Slight modifications required, full instructions supplied.

Battery 7/6 extra 69 v. + 1 1/2 v. Details S.A.E.

VOLUME CONTROLS

Midget size: Long spindle. Guaranteed 1 year. All values.

5 K. ohms up to 2 Meg. No switch 3/-, D.P. Sw. 4/6 Linear or Log Tracks.

80 ohm Coaxial Cable

Semi air spaced, 1/4 in. dia. Ideal Band III **6d**

Losses cut 50% 40 yds. 17/6. 60 yds. 25/-.

FRINGE QUALITY AIRSPACED 1/- yd.

COAXIAL PLUGS 1/- LEAD SOCKETS 2/6

PANEL SOCKETS 1/- OUTLET BOXES 4/6

BALANCED TWIN FEEDER per yd. 6d., 80 Q or 300 Q.

TWIN SCREENED BALANCED FEEDER 1/6 yd., 80 ohms.

ALUMINIUM CHASSIS. 18 s.w.g. Plain, undrilled, with 4 sides, riveted corners and lattice fixing holes with 2 1/2 in. sides 7 x 4 in. 4/6; 9 x 7 in. 5/9; 11 x 7 in. 6/9; 13 x 9 in. 8/6; 14 x 11 in. 10/6; 15 x 14 in. 12/6; and 18 x 16 x 3 in. 18/6. Panels 10 x 7 in. 2/3; 12 x 8 in. 3/-; 14 x 9 in. 4/-; 12 x 12 in. 4/6.

BLACK CRACKLE PAINT. Air drying, 3/- tin.

P.V.C. CONN. WIRE, coloured, single or stranded, 2d. yd.

NEON MAINS TESTER SCREWDRIVERS, 5/-.

CORED SOLDER RADIOGRADE, 4d. yd., 1lb. 5/-.

FAXOLIN 1/16in. x 8 in. x 10 in., 1/6.

AMERICAN MAGNETIC RECORDING TAPE FERRODYNAMICS "BRAND FIVE"

5in. 600 feet	16/-	MYLAR DUPONT	
5in. 900 feet	18/6	Super High Fidelity	
3 1/2 in. 1,200 feet	23/6	Double Play	
7 in. 1,200 feet	25/-	5in. 1,200 feet	37/6
7 in. 1,900 feet	35/-	7 in. 2,400 feet	60/-

Illustrated leaflet S.A.E.

Spare Reels 3 in. 1/6; 4 in., 5 in., 5 1/2 in., 7 in., 2/-.

"Instant" Bulk Tape Eraser and Head Defuser. 20/6

250 v. A.C., 27/6. Leaflet S.A.E.

RECTIFIERS. RM1 5/-; RM2 6/-; RM3 8/-; RM4 16/-; RM5 20/-; FC31 27/6; 14A88 17/6; 14A100 21/-.

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 75 mA. 12/6; 120 mA. 15/-.

COILS. Weirite "P" type 3/- each. Osamor Midget "Q" type add 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.

Ditto for transistors. M. & L. 10/-.

T.R.F. COILS. A/HF 7/- pair. H.F. CHOKES 2/6.

JASON F.M. TUNER COIL SET 29/-. H.F. coil aerial coil. Oscillator coil two I.F. transformers 10.7 Mc/s. Detector transformer and heater chokes. Circuit and component book, using four 6AM6 2/6. Complete kit FMT1 with Jason Calibrated dial and 4 valves, 26/5/-, or with New Jason Cabinet FMT2, £2 extra.

CONDENSERS. New Stock. .001 Mfd. 7 kv. T.C.C. 5/6; 20 kv. 9/6; 1 mfd. 7 kv. 9/6; 100 pf. to 500 pf. Micas, 6d. Tubular 500 v. 0.001 to 0.05 mfd., 9d.; 0.1, 1/-; 0.25, 1/6; 0.5, 1/9; 0.1/350 v. 9d.; 0.1/1,000 v. 1/9; 0.1 mfd. 250 v. 3/6; 0.001 mfd., 2.00 v., 1/9; 500 pf. 20 kv. 9/6.

CERAMIC CONDS. 500 v. 3 pf. to 0.01 mfd., 9d.

SILVER MICA CONDENSERS. 10% 5 pf. to 500 pf. 1/-; 600 pf. to 3,000 pf., 1/3.

CLOSE TOLERANCE (1± pf.) 2 pf. to 47 pf., 1/6. DITTO 1% 50 pf. to 815 pf., 1/9; 1,000 pf. to 2,000 pf., 2/-.

TRIMMERS. Ceramic 30, 50, 70 pf., 9d.; 100 pf., 1/6; 150 pf., 1/3. 250 pf., 1/6. 600 pf., 750 pf., 1/9. Philips, 1/- ea.

NEW ELECTROLYTICS. FAMOUS MAKES

TUBULAR	TUBULAR	CAN TYPES
1/300 v. 2/-	50/350 v. 5/6	16/450 v. 5/-
2/350 v. 2/3	100/25 v. 2/-	32/350 v. 5/-
4/450 v. 2/3	250/25 v. 2/6	100/270 v. 5/6
8/450 v. 2/3	500/12 v. 3/-	5,000/6 v. 5/-
8/500 v. 2/9	8+16/450 v. 3/6	16/450 v. 5/-
16/450 v. 3/-	8+16/450 v. 3/9	32+32/350 v. 5/-
16/500 v. 4/-	8+16/500 v. 5/6	32+32/450 v. 6/-
32/450 v. 3/9	16+16/450 v. 4/3	50+50/350 v. 7/-
25/25 v. 1/9	16+16/500 v. 6/-	64+120/350v. 11/6
50/250 v. 2/-	32+32/350 v. 4/6	100+200/275v. 12/3

SUB-MINIATURE ELECTROLYTICS (15 v.)

1, 2, 4, 5, 8, 25, 50 mfd., 100 mfd., 2/6 each.

SPEAKER FRET. Gold Cloth 17 in. x 25 in., 5/-; 25 in. x 35 in., 10/-; Tygan 52 in. wide, 10/- ft., 26 in. wide 5/- ft. Green or Red. Other colours. Samples S.A.E.

NEW and boxed VALVES 90 day guarantee

1R5	7/6	6L6G	10/6	EASO	1/6	EY51	9/6
1R5	5/6	6N7M	6/6	EACB80	8/6	EY86	10/-
1T4	6/-	6Q7G	7/6	EB91	6/-	EACB80	12/6
2X2	3/6	6SA7M	6/-	EB33	3/6	HYR2A	6/6
3X4	7/6	68J7M	6/6	EB41	8/6	MU14	8/-
3V4	7/6	68N7	6/6	EBF80	10/-	P61	3/6
5Y4	7/6	6V6G	6/6	ECC84	9/6	PCC84	9/6
5Y3	7/6	6X4	7/6	EFC90	9/6	PCF80	9/6
6X4	9/6	6X5	6/6	ECH42	10/6	PCL82	11/6
6X6	5/-	12A6	7/6	ECL80	10/6	PEN35	6/6
6BE6	7/6	12A7	8/-	ECL82	10/6	PL82	10/6
6BH6	9/6	12AU7	8/-	EP39	5/6	PY80	7/6
6BW6	9/6	12AX7	8/-	EP41	9/6	PY81	9/6
6D6	6/-	12BA6	8/6	EP50	5/6	PY82	7/6
6FG6	7/6	12BE6	8/6	EP80	8/-	SP61	3/6
6HG0T	3/6	12E7	6/6	EP88	12/6	UC41	9/6
6J6	5/6	12Q7	6/6	EP92	6/6	UCH42	9/6
6J6	5/6	35L6	9/6	EL32	5/-	UP41	9/6
6G7G	6/6	35Z4	7/6	EL41	9/6	UL41	9/6
6K6GT	6/6	80	9/6	EL84	8/6	UY41	8/-
6K7G	5/-	807	5/6	EZ40	5/6	UZ2	8/-
6K8G	7/6	954	1/6	EZ80	7/6	UZ2	7/6

DK36, DA96, DF96, DL86 8/6 ea. 30/- act.

RADIO COMPONENT SPECIALISTS

48-HOUR MAIL ORDER

337 WHITEHORSE RD. WEST CROYDON

POSTAL SERVICE 1/-, OVER £2 FREE, C.O.D. 1/6. (EXPORT C.W.O. POST EXTRA.) Wed. 1 p.m. THO 1665 Buses 133 or 69



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THE WALTER TRANSISTORISED BATTERY/MAINS PORTABLE TAPE RECORDER

An Outstanding Bargain Offer!

NOW ONLY **27 GNS** ORIGINAL PRICE **55 Gns.**
P. & P. £1

A truly Portable Tape Recorder having all the portable advantages of a battery operated Recorder and still retaining the Hi-Fi quality of the most expensive mains operated types. This Hi-Fi perfection is maintained whether the Recorder is used on battery or on mains. No longer need you be restricted to indoor recordings for with this machine you can record and play back wherever and whenever you wish. Recordings made with the machine on battery operation maintains the Hi-Fi quality when played back on mains. These machines are supplied complete with Microphone, Mains Lead and all necessary accessories, they are brand new in manufacturers' original cartons.



STAR FEATURES

- ★ 7-stage built-in Amplifier with separate bias oscillator and record level indicator. Push-pull output stage with negative feedback. Also separate feedback equalisation.
- ★ Full size 3-watt undistorted output.
- ★ 7 x 4in. High Flux Elliptical Speaker.
- ★ Large 5 1/2in. Spools.
- ★ 3 1/2 i.p.s. Tape speed.
- ★ Revolution Counter.
- ★ Mixing facilities.
- ★ Superimpose facilities.
- ★ Safety device on record (preventing accidental erasure).
- ★ Volume On/Off & Tone Controls.
- ★ Magic Eye Tuning Indicator.
- ★ Overall dimensions: 14 x 13 1/2 x 5 1/2in.
- ★ Weight 17 1/2 lb. (less Batteries).

In fact, all that could be desired of a Portable Tape Recorder. For use on 200/250-v. A.C. Mains 50 cycles. Or 3 Ever Ready PP9 9-v. Batteries or equivalent (Batteries Extra) SEND NOW FOR FULL DESCRIPTIVE LITERATURE

4-SPEED PORTABLE SINGLE PLAYER



MAY BE BUILT FOR ONLY **9 GNS** Plus 6/6 P. & P.

Consisting of:
The new EMI 985 4-speed single Player £4 9 6
2 valve Printed Circuit Gram. Amplifier £2 15 0
8in. x 2 1/2in. Elliptical Speaker £1 1 0
Portable Case finished All Items available separately if required.

refine covered red and white polka dot £1 1 0

TRANSISTORISED BATTERY AMPLIFIER



This exceptionally reliable 4-transistor printed circuit Amplifier is designed with full use of package components. It is complete with volume and tone control and will mount into almost any type of Cabinet, operating on a 9-volt Battery and giving an output of 1 watt. Specifications: sensitivity 120 millivolts 3dB for 50 milliwatts output, sufficient for lowest sensitivity Crystal Pickup, frequency response 50 cycles to 10 Kc., input impedance 330 K. ohms minimum, negative feedback 6dB average. Loudspeaker impedance required 20 ohms size 6 1/2 x 3 x 1 1/2in.

PRICE **89/6** incl. 8in. x 2 1/2in. 20 ohm speaker. Plus 2/6 P. & P.

introducing The NEW EMI 985 4-SPEED TURNABLE UNIT COMPLETE WITH PICK-UP

PRICE **89/6** Plus 3/6 P. & P.

An extremely reliable and inexpensive Unit suitable for Record Players and Radiograms, a heavy 8 1/2in. dia. Metal Turntable with low flutter performance, 5-position Switch, 4 speeds and off. Ivory finish with red T/T mat.

9 volt Battery-operated version available, identical to the above unit in appearance, £5/9/6, plus 3/6 P. & P.



BARGAIN OFFER!



A COMPLETE SELF-POWERED

FM TUNER

MAY BE BUILT FOR ONLY **£4.19.6** Plus 4/6 P. & P.

This tuner has been designed to the highest possible modern standards with all the features found only in the more expensive Units and yet still within a price range that all can afford. No extras required.

STAR FEATURES

- ★ Self powered
- ★ EM84 Magic Eye Tuning Indicator
- ★ Permeability Tuning
- ★ Philips FM Tuning Unit
- ★ Absolutely no drift
- ★ Frequency coverage; 88-100 mc/s.
- ★ Two IF Stages and Discriminator
- ★ OA 81 balanced diode output
- ★ Valve lineup: ECC85, 2-EF80, EZ80 Rectifier, EM84 Magic Eye.

Attractive full vision maroon and gold Glass Dial size 7in. x 3in., overall dimensions of Tuner 8 x 7 1/2 x 5 1/2in.

THE 'MID-FI'

A NEW DESIGN 4 1/2 WATT AMPLIFIER

KIT 95/- Plus 3/- P.P.

BUILT £6 POST PAID



A new circuit for the home constructor requiring a good quality medium-powered Amplifier for reproduction of Records or F.M. Broadcasts. Technical Specifications: separate bass and treble controls. Valve line-up EF86, EL84, EZ80. Voltage adjustment for A.C. mains from 200/250 volt. 3 or 15 ohm impedance. Negative feedback. Size 7 x 5 x 2 1/2in., overall height 5 in. Silver-hammered finished Chassis.



The SUPER 60

6-Transistor Battery Receiver

MAY BE BUILT FOR **£9.15.0** Plus 4/6 P. & P.

Ever Ready Battery PP10 Extra 11/-

STAR FEATURES—

- ★ Six 1st grade Mullard Transistors and one Diode.
- ★ Internal Ferrite Rod Aerial.
- ★ 7in. x 4in. Elliptical Speaker.
- ★ Printed Circuit.
- ★ 500 mW Push-pull output.
- ★ Full medium and long waveband coverage.
- ★ Calibrated Direct Drive Dial Drive Assembly.
- ★ Full point-to-point instructions supplied. Dimensions 16in x 7in. x 5in.

The Receiver is housed in an attractive contemporary mahogany finished cabinet trimmed with gilt, supported by gilt stands.

The Receiver will operate for months on one 9-volt long-life battery. Instruction Book separately at 2/6 p.p.

INTRODUCING THE TELEFUNKEN STEREO HI-FI AMPLIFIER



Original Price £16/19/6

Now only £9/19/6

P & P 5/-

At last perfection is now within the reach of all. This unique Amplifier has been designed to revolutionary Standards, both in appearance and technical design and backed by the full technical resources of Telefunken.

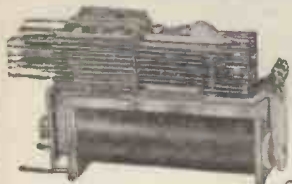
- Brief specifications:
- Power Output 5 Watts total (2 1/2 watts per channel).
 - Frequency Response 30 c/s to 40 Kc/s 2dB. 45 c/s to 30 Kc/s 1dB.
 - Total harmonic distortion less than 1% at 1 watt output.
 - Sensitivity Sufficient for all normal inputs from Tape Recorders, Pick-ups, Microphones Radios.
 - Power Requirements 110, 125, 150, 220, 240 volts A.C.
 - Piano key selecting.
 - Preselected tone control.
 - Size 12in. wide x 9in. deep x 2in. high.
 - Weighs 9 lbs.
 - Finish: Hammered enamel in grey/green with gold trimmings, Controls and press buttons in cream with black, blue and red lettering.
- Specially designed output transformers have been used having an extremely high transfer efficiency therefore delivering a far greater output to the speakers.

Wilkinsons

EST. 1921

RELAYS P.O. TYPE 3000

Built to your own specification
Keen Prices
Quick Delivery
Contacts up to 8-Changeover
KEY SWITCHES
Various P.O. types ex stock.

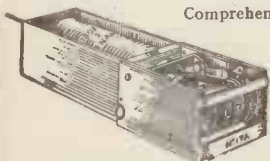


MINIATURE RELAYS

Siemens High Speed Sealed
2.2Ω + 2.2Ω H96A 15/6
500Ω + 500Ω H96D 22/6
1700Ω + 1700Ω H96E 25/-
Siemens High Speed Open
100Ω + 100Ω H85N 15/-
1000Ω + 1000Ω H95A 17/6

S.T.C. and G.E.C. Sealed
700Ω 2 C.O. 4184GD 19/6
2500Ω 1 m HD 4186EE 22/6
180Ω 2 m 2 b M1087 19/6
670Ω 4 C.O. M1092 21/6
670Ω 2 m 2 b M1095 21/6
2500Ω 1 C.O. M1022 22/6
5000Ω 2 C.O. M1052 25/-

Comprehensive range available from stock.



MAGNETIC COUNTERS

Counting to 9999.
2-6 v. D.C., 15/- each, post 1/6.
75-120 v. D.C., 15/- each, post 1/6.
HIGH SPEED TYPE No. 100c.,
100-120 v. D.C., 35/-, post 1/6.

ROTARY CONVERTER. Input 24 v. D.C. Output 220 v. A.C. 250 watts. Pedestal type with D.P. Ironclad switch. BRAND NEW, £17/10/-, carr. 15/-.

ROTARY CONVERTERS. Input 12 v. D.C. Output 230 v. A.C. 50 cy. 135 watts. The ideal job for T.V. and tape recorders where A.C. mains are not available, £8/10/-, carr. 10/-.

BATTERIES. Portable Lead Acid type, 6 volts 125 ampere hours. In metal case 16in. x 8in. x 11in. (Two will make an ideal power supply for our 12 volt Rotary Converters). Uncharged £6/10/- each, carriage 15/-, 24 volts 85 ampere, £14 each, carriage 15/-.

NIFE BATTERIES. Nickel Cadmium, 6 volts 75 amp. Crated and connected. Brand new £7/10/-, carr. 15/-.

WESTLITE BATTERY CHARGERS. Made by Westinghouse (type BC14-6/40). Input 200/250 v. A.C., will charge 6 volt or 12 volt batteries at 0/40 amps. Coarse control switch with eight positions and fine control switch with four positions including "off." Built-in 0/50 ammeter. Fused A.C. and D.C., grey enamel finish, dimensions 24in. x 14in. x 13in. £45 each.

15 AMP. BATTERY CHARGER (Westinghouse Type B.C.3) will charge three lead acid cells at 15 amps. Input 200/250 volts, 50 cycles A.C. Charging current is regulated by four-position switch and variable resistance for fine control. Fitted with 0/20 ammeter, rotary on/off switch and rewirable fuses. This first-class instrument at the bargain price of £16, carriage 15/-.

TELEPHONE SET TYPE "A." Ringing and speaking both ways on a four-core cable. Carries the voice loudly and clearly over any distance. Two handsets are supplied as illus, and the set is comp. with Pushes, Buzzers, Battery, Plugs and Sockets. Suitable 4-core PVC cable 10d. per yd. Price 75/- set, post 3/6.

TELEPHONE SET TYPE "K." The most compact telephone set available as the 4 1/2 in. flat battery and buzzer is built-in to the hand instrument. Ringing and speaking both ways on twin wire. Instrument is complete with 5ft. flex. Easily hangs on the wall. Set of two instruments, £5/10/-, post 3/6. Two core flex 3d. yard.

FANS INDUSTRIAL TYPE. 230/240 volt A.C. Capacitor Motor, 16in. blades, adjustable louvres, filter. Ideal for paint shop. Brand new, £20, carr. 25/-.

AIR BLOWER powered by a 230 v. A.C. motor, 15in. fan. Volume of free air at max. r.p.m. is 1,250 cu. ft. per min. At maximum efficiency 900 cu. ft. per min. Brand new £25, carriage 30/-.

AUTO CABLE waterproof. Single. 14/36. 20/- per 100 yds., post 1/6.
PUMP Electrically Driven by a 24 v. D.C. motor. Works efficiently on 12 v. Totally enclosed, self-lubricating, driven through 4 to 1 reduction gearbox delivering 60 g.p.h./30lb./sq. in. Inlet and outlet unions 1/2 BSP 37/6, post 2/6.

CERAMIC WAFER SWITCHES. Full list available.
1 Bank 1 pole 3-way .. 4/6 each 2 Bank 2 pole 4-way 10/6 each
1 Bank 1 pole 5-way .. 5/6 each 3 Bank 1 pole 11-way 18/- each
1 Bank 2 pole 2-way .. 5/6 each 3 Bank 6 pole 2-way 7/8 each

1/4 H.P. CAPACITOR MOTORS

230/240 volts, 50 cycles, 1420 r.p.m. 1/4 in. shaft on Standard foot mounting or with 3/4 in. shaft, resilient mounting. Either type, £5/10/-, carriage 10/-.

VACUUM PUMP AND COMPRESSOR. Edwards type IV, 1/4 in. shaft, complete with flywheel, couplings, oil filter and union, £6/10/-, post 3/6.

METERS GUARANTEED

F.S.D.	Size	Type	Price
100 Microamp	3 1/2 in.	MC/FR	80/-
50 Microamp	2 1/2 in.	MC/FR	75/-
250 Microamp	2 1/2 in.	MC/FR	40/-
500 Microamp	2 1/2 in.	MC/FR	37/6
1 Milliamp	2 1/2 in.	MC/FR	35/-
2 Milliamp	2 1/2 in.	MC/FR	25/-
30 Milliamp	2 1/2 in.	MC/FR	25/-
100 Milliamp	2 1/2 in.	MC/FR	25/-
1 Ampere	2 1/2 in.	MC/FR	35/-
3 Ampere	2 1/2 in.	MC/FR	35/-
5 Ampere	2 1/2 in.	MC/FR	35/-
10 Ampere	2 1/2 in.	MC/FR	35/-
20 Volts	2 1/2 in.	MC/FR	35/-
30 Volts	2 1/2 in.	MC/FR	35/-
40 Volts	2 1/2 in.	MC/FR	35/-
500 Microamp	2 1/2 in.	MC/FR	25/-
1 Milliamp	2 1/2 in.	MC/FR	27/6
5 Milliamp	2 1/2 in.	MC/FR	27/6
10 Milliamp	2 1/2 in.	MC/FR	27/6
20 Volts	2 1/2 in.	MC/FR	27/6
30 Volts	2 1/2 in.	MC/FR	27/6
40 Volts	2 1/2 in.	MC/FR	27/6
15 Amps	2 1/2 in.	MC/FR	15/-
3 Amps	2 1/2 in.	MC/FS	27/6
5 Amps	2 1/2 in.	MC/FS	27/6
30-0-30 Amps	2 1/2 in.	MC/FR	17/6
50-0-50 Amps	2 1/2 in.	MC/FS	17/6
500 Milliamps A.C.	3 1/2 in.	MI/FR	40/-
25 Amps D.C.	2 1/2 in.	MI/FR	7/6
50 Amps A.C.	4 1/2 in.	MI/F or PR	65/-
300 Volts A.C.	2 1/2 in.	MI/FR	25/-



Postage on meters 1/6



New Taylor pocket-size Multimeter Model 127A, 20,000 ohms per volt, 20 megohms, 20 ranges. A.C. & D.C. 110. Post 2/6. Complete list of meters available.

FREQUENCY METERS. 45-55 cycles per second, 230 volts, 6in. dia. Flush Round. Brand new in maker's box. £10/10/-, post 3/6.

METER RECTIFIERS 1 M.A., 5 M.A., F.W. bridge, 8/6, post 6d.

AMMETER. 0-3 amp. D.C., by Turner, MC/FR, 6in. 90/-, post 2/6.

MICROAMMETER. 250 F.S.D. 3 1/2 in. F.R. Sangamo Mod. 537. Scaled for valve voltmeter. Circuit available free, 55/-, post 1/6.

UNI-PIVOT GALVANOMETER, by Cambridge Instruments, 50-0-50 microamps, dia. 4in. Knife pointer, mirror scale. Complete with leather carrying case. Ideal for laboratory use, £10, carriage 3/-.

PORTABLE VOLTMETER. 0-160 volts A.C./D.C., accuracy within 2%, 8in. mirror scale, knife pointer, in polished case. A precision moving iron instrument at a very low price, £4/19/6, post 3/6.

PORTABLE AMMETER. 0-3 amp. A.C./D.C. 3in. scale in case with handle, 35/-, post 2/6.

AVO TEST BRIDGES. 220/240 volt A.C. Measure capacities from 5 pf. to 50 mfd. and resistances from 5 ohms to 50 megohms. Valve voltmeter range 0.1 to 15 volts and condensers leakage test, £9/19/6, post 3/-.

RACKS—POST OFFICE STANDARD. 6ft. high with U-channel sides drilled for 19in. panels, heavy angle base.

SLYDLOK FUSES. 15 amp with rewirable cartridge fuse. Latest type G15 M.M. Complete with studs, nuts and washers, 3/6 each, post 6d. Also available 100 amp., type M.M. G 99, 14/6, post 1/-.

T.C.C. CONDENSERS. Paper block type, 6 mfd. 400 v. A.C. wkg., 12/6, post 2/6. 1 mfd., 10 kv. 65/- each. All types of condensers available—send for list.

RESISTORS EX STOCK IN QUANTITY. WIRE WOUND, HIGH STABILITY CARBON, ETC., BEST MAKES AT LOWEST PRICES ALSO POTENTIOMETERS AVAILABLE

AMAZING OFFER!!
POWERFUL 6-12 v.D.C.
MINIATURE MOTORS.
OFFERED AT A FRACTION OF MAKERS PRICE

MINIATURE PRECISION MOTOR, 12 v. D.C. Size 1 1/2 in. x 1 1/2 in. diam. Latest development. Extremely powerful with low consumption. Weighs as little as two ounces and totally enclosed in polythene protective case. Three-position switch: forward, reverse

and stop. 7,000 r.p.m., self-lubricating and long life sintered bronze bearing, 15/6, post 9d. Ask for free length of polythene flexible drive.

ATTENTION ALL MANUFACTURERS. ONE-HOLE FIXING SWITCHES. Single-pole changeover, 3 amp., 250 volts A.C. 1/6 each, 12/- doz., £37/10/- per 1,000. Ask for quotation for 5,000 or upwards. 100,000 available from stock now!

SOLENOIDS suitable for remote control, mechanical indicators, etc. 12 v. D.C., 400 mA., 30Ω, 3 1/2 in. arm, 1/2 in. movement, 5/- each, post 1/6.

TERMINAL BLOCKS. 2-way 4/- doz., or box of 50 for 15/-, 3-way 6/- doz., 50 for 22/6, post 1/6.

HEAVY DUTY SWITCHES suitable for switchboards. Carries over 100 amps. Consists of 2 S.P.C.O. coupled, 50/- pr., post 3/-, or separately at 25/-, post 3/-.

SATCHWELL THERMOSTATS adjustable between 70°-190° Fahrenheit. 0-440 v. A.C., 20 amps., 1 1/2 in. stem. Fitted cover, 25/-, post 2/6.

ROOM THERMOSTAT. Adjustable between 45° and 75° Fahr., 250 v. 10 amp. A.C. Ideal for greenhouses, etc., 35/-, post 2/-.

GATHODE-RAY TUBES. VCR 139A, 2 1/2 in. diam., 30/-, post 3/-.

BARTLETT ELECTRIC DRYING OVENS. Internal dimensions 20in. x 20in. x 20in. 230 volt A.C. with adjustable thermostat giving automatic temperature control. Temperatures up to 160° shown on built-in gauge. Rotary on/off switch with pilot lamp. Brand new, £40.

L. WILKINSON (CROYDON) LTD.

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Phone: CRO 0839 Grams: WILCO CROYDON

TESTGEAR COMPONENTS (LONDON) LTD

15 ARCANY ROAD, SOUTH OCKENDON, ESSEX.

TEL: AMBassador 1958

The enormous response to our recent advertisements has overloaded our despatch organisation. To our many customers who have patiently endured the delays, we offer our apologies. The situation is being rapidly improved and we hope to have an opportunity of serving you again.

OFFICE DICTATING MACHINES

An obsolete type but the biggest bargain ever. Contained in portable carrying case, wind-up double spring clock-work motor, 4-valve oscillator amplifier (B7G type valves), 6-minute play recording mechanism using magnetic plastic discs that may be re-used indefinitely. Complete with crystal mike that doubles as playback speaker. Send for full details. Complete with 10 discs (extras 1/6). Price £33/-. Batteries (67½ & 6v.) 10/6 extra

POT CORES

Mullard Vinkor complete assembly type LA2509. Build your "Q" Multiplier with this and obtain a "Q" of over 4,000. Price 12/6.

DYNAMOTORS

Hoover No. 2. Input 12v. Output 600 v. 250 mA. Price 45/-.

Type 1520. Input 26 v. Output 288 v. 165 mA. and 50 v. 50 A. Has a magnetic clutch and 480-1 stepdown gear box. May be used as a mains motor. Price 10/-.

Type APN1. Input 28 v. Output 275 v. 65 mA. (command type). Price 7/6.

ELECTROLYTIC CONDENSERS

New Perfect Goods at Bargain Prices. Reductions for Quantities.

Cap.	Wkg. volts	Size	Fitting	Price
500	6	5/8 × 1 1/4	Clip	1/-
8	450	3/4 × 2	Clip	1/-
100	15	3/8 × 1 1/4	Wire End	1/-
50	25	3/8 × 1 1/4	Wire End	1/-
50	350	1 × 3	Clip	1/-
40/40	150	1 × 2	Clip	1/6
16	450	7/8 × 2	Clip	2/-
50	50	3/8 × 1 1/4	Wire End	1/-
50/30	150	1 × 2	Wire End	1/-
50/30/20	150/150/25	1 1/2 × 2	Wire End	1/6
500	12	3/8 × 1 1/4	Clip	1/-
16	350	3/4 × 2	Clip	1/-
50/50	275	1 × 3	Clip	1/6
50	12	3/8 × 1	Wire End	1/-
1600	12	3 × 1 1/4	Clip	1/6
250	50	2 1/2 × 1 1/4	Clip	1/6

SUB-MINIATURE ELECTROLYTIC CONDENSERS

Capacity in Mfd.	Working voltage	Size
.25	15	1/10 × 15/32in.
3.2	70	3/16 × 23/32in.
20	15	1/4 × 25/32in.
10	15	3/16 × 23/32in.
8	3	1/8 × 21/32in.

PRICE (all types): 1/-.

TRANSISTORISED

D.C.-D.C. CONVERTER KITS

Type (1). Input 12 v. Output 300 v. or 250 v. or 200 v. at 30 w. A complete kit of parts incorporating high-grade toroid transformers, silicon (bridge) rectifiers, New Market V30/10P transistors. Full audio and R/F filtering to V.H.F. Operating frequency 400 c. Efficiency 85%. All component parts mount on heatsink which is supplied completely drilled. Size 5 × 4 × 3in. H. Price: £5/15/-.

Type (2). As above but output 45 w. Uses OC35 transistors. Price: £6/17/6.

50 MICROAMP METERS

Made by Sangamo Weston. Brand new. Type S.145. Size 3 × 2 1/2in. 850 ohms resistance. Four scales operated by lever "Set Zero" "0-3" "0-300." Easily coupled to rotary range switch by cord or lever. Complete with suggested circuits, a gift at 20/-.

Terms of Business. All prices include postage or carriage. Handling charge of 1/6 on orders under 10/-.

Payment cash or C.O.D. over £1. Export orders welcomed.

METER BOXES

A range of attractive useful Meter Cabinets that can be supplied ready punched to take above meter. Useful for all kinds of testgear: a quality job with fully-formed pressed steel lids, welded construction, grey hammer finish enamel. Price: 4 × 5 1/2in. Panel in depths of 2in., 3in. or 4in., 10/3, 10/9 and 11/3 respectively, or with 4 1/2 × 7 1/2in. panels, 12/-, 12/9 and 13/-. Available punched to take above meter 1/6 extra.

MOBILE RADIO TELEPHONES

Type B.44 Mk. 2 covers 60-95 Mc/s. Crystal controlled. Receiver is crystal controlled double superhet. Fully tropicalised, in robust waterproof aluminium case, built-in speaker and 12 v. power supply. Uses modern B7G tubes. Output 3 watts. Supplied in perfect order and aligned to your specified frequency. Size 14in. wide., 7in. high, 13in. deep. Complete with manual and plugs. Price: £20 carr. paid U.K. or F.O.B. London. Extras required are M/C microphone. Price 17/6. Pair of crystals (our selection in 4-metre band). Price 22/6, or supplied to your specified frequency £6. Available for amateur use or export only.

SILICON RECTIFIERS

Sub-miniature silicon power diodes at new low prices. Made by one of England's greatest manufacturers. 250 mA. D.C. output. Type (1) 400 P.I.V. Price 3/6. Type (2) 600 P.I.V. Price 5/6. Type (3) 800 P.I.V. Price 7/6.

NUVISTORS

Now available, the R.C.A. 6CW4 at a new low price. The hottest front end tube for 2 metres. Price 12/6 each. Write for details of kits using these amazing tubes.

PIEZO ELECTRIC CRYSTAL ELEMENTS

Originally made for Crystal Pick-ups. Flying lead connections. Type (1). Size 3/4 × 1/5 × 1/20in. thick. Price: 4 for 2/6. Type (2). Size 1 1/4 × 1 1/8 × 1/5in. thick. Price 2/- each.

TYPE 46 TRANSCEIVERS

The best bargain for many years. These fine Walkie Talkies are now available in new condition complete with all accessories at a give-away price. 3-channel Crystal controlled T/X and R/X, supplied complete with one pair crystals, coil box, rod aerial, leads and plugs, valves, balanced armature headset with throat mike and carrying satchel. 1 watt output. Coverage 3.6-4.3 Mc/s. or 6.4-7.6 Mc/s. by means of plug-in coil box. Inland buyers supplied with crystals in 3.5 or 7 Mc/s. band (state which required), other frequencies available for export. Requires only 150 v., 15 v. and 3v. dry battery. Range over 10 miles. Full instructions and circuit supplied. These units have been "demobbed" by removal of the "Send Receive" switch. A replacement switch with fitting instructions is supplied. We offer this fine unit with all accessories as listed above at the ridiculous price of 30/- or two for 57/6. We will supply an extra 46 set, complete with valves (but no accessories) as a source of spares for only 7/6 extra. Batteries are available at 18/6 per set. A low-priced transistorised kit of parts for operation of above from 6 v. or 12 v. D.C. will soon be available.

CRYSTALS

FT.241 72nd Harmonic Type. 120 crystals with fundamentals from 370 Kc/s. to 540.277 Kc/s. in steps of 1.388 Kc/s. (channels 270-389). From 448.611 to 472.222 inclusive and 500 Kc/s. Price is 7/6. All others 2/6 each or 6 for 10/- for any six consecutive channels. Special quotations for other assortments.

A.C. RELAYS

Magnetic Devices 230 v. 50 c. Operated. D.P.C.O. 1 amp. contacts. Price 15/-.

If you have ever written to us you will receive a copy of our comprehensive list within a few days, if not, then please let us have your name and address.

NEW! MINIATURE PANEL METERS



Precision built clear plastic miniature panel meters. Featuring d'Arsonval movements, jewelled bearing, silvered dials with black numerals and pointers. Accuracy 2% of full scale. 1.21/32in. square fronts, 1/4in. overall front to back. Require 1/4in. diameter round hole in panel. All have clear plastic fronts with zero adjustment screws.

"S" METER MODEL SR. 2P. Standard "Ham" signal strength indicator. Calibrated in "S" units from 0-9 with scale terminating in +10 to +30db calibrations. Additional full scale calibrations of 0-5 +0-10 in linear scale divisions. A "must" for radio amateurs for conversion of any Communication Receivers with AVC action to give calibrated signal strength action. 35/-

VU METER MODEL VR. 1P. Calibrated and damped in accordance with standard VU Meter Practice. Upper scale reads -20 to +3VU. Lower scale reads 0-100% modulation. Uses precision carbon film multiplier resistor and full wave rectifier. 42/6.

MICROAMMETERS, Model MR. 25. 0 to 50μA. 39/6.

Model MR. 250. 0 to 500 μA. 32/6.

DC MILLIAMMETER Model MR. 21. 0 to 1 mA. 27/6.

All Models Individually Boxed and Fully Guaranteed. P. & P. 2/6 each.

TELEPHONE PICK-UP COILS



MODEL FC-8 Induction Pick-up coil enabling conversations to be picked up without tapping of wires or special telephone circuits. Simply place telephone on the pick-up platform and connect lead to the input of any medium gain amplifier or direct to any tape, disc, or wire recorder. Brand new complete with 5ft. shielded cable. Requires no Electrical connections—offers virtually unlimited use. ONLY 16/-. P. & P. 1/6.

A.R. 88D RECEIVERS

Frequency coverage 550 kc/s to 32 Mc/s perfectly fully reconditioned and in perfect working order. ONLY £35. Carr. 30/-.

LAPEL MICROPHONE 178



Precision engineered Crystal Microphone—for lapel or hand use. Only 1/4in. dia. Exceptionally sensitive. Chrome-plated case and clip. 5ft. shielded cable, Only 17/6. P. & P. 1/-.



PORTABLE MAINS SOLDERING IRON S.P.1.

30 watt. Designed for lightweight applications. High stable heat characteristics assure long life and safety in use. Features a removable handle that may be used to cover the tip and barrel to permit the iron to be carried safely even while hot. Complete with vinyl bag, mains lead and plug. 18/9. P. & P. 1/3.

NEW DYNAMIC MICROPHONE

Model DM-175. Beautifully designed and attractively finished lightweight, complete with stand. Output Imp. 1K ohm, freq. response: 150-9,000 c.p.s. ±3db. Sensitivity: -73db. Ideal for almost all applications. 49/6. P. & P. 2/6.

SIGNAL GENERATOR SWO-300

Freq. Range: 150 kc/s-150 Mc/s on fundamentals (6 bands), 150 Mc/s-300 Mc/s on harmonics. Calibration accuracy within ±1 per cent. Modulation internal and external. Attenuation: To-40 db. Output: Facilities for high and low. Power Supply: Internal 230 v. A.C. Size: 7 x 10 x 5in. Complete with test leads and instruction manual. ONLY £14/19/6. Carr. 5/6. Fully guaranteed.



AERIAL VARIOMETERS

These magnificent instruments will enable you to receive maximum signal strength on all Short Wave receivers. Precision calibrated control. 12/6. P. & P. 2/6.



EP.10K MULTI-METER



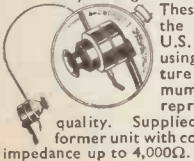
10,000 O.P.V. on BOTH A.C. and D.C. Ranges: D.C. Voltage: 0-6-30-120-600-1,200 v. (10,000 o.p.v.). A.C. Voltage: 0-6-30-120-600-1,200 v. (10,000 o.p.v.). D.C. Current: 0-120μA, 0-12-300 mA. Resistance: 0-20K, 0-2 Meg. (150 ohm, 15K at centre scale). Capacitance: 0.005 to 0.15μF (at A.C. 6 v.). Decibels: -20 to ±63db (600 ohms 1 mW., odBm=0.775 v.). Accuracy: D.C. voltage and current ±2% f.s. A.C. Voltage ±4% f.s. Resistance ±3% of total scale length. Size: 4 1/4in. x 3 1/4in. x 1in. Complete with test leads, battery and instructions. £5/19/6. P. & P. 2/6.

PM.242 POWER MEGAPHONE

New lightweight portable transistorised megaphone. Features removable microphone for remote operation. Extreme battery economy despite high sound volume output. Features pistol grip switch, lightweight spun aluminium horn. Weight only 4lb. £14/10/-. Post paid.



AMERICAN LIGHTWEIGHT HEAD SET



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

SUB-MINIATURE TRANSFORMERS

Here is outstanding value in transistor transformers consisting of one Driver Transformer and one Output Transformer. Ideal pair for miniature transistor portables, etc. Driver Model LT44: Primary: 20k. Secondary: 1k. Centre Tapped. Ratio: 5:1. Output Model LT700: Primary: 1.2K. Centre Tapped. Output: 3.2 ohms. Ratio: 20:1. ONLY 9/6 per pair. P. & P. 1/6.



PERSONAL EARPHONE

A really sensitive dynamic earphone of exceptionally fine quality. Provides clear reproduction of music as well as speech. Fully guaranteed and complete with ear insert, 3 feet cord sub-miniature plug and socket. Model CR.5 Crystal Earpiece, high imp., Model MR-4 Magnetic Earpiece, low imp.



8/- each POST 1/-.

RH-20 RADIO HEADPHONES



Hi-impedance-2,000 ohms-general use headset. Black and Ivory plastic cased electro-magnetic units with adjustable head-band for comfortable fit. Individual listening for all types of applications. Individually packed, with flexible cord attached. 14/6, post paid.

SLIM RADIO PLUG AND SOCKET P.31

Two way, black bakelite, solder terminal plug. STURDY standard JACK SOCKET. Panel mounting, neat finish. 5/6 per pair. Post paid.



U.S.A. DYNAMOTORS

manufactured by EICOR (as illus.). Input 12 v., output 400 v. at 180 mA. Size 7 x 4 x 4 1/4in. Brand new 45/- P. & P. 3/6.

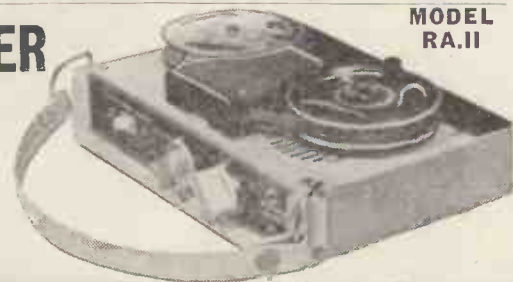


TRANSISTOR TAPE RECORDER

Size only 6in. x 8 1/4in. x 2 1/4in. and weighs a mere 2 1/2lb. Fully transistorised complete with mike, earphone, built-in speaker and amplifier. Powered by three inexpensive batteries. Twin track recording at 3 1/2 I.P.S. for maximum economy. Records and plays for over one hour on standard 3in. reel. (34 minutes each track.) The RA.11 is a precision miniature tape recorder which slips easily into a brief case or handbag. Utilises advanced transistor circuitry and built-in 2in. x 3in. P.M. speaker and amplifier. Engineered for ease of operation. All controls are accessible on front panel. The magnificent two-tone plastic and metal case features a carrying handle and snap open top for fast, easy tape loading. Complete with batteries, tape and accessories.

ONLY 15 gns.

Post paid.



Mail Orders:

(DEPT. W.) 32A COPTIC STREET, LONDON, W.C.1



Callers:

87 TOTTENHAM COURT ROAD, LONDON, W.1. MUS. 9606

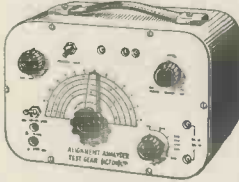
OSCILLOSCOPE FOR D.C. & A.C. APPLICATIONS



Engineered to precision standards, this high-grade instrument is made available at the lowest possible price, incorporating the essential features usually associated with luxury instruments. This "SCOPE" will appeal particularly to Service Engineers and Amateurs. A high gain, extremely stable differential V-Amplifier (30 mV/C.M.). Provides ample sensitivity with A.C. or D.C. inputs. Especially suitable for measurement of transistor operating conditions where maintenance of D.C. levels is of paramount importance. Push-Pull X amplifier; Flyback suppression; Internal Time base Scan Waveform available for external use; pulse/output available for checking T.V. Line O/P Transformers, etc.; provision for external X I/P an 1 CRT. Brightness Modulation. A.C. mains 200/250 v. £15/15/- plus P. & P. 7/6 or 30/- deposit, plus P. & P. 7/6 and 12 monthly payments of 2/6/-.

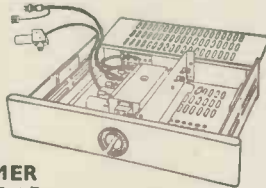
ALIGNMENT ANALYSER TYPE MC12

A.C. MAINS 200/250 volts. Provides—"MODULATOR" (SWEEP FREQUENCY) OPERATION, for FM/TV alignment linear frequency sweep up to 12 Mc/s. From 400 Kc/s—80 Mc/s. CAPACITANCE MEASUREMENT. Two ranges provided 0-60 pf. and 0-120 pf. SPECIAL FACILITY enables true resonant frequency of any tuned circuit I.F. transformer, etc. to be rapidly determined. Cash price £8/19/6 and 5/- P. & P. H.P. terms 25/- deposit and 5/- P. & P. and 6 monthly payments of 2/6/-.



CHANNEL TUNER

Will tune to all Band I and Band III stations. BRAND NEW by famous manufacturer. Complete with P.C.C. 84 and P.C.F. 80 valves (in series), I.F. 18-19 or 33-38. Also can be modified as an aerial converter (instructions supplied). Complete with knobs.



32/6 Plus 3/6 P. & P.

HEATER TRANSFORMER

To suit the above, 200-250 v. 6/- plus 1/6 P. & P.

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



4-speed plays 10 records 12in., 10in. or 7in. at 16, 33, 45 or 78 r.p.m. Intermixes 7in., 10in. and 12in. records of the same speed. Has manual play position; colour brown. Dimensions: 12 1/2in. x 10 1/2in. Space required above baseboard 4 1/2in., below baseboard 2 1/2in. Fitted with Ful-Fi turnover crystal head. £8/19/6. Plus 5/- P. & P.

STEREO HEAD £7/19/6 Plus 5/- P. & P.

LINE E.H.T. TRANSFORMER

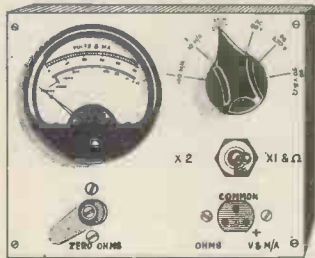
With built-in line and width control. 14 KV Scan Coll. 90in. deflection, on ferrite yokes. Frame O.P. transformer 500 pf. 18 KV. smoothing condenser. Can be used for 14in., 17in. or 21in. tubes.

Complete with circuit diagram

As above, but for 625 lines £2.10 Plus 4/- P. & P.

FOCUS MAGNET suitable for the above (state tube), 10/-, 2/6 P. & P.

A.C./D.C. POCKET MULTI-METER KIT



2in. moving coil meter, scale calibrated in A.C./D.C. volts, ohms and milliamps. Voltage range A.C./D.C. 0-50, 0-100, 0-250, 0-500. Milliamps 0-10, 0-100. Ohms range 0-10,000. Front panel, range switch, wirewound pot (for ohms zero setting), toggle switch, resistor and rectifier. 19/6. P. & P. 1/6. Wiring diagram 1/-, FREE with kit.

BATTERY RECORD PLAYER AND AMPLIFIER

Incorporating 45 r.p.m. "Starr" motor, "Acos" crystal pick up, 3 transistor push-pull, amplifier complete with transistors. Output 500 milliwatts, 49/6 plus 3/6 P. & P.

SIGNAL GENERATOR



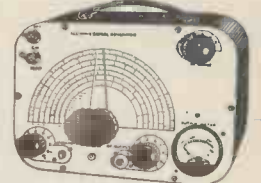
£6/19/6

Covering 100 Kc/s-100 Mc/s. on fundamentals and 100 Mc/s to 200 Mc/s. on harmonics. Metal case 10in. x 6 1/2in. x 5 1/2in., grey hammer finish. Incorporating three miniature valves and Metal Rectifier. A.C. Mains 200/250 v. Internal Modulation of 400 c.p.s. to a depth of 30%. Modulated or unmodulated R.F. output continuously variable 100 millivolts C.W. and mod. switch, variable A.F. output. Incorporating magic-eye as output indicator. Accuracy plus or minus 2%.

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

SIGNAL GENERATOR

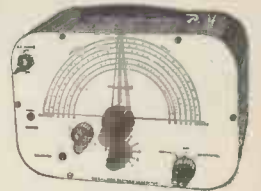
Coverage 120 Kc/s-230 Kc/s., 300 Kc/s.-900 Kc/s., 900 Kc/s.-2.75 Mc/s., 2.75 Mc/s.-8.5 Mc/s., 8 Mc/s.-28 Mc/s., 16 Mc/s.-56 Mc/s., 24 Mc/s., 84 Mc/s. Metal case 10in. x 6 1/2in. x 4 1/2in. Size of scale 6 1/2in. x 3 1/2in. 2 valves and rectifier. A.C. mains 230-250 v. Internal modulation of 400 c.p.s. to a depth of 30 per cent. modulated or unmodulated R.F. Output continuously variable. 100 millivolts C.W. and mod. switch variable A.F. output and moving coil output meter. Grey hammer finish case and white panel. £4/19/6 Accuracy plus or minus 2%.



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

SIGNAL & PATTERN GENERATOR

£6/19/6 P. & P. 5/-
Or 25/- deposit. P. & P. 5/- and 6 monthly payments of 21/6.
Coverage 7 1/2 Mc/s.-210 Mc/s. in five bands, all on fundamentals slow motion tuning audio output. 8 vertical and horizontal bars, logging scale. In grey hammer finished case with carrying handle. Accuracy ±1% A.C. mains 200-250 v.



MAINS TRANSFORMER

All with tapped primaries 200-250 volts
0-160, 180, 200 v., 60 ma., 6.3 v. 2 amps., 10/6, 350-0-350, 70 ma., 6.3 v. 1 amp., 6.3 v. 2 amp., 10/6, 250-0-250, 70 ma., 6.3 v., 2 amp., 10/6. Postage and packing on the above 3/-
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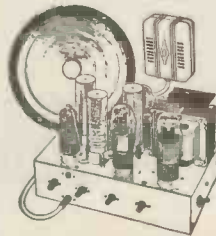


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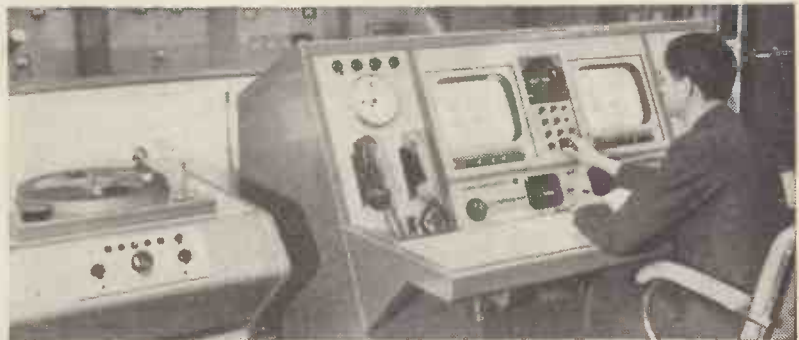
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As a result of the continued expansion of the Airborne Radar Division of EMI Electronics Ltd., a number of interesting new vacancies have become available.

SENIOR ENGINEER—to lead a team concerned with the design and development of radar and radar-like equipment from the specification stage to prototype completion. Applicants should be qualified to good degree or H.N.C. standard and be thoroughly conversant with the techniques pertaining to Transistor Circuitry. Experience in the fields of Radar, Display and Pulse Circuitry, and Links would form a distinct advantage.

ENGINEERS—to join the team described above. Applicants should be of H.N.C. standard and have experience of Transistor Circuitry.

SENIOR ENGINEER—to engage in electronic circuit design and development work for experimental airborne equipment. This is a specialist post for a man with a good degree in Electrical Engineering, and with some considerable experience of initiating transistor circuit design in a research context.

The work of the Airborne Radar Division is extensive in range, and involves problems relating to Optical, Photographic, Digital and Analogue Computing, and Wideband Recording techniques. Its diversity offers qualified personnel an unusual opportunity to develop their careers in an expanding field.

Please write, giving full details and quoting Ref. EL/3/A2, to:

Personnel Manager,
EMI ELECTRONICS LTD.
HAYES, MIDDLESEX.



CALIBRATION ENGINEERS

EMI Electronics Ltd. has interesting vacancies for Calibration Engineers to engage on the calibration, maintenance and repair of a wide range of advanced test gear equipment.

Applicants should have at least two years' experience of calibration or test-gear servicing activities, either in industry or the Armed Services. An O.N.C. would be an advantage, but is not essential.

Initial salaries will be determined by qualifications and experience and it is Company practice to review salaries annually.

Please write, giving full details and quoting Ref. EL/9/B4, to:

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Interesting vacancies have occurred in the Feltham laboratories of EMI Electronics Ltd., for the following:

WIRING DRAUGHTSMEN to engage on the design and layout of wiring for complex miniature electronic units and associated test gear. Candidates for these posts should possess sound practical knowledge of electronic circuitry and hold an O.N.C. in Electrical Engineering or equivalent qualification. Ref. Da/0/46

TECHNICAL SPECIFICATION WRITERS. Candidates must have a background of electronics and must be able to write clearly and concisely. The posts involve the preparation of technical reports for publication and entail close liaison with engineering teams. Ref. Sa/10/3

ELECTRONIC DEVELOPMENT ENGINEERS to engage on a variety of aspects of the development of G.W. equipment. Applicants for these posts must have a degree or H.N.C. in Electrical Engineering. Experience of one or more of the following will be of distinct advantage.

Radar Techniques
Transistor Circuit Design
Engineering Development Circuits
Design of Laboratory Test Gear
Inter-Company Liaison on Ministry Work
Ref. Pa/4/52

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TRANSISTOR CIRCUIT ENGINEER to engage on the design and development of a wide range of transistor circuits for G.W. applications. Circuits to be designed include those presently in the development stage and also those required to validate specifications laid down by the advanced study group. Candidates must have a degree or H.N.C. with at least two years' circuit design experience, preferably with some transistor content. Ref. Pa/4/60

ENGINEER INSPECTORS are required by the Inspection Department to join a team carrying out electronic inspection of complex electronic equipment under development and to conduct liaison with development teams and workshops. A sound engineering background with experience of similar work is necessary. Candidates should have H.N.C. (Electrical Engineering) or equivalent. Ref. Ia/1/58

Starting salaries will be determined by qualifications and experience and it is company practice to review salaries annually on the basis of ability and potential.

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This company specialises in the production of high quality optical instruments for use in spectrum analysis and has an international reputation as a leader in this field. At all stages of manufacture the best standards of workmanship are needed.

We have vacancies for men with electronic experience for testing. Radar and Radio Technicians with fault-finding experience would be suitable.

If you have the kind of background which you think would fit you for this interesting work in a pleasant University City, please let us have full details of your qualifications and experience.

Write to: The Works Manager, Unicam Instruments Ltd., Arbury Works, Cambridge quoting reference E.S. 57.

ROBINSON RENTALS LIMITED

Due to continued expansion this National Rental Organisation requires additional TELEVISION ENGINEERS in all parts of the country. Permanent, pensionable posts at branches or with mobile servicing teams. Excellent promotion prospects. Reply in confidence to:—

Service Executive,
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ELECTRONIC TEST ENGINEERS

To meet its expanding development and production programme, E.M.I. Electronics Ltd. has a number of interesting vacancies for Test Engineers to be engaged on a wide range of equipment including Computers, Radar and Broadcast Equipment.

Applicants must have previous experience of electronic inspection techniques or of the inspection of electronic components.

An O.N.C. (Electrical) would constitute a distinct advantage but is not essential.

These posts are of staff status and offer good initial salaries.

Please write, giving full details and quoting Ref. EL/9/B5, to:—

Personnel Manager,
E.M.I. ELECTRONICS LTD.,
HAYES, MIDDLESEX

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1/10, 1/2 & 1/4	1% 5%	6d.	2% 7 1/2d.	1% 9d.
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COMPETENT RADIO ENGINEER

is required to occupy a senior position in the Factory Laboratory at our Skegness branch factory. Applicants should have a good knowledge of Radio and Television circuits, measurement technique and the ability to assist the test and inspection departments in maintaining a high quality product. No design work is involved. The appointment has excellent prospects for the right man, and assistance will be given with housing accommodation. Apply, with details of age, experience, etc., to:

Personnel Officer

(Ref. P.C. 94),

Murphy Radio Limited,

Bessemer Road,

Welwyn Garden City,

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ELECTRONIC MANUFACTURERS

American manufacturer and importer of prime quality high fidelity equipment seeks additional products to distribute through network of 1,500 dealers throughout U.S.A.

Box No. 5031 c/o "WIRELESS WORLD"

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The prospects of further advancement for the selected applicant are excellent.

Please reply, giving full details, to Box No. 5029 c/o "Wireless World"

A Company, well-known and expanding in the Relay field, has established a group of engineers to extend and develop its present comprehensive range of miniature relays and requires a Project Leader to control and expand this team.

Relay Engineers are invited to apply for this position which demands ability to inspire and lead, together with technical competence of a very high order in this field. The appointment carries senior staff status, and a salary of about £1,750 per annum is envisaged.

GROUP LEADER Electronics

A Company, well-known and expanding in the Semiconductor field, has established a group of engineers to develop static switching and requires a Group Leader to control and expand this team.

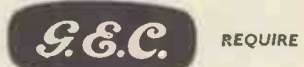
The prospects of further advancement for the selected applicant are excellent.

Please reply, giving full details, to Box No. 5030 c/o "Wireless World"

Electronic Engineers are invited to apply for this position which demands ability to inspire and lead, together with technical competence of a very-high order in this field.

The appointment carries senior staff status, and a salary of about £1,500 per annum is envisaged.

SYSTEMS PLANNING ENGINEERS



REQUIRE

SYSTEMS PLANNING ENGINEERS

for their Transmission Division in Coventry.

Qualifications:

The successful candidates will be men with experience of planning large telecommunications systems and with a particular knowledge of UHF and SHF radio. A wide experience of telecommunications, preferably in an operating organisation, would be an advantage.

Salary:

These are senior appointments and will carry a starting salary of about £1,200 and upwards, depending on experience.

Apply:

Giving age, qualifications and experience to:—

The Staff Officer
THE GENERAL ELECTRIC
CO. LTD.
Copsewood, Coventry, Warwickshire

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

ATOMIC ENERGY ESTABLISHMENT, WINFRITH

Vacancies exist at A.E.E. Winfrith, Dorchester, Dorset, for

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(Electronic and Electro-Mechanical)

Applicants should be familiar with the construction of Electro-Mechanical experimental equipment and components; ability to read circuit diagrams and drawings, and to construct, wire and test electrically complex equipment is desirable. Duties will include the major overhaul and repair of a wide variety of electronic and electro-mechanical equipment including potentiometric recorders, moving coil instruments, pressure, vacuum and flow transducers, oscilloscopes, signal and pulse generators, all types of amplifiers and high vacuum Ionisation gauges.

Housing may be available to the successful applicants, but this would be determined at the time of interview. Excellent working conditions including sick pay and pensions schemes.

Further details of conditions of employment, rates of pay and application forms may be obtained from the Labour Department, A.E.E. Winfrith, Dorchester, Dorset, quoting Reference Number IM/PW/PT.

VACANCIES FOR RESEARCH AND DEVELOPMENT CRAFTSMEN IN GOVERNMENT SERVICE

ELECTRICAL (1) **RADIO MECHANICS** for the maintenance and installation of radio communication receivers and equipment.
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(3) **WIREMEN** for prototype sub-assembly lay out, wiring and testing of radio and computer type chassis.

MECHANICAL Instrument makers and general machinists with bench fitting and machine shop experience for construction of experimental and prototype electronic apparatus.

BASIS PAY £9 18s 2d plus merit pay in the range of 10/- to 100/- per week. Merit pay will be assessed at interview based on ability and the necessary basic qualifications.

Opportunities for eventual permanent and pensionable posts. Five day, 42 hour net, week; good working conditions; single accommodation available.

Apply in writing to: Personnel Officer (RDC/3), Government Communications Headquarters, 53 Clarence Street, Cheltenham, Glos.

PLYMOUTH AND DEVONPORT TECHNICAL COLLEGE

Tavistock Road, Plymouth.

Principal: E. Bailey, B.Sc., F.R.I.C., A.M.I. Chem. E.

RADIO OFFICERS COURSES

Full-time courses start in September 1961 for P.M.G., Radio and M.O.T. Radar Maintenance Certificates. Applications, giving particulars of previous education, should be made now to the Principal.



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the

NEVEYE

A low priced CCTV CAMERA

Modern circuit design, the use of transistors and semi-conductors have been instrumental in the production of this equipment at the really low cost of 119 guineas. The Neveye has been designed to work direct to any standard domestic TV receiver from ordinary mains supply. The output from the camera is a composite modulated radio frequency signal and is tunable to any

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Industrial Control Equipment

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Staff Positions—Superannuation—Attractive Salaries.

Applications in **strict confidence** to:—

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MURPHY RADIO LIMITED

Have a vacancy for a **RADIO ENGINEER** in their Welwyn Garden City Factory Laboratory.

The position demands a sound knowledge of Television and Radio circuits and testing techniques. No design work is involved, but the Department is concerned with maintaining the high standard of the product.

The appointment offers excellent prospects for the right man.

Apply giving full details of experience, age, etc., to the

Personnel Officer (P.C.93)
Murphy Radio Limited,
Bessemer Road,
Welwyn Garden City,
Herts.

COUNTY OF ESSEX
 SOUTH-EAST ESSEX TECHNICAL
 COLLEGE, Longbridge Road, Dagenham

MARINE RADIO OFFICERS' COURSES

The College offers full-time courses of one or two years' duration leading to the 1st and 2nd Class P.M.G. Certificates and the M.o.T. Radar Maintenance Certificate. Applications for enrolment should be made as soon as possible. Late enrolments may be considered up to 11th September, 1961. Officers possessing the P.M.G. 2nd Class or both 1st and 2nd Class Certificates may join the course at appropriate points to complete their qualification.

For further particulars apply to the Principal.

County Borough of Bolton—Education Dept.
BOLTON TECHNICAL COLLEGE

PRINCIPAL A. J. JENKINSON, M.A.
ELECTRICAL ENGINEERING DEPARTMENT

HEAD OF DEPARTMENT
 A. C. NORMINGTON, B.Sc.(Eng.), M.I.E.E.,
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DIPLOMA IN ELECTRONIC ENGINEERING
 A three year full-time course for the College Diploma.

Entry requirements: Four G.C.E. passes, including English language, Mathematics and Physics at "O" or "A" Levels.

Diplomates are exempted from: The entire examination of the British Institution of Radio Engineers.

Parts I and II of the examination of the Institute of Electrical Engineers.

Further particulars from the Principal, Bolton Technical College, Manchester Road, Bolton.



SWISSAIR,

Swiss Air Transport Company Ltd.,
has vacancies for

HIGH-FREQUENCY MECHANICS

(Radio Mechanics, Radio Electricians and Fitters), in its Radio Workshop at Zürich-Airport. The Work consists in servicing wireless and radar equipment of aircraft (LORAN-Navigation and Communications equipment, Radio-compass, etc.) as well as the technical maintenance of a DC-8 Flight Simulator.

Requirements :-

Technical training should be completed and the appropriate certificate(s) obtained. Practical experience. A basic knowledge of the German language. Minimum age 23 years.

Swissair offers :-

Steady working conditions, adequate monthly salary (according to age, experience and qualifications), plus certain allowances and travel expenses.

Those interested in becoming conversant with the newest and latest radio and electrical aids to flight-techniques, are invited to obtain an application form from SWISSAIR, 126 Regent Street, London, W.1.

The application form should be completed in handwriting and returned with photo, copies of certificates and references to our representative at the above address (not to Zürich).

ENGINEERING AUTHORS

One of the leading Companies in the electronics field located in the Home Counties, wishes to strengthen the Group responsible for preparing technical publications and maintenance manuals of their products. Vacancies exist for Senior Authors in the Radar, Data Processing, Microwave Communications, High Power Transmitter and Television Studio fields. These are senior appointments on the Company's permanent staff. Salaries will be attractive and will normally be in the range £1,100 to £1,400 p.a.

Some junior posts are also vacant, and candidates without the experience necessary for the senior appointments will be considered for these, which carry excellent prospects for advancement.

Reply in confidence to Box WW 1016 LPE 60/62 St. Martin's Lane, London, W.C.2.

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Required by TANGANYIKA GOVERNMENT, Police Department, on contract for one tour of 21/27 months, commencing salary (including Overseas Allowance) £1,287 a year in scale rising to £1,671 a year. Gratuity 25% of total salary drawn. Outfit allowance £45. Free passages. Liberal leave on full salary.

Candidates under 40 years of age, must have a wide experience of installation, running and maintenance of medium and low powered H.F. and V.H.F. equipment together with ancillary apparatus. Experience of telephone and teleprinter practice, erection of lattice and other masts and installation and maintenance of generating plant an advantage.

Apply to CROWN AGENTS, 4 Millbank, London, S.W.1. for application form and further particulars, stating age, name, brief details of qualifications and experience and quoting reference M2A/51288/WF.

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 SET of 6 Transistors and 1 Diode, 45/-.
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 Comprehensive range in stock.

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CLOSE TOL. 5/MICAS. 10% 1 pf.-500 pf., 9d. 600-6000 pf., 1/- 1% 2 pf.-100 pf., 9d. 100 pf.-500 pf., 11d. 575 pf.-5000 pf., 1/6.
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W/W RESISTORS. 25 ohms to 10K 5W., 1/3, 10 w., 1/6, 15 w., 2/-.
PRE-SET T/V POTS. W/W 25 ohms-50 K, 3/-, 50 K-2 Meg. (Carbon) 3/-.

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TAPE REELS. Special offer. Manfr. surplus. Replacement plastic spools. 7in. 3/6, 5 1/2in. 3/3, 5in. 3/-, 3in. 2/6.

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DP96 9/-	EL84 8/6	PL82 9/6
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JASON FM TUNER UNDS
 Designer-approved kits available.
 FMT1, 5 gns. 4 valves, 20/-.
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 NEW JASON F.M. HANDBOOK, 2/6.
 48 hr. Alignment Service, 7/6 plus 2/6

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Brand New—3VA	1st Grade.
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XA102	10/- OC70
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We manufacture all types Radio Mains Transf. Chokes, Quality O/P Trans. etc. Enquiries invited for Specials, Prototypes of small production runs. Quotation by return.

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Latest 5-valve circuit based on Mullard's design. Magic eye and tone controls. Printed circuit already wired. A sensitive quality recorder. B.S.R. Kit 95/- B.S.R. Tape Deck £8/10/- Collaro Kit £6/5/- Collaro Tape Deck £12/10/- Set of 5 valves 45/- Special Unit Kit Prices—Send stamp for detailed list. Handbook (full details) 2/6.



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Frequency range: 590-1,300 mc/s., R.F. or pulsed. Output: 1 μ V to 100 mV into 50 Ω . Pulsed output: rectangular envelope 100% modulated. Internally or externally synchronised. Pulse rate: 60-2,500 c/s.; pulse width 2-30 μ sec.; pulse delay 3 to 300 μ sec. The instrument is supplied complete with set of calibration and correction charts. Power supplies 115 v. A.C. PRICE: fully overhauled and guaranteed £135 0 0 Packing and carriage £1 0 0

MEASUREMENTS CORPORATION TYPE 84 SIGNAL GENERATOR

Range 300-1,000 mc/s. In one band, directly calibrated. Accuracy $\pm 5\%$. Output 1 μ V-100mV into 50 Ω . Internal sine wave modulation at 400-1,000-2,500 c/s up to 30% and pulse at 60 to 100,000 p.p.s., 1 to 50 μ sec wide, with delay variable from 0 to 50 μ sec. Power supplies 117 v. A.C. Calibrated inductive attenuator. Fully overhauled and guaranteed £220 0 0

HETERODYNE WAVEMETERS

TS-173 Heterodyne Crystal Controlled Frequency Meters range 80 to 450 Mc/s. Individual Calibration Books with numerous crystal check points. Accuracy .005% nominal and .01% interpolation. Power required; dry batteries 6 V. and 135 V. PRICE, fully overhauled and guaranteed £120 0 0
TS-176 Heterodyne Crystal Controlled Frequency Meters, range 80 to 1,000 Mc/s., otherwise as above. PRICE fully overhauled and guaranteed £150 0 0 Also BC-221 and LM-14. Please write for details.

MARCONI TYPE TIME-18 FIELD STRENGTH METERS

Transportable test set for measuring field strength of signals in the range of 150 kc/s. to 25 Mc/s. The instrument consists of sensitive superheterodyne receiver providing I.F. bandwidths of 120 and 600 c/s., interchangeable aerial systems to cover complete range, and substitution oscillator. Output of the instrument can be read on a meter, recorded or displayed on an oscilloscope screen. Field strength measurements range from 1 μ V/metre to 5V/metre with an accuracy of 10%. All readings are in db with reference to 1 μ V/metre and no calibration curves are required. 6 V. accumulator operation. Fully overhauled and guaranteed £220 0 0

CT-82 NOISE GENERATOR AND RECEIVER NOISE FACTOR METER

Portable Mains operated instrument providing noise signal in the frequency range of 100 kc/s. to 160 Mc/s. and measuring the output of the receiver. 3-step input attenuator. Output impedance 43, 75 and 400 Ω . 115/230 V. operation. PRICE, fully overhauled and guaranteed £55 0 0 Packing and carriage £1 0 0

MARCONI TYPE TF-885A VIDEO OSCILLATORS

Frequency Range 25 c/s. to 5 Mc/s. for sine wave output and 50 c/s. to 150 kc/s. for square wave output, covered in two bands; max. output 1 V. into 1,000 Ω sine wave and 30 V. peak square wave. Distortion better than 3% at full power. Fully calibrated attenuator. Mains operation. PRICE, fully rebuilt to the original specification and guaranteed £150 0 0 Packing and carriage £2 10 0

MARCONI TF-195L BEAT FREQUENCY OSCILLATOR

Frequency range 0 to 40,000 in two ranges. Power output 2 watts max. Total harmonic distortion less than 1.5% at 5 watts output and less than 2.5% at 2 watts between 80 c/s. to 15 kc/s. Frequency calibration accuracy $\pm 1.5\%$ approx. Mains operation. PRICE fully overhauled and guaranteed £65 0 0 Packing and carriage £1 10 0

TS-102/AP PULSE GENERATOR

The instrument provides: triggered pulses, μ sec. wide at 30-35 v. ampl. positive or negative, into 72 Ω load, at a rate of 500-800-1,600-2,000 c/s. and marker pulses μ sec. wide spaced at μ sec. continuously variable from .5 V. Marker pulses can be delayed with respect to trigger pulses from 0 to 360°. Marker pulses spacing accuracy $\pm 1\%$. 115 v. A.C. operation. £18 0 0 Packing and carriage 15/-.

HIRE PURCHASE TERMS

AVAILABLE FOR THE FOLLOWING COMMUNICATIONS RECEIVERS.

MARCONI CE-100, 60 kc/s to 30 Mc/s in good working order. Cash Price £25 0 0
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Please write for details of H.P. Terms.

SPECIAL RECEIVERS

R-1359; frequency range 130-590 Mc/s. In two bands. Tuned coaxial line input circuit, crystal mixer, CV-62 local oscillator, four IF stages at 13.5 Mc/s. and bandwidth of 3.5 Mc/s. and 420 kc/s., detector, Video Amplifier and Cathode Follower Stage, Beat Frequency Oscillator. Video or Audio output. Sensitivity approx. 10 μ V. for 6db S/N ratio. External mains power supply unit. Fully overhauled and guaranteed, complete with power supply unit for 230 V. mains operation £95 0 0
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External power supply unit can be supplied at extra charge.
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TELEFUNKEN RS1/20/AM/FM Receiver, 400-800 Mc/s. I.F. 2.25 Mc/s. B.F. sensitivity at 450 Mc/s. 10 μ V for S/N of 10 db; Mixer-Oscillator-Four I.F. stages and two A.F. stages. Power supplies 230 v. A.C. £110 0 0
AN/AMP-4. The receiver unit is essentially an I.F. Amplifier with the associated audio and video stages and mains (118V. A.C) power supply unit. I.F. 30 Mc/s.; bandwidth 4 Mc/s. and .6 Mc/s.; I.F. sensitivity from 35 to 56 μ V. Different frequency ranges are obtained by means of interchangeable plug-in tuning units containing mixer and local oscillator stages. These units are available for the following ranges: 38-95 M /s.; 74-230 Mc/s.; 300-1,000 Mc/s. and 1,000-2,000 Mc/s. Prices on application—please specify the ranges required.

AVOMETERS MODEL 7

Fully overhauled and guaranteed £12 10 0 p.p. 10/-
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Leads: 15/- extra per pair.

OSCILLOSCOPES

COSSOR TYPE 1035 DOUBLE BEAM. Time Base 15 μ sec. to 150 millisecc. triggered or free running. Y1 Amplifier gain 3 to 3,000, with frequency response up to 7.0 Mc/s. for low gain and up to 60 kc/s. for high gain. Y2 Amplifier directly calibrated in Volts £100 0 0
AIRMEC TYPE 733 SINGLE BEAM. Time Base 1 μ sec. to .5 sec. sweep, triggered or free-running. Amplifier Frequency Response D.C. to 5 Mc/s. for sensitivity of 200 mV/cm. and 30 c/s. to 30 kc/s. for sensitivity of 20 mV/cm. Automatic brilliance control. Adjustable HHT Voltage. Mains operation £75 0 0
EMI TYPE 3794TA HIGH SPEED WAVEFORM VIEWING OSCILLOSCOPE. Time Base 1.5 μ sec. to 50 m/sec. triggered or free running. "Y" amplifier provides sensitivity of 2 to 120 mV/V. Time rise .07 μ sec. Frequency response D.C. to 6 Mc/s. for 2.5 db. down. Time measurements range 1 μ sec. with an accuracy of $\pm 2\%$. Voltage measurements range 0-500 V. D.C. or E.M.S. in six ranges, with accuracy of .3% F.S.D. Mounted on a trolley, with mains power supply unit. P.P. 50/- £130 0 0
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Other Calibrations £4 10 0

RADIO TRANSMITTER-RECEIVERS

MAR TYPE TRANSMITTING AND RECEIVING INSTALLATION. 10-crystal channel operation in the range 225-330 Mc/s. This is an extremely flexible equipment suitable for operation from 12, 24, 115 or 230 V. A.C. or D.C. Complete installation is enclosed in three separate units, each housed in steel waltlight case. Eleven crystals only are required to cover all ten channels. PRICE, complete with all accessories, ready to work £220 0 0
681 SERIES UHF TRANSMITTING AND RECEIVING INSTALLATION. 10 crystal channels in the range of 277 to 293 Mc/s. FM/AM operation. Complete installation is enclosed in two separate units, each of which can be used independently. These are: Transmitter with its mains power supply unit and receiver with its mains power supply unit. Transmitter and Receiver Units are also available separately. PRICE of complete installation ready to work £230 0 0
Please send for further details.

RT-159/URC-4 POCKET SIZE WALKIE-TALKIES

Two crystal channels in the band 120-130 and 240-260 mc/s. Fully self-contained. Dimensions 6 1/2in. x 2in. x 3 1/2in. with aerial folded. Weight 2 lbs. without batteries. The set uses Mallory Mercury batteries which clip to the back of the set. PRICE, fully overhauled and guaranteed, without crystals, with one battery £32 each

H.T. FLASH-OVER TESTERS

Test voltage continuously variable from 0 to 5 kV. A.C. or D.C. Power supplies 230 v. A.C. Complete with probes. PRICE, fully overhauled and guaranteed. £28 0 0 Packing and carriage £1/10/-.

H.T. LEAKAGE INDICATORS

A.M. Ref. No. 5G/2124
Portable Hand Operated H.T. Tester for testing leakage of Aircraft Ignition Leads. Meter calibrated directly in megohms. Completely rebuilt and fully guaranteed. Complete with two H.T. leads fitted with crocodile clips. PRICE £21 0 0 Packing and carriage 15/-.

BONDING TESTERS

Portable instrument for measuring resistance of bonding under conditions of high current. Scale calibrated from 0 to .10 Ω , first division being at .002 Ω . Complete with pair of special test leads of heavy cross-section, fitted with special test probe £8 15 0
NIPE cell for use with the above £8 10 0

AUDIO OUTPUT METERS

TAYLOR 150A: measurements range 0 to 5 watts in five ranges; 50 settings of impedance from 2.5 to 20,000 Ω £25 0 0
TAYLOR 160A: measurements range 0 to 2.5 watts in five ranges; 10 settings of impedance from 2.5 to 20,000 Ω £22 0 0

MARCONI TYPE TF948 FM/AM SIGNAL GENERATOR

Frequency range 20 to 80 Mc/s in two ranges. Built-in Crystal Calibrator with audible beat indicator. Output 1 μ V to 1mV into 75 Ω and fixed high output of 1V. Internal pulse, AM and FM modulation at 300, 1000, 1500 and 3000 c/s. Max FM deviation 600 kc/s. Provision for external modulation. Power supplies 100/150 V. and 200/250 V. Fully overhauled and guaranteed £200 0 0

PORTABLE METERS

8in. Mirror scale grade I Moving Iron Meters, calibrated 0-160 V. A.C./D.C., enclosed in a polished wooden case with lid and carrying strap. New and guaranteed £3 0 0

WESTINGHOUSE SELENIUM RECTIFIER POWER UNITS

Input 115/230 v. fully smoothed and fused. Output adjustable from 80 to 140 V. D.C. by means of fine and coarse tap switches in the secondary winding. Maximum current 400 mA. continuous. Dimensions 1 1/2in. x 10 1/2in. deep x 3 1/2in. high...p.p. 7/6. 40/-.

"S" METERS

2in. Rd. Panel Mounted Signal Strength Meters. Basic movement 1 mA. D.C. Translucent scale with provision for internal illumination, calibrated from 0 to 20 "8" units at half scale and from 0 to 40 db above 20 "8" units. Suitable for HRO receivers. 35/-.

ALL THE ABOVE EQUIPMENT WILL BE SUPPLIED FULLY OVERHAULED AND GUARANTEED FOR TWELVE MONTHS FROM THE DATE OF PURCHASE.

HIGH SPEED RELAYS
SIGMA TYPE 401 OR ALLIED TYPE G.
 1B 1 Amp. contact, 6,000 Coil. Current 4 mA. ± 5 mA. Will operate with change of current of 2 mA. Secondhand 5/6
STEVENS ARNOLD TYPE 358 MILLISECOND.
 Realed, Octal Base, 24V. 1,400 Coil, 1 C.O. contact 17/5
SIEMENS TYPE HIGH SPEED SEALED RELAYS.
 1 C.O. 600 mA. contact. Twin Coil 2 x 150. Operating current 15 mA., with coils in series and 30 mA. with coils in parallel. Secondhand 5/-

POST OFFICE RELAYS
 Secondhand—guaranteed.
 Type 800: 600 Ω Coil, 2 CO contacts 6/6
 Type 3000: 500 Ω Coil, 2 CO contacts 7/6
 Type 3000: 100 Ω Coil, 2B+2M contacts. Operates on 6V 3/6

MINIATURE AND MIDGET RELAYS
STKX-20. (Allied Contact), 2 CO contacts at 2 Amps. 300 Ω Coil. Operating current 35 mA., release 20 mA. 5/-
55251 (BBM). 1M contact at 1 Amp., 270 Ω Coil. Operating current 35 mA., release 10 mA. 3/6
55252 (BBM). 3M contacts at 1 Amp., 270 Ω Coil. Operating current 45 mA., release 25 mA. 5/-
55338 (BBM). 1 CO contact at 2 Amps., 300 Ω Coil. Operating current 40 mA., release 20 mA. 3/6
S.T.O. Relays, secondhand, in good condition and guaranteed. Overall dimensions 1 1/2" x 1 1/2" x 1 1/2"
 1M contact at 5 Amps., 250 Ω Coil. Operating current 40 mA., release 15 mA. 6/6
 2 C.O. bifurcated contacts at 500 mA., 700 Ω Coil, operating current 16 mA., release 5 mA. 7/-

HEADPHONES
 DLR (low resistance), brand new; can be used as sound power microphones 10/-
 HS-30 American Lightweight Headphones, Low Impedance 15/-
 Ditto with High-to-Low Impedance Transformer incorporated in the cord 17/6

E.H.T. METAL TUBULAR RECTIFIERS
 Half Wave. Max. r.m.s. volts 1220V. at 2MA.
 Screw Terminals 7/6
 Solder Terminals 5/-
 P. P. 9d. per rectifier.

MEDIUM POWER GERMANIUM RECTIFIERS
 TYPE GJ5M.
 Peak Inverse Voltage 300V at maximum rectified current of 500mA. Screw terminals 10/6 p.p. 9d.

REVERSIBLE 12V. D.C. MINIATURE MOTORS
 Delivers approx. 5 Watts power at 7,000 r.p.m. Dimensions 1 1/2" long x 1 1/2" dia. Shaft extension 0.771" dia. x 4 1/2" long. Centre-off reversing switch integral with the motor. Self-lubricated sintered bronze bearings. Brand new 15/6 post free.

BTH TAPE DECK MOTORS
 200-250V. AC. output 2 watts at 1,450 r.p.m. Can be run either way by reversing end shields. Secondhand guaranteed 17/6, p.p. 2/-.

CRYSTAL OVENS
 Thermostatically controlled 230V. AC mains operated crystal ovens, maintaining a temperature of 65°C. ± 5°. Complete with crystal chassis for mounting five B7C twin crystals, with crystal switch 10/-, p.p. 2/6.

VENNER 8-DAY TIME SWITCHES
 For plug-in mounting. 1 make and 1 break every 24 hours. 24-hour dial with night and day marking. Contacts capacity 1A. at 250V. Complete with key. Secondhand, guaranteed 27/6, p.p. 3/6.

VARIACS TYPE 80
 Toroidal Wound limited range Variable Transformers. Input 200-240V. Output 220V. at 7.5 Amps. Secondhand, but guaranteed 24 p.p. 10/-.

SUB-CHASSIS FROM TR-1985 AIRCRAFT CRYSTAL CONTROLLED 40-CHANNEL TRANSMITTER-RECEIVER

Transmitter Chassis Type 81.
 Frequency range 100-28 mc/s. Consists of 4.88 mc/s. crystal oscillator (CV-136) coupled to Balanced Modulator (two CV-135) to which a signal at half the final receiver frequency is applied. After mixing the resulting frequency is doubled at CV136, A.F. modulated at QV04-7 and finally amplified at TT-15. PRICE, complete, but less valves 3/6, p.p. 2/9.
 Modulator Chassis. Consists of microphone amplifier CV-138. Less valves 5/-, p.p. 2/6.
 Receiver Chassis type 114.
 Frequency range 100-125 mc/s. Consists of crystal oscillator tuned to the third harmonic, CV-136, trebler, CV-135 and doubler CV-138, tuned RF stage CV-135 and Mixer CV-138. Less valves 5/-, p.p. 2/6.
 LF. Amplifier Chassis. Three stage IF Amplifier—two CV-131 and one CV-138. Detector and AVC Diode CV-140, Squelch valve CV-138 and AVC Amplifier CV-138. Intermediate frequency 9.72 mc/s. Bandwidth 90 kc/s. Less valves 5/-, p.p. 3/6.
 For valves see list below:

also available
 DYNAMOTOR UNITS from the above sets. Input 200-240V. DC Output 250V. RT fully smoothed, at up to 200mA. and Grid Bias supplies of -50V. At one end of rotary transformer the channel change drive mechanism is mounted. PRICE 17/6, p.p. 5/-.



RATCHET MOTORS 12V.
 1 Amp. (Impulse Motors) 6.75 ohms 3/6 each
 Packing and postage 1/6

0A2	6/-	3D6	4/-	6J6	3/6			
0A3	10/-	3Q4	7/-	6J6WA	7/-			
0B2	6/-	384	5/-	6J7G	5/-			
0B3	5/6	3V4	6/6	6K7	4/-			
0C3	5/6	4B2B	15/-	6K7G	7/-			
0D3	5/6	4R31	12/0	6K8G	7/-			
0Z4A	5/6	4C35	60/-	6L5G	6/-			
1A3	3/-	4D32	100/-	6L6	9/-			
1A4H	5/-	5B21	25/-	6L6G	7/-			
1A2	10/-	5C22	120/-	6N7	6/-			
1B32	5/-	5R4G1	9/-	6Q7G	6/-			
1B35A	20/-	5R4GY	9/-	6R47	7/-			
1B38	50/-	5R4GY	9/-	6R47	7/-			
1B41	50/-	5T4	9/-	6R7	3/-			
1B44	40/-	5U4G	5/-	6R7G	5/6			
1G6GT/07	5V4G	10/-	68L7GT	89	10/-			
1L4	3/6	68XGT	6/6	100TH	60/-			
1L5D	6/-	6Z3	3/-	1172GT	6/-			
1L6	5/-	6Z4	9/-	68R7	3/-			
1R4	6/-	6Z4G	7/-	6V8	9/-			
1R5	6/-	6A6	5/-	6V8GT	5/6			
1R4	6/-	6A7	9/-	6X4	5/-			
1R5	6/-	6A7B	4/-	6X4	5/-			
1R4	4/-	6A7C	3/-	6Y6G	3/-			
1T5GT	6/-	6AD4	20/-	6Z4	6/-			
1U4	7/-	6AG5	3/-	7C5	3/-			
1U5	6/-	6AG7	7/6	7C7	5/-			
1V	4/-	6AK5	5/-	7E5	5/-			
1X2A	7/-	6AK6	7/-	7G7	7/-			
2A3	5/-	6AK7	7/6	7Z4	4/-			
2A5	6/-	6B2	11E2	20/-	801A	6/-		
2A815	30/-	6AM5	4/6	11E3	20/-	805	30/-	
2C26	2/-	6AM6	4/6	12A6	3/-	807	6/6	
2C26A	5/-	6AN5	15/-	12AH7GT	811	20/-	813	60/-
2C34	4/6	6AQ5	7/-	12AT7	6/-	815	30/-	
2C39A	90/-	6AS9	7/-	12AT7WA	10/-	822B	50/-	
2C42	25/-	6AT6	5/-	12AU7	6/-	832	15/-	
2C48	42/6	6AT6	5/-	12AU7WA	6/-	838	15/-	
2C51	15/-	6AU6	7/-	12AU7WA	6/-	845	25/-	
2C52	12/-	6AV6	6/-	12AX7	7/-	861	10/-	
2C53	60/-	6B4G	10/-	12AX7G	7/-	868A	10/-	
2C58	6/-	6B8	6/-	12AY7	10/-	872A	20/-	
2E22	15/-	6B9G	3/-	12C8	3/-	884	7/-	
2E26	20/-	6BA6	6/-	12C8	3/-	931A	60/-	
2X2	4/-	6BE6	6/-	12E6	10/-	955	3/-	
2X2A	7/-	6B7	12/6	12E6GT	3/6	957	5/-	
3A4	5/-	6C4	2/6	12E6GT	3/6	958A	5/-	
3A5	5/-	6C5	8/-	12H7	3/-	991	7/-	
3A100B	6/-	6C6	4/-	12H7	3/-	1005	2/6	
3A147J	30/-	6C8	4/-	12K7	5/-	1025	6/-	
3A147J	40/-	6C8G	7/-	12K7	5/-	1032	6/-	
3A148J	40/-	6C8G	7/-	12N7GT	10/-	1080	6/-	
3B2	35/-	6D6	6/-	12Y4	10/-	1080	6/-	
3B22	20/-	6E8	7/-	13D1	5/-	2050W	15/-	
3B24	5/-	6F6	5/-	25L6GT/G	8/-	4024B	20/-	
3B24W25	6/-	6F6G	6/6	8/-	4024B	20/-		
3B26	20/-	6F3	7/-	28D7	7/-	4061A	12/6	
3B28	15/-	6G0G	2/6	32	6/-	4242A	35/-	
3B29	30/-	6K0	16	33T	17/6	5817	6/-	
3B300B	5/-	6J4	9/-	38	7/6	5844	100/-	
3CX100A5	6J5	4/6	39/44	33	6/6	5843	30/-	
200/-	6J5GT	4/-	41	5/-	5851	8/-		

TESTED and GUARANTEED VALVES

SPECIAL OFFER

Any twelve of the following types (in any combination of types) are offered at less than half the usual cost, namely 20/-, plus 2/-, for p.p. (for comparison, our list prices are given in brackets.)

IL4	(3/6)	6J6	(3/6)	717A	(4/-)	T205-50	(5/-)
2C34	(4/6)	6K7G	(3/-)	955	(3/-)	TT11	(3/-)
3B24	(5/-)	68H7	(3/-)	ARP34	(4/-)	VR56	(4/6)
6AC7	(3/-)	6887	(3/-)	DL810	(4/-)	VR65	(4/-)
6AG5	(3/-)	12A8	(3/-)	EAC91	(4/-)	VR135	(4/-)
6AM6	(4/6)	12C8	(3/-)	EC91	(3/-)	VR136	(4/-)
6C4	(2/6)	12JGT	(3/6)	EC91	(3/-)	VR137	(4/6)
6D6	(6/-)	12H7	(3/6)	EP92	(3/6)	VX3208	(5/6)
6G6G	(2/6)	13D1	(5/-)	N161A	(4/-)	VX8190	(5/6)
6J5G	(3/-)	39/44	(3/-)	NGT1	(3/6)	Y65	(5/-)

CATHODE RAY TUBES

2AP1	.....	25/-	4/11	.....	60/-	128P7	.....	40/-
3BP1	.....	17/6	5BP1	.....	50/-	ACR1	.....	20/-
3CP1	.....	15/-	5CP1	.....	30/-	09D	.....	80/-
3DP1	.....	15/-	5FP7	.....	12/6	09J	.....	90/-
3J3P1	.....	40/-	5BP7	.....	140/-	DG7-6	.....	55/-
3JP7	.....	50/-	7BP7	.....	40/-			

KLYSTRONS

2K25	.....	24	726B	.....	25	CV228	.....	29
2K26	.....	240	5721	.....	260	CV238	.....	25
2K41	.....	230	CV38	.....	25	K301	.....	24
2K28	.....	28	CV36	.....	26	KRN2A	.....	24
6B46	.....	210	CV67	.....	25	KRN3	.....	23
417A	.....	22	CV116	.....	24	KRN6/1	.....	24
723A/B	.....	22/10	CV129	.....	24	KRN6/2	.....	24
726A	.....	24	CV217	.....	23	KRN6/3	.....	25

MAGNETRONS

2J37	.....	22/10	4J33	.....	255	M508-CV370	
2J31	.....	25	5J30	.....	22	M518-4J63	£10
2J39	.....	210	706A-Y-GY-series	.....	24	M528-CV160	
2J48	.....	210	706A-Y-GY-series	.....	24		
2J49	.....	218	714A/Y	.....	25		
2J31	.....	210	720CY	.....	28	CV991	25
4J31	.....	235	725A	.....	22/10	CV994	27
4J50	.....	235	725A	.....	22/10		

DAF96	7/6	GM5B	20/-	D20	8/6
DF64	10/-	GS10C	20/-	U50	7/-
DF91	5/-	GT1C	10/-	UCL38	
DF92	3/6	GU20/27		UF80	12/6
DF96	7/6	GU20	40/-	UL84	8/-
DH63	6/-	HU50	20/-	VR13C	5/-
DK91	6/-	HL2	3/-	VR21	3/6
DK92	9/-	HL4	4/-	VR22	7/-
DL68	10/-	K78	27/6	VR40	10/6
DL92	5/-	KT38C	6/-	VR53	4/-
DL93	5/-	KT38	20/-	VR54	1/6
DL94	6/6	KT66	12/6	VR55	8/-
DL95	7/-	K781	17/-	VR56	4/6
DL96	7/6	K7Z63	9/-	VR57	6/-
DL96	7/6	MH4	5/-	VR65	4/-
DL96	7/6	ML6	3/6	VR66	3/-
DL96	7/6	MRP5	5/-	VR75-30	
DL96	7/6	MRP5	5/-	VR78	5/-
DL96	7/6	MRP5	5/-	VR81	1/6
DL96	7/6	MRP5	5/-	VR100	6/-
DL96	7/6	MRP5	5/-	VR101/20	3/6
DL96	7/6	MRP5	5/-	VR106	3/6
DL96	7/6	MRP5	5/-	VR107	6/6
DL96	7/6	MRP5	5/-	VR108	3/6
DL96	7/6	MRP5	5/-	VR135	2/6
DL96	7/6	MRP5	5/-	VR136	4/-
DL96	7/6	MRP5	5/-	VR137	4/6
DL96	7/6	MRP5	5/-	VR138	4/6
DL96	7/6	MRP5	5/-	VR140	4/6
DL96	7/6	MRP5	5/-	VR142	4/6
DL96	7/6	MRP5	5/-	VR143	4/6
DL96	7/6	MRP5	5/-	VR144	4/6
DL96	7/6	MRP5	5/-	VR145	4/6
DL96	7/6	MRP5	5/-	VR146	4/6
DL96	7/6	MRP5	5/-	VR147	4/6
DL96	7/6	MRP5	5/-	VR148	4/6
DL96	7/6	MRP5	5/-	VR149	4/6
DL96	7/6	MRP5	5/-	VR150	4/6
DL96	7/6	MRP5	5/-	VR151	4/6
DL96	7/6	MRP5	5/-	VR152	4/6
DL96	7/6	MRP5	5/-	VR153	4/6
DL96	7/6	MRP5	5/-	VR154	4/6
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DL96	7/6	MRP5	5/-	VR160	4/6
DL96	7/6	MRP5	5/-	VR161	4/6
DL96	7/6	MRP5	5/-	VR162	4/6
DL96	7/6	MRP5	5/-	VR163	4/6
DL96	7/6	MRP5	5/-	VR164	4/6
DL96	7/6	MRP5	5/-	VR165	4/6
DL96	7/6	MRP5	5/-	VR166	4/6
DL96	7/6	MRP5	5/-	VR167	4/6
DL96	7/6	MRP5	5/-	VR168	4/6
DL96	7/6	MRP5	5/-	VR169	4/6
DL96	7/6	MRP5	5/-	VR170	4/6
DL96	7/6	MRP5	5/-	VR171	4/6
DL96	7/6	MRP5	5/-	VR172	4/6
DL96	7/6	MRP5	5/-	VR173	4/6
DL96	7/6	MRP5	5/-		

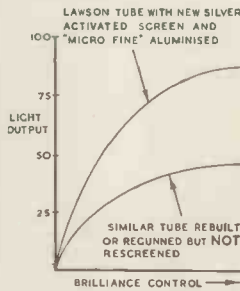
NEW—Quality Tools at cut prices.
ENGINEERS 12-in. ADJUSTABLE SQUARE WITH SPIRIT LEVEL 9/6.
5in. VERNIER CALIPERS WITH DEPTH GAUGE 9/6.
WHIT. OPEN END SPANNERS, drop forged and plated, set 6, 3/4 in. to 1 1/2 in., 13/6.
POCKET NEON TESTER, with retractable screwdriver, 5/-.
5in. SIDE CUTTERS 5/6.
5in. PLATED ROUND NOSE TAPERED PLIERS, 5/6.
7in. FLAT NOSE BOX JOINT TAPERED PLIERS, 8/6.
7 1/2 in. COMBINATION PLIERS, 6/-.
TUB. HACKSAWS (Eclipse type), 11/9.
H.S. TWIST DRILLS. Set of 7, 1/8 in. to 1/2 in., 4/-.
Full size in wallet, 5/-.
Set of 13—9/6.
Set of 17, 1/8 in. to 1/2 in. in wood case, 15/6.
Double Geared 1/2 in. Chuck hand drill 24/-.
OUR FAMOUS TRANSFORMERS. Input 200/250 v. Output tapped 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30 v., 2 amp., 24/6.
17, 11 v., 8 a., 30/-.
5 a., 24/6.
3.5 v., 9, 17 v., 1 a., 13/-.
P.P.
12in. SPEAKERS WITH 5in. TWEETERS by leading makers, 75/-.
Less than half list price.
NEW 12in. SPEAKERS, 12 watt (list price £12/12/-), £6/17/6.
NEW CELESTION OVAL SPEAKERS. 8 1/2 x 5 1/2 in. 24/-.
RELAYS. Single make contacts, 24 v. 25 amp., 15/-.
RELAYS. 4,000 ohm. S.M. or S.B., 6/-.
LAVOIS LABORATORY MICRO WAVE FREQUENCY METER. 300-600 Mc/s., £25.
P.V.C. Recording Tape. Finest Quality. 850ft. reels, 19/-.
HI-FI CRYSTAL MICROPHONES in Grey Bakelite case, 15/6.
G.B. ELECTRONIC CRYSTAL STICK MICROPHONE in polished steel case. 1 1/2 x 6 in., complete with lead and plated Bulgin jack plug, 42/6.
Weight 5 ozs.
F.W. METAL RECTIFIERS. 12/6 volt, 1 a., 7/6; 3 a., 13/-; 4 a., 17/6; 6 a., 27/6; 24 v. 2 a., 23/6; 12 v. 6 amp., 30/-; 12 v. 16 a., 45/-.
ARCO SLIDE SWITCHES. D.P.D.T. 2/6.
TOGGLE SWITCHES DPDT 3/6. SP 1/9.
MICRO SWITCHES, spring leaf, Make and Break, 5/6.
MAINS TRANSFORMER AND RECTIFIER giving 12 v. 1 a. D.C. Output, 19/6.
And with Output 30 v. 2 a., 33/6.
NICKEL NIFE BATTERIES. 1.2 volt. 2.5 amp. Size 3 x 2 1/2 x 1 in. Practically everlasting. 6/- or 3 for 16/-.
4 for 21/-.
Ex W.D. MORSE KEYS. 3/6, 6/- and 8/6.
1,000 NEW S.T.C. FREQ. CRYSTALS 10,555 kc/s. to 19,872 kc/s., 5/6 each. Plus 6d. postage. Lists available.
PAXOLIN PANELS 12 x 6 x 3/8 in., 3/6. P.P. 4ft. x 3 1/2 in. x 3/8 in. 10/6.
W/W RHEOSTATS 12 v. 1 a., 2/6; 5 a. 4 1/2 in. Dia. 10/6.
12 v. MINIATURE RELAYS. 1 1/2 x 1 1/2 x 1 in. Wgt. 1 1/2 ozs. S.P.C.O., 8/6. S.P.C.O. and 3 M. 9/6.
12 v. D.C. RELAYS 2 make 6/-; 2 for 11/6.
BENCH GEARED HAND-GRINDER. 6 x 1 in. stone 33/6.
BENCH VICE. 2 1/2 in. with clamp. 15/6.
EX. W.D. 12 v. D.C. Reversible Geared Motors. 2 1/2 x 1 1/2 in. Ideal for all model use, 16/6. Wgt. 10 ozs.
RELAYS.—WE HAVE 100,000 PLAIN AND SLUGGED WHICH WE CAN OFFER AT EXTREMELY COMPETITIVE PRICES TO INDUSTRIAL USERS.
Enquiries welcome for RELAYS to meet your requirements. Please state operating voltage and/or current. Contacts and applied voltage.
Lists sent on request. All post paid.

THE

RAID & ELECTRICAL MART

P.O. Box 9 G.P.O. Tunbridge Wells, Kent

LAWSON



EXPRESS SERVICE
 Orders received by 3 p.m. are dispatched same day. Special direct services to Ireland and Scotland.

LAWSON TUBES LTD.
 156, PICKERSLEIGH ROAD, MALVERN, WORCS.
 TEL: 3798

DIRECT REPLACEMENT Reprocessed TV TUBES

FULLY GUARANTEED 12 MONTHS

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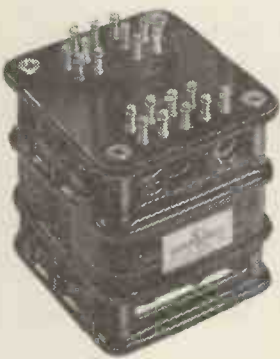
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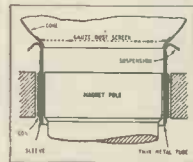
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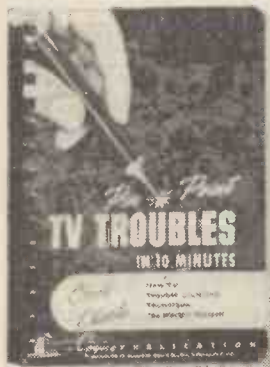
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ELECTRONIC design, development, prototype manufacture. Sub-contract work undertaken. London area.—Box 5013. [9579]

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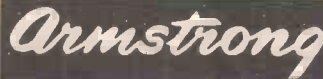
PAKISTAN
PUNJAB UNIVERSITY, Lahore
APPLICATIONS are invited for the post of Laboratory Technician in the English Language Unit of the Punjab University. Duties, to have charge of a small phonetics laboratory, to act as recording engineer, to devise new applications of instrumental techniques and to train Pakistani assistants, as necessary. Candidates should have a thorough electrical training, and a good knowledge of electronic sound equipment. SALARY on scale £940X£30 to £1,050. Oversea allowance (maximum): single £525, married £995 children's and home education allowances. Free furnished accommodation. Installation grant. Medical scheme. Fares paid, and for family (including mid-tour passages for children in U.K.) and for home leave. Employer's portion U.K. superannuation paid. Contract with British Council for two years, renewable from 1961. Secondment from home employment may be arranged. Write, quoting N.S.W(61) and enclosing stamped, addressed foolscap envelope, to Director, Recruitment Department, British Council, 85, Davies St., W.1. For further particulars and application form to be returned completed within two weeks of receipt. [9643]

ROYAL VICTORIA HOSPITAL.

ELECTRONIC TECHNICIAN.
APPLICATIONS are invited for the post of Electronic Technician in the Clinical Pathological Department (including Radioactive Isotopes) of the above hospital. The person appointed will be required to have experience in electronic instrumentation and an ability in, and enthusiasm for, the scientific application of electronics. The post is one which will almost certainly increase in responsibility and scope. The salary will be in the range £710 to £905 per annum.
APPLICATIONS to be made on a form obtainable (with further particulars) from the Secretary, Belfast Hospital Management Committee, Royal Victoria Hospital, Grosvenor Road, Belfast, 12, to arrive not later than 1st August, 1961. [9638]

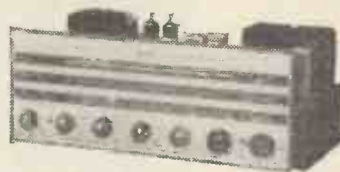
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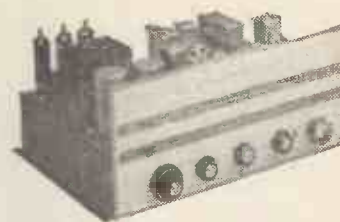
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APPLICATIONS are invited for the post of research technician at the Gatty Marine Laboratory, St. Andrews. The successful applicant will be required to assist with research on the study of the nervous systems of lower animals by electronic or chemical techniques. Salary in the range £400-£500 according to age and qualifications; appointment for 3 years. There are facilities for further training. Applications, with names of two referees, should be lodged not later than 31st July, 1961, with the Joint Clerk to the University Court, College Gate, St. Andrews. [9642]

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BRISTOL TECHNICAL COLLEGE.

SCHOOL OF NAVIGATION.

TECHNICIAN required for School of Navigation and Marine Radio and Radar. DUTIES will be to service and maintain radio and electronics equipment, including Marine and Aircraft communication sets and demonstration equipment, to issue and record stores and spares.

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THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY, Sackville Street, Manchester, 1.

A Technician and a Senior Technician are required in the Chemistry Department to work with a research team engaged on important chemical research, and specifically to devise, develop and operate electronic equipment playing a vital part in these researches.

A recognised qualification in electronics would be desirable, but not essential. APPLICANTS should have a good theoretical knowledge with either industrial experience or H.M. Forces training.

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AN addition to the above rates of £30 per annum (Technician) and £30-£50 per annum (Senior Technician) is payable for approved qualifications. 5-day week. Superannuation scheme.

APPLICATIONS with full details quoting Ref. No. C13, should be addressed to the Bursar at the above address to arrive not later than one week after appearance of advertisement. [9616]

CENTRAL London firm requires competent organisers of postal and equipment sales. Age immaterial, refs. wanted. Part-time application considered.—Box 2462. [0133]

ARE you interested in joining a team of Design and Development Engineers engaged in producing auto-pilots for new helicopters now under development?

LOUIS NEWMARK, Ltd., of Croydon, are desirous of appointing Design Engineers and Assistant Engineers to these posts, senior and junior appointments are available.

PLEASE send details of qualifications and experience to Personnel Manager, Louis Newmark, Ltd., Gloucester Road, Croydon. [0337]

YOUNG electronic engineer required with knowledge of transistor circuits; attractive salary, progressive position, contributory pension scheme.—Box 5016. [9587]

UNLICENSED Aircraft Radio Engineer required for service in the Persian Gulf area. APPLY to: The General Manager, Airwork Services, Ltd., Bournemouth (Hurn) Airport, Christchurch, Hants. [9164]

STORE-KEEPER preferably conversant with valves, for Paddington area; salary above average, age or nationality no bar.—Z. & I. Aero Services, 14, South Wharf Rd., W.2. Amb. 0151. [9647]

REDIFFUSION require test engineers. Television production experience an advantage. Excellent rates of pay, superannuation scheme. Canteen.—Applications to: Chief Engineer (Test Department), Rediffusion Vision Service, Ltd., Fullers Way South, Chessington, Surrey. [9589]

INSTRUMENT mechanics required for work on elec. measuring instruments, m/coil, m/iron meters, rate for fully expd. men 6/3 hr. plus bonus, perm. work; holiday arrangements honoured.—Anders Electronics, Ltd., 103 Hampstead Rd., N.W.1. Eus. 1639. [9575]

EXPLORATION company requires Electronic Engineers with practical experience and theoretical knowledge of HF equipment. Must be prepared to travel; excellent prospects.—Full personal particulars and salary requirements to Box 5027. [9615]

ELECTRONICS engineers: Men or women with at least O.N.C. or equivalent experience to do final tests and inspection on a wide range of high accuracy instruments. These are permanent staff positions with pension fund and club room facilities.—Electronic Instruments, Ltd., Richmond 6434. [0124]

PAPER-MAKING company in Hampshire requires maintenance technicians for electronic equipment. Applicants up to 40 years of age should have good industrial, TV, radio or radar servicing experience. The work is interesting and varied as continuous development is in hand. Successful applicants would work shifts earning more than £21 per week. A profit-sharing scheme is in operation.—Box 5037. [9641]

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YOUNG electronics engineer required, O.N.C. or equivalent, minimum qualifications and some experience of domestic radio, television and audio equipment preferable; attractive position with good prospects; facilities for further education.—Write to: The Chief Engineer, Radiospares Ltd., 4-8, Maple St., London, W.1. [9649]

TECHNICAL writer required for compiling radio and television service manuals; must have good theoretical and practical knowledge of radio and television receivers, and the ability to write good English.—Apply with details of age, experience, etc., to Personnel Officer (Ref. P.C.555), Murphy Radio, Ltd., Welwyn Garden City, Herts. [9620]

TEST engineers.—Applications are invited from test engineers with previous industrial experience of testing radio communications, receivers and transmitters; successful applicants will be offered positions on the company's permanent staff; starting salaries commensurate with qualifications and experience.—Apply in writing, giving full details to Personnel Officer, Redifon, Ltd., Broomhill Rd., S.W.18. [0252]

METROPOLITAN Police—engineering department require wireless mechanic for maintenance of mobile V.H.F. R/T equipment; basic pay 200s 8d per 42-hour week; also merit pay scheme with awards up to 45s per week according to skill and experience; overtime and allowances averaging about 100s per week payable when working shifts.—Written applications to Wireless Engineer, Metropolitan Police Wireless Station, Grove Park, Camberwell, S.E.5. [9631]

MEDICAL Research Council require electronic engineer to assist in development, construction, maintenance and experimental application of equipment used for the investigation of balance and hearing; salary according to age and experience within the range £710-£870 (Senior Technician 1).—Apply in writing, stating age, qualification and experience to Dr. C. S. Hallpike, F.R.S., Director, Otological Research Unit, M.R.C., National Hospital, Queen Square, W.C.1. [9634]

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INTERNATIONAL AERADIO, Ltd., has periodic vacancies overseas for Radio Technicians, City and Guilds Intermediate Telecoms, an advantage but not essential if applicant has considerable experience installation/maintenance H.F./V.H.F. low/medium power communications. Equipment; applications ex-service personnel or fully skilled categories welcomed; posts are permanent and pensionable; normally accommodation is provided with tax free emoluments equated to local conditions; additional marriage and child allowances; free air passages and insurance; kit allowance; generous U.K. leave; apply in writing.—Personnel Manager, 40, Park St., W.1. [0262]

VHF/UHF radio engineer for planning multi-channel systems associated with H.F. radio and coaxial cable projects, the engineer is required to have a good practical knowledge of VHF/UHF radio equipment, multi-channel carrier equipment, and allied signalling and switching systems, employment in first instance offered on a three-year contract basis, with salary according to qualifications and experience, holiday arrangements respected this year, reasonable removal expenses reimbursed.—Write giving brief details of qualifications and experience to: Staff Manager, Cable and Wireless Ltd. Mercury House, Theobalds Rd., London, W.C.1. [9646]

AIR Ministry have vacancies for Civilian Radio Technicians at R.A.F. Sealand, Cheshire, and various other R.A.F. stations throughout the United Kingdom, for the servicing, repair, modification and testing of air and ground radio and radar equipment. Commencing salary (National) (according to age) is £630 to £810 p.a., max. salary £930 p.a. Rates are subject to small deduction at certain provincial stations. A limited number of houses may be available for renting at West Kirby, some 15 miles from Sealand. Apply to Air Ministry, C.E.2, Princes House, Kingsway, London, W.C.2, or to any Employment Exchange quoting City O/N 3057. [0037]



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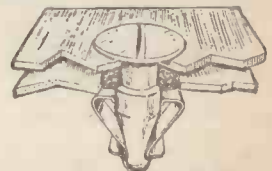
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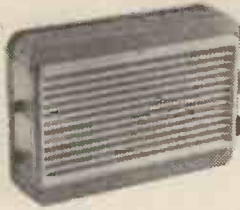
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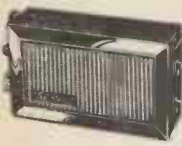


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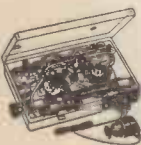
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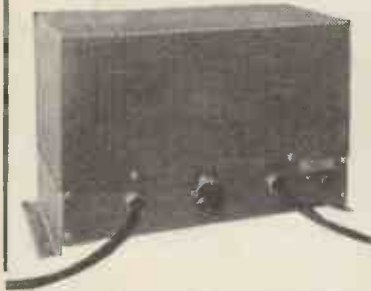
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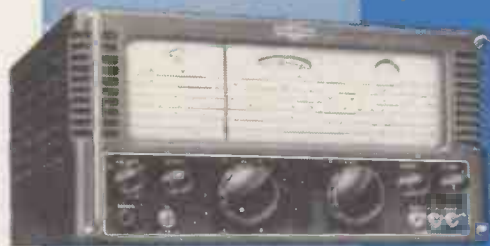
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