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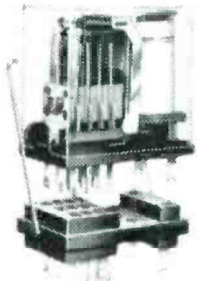

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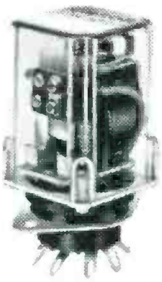

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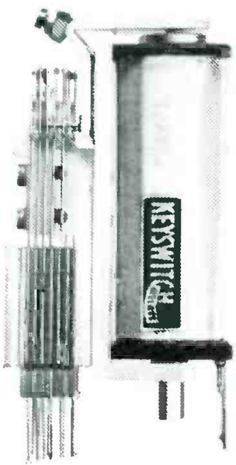

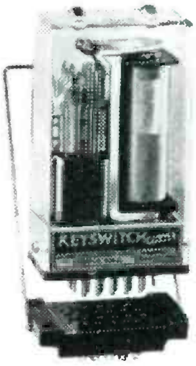

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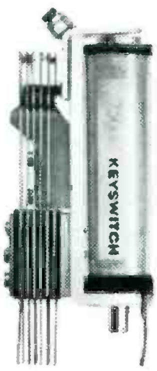

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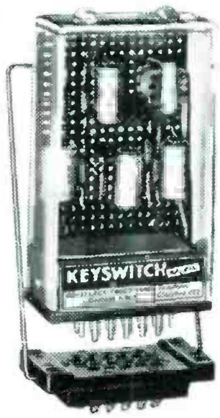

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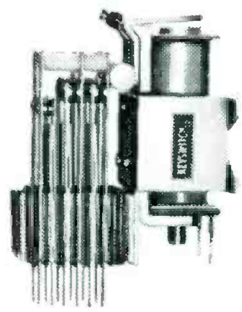

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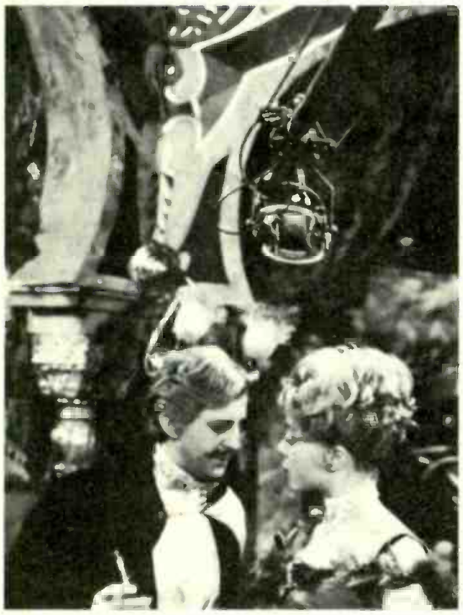

This month's cover. *The tête-à-tête being overheard by a microphone, a scene from a production at the B.B.C. Television Centre, prettily introduces two features in this issue: 'Developments in Microphones' by H. D. Harwood (p. 58) and a microphone supplement. The microphone on the boom is a moving-coil type with a cardioid characteristic, a kind used extensively in television work.*

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Wireless World

Audio Myths, Maths and Measurements

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The other day a highly respected audio equipment manufacturer told us he was obliged to extend the frequency response of his amplifiers far beyond the normal requirements of hearing because people insisted on testing his products with square waves and wanted to see nice right-angled corners on their oscillograms. This is a case of objectivity in measurement gone crazy, to the extent of bringing in irrelevant, visual subjective criteria.

The imminence of the London Audio Fair reminds us that audio engineering, of all the branches of electronics, seems particularly prone to this irrational type of approach. The very word "audiophile" suggests that the hardware possesses some kind of human personality, best understood through psychology rather than physics. Readers of this journal are not likely to be caught in such mental traps. But it is still possible for us to fall into rather narrow—and perhaps even misleading—ways of thinking about performance testing. The trouble is that the criteria in common use tend to arise from the types of instruments that can be readily manufactured. For example, we glibly talk of "frequency response"; but, as H. D. Harwood gently reminds us in the captions to his graphs (pp. 74-78 this issue), it is really output/input amplitude ratios we are measuring, at a number of different frequencies. Frequency response curves are in fact graphical representations of transfer functions (without the phase information), in terms of ω rather than d/dt. And the ω comes in because we are using the rather artificial sinusoidal form of excitation. Sine-wave testing is convenient and oscillations of adequate purity are easy to generate, but sine waves as such hardly ever occur in normal sound programmes —perhaps an occasional solo note on a flute. It's odd that we resort to them so much.

Also easy to generate are noise signals, and their use in testing audio equipment is now well established. This type of excitation, whether it be white, pink or what-have-you noise, can, of course, be considered as providing simultaneously a wide range of frequencies (as can the step functions in square-waves) and herein lies its usefulness for rapid response /frequency testing. A more realistic way of looking at noise is simply as a random function of time. As such it is much more like the transients in music or speech than are sine waves. Its statistical properties can be utilized for testing by means of correlation computing techniques. With white noise excitation, the cross-correlogram between the input and output time functions is, in fact, the impulse response (multiplied by a constant) of the device under test.

Computers are transforming not only measurement techniques but methods of system analysis. The current interest in state variables* is a case in point. Audio transducers, say, or filters, are often represented by second (or higher) order differential equations, but these can be difficult to handle by conventional methods, particularly if non-linearities are present. State variables are variables related to energy storage elements in a system (e.g. current through an inductor) and since these elements can be represented by first-order differential equations, the set of "state space" equations describing a device or system can be readily solved on analogue or digital computers. It remains to be seen how useful this approach will be in practical design work, but at least it opens another window to let us look at the old familiar scenery with a fresh eye.

*The concept of state, first used explicitly by Newton in laws of motion, was later developed into a method of analysing dynamical systems by Poincaré for his work on celestial mechanics.

How Important Is Detection?

An alternative to the common envelope detector, using integrated circuits

*by R. C. V. Macario,** B.Sc., Ph.D., M.I.E.E.

A systematic study of the processes of detection in an a.m. receiver indicate that detection plays a bigger role in the final performance than one would deduce from the hardware and/or cost breakdown. Previously any departure from the simplest envelope detection schemes would have been uneconomical because of the relatively small performance improvement for the added circuitry, but with the advent of integrated circuits alternative approaches may hold promise. One of these alternatives is described in this article. The operation indicates that a fresh look can be taken at the ratio of linear gains in the i.f. and a.f. sections, as well as at the selectivity performance of these two sections. A practical system designed from the result is also described. This circuit can be added to existing receivers, and comparative listening tests have indicated better reception under selective fading conditions, in particular on short-wave bands. The improvement would be greater if one were prepared to add a carrier selection filter (with no phase shift) ahead of the system. The study also suggests further ways in which reception under selective fading conditions may be realized.

IT is not an undue exaggeration to represent a typical broadcast receiver by a block diagram along the lines of Fig. 1. The relative amounts of hardware are indicated for the two main sections, these being the selectivity and audio stages respectively. In terms of cost, the distribution would be even more remarkable. Considering how important a function is detection† or demodulation, it is surprising how small a part of the receiver is allocated to this undertaking.

In this article a brief review of the principles underlying the process of recovery of the transmitted signal is made. The conclusions drawn indicate that certain changes in the familiar superheterodyne structure may well take place with the advent of more easily available complex circuits as a result of integrated circuit technology. A number of these features are illustrated experimentally. In particular, a scheme is described by which additional non-linear circuitry may be added to an existing receiver to provide faithful demodulation of low level signals.

Theory

One can reasonably assume that an a.m. signal leaving a transmitter consists of a stable carrier surrounded on each side by a pair of sidebands of fixed bandwidth, with a modulation depth that never exceeds 100%. During propagation to the receiver the signal may suffer transmission impairment, which we assume is a linear function. That is, if we consider a carrier of frequency ω_c, two individual sidebands $\omega_c - \omega_m$ and $\omega_c + \omega_m$, and a modulation depth m, the received signal has the form

$$e_a(t) = a\cos(\omega_c t + \Phi_c) + \frac{am_u}{2}\cos(\omega_c + \omega_m t + \Phi_u) + \frac{am_l}{2}\cos(\omega_c - \omega_m t + \Phi_l)$$

where

a = carrier amplitude at receiver
m_u = relative u.s.b. depth of modulation
m_l = relative l.s.b. depth of modulation
Φ_c, Φ_u, Φ_l are relative component phase shifts at the receiver aerial.

The general case of a broadband modulation signal is obviously more complex than that of the single tone as written here, but the latter suffices to demonstrate certain features we wish to show.

At the same time our wanted signal arrives surrounded by a very large number of similar transmissions, which are, we hope, at least separated in frequency by carrier differences of twice the minimum acceptable audio bandwidth.

Mixing

Assuming we have no cross modulation in the first stages of the receiver, a stage of mixing faces the signal. For a self-oscillating transistor mixer a type of square-law signal transfer

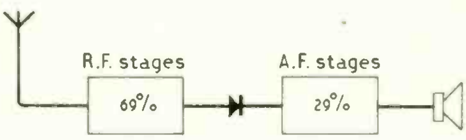

Fig. 1. Basic block schematic of a.m. broadcast receiver.

is employed, with the signal and a locally generated carrier $e_o = \cos(\omega_o t + \Phi_o)$, being superimposed, producing an intermediate signal e_i.

Writing

$$e_i = k.(e_o + e_a)^2$$

$$\therefore e_i = k\Big[\cos(\omega_o t + \Phi_o) + a\cos(\omega_c t + \Phi_c) + \frac{am_u}{2}\cos(\omega_c + \omega_m t + \Phi_u) + \frac{am_l}{2}\cos(\omega_c - \omega_m t + \Phi_l)\Big]^2$$

The mixer stage is followed by a frequency selective amplifier. This last strange sounding description of an i.f. amplifier is brought in to give an excuse for mentioning how

*Division of Electrical Engineering, University College of Swansea.

†H. S. Black has suggested the word "remodulation" for product detectors and the like, but keeps to "detector" for the simple diode circuit.

he choice of the value of $\omega_o - \omega_c$ affects the etymology of he names given to receiver systems[1]. This is most easily lone by means of a table:

Choice of $\omega_o - \omega_c$	System Name
$\omega_o \neq \omega_c$	*hetero*dyne
$\omega_o - \omega_c = \omega_i < \omega_c$	*superhetero*dyne
	i.e. supersonic also known
$\omega_o - \omega_c = \omega_i > \omega_c$	as singlespan[2]
$\omega_o = \omega_c\ \omega_i = 0$	*synchro*dyne[3]

The *homo*dyne does not have a separate oscillator and is described below. *Auto*dyne refers to a self-oscillating mixer and so does not constitute a complete receiver system.

Returning to our main discussion and the previous equation, assuming the i.f. amplifier is tuned to $\omega_i = \omega_o - \omega_c$, the only terms which will come out of the i.f. will be the cross product terms

$$\begin{aligned} e_{i\ \text{i.f.}} &= \frac{a}{2}\cos(\overline{\omega_o - \omega_c t} + \Phi_o - \Phi_c) \\ &+ \frac{am_u}{4}\cos(\overline{\omega_o - \omega_c - \omega_m t} + \Phi_o - \Phi_u) \\ &+ \frac{am_l}{4}\cos(\overline{\omega_o - \omega_c + \omega_m t} + \Phi_o - \Phi_l) \end{aligned}$$

There is thus no distortion. Departure from the square law will of course create intermodulation products, but of more concern are the other signals reaching the mixer. Each signal will undergo a similar process to the one just described and both the cross-product and square terms can give frequencies which will fall within the i.f. passband. This is the reason why in a review of broadcast receivers[4] it was stressed that adequate selectivity before the mixer stage was in fact more important than selectivity after the mixer stage.

The main reason for having a sharp sided filter in the i.f. section is to improve the adjacent channel selectivity should one wish to receive a weak station close to a strong unwanted signal.

A way of reducing the r.f. selectivity requirement, however, is to have a linear switched modulator in which the local oscillator signal $\cos(\omega_o t + \Phi_o)$ effectively multiplies the incoming signals, then

$$e_i = \cos(\omega_o t + \Phi_o) \cdot \left[a\cos(\omega_c t + \Phi_c) + \frac{am_u}{2} \ldots + \frac{am_l}{2} \ldots \right]$$

leading to exactly the same result for the ideal square law device, but without the likelihood of interfering cross-product terms.

This, of course, advocates a separate local oscillator and a balanced on/off modulator, which could well be economic with integrated circuits[5] and leads to better spurious signal immunity[6].

Synchrodyne

It is worth noting that in the case of the synchrodyne we make $\omega_o = \omega_c$ and $\Phi_o = \Phi_c$, that is, mix with an oscillation which has exactly the same phase and frequency as the received carrier. The filtered output becomes

$$\begin{aligned} e_{i\ \text{a.f.}} &= \frac{a}{2} + \frac{am_u}{4}\cos(\omega_m t + \Phi_c - \Phi_u) \\ &+ \frac{am_l}{4}\cos(\omega_m t + \Phi_c - \Phi_l) \end{aligned}$$

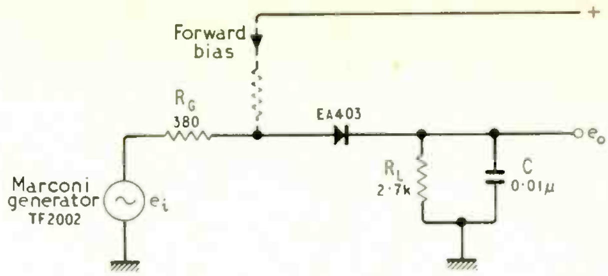

Fig. 2. Conventional diode envelope detector.

Writing $m_u = m_l + \Delta m$

$$\begin{aligned} e_{i\ \text{a.f.}} &= \frac{a}{2} + \frac{am_l}{2}\cos\left(\omega_m t + \frac{\Phi_u + \Phi_l}{2}\right) . \cos\left(\frac{\Phi_u - \Phi_l}{2} - \Phi_c\right) \\ &+ \frac{a\Delta m}{4}\cos(\omega_m t + \Phi_u - \Phi_c) \end{aligned}$$

As it is rather unlikely that $m_u = m_l$ when $\Phi_u - \Phi_u - 2\Phi_c = \pi$, under extreme selective fading conditions, the ideal synchrodyne receiver will always recover an undistorted component of the modulation, but reduced amplitude. However, in practice it is rather difficult to derive a locally locked carrier without a phase error, and this leads to distortion of the recovered signal[7]. The distortion is very similar to that pertaining to a homodyne detection scheme described below, so further description will be delayed till then.

Detection

Let us suppose our signal arrives at the detector stage without further distortion. (This may be more difficult than one can easily suppose. For example, it is well known that in s.s.b. and i.s.b. transmissions the necessary curtailment of the low audio frequencies, and extra sharp filters, destroy speech quality.) Fig. 2 shows a basic envelope detector. The capacitance is assumed to be a short circuit to the r.f., but open circuit to the i.f. This is not practical for an i.f. of 465 kHz; there is an error of about 10%, which means that the full modulation index range cannot be processed in this circuit.

Of more importance, possibly, is the nature of the signal recovered when it suffers transmission impairment and has a form similar to that assigned to $e_u(t)$ above. Then it can be shown that the envelope is given by[8]

$$\begin{aligned} E(t) = \Bigg\{ &\left[a + \frac{am_u}{2}\cos(\omega_m t + \Phi_u - \Phi_c) + \frac{am_l}{2}\cos(\omega_m t + \Phi_c - \Phi_l) \right]^2 \\ &+ \left[\frac{am_u}{2}\sin(\omega_m t + \Phi_u - \Phi_c) - \frac{am_l}{2}\sin(\omega_m t + \Phi_c - \Phi_l) \right]^2 \Bigg\}^{1/2} \end{aligned}$$

Apart from the fact that the envelope, which started with the form $am\cos(\omega_m t + \Phi)$, certainly has changed its relative depth of modulation, harmonics of ω_m are also generated. These are more disturbing than loss of signal.

The distortion is further aggravated if the diode is not operated over its linear range. That the diode should operate in a linear mode is further required in order to gain the apparent demodulation of a weak signal by a strong one[9]. The degree of suppression for a linear diode is[1,9]

$$\left[\frac{\text{Wanted strong signal modulation}}{\text{Unwanted weak signal modulation}}\right]_{\text{after d'tion}} = \frac{1}{2}\left[\frac{e_{\text{strong}}}{e_{\text{weak}}}\right]^2_{\text{before d'tion}}$$

This, as well known, explains why about an 18 dB adjacent

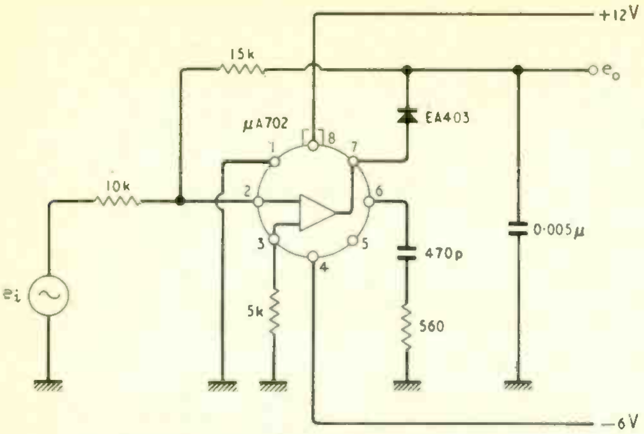

Fig. 3. Amplifier/diode envelope detector.

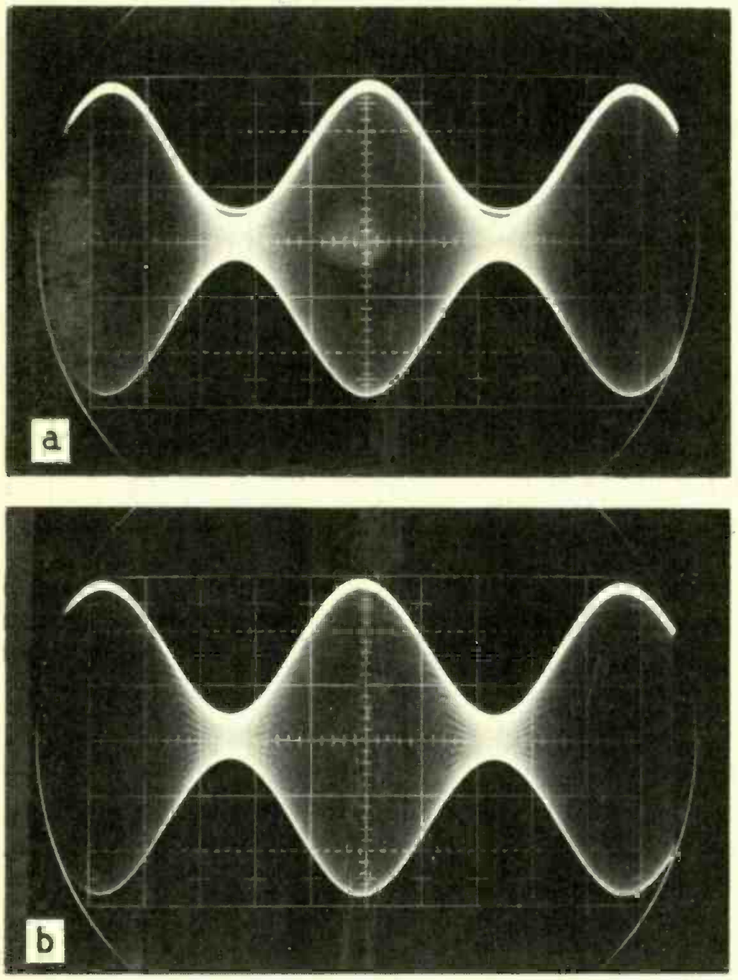

Fig. 4. Observed waveforms: (a) response of Fig. 2 circuit; (b) response of Fig. 3 circuit. In each case the 1kHz detected envelope is superimposed on the 470kHz, 80% modulated input carrier, adjusted so that waveforms have equal amplitude. The carrier level was 1 volt peak-to-peak.

channel selectivity in the i.f. of standard receivers is acceptable.

If the diode is operated at a low level on the other hand, its characteristic may no longer be linear and no apparent demodulation is obtained at all,[9], in addition to the increased distortion just mentioned. Unfortunately, diodes with good linear characteristics usually have a forward conductance threshold. This can, however, be reduced by forward biasing. Another way is to use an amplifier/diode arrangement as shown in Fig. 3[10].

Fig. 4 compares the performance of these two arrangements for 1V peak-to-peak 450 kHz carrier, modulated with a 1 kHz tone to a depth of 80%. The value of the smoothing capacitor C is chosen from the formula

$$C = 1/R_L\sqrt{\omega_c\omega_m}$$

which gives about the optimum value.

Each illustration in Fig. 4 shows the recovered envelope superimposed on the input waveform. The diode circuit gave an 8 dB envelope amplitude loss compared with a gain of 3 dB for the amplifier/diode arrangement. The power gain difference is of course much greater due to the different source impedances. The distortion due to the unsupported diode at low carrier levels is easily seen. Both circuits distort, however, if the modulation depth is raised to 90% because of the necessary choice of the capacitor C.

Homodyne Detection

The distortion referred to earlier on the envelope of a severely impaired signal increases as the modulation depth is increased. In the homodyne system energy is put in at the same frequency (derived directly from the signal, not from a synchronized oscillator as in the synchrodyne [1,3]) an immediate result of which is to reduce the depth of modulation and hence envelope distortion. Crosby[11] described a system along these lines as "exalted carrier reception," but the difficulties of selecting out the carrier with a crystal circuit and adding it to the signal with the proper phase relationship were not to be envied.

An alternative method of obtaining knowledge of the state of the instantaneous carrier is to note whenever the incoming signal crosses zero amplitude. A zero crossing detector does just this and usually produces a square wave with a fundamental frequency equal to that of the signal oscillation within the modulated envelope $E(t)$. This signal, however, differs slightly from that of the carrier $\cos(\omega_c t+\Phi_c)$, and is given by[8]

$$e_z = \cos(\omega_c t+\Phi_c+\psi)$$

where $\psi =$

$$\tan^{-1}\left[\frac{\frac{am_l}{2}\sin(\omega_m t+\Phi_c-\Phi_l)-\frac{am_u}{2}\sin(\omega_m t+\Phi_u-\Phi_c)}{a+\frac{am_u}{2}\cos(\omega_m t+\Phi_u-\Phi_c)+\frac{am_l}{2}\cos(\omega_m t+\Phi_c-\Phi_l)}\right]$$

This fixed amplitude carrier can be added to the signal and used to switch the detecting diode in an on/off mode and thereby operate faithfully up to 100% modulation level. The detected components are those remaining after product mixing, namely, multiplying e_a by e_z, then

$$E_z(t) = \frac{a}{2}\cos\psi + \frac{am_u}{4}\cos(\omega_m t+\Phi_u-\Phi_c-\psi)$$

$$+\frac{am_l}{4}\cos(\omega_m t+\Phi_l-\Phi_c+\psi)$$

The result is similar to that obtained for ideal synchrodyne reception, except for the term $\psi(t)$. (It can be reduced to zero if the sidebands are filtered off before zero-crossing detection, i.e. synchrodyne.)

At first sight the result looks rather different from the expression for the envelope of the original signal $E_r(t)$, but if one studies the two results for the important selective fading condition when the phase of the carrier is rotated

90° relative to the two sidebands, one finds they are similar. For example, letting

$$m_u = m_l = m,$$

$$\Phi_u = \Phi_l = 0, \Phi_c = \pi/2$$

then $E_r = \sqrt{\left(a^2 + \frac{a^2m^2}{2} + \frac{a^2m^2}{2}\cos 2\omega_m t\right)}$

showing the modulation is reduced as well as doubled in frequency.

For the zero crossing homodyne scheme we have:

$$E_z = \frac{a}{2}\cos\psi + \frac{am}{2}\cos\left(\omega_m + \frac{\Phi_u - \Phi_l}{2}\right) \times$$

$$\cos\left(\psi + \Phi_c - \frac{\Phi_u + \Phi_l}{2}\right)$$

which becomes

$$= \frac{a}{2}\cos\psi - \frac{am}{2}\cos\omega_m.\sin\psi$$

Clearly ψ will not have, nor can we choose, a value which will recover the modulation in all cases.

The actual value of ψ will be, for this case,

$$= \tan^{-1}(m\cos\omega_m t)$$

$$= m\cos\omega_m t - \frac{m^3}{3}\cos^3\omega_m t + \ldots$$

or, for small percentage modulations,

$$= m\cos\omega_m t$$

If this value is substituted into the expression for E_z, it can be shown that E_z is not dissimilar to the envelope $E_r(t)$. (In the synchrodyne case the distortion is missing, but so is the modulation.)

The result is more clearly illustrated by Fig. 5. The top waveform shows the unimpaired signal, the next waveform the detected signal when the carrier phase is rotated by 90° during transmission, and the bottom waveform shows the instantaneous phase angle ψ of the zero crossing waveform. (When there is no impairment $\psi(t) = 0$, of course.)

The interesting feature of Fig. 5, is that though the modulation signal is missing from either detected signal, it is retained by the phase term. Clearly, if one were to use both the envelope and phase information, added in a proper manner, much of the familiar short-wave phase distortion could be reduced.

The remainder of this article is therefore devoted to a description of a circuit by which the zero-crossing waveform, and hence $\psi(t)$, may be realized in a receiver, and of a detector utilizing this signal to achieve a very linear performance over a wide dynamic range.

Practical System

A practical system by which a zero-crossing detection signal can be generated falls within the sphere of digital circuit technology; as a result a large number of alternative approaches can be contemplated. The one to be described, therefore, is mainly illustrative. Its primary purpose is to demonstrate the features necessary for the system to operate satisfactorily. These features are: (1) the switching signal e_z must be free of amplitude modulation, and (2) should approach as nearly as possible an ideal square wave; (3) if the zero crossing signal fails during a deep fade or a 99% modulation dip, no interruption signal appears in the signal path.

A circuit system which goes some way towards meeting the requirements just set down is shown in Fig. 6. The i.f. signal available in the existing receiver is picked off by a high gain amplifier. This amplifier need not have a linear characteristic, but must limit symmetrically. The partially limited signal is then fully limited by a stage having a sharp threshold characteristic, viz., a Schmitt trigger (μL914) or a level comparator (μA710). The threshold levels of this circuit are arranged by proper d.c. levelling to correspond as closely as possible to the zero crossing level of the incoming i.f. signal—point (1). The output then consists of a sharply rising on/off waveform constituting e_z—point (2).

If the input i.f. signal is at too low a level, however, and so fails to exceed the threshold of the Schmitt trigger, the output e_z also fails. Since this interruption is effectively added to the wanted signal, when it is weakest, a balanced product detection arrangement is mandatory—point (3). A shunt modulator is shown, as this preserves knowledge of the input carrier level, i.e., d.c., which can be used for a.g.c. if a.g.c. is not derived elsewhere in the receiver. The diodes in the bridge operate as nearly ideal diodes, since they are switched by the strong derived carrier signal, e_z, and not the signal, i.e. the homodyne mode.

Fig. 7 illustrates the waveforms associated with a system such as Fig. 6 when using a Schmitt trigger. Fig. 7 (a) shows how the Schmitt waveform is almost completely free of modulation, and how the signal envelope is accurately preserved. If, however, the modulation depth is taken to 100%, the Schmitt necessarily drops out, but, in the main, this is taken care of by the balanced drive to the diode ring.

The fact that the zero crossing detector has a threshold and that we are dealing with amplitude modulated signals whose level may well periodically pass through this threshold creates an interesting circuit problem.

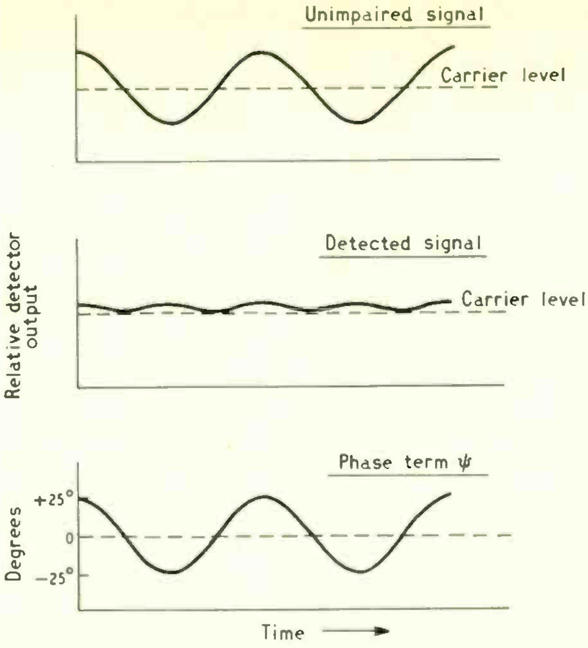

Fig. 5. Calculated waveforms for 50% modulated a.m. signal. (Carrier phase rotated 90° during transmission.)

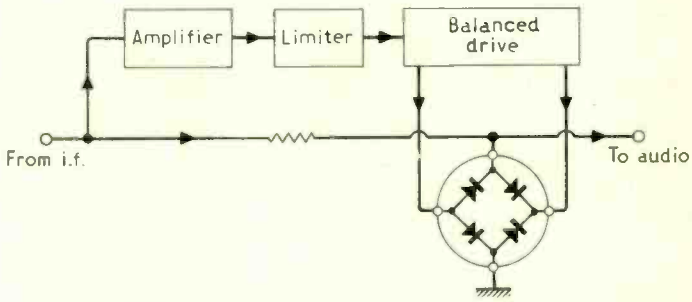

Fig. 6. Zero-crossing detection system.

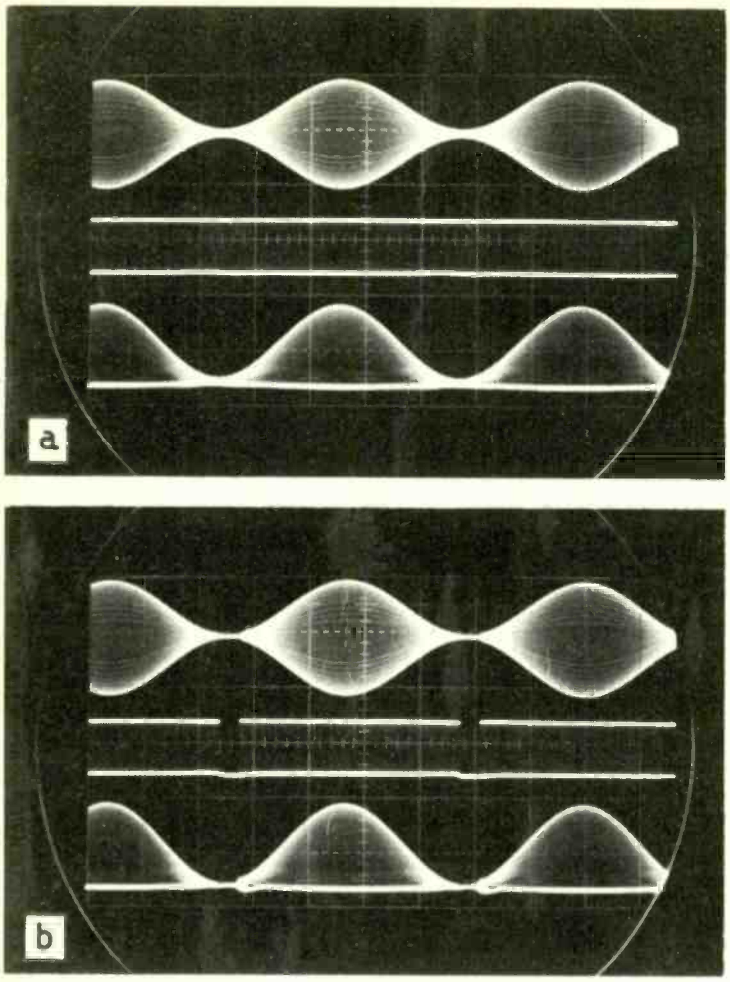

Fig. 7. Waveforms associated with a system such as Fig. 6, using a Schmitt trigger: (a) modulation depth 90%; (b) modulation depth 100%. In each picture the top waveform is the input carrier, the middle one the Schmitt waveform and the bottom waveform the demodulated output.

For example, if we assume a usable i.f. signal is a.g.c. controlled so it only varies in carrier level by 20 dB, but on top of this we are to guarantee a 99% modulation range, this means the circuit must be able to handle at least a 66 dB dynamic range, above the threshold.

Between stations, or on a very weak station, because of the threshold the detector will be modulated at a rate equal to the number of times the incoming signals cross the threshold (a few dB wide), and if the diode bridge is not balanced for a partial switching condition (at threshold) the noise breaks through into the audio stages—emphasised by the gain in the zero crossing loop!

The practical circuit given here, therefore, in addition to meeting the requirements set forth above, has the following features: (4) symmetrical limiting, (5) high sensitivity, (6) balanced pulse drive. The circuit is shown in Fig. 8.

The first module (μL900) acts as a symmetrically limiting amplifier, and has a low output impedance to drive the comparator (μA710). The comparator provides the principal sensitivity, producing a sharply rising square wave of approximately 3.6 V amplitude. A two-winding pulse transformer on a small toroid conveniently provides the balanced drive for the diode bridge (BAX52). For a 1 : 1 : 1 winding and the drive resistances shown about 2mA is available for switching the diodes, sufficient for input signals up to 5 volts peak. The primary inductance has to be at least 100 μH.

Performance

A measurement of circuit performance is shown in Fig. 9. The relative audio signal (after filtering) is plotted against input signal level, for various depths of modulation. At nominal signal levels a linear relationship exists. Any departure from a linear dependence is due to variation of the zero crossing pulse width. This tends to narrow at low signals as less drive is available to the μA710, and the diodes fail to switch at the same instant as the carrier crosses zero.

At low signal levels threshold breakthrough occurs, which is a function of any unbalance in the shunt detector circuit. Below this level the detector stops altogether, and all becomes quiet. This noise plateau has the effect of raising the noise level between stations. With more gain in the control loop of Fig. 8, however, it will move to a lower level. On the other hand, the detector operates at much lower signal levels, and hence the a.g.c. control is made more accurate, so that the circuit would nearly always operate at the nominal signal level of say 100 mV (r.m.s.) or less.

Listening Tests

The main interest with the circuit has, of course, been comparative listening tests on a.m. stations, subject to selective fading distortion.

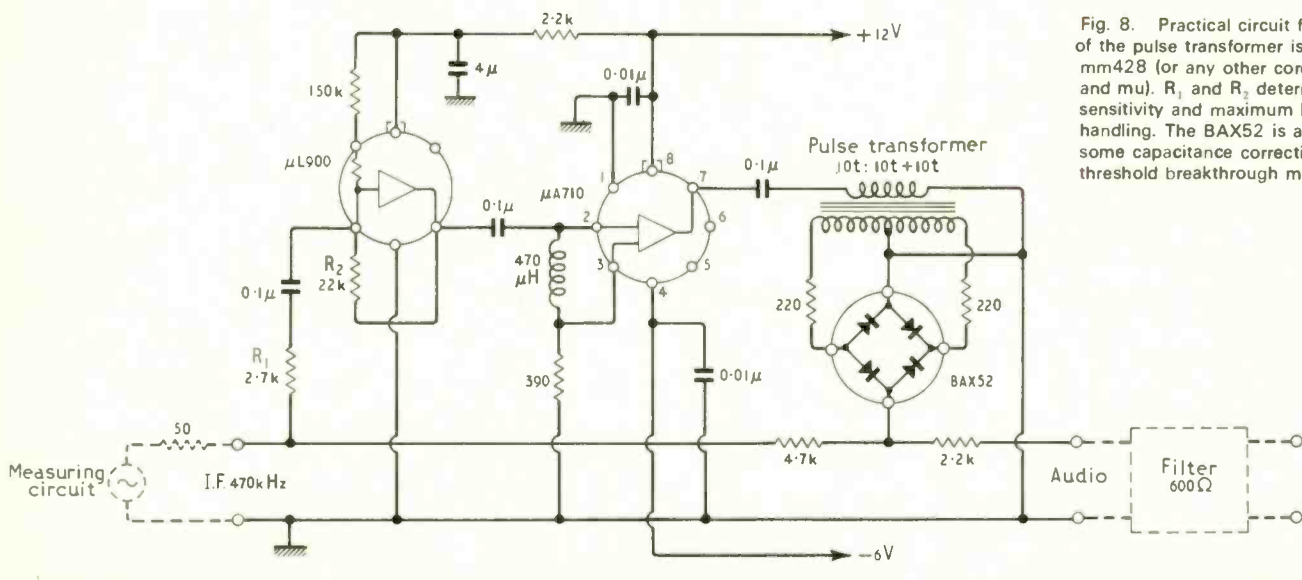

Fig. 8. Practical circuit for detector. The core of the pulse transformer is a Ferralex type mm428 (or any other core of similar size and mu). R_1 and R_2 determine threshold sensitivity and maximum linear signal handling. The BAX52 is a matched quad, but some capacitance correction for minimum threshold breakthrough may be necessary.

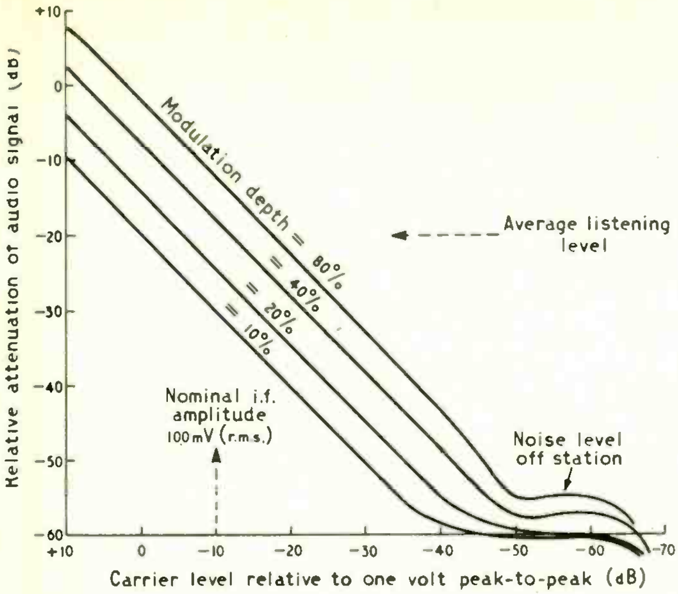

Fig. 9. Dynamic performance of Fig. 8 circuit (i.f. = 470kHz, a.f. = 1kHz).

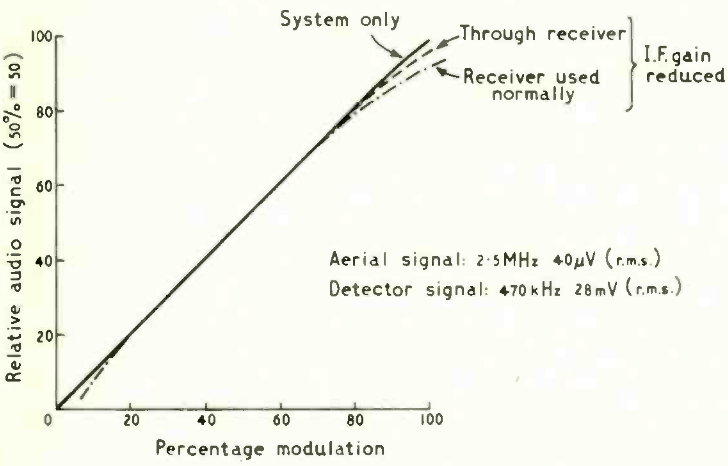

Fig. 10. Modulation depth curves.

Fig. 10 is included to show the difference between modulation linearity using the existing detector in a standard communications receiver (Eddystone Model 940) and the new system. Incidentally, when attempting to measure the distortion versus modulation percentage for the system on its own, the distortion was found to be below the distortion level quoted for the signal generator available.

The audio signals from Fig. 8, and from the receiver, were reproduced through the same good quality speaker system using a sharp cut-off audio filter. (This works as well as, or better than, narrowing the receiver i.f. bandwidth.) As might be expected, there is really no perceptible difference on a primary, say medium wave, broadcast, or to the operation of the receiver.

On the other hand, listening, for example, on the 15 MHz band, to speech broadcasts subject to the usual short wave distortions, it can be stated that the detection system described adds an extra sharpness and greater degree of intelligibility to the received signal, compared with the standard receiver. This may well be due to the more faithful following of the signal during carrier fade.

Acknowledgements. The writer wishes to acknowledge the interest of Dr. K. R. Sturley during the preparation of this article, Mr. B. Santaniello for assistance with many of the practical circuits evaluated, and Mr. W. Liew for calculating the results in Fig. 5.

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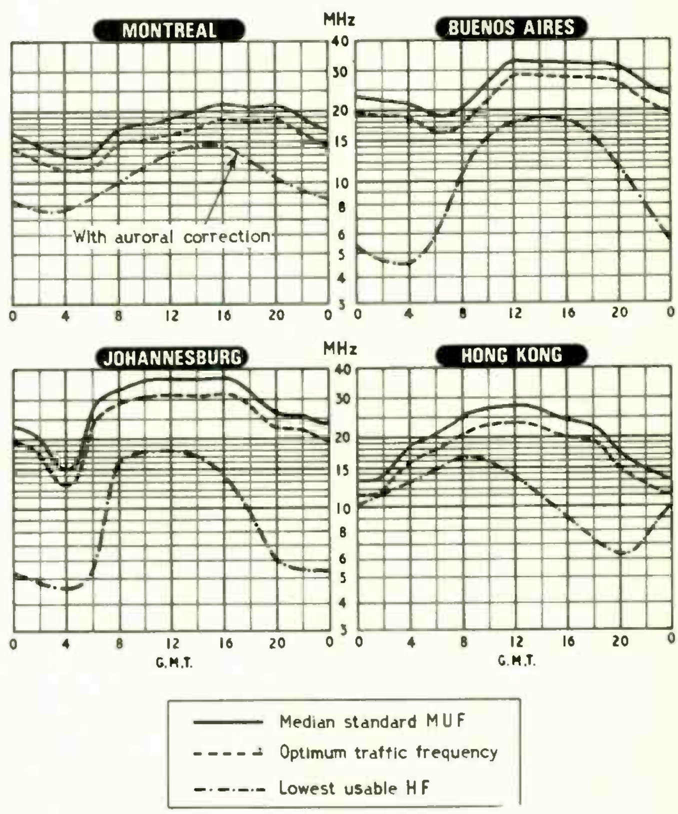
H. F. PREDICTIONS — APRIL



Predictions are based on an ionospheric index (IF2) of 132 and sunspot number 115. April/May is forecast as maximum of the current sunspot cycle.

Seasonal changes are evident on the two northern hemisphere routes, MUF curves are lower and smoother than recent months. On the trans-equatorial routes optimum frequencies remain around 25-30 MHz throughout daylight hours.

LUF curves were drawn by Cable and Wireless Ltd. for reception in the U.K. of point-to-point telegraphy. Their proximity to the optimum traffic frequencies is a guide to weak or no-signal periods on other types of service.

Developments in Microphones

A review of recent innovations in design

by H. D. Harwood, B.Sc.*

THERE has been a considerable amount of work on microphones during the last few years, resulting in improved frequency characteristics, better signal-to-noise ratio and smaller size. It is difficult to say at this stage whether all the variations are likely to endure or whether some will eventually predominate on the grounds of simplicity or price, but at the moment the spate of innovations shows no signs of slackening.†

Capacitor Microphones

Perhaps the class of microphone which has changed most generally over the past few years is the capacitor type. Most of these changes are associated with the design of the head amplifiers and biasing.

Circuit Design.—For many years the capsule of a capacitor microphone operated into a triode valve and special quiet valves have been designed which achieve the very high input impedance required for this purpose; however, in practice, the valves became noisy after a period of time and the reputation of capacitor microphones has suffered accordingly. When the field effect transistor, with its very high input impedance, was developed, one of the first obvious applications was to this problem, provided the necessary requirements could be met. The electrical noise from a capacitor microphone consists of three bands, at low, middle and high frequencies respectively. The low frequency portion is that generated by the resistive component of the gate input impedance. This consists of the capsule and input capacitances in shunt with the resistance of the gate input circuit and has a "red" noise spectrum falling at 6 dB per octave with respect to white noise. The middle frequency portion consists of the pink noise from the f.e.t., while the upper frequency portion consists of white noise from the f.e.t. The position is thus strictly analogous to that obtaining with a triode, and the problem is one of securing adequately low noise levels and a high degree of reliability.-The red low frequency noise can be reduced to an insignificant level by increasing the input resistance of the amplifier; f.e.ts do not present any difficulty in this respect and the other two sources of noise therefore remain the main problem. The pink and white noise levels vary considerably from type to type, and although special low-noise f.e.ts are now made, it is usually necessary to resort to selection in order to find quiet enough specimens; this involves considerable expense.

One potential source of trouble which so far has not proved serious is dampness of the capsule, resulting in lowered resistance across the capsule terminals. In the old designs, with a valve close to the capsule, the heat was sufficient to dry the insulation but with the advent of f.e.ts fears were expressed that dampness would prove a problem. It is to the credit of the designers that because of the use of improved insulating materials and other measures no trouble seems to have been met. One disadvantage with some types of f.e.t. however, is that the gain appears to wander over a period of time. Users requiring extreme stability of gain should therefore check this feature.

It is a pleasure to be able to record that the first microphone employing f.e.ts was made in this country by Standard Telephones and Cables, and this microphone, the type 4126, also has the claim of being the smallest on the market. The output is comparable with that of dynamic microphones. A later version, type 4136, has a higher output and uses a cable with only two conductors instead of the multicore cable required for the earlier model. This arrangement, which is, of course, operationally more convenient and reliable, has been adopted by the Neumann company with their whole range of f.e.t. operated microphones, (an example of which, type KM76, is illustrated). In this case the power is supplied down the lead, either direct to the microphone or via a d.c. converter built into the microphone itself. In either case the power requirements are low and can be supplied by batteries, especially for the direct supply condition for which a typical life is said to be 200 hours.

A.K.G. of Vienna have also entered this field with their model C451.

The noise levels claimed for capacitor microphones with f.e.ts are rather difficult to assess, as various weighting curves are in use in different countries (a matter which

* B.B.C. Research Department.

† It has been necessary from time to time to refer to specific makes as illustrations of trends, but it should be clearly understood that these are mentioned solely because they have some particular item of interest, and no comment on their performance is intended; on the other hand the exclusion of any make or type is not intended to reflect on its excellence in its own particular field.

Capacitor microphone incorporating an f.e.t. head amplifier (Standard Telephones and Cables type 4126).

(Left) Capacitor microphone with f.e.t head amplifier made by Neumann (type KM76).

(Right) Pressure type capacitor microphone, MKH110, mad by Sennheiser.

the I.E.C. could well look into), but at their best they appear to be slightly better than their nearest valve equivalents. With the continued development of transistors it may be expected that noise levels will decrease still further and that f.e.ts will prove themselves to be more reliable than valves.

The second revolution which has taken place in capacitor microphones has been the reintroduction of radio-frequency biasing. It is interesting to note that in the early 1920s when it was difficult to obtain high input impedance amplifiers this form of biasing was used in various ways. Today it is usual to employ some form of bridge circuit and an r.f. of the order of 5 MHz.

In the absence of an acoustic signal the bridge should be balanced, and therefore if it is necessary to change the capsule the bridge must be rebalanced. On the other hand it is noteworthy that very low electrical noise levels are quoted by A.K.G. and Sennheiser for this form of circuit; the noise level claimed for the Sennheiser MKH104 and 105 omnidirectional microphones is so low that the air impedance is stated to affect the value obtained. Very efficient r.f. filtering is used to ensure that none of the carrier frequency is transmitted outside the microphone case. At these frequencies the impedance of the capsule is relatively low, of the order of $1k\Omega$, and it has been found necessary to gold-plate the capsule contacts to ensure that oxide contamination does not contribute to the noise level.

Capsules.—Progress has also been made in the design of capsules to go with the improved circuits. The axial frequency range has been extended and the directional properties made more constant with frequency. For example, the Neumann KM74 cardioid type is claimed to have a directional characteristic constant with frequency out to an angle of 135° from the forward axial direction. This feature is useful not only in widening the angle within which direct pick-up can be obtained but also in ensuring that the reverberation is not coloured so as to sound different from the direct pick-up.

The front-to-back ratio of cardioid type capsules has also improved and there is not now such a tendency for this to fall off at the bass. One manufacturer, S.T.C., actually claims a front-to-back ratio of 32 dB but it must require facilities of a very high order to measure this, let alone maintain it in production.

A very interesting capsule is used by Sennheiser in the type MKH110. This is of the pressure type but has been made with such a low time constant that the sensitivity is uniform down to about 0.1 Hz. As it uses the r.f. biasing system described earlier, which operates efficiently down to d.c., the full capabilities of the capsule can be exploited and it should be ideal for studying sounds such as sonic bangs which have prominent low-frequency spectral components.

Ribbon Microphones

Development work still proceeds on ribbon microphones, these having the advantage that their characteristics can be more accurately duplicated than can those of any other type of microphone. The Japanese broadcasting authority's (NHK) research laboratories have brought out the NHK RVI-A, an instrument which is a modern version of an old R.C.A. device. It incorporates a ribbon, the rear of which is partially covered by a tube leading to an acoustic labyrinth. Omnidirectional, figure-of-eight and cardioid characteristics are available. Although much smaller than the old R.C.A. device, it is still fairly large by present-day standards, but on the other hand the performance is stated to be of very high quality.

Also worthy of note as the smallest unidirectional ribbon microphone on the market is the Beyer M160. The directional characteristic is of the hyper-cardioid type and an interesting point is that to achieve a higher sensitivity two parallel ribbons are used in the air gap; although this device has been suggested before, this is the only microphone in production in which it is used. It has significant advantages over using a ribbon of twice the thickness in that a lower resonance frequency and better control of the ribbon overtones can be obtained, but, of course, it raises a number of problems in production as the ribbons must never be allowed to touch each other.

The other ribbon microphone of interest is also from the NHK laboratories. This is the "group talk" microphone and appears to be an embodiment of patent No. 2,539,671 taken out by Olson in 1951. It consists of two figure-of-eight microphones at right angles to each other, the outputs of which are combined through a quadrature network. The polar diagram is in the form of a toroid generated by rotating a figure-of-eight about an axis at right angles to the principal axis. The object is to provide a device which is suitable for discussion groups while maintaining some directional properties in the vertical plane. However, the directivity index is of necessity low, ⅔ or −1.8 dB, as would be expected from a combination of two figures-of-eight, and it remains to be seen whether in practice it proves to be more useful than a cardioid with the acoustic axis vertical.

Ribbon microphone incorporating an acoustic labyrinth, type NHK RV1-A, developed by the Japanese broadcasting authority's research laboratories.

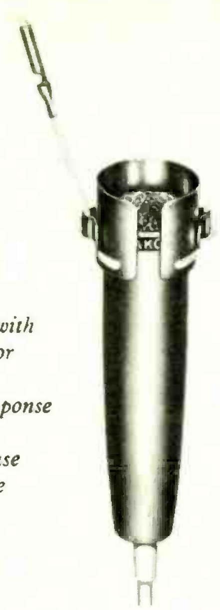
Smallest unidirectional ribbon microphone on the market, the Beyer type M160, uses two parallel ribbons.

Moving Coil Microphones

The most interesting new moving coil microphone is a two-unit cardioid device, type D202, made by A.K.G. This is a development of the variable distance microphones introduced by the same firm and by Electrovoice in America. One unit is used for the low frequency end of the spectrum and another for the high frequencies. In this way it is possible to employ a much greater front-to-back path difference (about 14 cm) for the low-frequency unit than if it had to cover the whole frequency range and therefore the acoustic driving force is correspondingly greater. For this reason the susceptibility to mechanical vibration and wind noise is much less and so is the effect of close talking. The crossover frequency between the two units is at 500 Hz, and the front-to-back path for the high-frequency unit is only 1.2 cm, thus enabling a wide high-frequency range to be maintained; it is also claimed that the ±90° curves run parallel to the axial curve. The

This moving-coil microphone made by A.K.G. (type D202) contains two units, one for low and the other for high frequencies.

Noise cancelling moving-coil microphone for commentators, using two spaced tubes to pick up the sound (NHK/Sankon type ML/1).



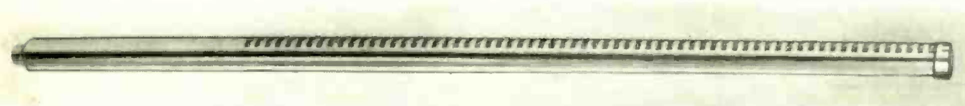
Lavalier microphone with sliding clip for altering the frequency response for different positions of use (A.K.G. type D109).

models 200 and 224, designed for p.a. and studio use, complete the range of this type. It is interesting to note that for the first time the specification for this microphone quotes a value for the wind noise, and it is hoped that this practice will spread as soon as standards of wind speed and of weighting curves are agreed. In this connection it has been the practice for a number of years in the B.B.C. to measure wind noise at 10 m.p.h. for studio-type microphones and 40 m.p.h. for outdoor types; ASA weighting is used.

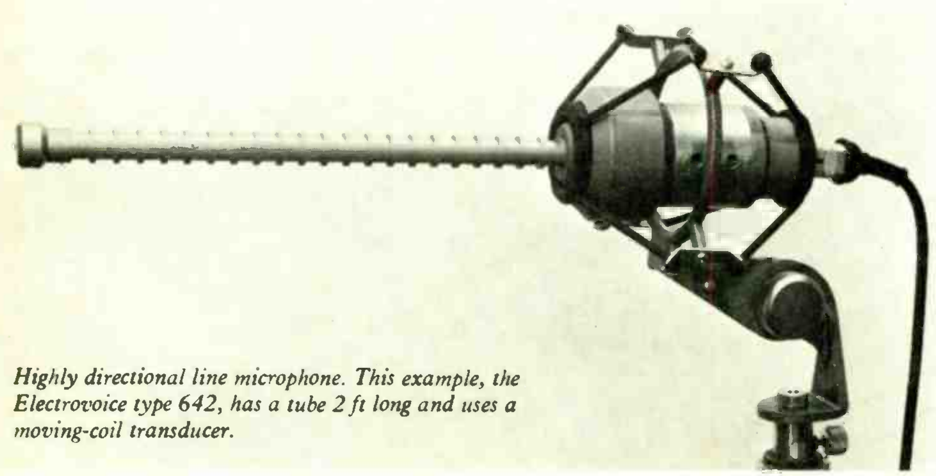
Another moving coil microphone of interest comes from the same stable, namely the type DX11. This has a cardioid characteristic but the unconventional feature about it is the inclusion of a reverberation unit of the spring type. It has been designed for dance band work and the reverberation time is controllable, with a maximum of 2.5 sec, by means of a button on the microphone handle. The associated transistors are powered by batteries located in the microphone handle.

The NHK/Sankon type ML/1 moving-coil microphone is of a different kind. This is a so-called noise cancelling type designed for use at the Olympic Games in 1964. The object was to produce a commentator's microphone which leaves the user with both hands free for writing or holding field glasses and this has been achieved by mounting the microphone on a peaked cap. Sound is picked up by two tubes, the ends of which are about 2 cm apart and placed at the side of the head at a level between the nose and mouth. The tubes are each terminated acoustically at the entrance and communicate with a moving-coil element mounted near the user's ear. The tubes are on anti-vibration mountings and a wind shield can be fitted over the openings. The whole device is very light but the necessity of wearing the cap limits the use on many occasions.

The last kind of moving-coil microphone to be considered is the Lavalier type which has now become very popular. This type was first developed in the U.S.A., where R.C.A. have carried out a considerable amount of development work in this direction, producing some very small models having an axial response designed to compensate for the lack of high frequencies at chest level. However, miniaturization can carry with it high manufacturing costs, and the latest models from this company are rather expensive. Another approach to the problem has been made by A.K.G. who have produced a model, type D109, which is nearly as small as the latest R.C.A. device. The D109 carries a sliding clip which is depressed when the instrument is held in the hand and raised when used as a Lavalier microphone. In the first instance the axial frequency response is said to be almost uniform, while raising the clip has the effect of giving an appreciable increase in response at the higher frequencies, thus compensating for the reduction of this frequency band when used in the hanging position.



Line microphone with capacitor transducer and r.f. biasing (Sennheiser type MKH804).



Highly directional line microphone. This example, the Electrovoice type 642, has a tube 2 ft long and uses a moving-coil transducer.

Line Microphones

Finally, we come to the highly directional line microphone. With a simple microphone of this type the directivity varies with frequency and approximates to that of a cardioid when the wavelength of the incident sound is twice the length of the tube. Modern line microphones, therefore, have transducers with cardioid characteristics at the bass so that the directional characteristic never becomes more omnidirectional than this.

Two examples of this design are the Electrovoice types 642 and 643, with lengths of approximately 2ft and 6ft respectively. Each uses a moving coil transducer with a very large magnet and the correspondingly high signal to electrical noise ratio enables the directional properties to be fully exploited.

A third example is the Sennheiser type MKH804. This is unusual in that while the directional characteristic degenerates into a cardioid at the bass, that of the higher frequencies does not become progressively sharper with frequency but reaches a figure of about -10 dB at 90° away from the axis and maintains this over a wide frequency band. In this case the transducer is of the capacitor type and a good signal-to-electrical noise ratio is achieved by the use of the r.f. biasing circuit described earlier; this construction makes for a very light instrument.

A fourth type due to appear soon is made by A.K.G. as an attachment to the C451 f.e.t. microphone. The tube is about 2ft long and the directivity varies with frequency. A lightweight version of each type will thus be available and it will be interesting to see which proves the more popular.

A feature common to all line microphones is the fact that they have an inherently good signal-to-wind-noise ratio, as the wind-noise at each opening adds up in an r.m.s. manner whilst the signal adds up linearly. Wind shields are provided but these are unnecessary except for use in high winds.

Wide-range General Purpose Signal Generator

A transistor instrument covering 150 kHz–120 MHz in six bands

by L. Nelson-Jones, A.M.I.E.R.E.*

AN r.f. signal generator is a most useful if not essential piece of test equipment so far as the amateur radio or electronics enthusiast is concerned. It is, however, also one of the most expensive, if an instrument of reasonable accuracy, and performance is required. The author found that the available commercial instruments fell into two main categories: Those with a means of monitoring the r.f. level and those without level monitors. In the second class there was in general an uncertainty in the generated r.f. level of at least ±6 dB. One such unmonitored instrument which the author had the misfortune to meet some years ago, changed its output by nearly 10 dB over a frequency change of 10% (41-45 MHz) on the highest frequency band.

The accuracy of the majority of monitored instruments was ±2 dB overall though a few were good to only ±3 dB. The inaccuracies were in general spread about equally between the attenuators and the level monitoring circuit. The majority of the instruments studied had a maximum output of 100 mV into either 75, or 50Ω, and nearly all quoted a frequency setting accuracy of 1%.

From these various specifications, and the facilities available to the author, a specification was drawn up for the instrument to be described.

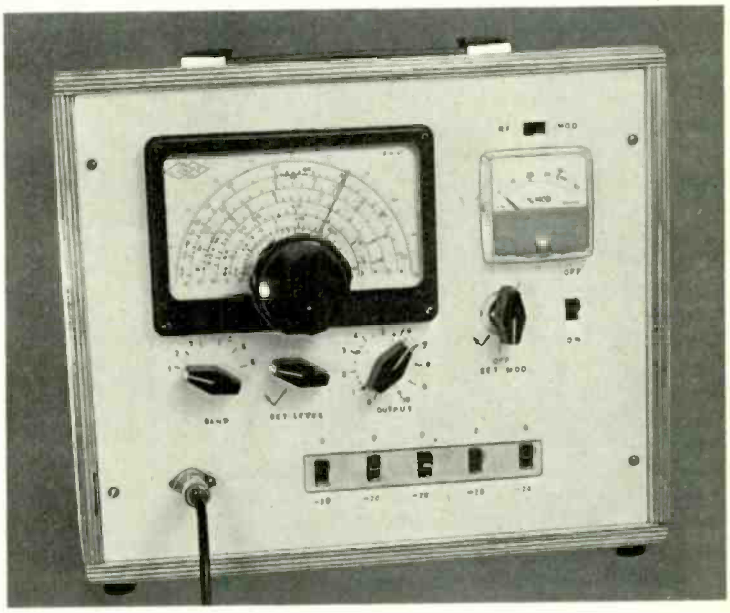
Accuracy of frequency setting	± 1%
Accuracy of level monitor	± 1 dB
Accuracy of step attenuator	± 0.5 dB per 20 dB step
Attenuation range of step attenuator	100 dB
Attenuation range of variable attenuator	0-20 dB calibrated
Accuracy of variable attenuator calibration	± 1 dB
Modulation level range	0-50%
Accuracy of modulation level setting	± 5% of indication from 10-50% modulation
Modulation frequency	400 Hz ± 50 Hz
Maximum unmodulated r.f. level	100 mV (terminated)
Output Impedance	75Ω constant

R.F. Oscillator

The circuit used is shown in Fig. 1 and is basically the familiar Hartley oscillator with the earth point moved to give a grounded collector configuration. The advantages found for this arrangement were that one side of the tuned circuit is grounded, greatly simplifying switching and layout; that only a single tapped winding is used on each range; and since the windings are grounded at one end it is a simple matter to arrange that unused windings are both grounded and shorted out. This prevents unused coils resonating with their stray capacitance and causing peaks or troughs in the output of the other ranges. The effect is similar to that found with the grid dip oscillator and is due to the coupling between coils resulting from their proximity to one another.

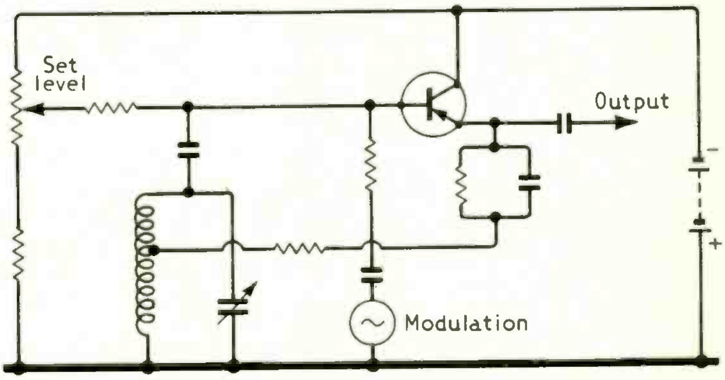
The level of oscillation is controlled by variation of the bias voltage applied to the oscillator. Further control of the level of oscillation, together with a reduction of harmonic content of the output, and some degree of equalization between ranges is provided by the degeneration produced by the unbypassed emitter resistor. Control of the oscillator by this means also saves changing the coil tapping point to find the correct degree of feedback for each range and makes it possible to use commercially available coils for the three lowest ranges. (For those with wave-winding facilities a tap at approximately 20-25% from the top of the winding is satisfactory.)

To improve the overall stability of the oscillator further and



The author's protype signal generator. The front panel is overlaid with Perspex lettered on the reverse side.

Fig. 1. The basic circuit of the r.f. oscillator employed.



*Plessey Automation Ltd.

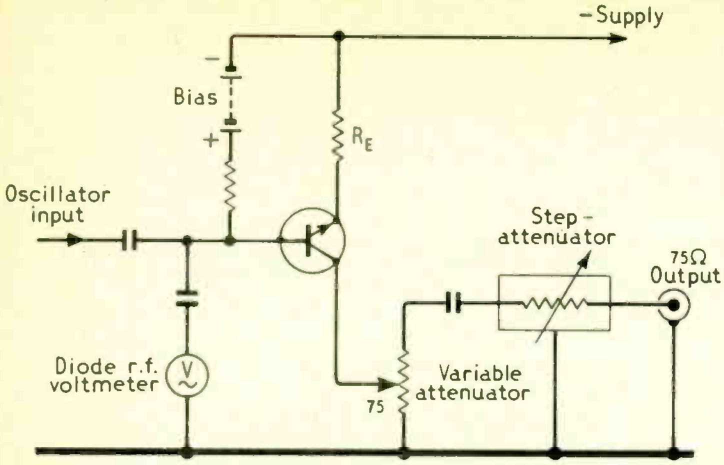


Fig. 2. Oscillator output amplifier and attenuator arrangement.

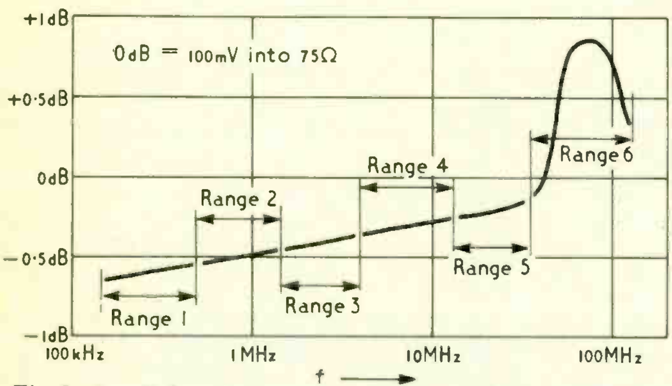


Fig. 3. Graph showing output versus frequency for a constant setting of the r.f. level indicator.

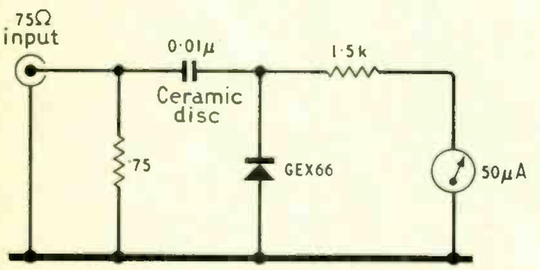


Fig. 4. Circuit used to obtain the graph of Fig. 3.

to help in reducing any tendency to squegging an additional emitter resistor is added, which is bypassed to r.f. The value of the unbypassed emitter resistor is chosen to be as high as possible while maintaining an adequate level of oscillation throughout the range at the minimum battery voltage (in this case 8 V).

Output Amplifier and Attenuator

The oscillator described above generates a good sinewave signal, but at a level and impedence unsuitable for general use. In many commercial generators a coupling winding is placed on the oscillator coil to obtain a suitable output level, this is then applied to a low inductance potentiometer followed by an attenuator pad in order to ensure a reasonably constant output impedance at the highest level settings. The use of such a coupling coil necessitates the use of another bank of contacts on the range selection switch.

It was felt that this method, though it works well enough, is a rather crude way of achieving the required end. A more fundamental method, made possible by the availability of good u.h.f. transistors, was therefore tried with considerable success. The method consists of feeding the variable attenuator, which is wired as a current-divider from a constant current generator. The result is a variable attenuator with a constant output impedance equal to the value of the potentiometer, providing that the output impedance of the current generator does not appreciably shunt the potentiometer.

The practical circuit used to achieve this is shown in Fig. 2. Level monitoring is achieved by the use of a diode voltmeter which measures the input to the current generator.

The current generator transistor operates in class A and a bias source is used rather than a potentiometer across the supply. The bias potentiometer, if used, would have to be chosen to give sufficient collector current at minimum battery voltage and would result in a very high collector current at maximum battery voltage, with consequently reduced battery life. The current in this stage must exceed:

$$[(E_{OUT}\sqrt{2})/R_{LOAD}]10^3 \text{ mA},$$

for class A operation. For 75Ω output impedance and 100 mV r.m.s., this gives:

$$(0.1\times1.414\times10^3)/37.5=3.77\text{ mA}$$

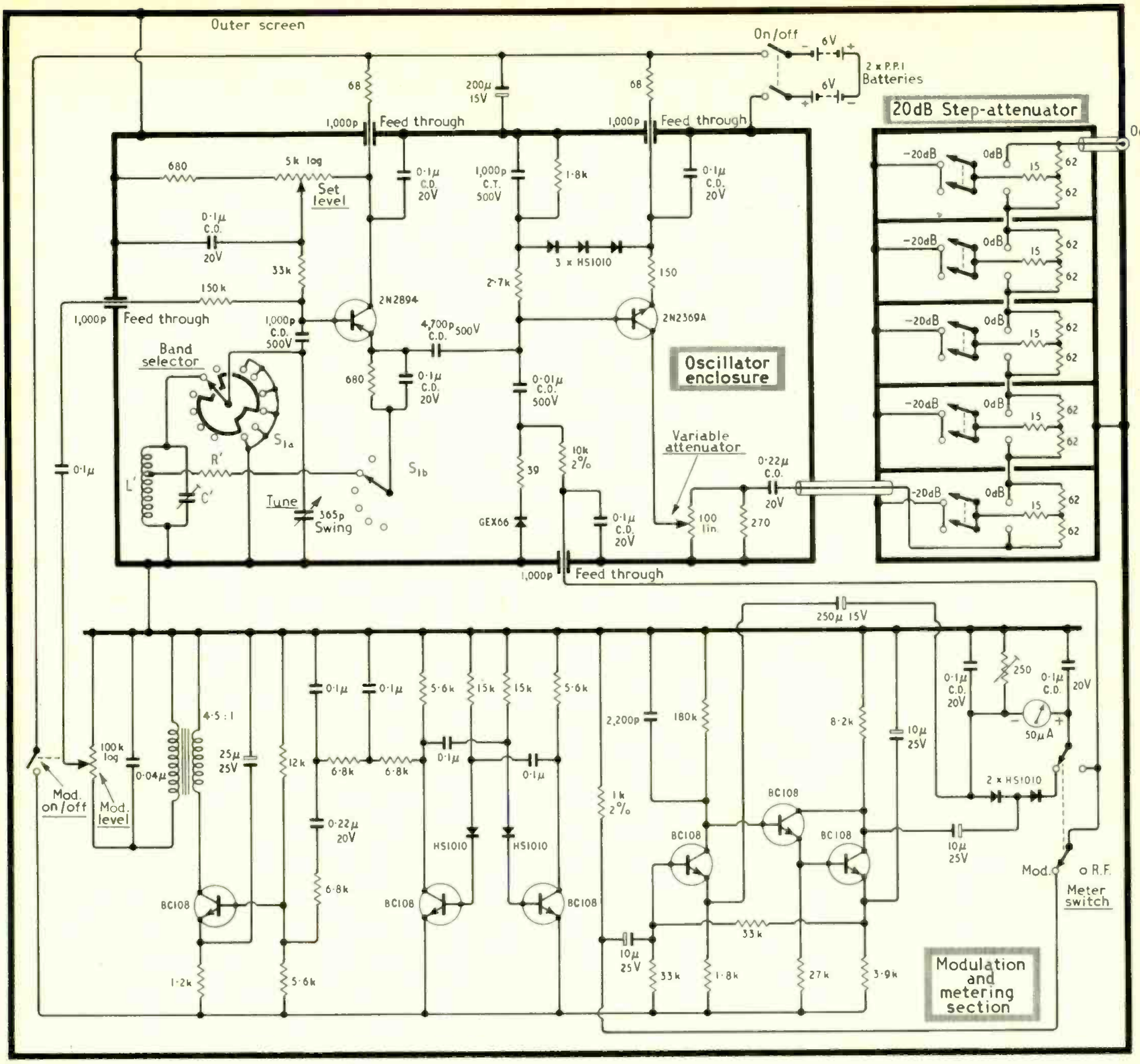
$R_{LOAD}=37.5\ \Omega$ since so far as the current generator is concerned the current divider, and load (both 75 Ω are in parallel. A current of 5 mA is, therefore, adequate. In the circuit used (Fig. 5) the bias source is three forward biased silicon diodes, which provide approximately 2 V that is reasonably independent of supply voltage. This potential does, of course, vary with temperature, but for normal operating temperatures this is of little consequence providing that the collector current of the current generator is approximately 150% of the minimum as indicated above. The value of R_E depends on the voltage available from the oscillator and on the voltage required by the diode r.f. voltmeter for a reasonable value of d.c. output current for a level indicator. A value of 150 Ω was found to be a reasonable compromise, giving a d.c. current to the indicator of 36 μA. The meter semsitivity should not be lowered too much however or both the r.f. oscillator and the modulation measuring transistor will be unable to provide enough drive.

The performance of the output stage is illustrated in Fig. 3 which shows the variation of actual output for a constant reading of the level indicator (that is a constant input to the current generator stage). The circuit of the voltmeter used to measure this and terminate the output of the signal generator is shown in Fig 4.

The current divider potentiometer used is a solid moulded carbon type (Plessey type E), which is stable and has a long operating life. Deposited track carbon types are not suitable because of wear problems. The lowest value available is 100 Ω but this can be reduced to 75 Ω by connecting a 270 Ω resistor across the potentiometer.

Attenuator

The majority of commercial generators use a ladder attenuator having either four, or five steps of 20 dB each. Owing to the difficulty of making a suitable screened enclosure and switch for such an attenuator it was decided to make a set of five separately switched attenuators. A suitable screened enclosure can then easily be made covering the complete attenuator and the output socket (see Fig. 7). The screen has intersection screening plates, each having a small slot to allow the coupling wire to pass through. The switches themselves are standard two-pole slide switches with a change-over action. Tinned steel sheet was used for the fabrication of the attenuator screen and all internal joints are soldered (in order to stop rusting the cut edges may be filed smooth and tinned also). The screen is made a close fit on to the aluminium front panel and secured with screws at frequent intervals.



All resistors — ¼W ±10% carbon composition } Unless otherwise marked
Capacitors — polyester tubular

C.D. = Ceramic disc
C.T. = Ceramic tubular (or disc)

For details of attenuator resistors see text

Fig. 5. Overall circuit diagram of the generator. Some reduction in cost may be realized by using the transistors marked with an asterisk in the components comments section.

Very good screening of each section of the attenuator from the others; of the output socket from the rest of the generator; and the generator from the outside world is essential if the attenuator is to have any sort of accuracy at high degrees of attenuation, especially at the highest frequencies covered.

It was at first thought that obtaining suitable resistors for the attenuator was going to be a major stumbling block, fortunately experiments showed that the commonly available solid carbon moulded resistors were surprisingly good for this application. Such resistors are usually available only in 10% tolerance, which means buying two or three times the quantity required, and selecting resistors. This is still a cheap way of obtaining attenuator resistors. Since the resistors will be required to dissipate only a small amount of power, stability should not prove a problem, but care should be taken in soldering them into position to minimize heat transfer to the resistors. A pair of pliers gripping the lead between the resistor and the soldered joint, during soldering should suffice.

High stability cracked carbon, metal oxide, and other film resistors must not be used, since these will all have spiral tracks and will cause serious errors at the higher frequencies due to the inductive component of the resistor's impedance. Commercial attenuators do, in fact, use film resistors, but these are specially manufactured and do not have spiral tracks. Such resistors are expensive and not readily available, but if any reader is lucky enough to have such a source of non-spiral 15 and 62 Ω resistors he should certainly use them. (Calculated values 15.15 and 61.35 Ω).

A "T" configuration was chosen for the step attenuator sections since at high frequency stray capacitance is the most serious cause of attenuator error and as the value of the resistors used in the "T" are lower than in a "Π" arrangement the stray

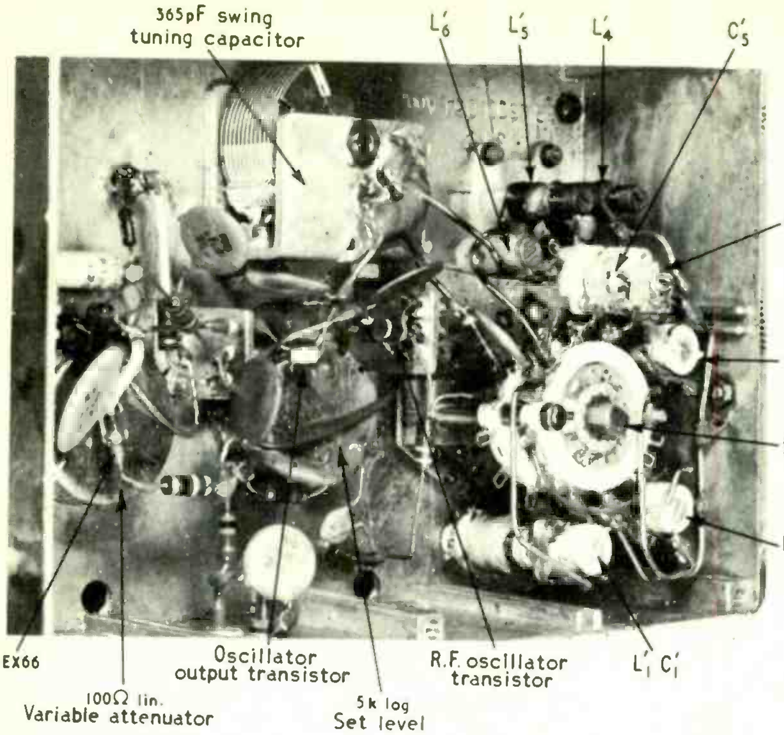
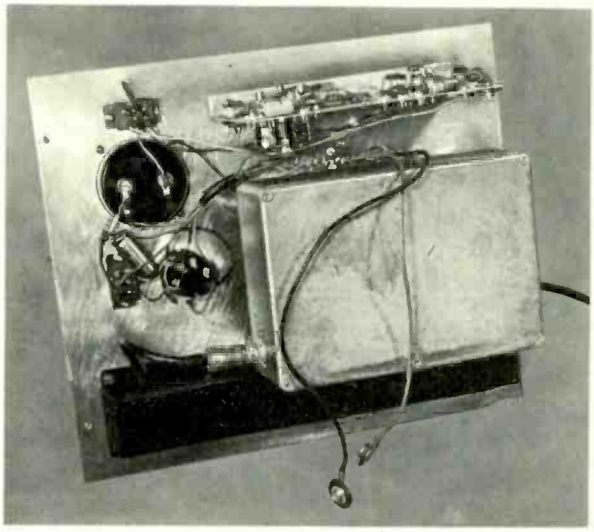


Fig. 6. Internal view of the r.f. oscillator enclosure.

Fig. 7. Rear view of the instrument. The step attenuator is behind the metal case below the r.f. oscillator enclosure.



capacitances produce less shunting action. The values for the arms are 62Ω for the series elements and 15Ω for the parallel element. 15Ω is a standard value in the 10% range and suitable resistors may therefore be selected on a bridge. For the 62Ω resistors (a standard value in 5% resistors), 68Ω resistors (unselected) were each shunted with a resistor ranging from 470 to 1,000Ω to obtain a value, as measured on a bridge, which was as close to 62Ω as possible (±1%). This method increases the shunt capacity of the series arms, but does not appear to have produced any serious error even at 100 MHz, with the "T" configuration. The resistors are soldered directly to the switches and all leads kept as short as possible. Earth tags are put under the fixing screws of each switch and the leads to them are kept as short as possible.

Modulation

The modulating voltage is applied to the base of the oscillator transistor (Fig. 1) through a high value resistor to avoid shunting the r.f. voltages, a d.c. blocking capacitor is placed in series with this resistor to avoid shunting the oscillator transistor bias circuit. The modulating voltage required to produce a given level of modulation is not constant but depends on the collector current in the oscillator transistor and this in turn depends on the operating frequency. At the higher frequencies the oscillator transistor has to pass a larger collector current because of the higher losses of the tuned circuits, the lower dynamic impedance of the high frequency tuned circuits (both factors requiring a higher loop gain to maintain oscillation) and reduction of the f with current in the oscillator transistor.

Logarithmic potentiometers are used for both the r.f. and modulation level setting controls to enable easier setting despite the wide variations in the requirements with frequency. Since the modulation depth cannot be measured by measuring the modulating voltage, it was decided to measure the audio component of the r.f. level detector output. To achieve this a resistor is substituted for the meter in the level detector and a transistor millivoltmeter measures the audio component across it with the level meter connected to the output of the audio millivoltmeter. The frequency response of the millivoltmeter is limited to a few thousand cycles so that r.f. voltages cause no errors.

In the prototype instrument the 0-50 scale of the basic 50 μA meter indicates percentage modulation, as the degree of feedback is sufficient to linearize the scale of the millivoltmeter. With the circuit shown in Fig. 5, 50% modulation corresponds to 15 mV at the input to the millivoltmeter.

The modulation depth was set (using an oscilloscope) to 33%, and the r.f. level carefully monitored also (this must, as is customary, be set correctly before setting the modulation depth). The sensitivity (feedback value) of the millivoltmeter was then set to give a reading on the meter of 33 μA. 33% was chosen as being close to the commonly used figure of 30% modulation, but being easier to set up on the oscilloscope. The carrier is first set to 6 cm on the oscilloscope (peak-to-peak) and the modulation is increased until the trough of the modulation reduces the carrier to 4 cm, and the peak modulation increases the carrier to 8 cm, the modulation index is then 33%.

A simple *LC* oscillator was rejected for this application, although at first it might seem the most obvious choice. The main reason was the difficulty of maintaining a reasonable waveform and an adequate level of oscillation with varying battery voltage at all battery voltages, Stabilization of the supply voltage would cure this problem, of course, but this was felt to be too wasteful of battery power.

The circuit used consists of a multivibrator feeding a shaping filter which in turn drives a tuned output stage. This tuned output stage provides the necessary drive to the modulation input of the r.f. oscillator via the modulation level setting potentiometer. The main problem is to obtain an accurate inductance for the secondary of the tuned output transformer which has a value of 3 henries, in the prototype an ungapped 25 mm ferrite pot core was used. Two courses are open in order to get accurate tuning. (a) If a bridge is available, the secondary can be wound on first with excess turns, which are then removed until the correct value is obtained, and the correct number of primary turns calculated by dividing the secondary turns by 4.5; or (b) The transformer can be wound using the nominal turns given later and the tuning capacitor varied by trial. In either case the tuning is not critical as the Q is low. The effect of severe mistuning is a loss of output and increased waveform distortion. The values given for the multivibrator in Fig. 5 result in a modulation frequency of a little over 400 Hz (the prototype gave 430 Hz). The base resistors of this multivibrator can, of course, also be varied to bring the multivibrator to resonance with the tuned output transformer, providing that the tuned transformer is not too far from its correct frequency.

Calibration

The dial for the r.f. section of this instrument can be calibrated in two ways:

The output of the generator can be mixed in a diode mixer with the output of another signal generator with known errors. An audio amplifier and loudspeaker are connected to the diode mixer and the dial is calibrated by beating the fundamentals together and noting the dial reading for zero beat, using the 0-100 scale printed on the Eddystone dial. The dial readings are then plotted on graph paper against the known frequency and a smooth curve drawn, from which to read off the exact readings for any desired frequency marking. This information is then transferred to the dial.

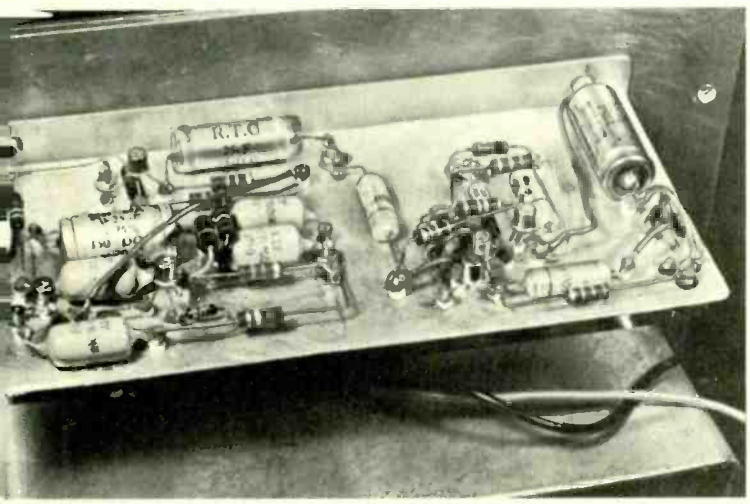
In the second method the output of the generator is fed into a receiver. The difficulty with this method is the gaps left, for instance, a receiver using a 460-470 kHz i.f. will not cover this frequency. The range above 30 MHz is also rather a problem.

In both these cases checks of the calibration of the reference standard, whether it be another signal generator, or a receiver, can be made against a crystal oscillator or other frequency standard. The author used the 1 MHz standard described in the January 1968 edition of *Wireless World* to check the calibration of a borrowed signal generator. The borrowed generator only covered up to 80 MHz so that harmonics were used above this, with a check using an f.m. receiver on the 88-108 MHz band. No doubt the ingenuity of readers will find other ways of achieving an accurate calibration, and the lucky few may even have access to a high-frequency digital counter for a short while.

It may be found impossible to maintain oscillation at the low frequency end of bands 5 and 6 due to the very unfavourable *L.C.* ratio. This is of no consequence as there is considerable overlap between these bands. The phenomena is present on at least one commercial signal generator and need cause no concern.

In the initial stages of calibration the extremes of each range are first set by means of the dust cores of the coils, and the trimmer capacitors so as to obtain a small overlap of the lowest three ranges, and with the lowest range starting at about 145 kHz. A greater overlap will be found possible on the upper ranges.

Fig. 8. Modulation oscillator and modulation voltmeter chassis. The modulation output transformer is under the left hand of chassis and the voltmeter sensitivity adjustment potentiometer is under the right-hand edge of the chassis.



The coils specified for ranges one, two and three have their cores accessible only from outside the screened enclosure at a point lying behind the front panel, but as the normal adjuster is flexible no trouble was found in adjusting these cores. There is a space of some two inches between the panel and the oscillator enclosure to allow for the flexible coupling between the dial assembly and the tuning capacitor shaft.

Two Ever-Ready PP1 batteries or equivalent, are used in series to provide a 12-volt supply which should give 300 hours life with average use. As has been said, no stabilization of their output has been used since no advantage was found, in accuracy, or in any other way from doing so.

Constructional Details

The prototype generator is housed in a plywood case finished in polyurethane varnish. The inside of the case is lined with tinned steel, the joints being soldered. The front panel is fixed to brackets soldered to this lining and additional spring contacts provide extra connection points with the front panel so as to form a second complete screen round the oscillator which is mounted in a metal case, in order to reduce stray radiation.

The use of batteries for power is of great assistance in reducing stray radiation since there is no need for elaborate filtering of mains leads where they pass through the outer casing. In the author's experience the mains lead of many signal generators is a major cause of such stray radiation. Another cause is the meter used for the level indicator, since this is connected to the diode r.f. voltmeter circuit. The body of the meter is in most cases of a plastic construction, and there is, as a result, a "hole" in the screen where the meter passes through the front panel. If this is found to be a source of an unacceptable level of stray radiation it will be necessary to fit a complete metal screen over the rear of the meter with feed-through capacitors for the connections. This is done in many commercial generators.

The front panel of the prototype is of $\frac{1}{8}$in. Dural, but this is overlaid with a $\frac{3}{32}$in. Perspex panel. This overlay has all the dial markings in Indian ink (in reverse) on the rear of the panel. A lettering stencil was used to letter the panel with a stylus pen, the stencil being reversed. After lettering, the rear of the Perspex overlay was painted with two coats of white cellulose paint. The result of the use of this overlay is a front panel of neat appearance which is easily cleaned, and from which the lettering will not rub off. The overlay is held in position by the dial assembly, the meter, the output socket, and the front panel screws. A further advantage of this overlay, is that it has enabled the various other component fixing screws to be hidden, the front panel being thick enough to take countersunk screws. In marking the Perspex with Indian ink it may be found hard to get clear lines due to lack of "wetting", but if the area to be lettered is first rubbed over well with a hard typing eraser and then cleaned well, the slight roughening will enable the lettering to adhere. The slight roughening will not show once the panel is painted white, provided it has been well cleaned after using the eraser.

The instrument described provides a standard of performance equal to many of the commercially available instruments costing many times the outlay required for its construction. It is hoped that this article will encourage others to construct their own instruments, and that it has shown the guiding principles which led to the successful conclusion of the author's design.

Coil details

Band 1; Electroniques MZT.8.
Connections, green to chassis, yellow to R', black to S_{1A}.

Band 2; Electroniques MZT.9.
Connections, brown to earth, yellow to R', black to S_{1A} Link blue to green.

The coupling winding, which is not used on Bands 1 & 3, is connected in series with the main winding on Band 2 to enable coverage of the 460-470 kHz region.

Band 3; Electroniques MZT.10.
Connections as Band 1.

Band 4; 30 turns of 28 s.w.g. enamelled copper wire, tapped 6 turns from the top, close wound. Bottom of winding to earth, tap to R', top to S_{1A}.

Band 5; 8 turns of 24 s.w.g. enamelled copper wire, tapped 2 turns from the top, connections as Band 4. Close wound.

Band 6; one turn of 18 s.w.g. enamelled copper wire wound with a pitch of 0.2 inches. There is no tap on this coil as the lead inductance of the oscillator circuit provides a large part of the required inductance. The resistor R' connects direct between S_{1A} and S_{1B}. The lead from S_{1A} wiper to the tuning capacitor stator is also very much part of the tuning inductance on this range and should be as short and straight as possible. The former is cemented to the single turn coil.

Bands 4, 5 & 6 coils are wound on formers which are of 6 mm internal diameter, and of 0.3 inches outside diameter such as Aladdin 8A-6044-21/6E moulded in bakelite with a square base. Suitable cores are Aladdin 9R-1044-81 which have a similar adjustment slot to the cores of the coils for bands 1, 2 & 3. Both these items are also supplied by Electroniques. A suitable trimming tool type TT.1 is also available from this source. Finish with a thin coat of the same polyurethane varnish as used on the case. The coil for former band 6 has the square base removed and the core may be cut in half if adjustment is difficult.

Modulation transformer; Secondary, 667 turns, primary 149 turns, 40 s.w.g. enamelled single silk covered wire. Core, 1 pair of Mullard FX 2240 ungapped cores. Former, Mullard DT.2179 (mounting used in prototype, terminal board DT.2227; mounting clip DT.2228).

Component comments

Band switch; S_{1A} wafer TSW/2/S. S_{1B} wafer TSW6/2/—. Switch mechanism TSW/SH/2½/2. Studding 6 BA. TSW/ST/6/12 (12 inches). Spacers 0.5 inch TSW/SP/½L (4 off). Available from Electroniques.

Wafer S_{1B} is assembled nearest to the front panel.

Tuning capacitor; Jackson Bros., type JB/5250/1/365.

Trimmer capacitors; (bands 4 & 5 only) Jackson Bros., type JB/5440/8 or Mullard type E7850 or E7875. 2-8 pF concentric type available from Henry's Radio who can also supply a 10 pF capacitor similar to the Jackson type named.

Variable attenuator; Plessey type E, 100 Ω, linear. Available from Electroniques under part no. E/100/LIN.

Dial assembly and flexible coupling; Eddystone Radio type 598 with type 893 coupler or Jackson Bros., type JB/4693.

Resistors R′; Band 1—1kΩ; Band 2—820Ω; Band 3—820Ω; Band 4—680Ω; Band 5—390Ω; Band 6—68Ω.

Attenuator resistors; Erie type 16, Morganite type S or Radiospares ½-watt (see text).

Transistors; r.f. oscillator output stage—2N2369, 2N2369A, TIS49*, types BSX20 and BSX44 should also function satisfactorily. For the r.f. oscillator—2N2894, V405A or TIS50*.

Diodes; silicon Emihus HS1010 (high conductance with V_f less than 1 V at I_f= 50 mA) most high conductance silicon diodes are suitable, e.e., 1S120*, OA200/202, CV7040. The germanium device in the level monitor circuit is Mullard GEX66 or 64. Most other germanium point contact diodes are unsuitable and give too large an error at the highest frequencies.

Semicinductors marked are likely to be cheaper and easier to obtain than the others specified.*

Feed-through capacitors; 1000 pF, Erie type 361.

Attenuator switches; (also used for ON/OFF and meter switch) Radiospares "slide switches".

Oscillator enclosure; S.T.C. die-cast case type 46R.C500.-064.A00 available as type 46R.064.A. from many suppliers.

P.C.M. Copes with Everything

The recent introduction of 24-channel pulse code modulation systems using 1.536 Mbits, carried by conventional telephone cables repeatered at 2000 yd intervals, is only the first step in an integrated system covering the whole country. This emerged from a colloquium at the I.E.E. at which the present state of p.c.m. was discussed by representatives of the Post Office and the communications industry. At present the larger capacity systems are only at the laboratory stage and some are little more than gleams in the eyes of the designers. The next step (according to A. C. Frost and K. W. Cattermole) will probably be 96-channel systems using 6-8 Mbits. These will make the viewphone a practical proposition, probably causing an increased demand for communication links. It is visualized also that bit rates will be increased to between 100 and 1000 Mbits to accommodate future needs including television links. Signals with these high bit rates will probably be transmitted by microwave links either in waveguides or freespace, intercontinental links using satellite relay stations.

The subject of distortion was discussed at some length, and a recording of music, presented by D. E. L. Shorter of the B.B.C., very effectively demonstrated the increase in background noise when the number of quantizing steps is reduced. The quantizing noise gets less "white" and an audible interference pattern is produced. While 2^7 levels are quite adequate for telephonic speech, 2^{11} or 2^{12} need to be used for high quality music. It is possible to accommodate 4 music channels in a 1.536 Mbit system normally used for carrying 24 speech channels. Television is more tolerant of quantization distortion than music and 2^7 or 2^8 levels provide a good quality picture. However, this results in a bit rate in excess of 100 Mbits.

The closing talk was given by A. H. Reeves, the inventor of p.c.m. Letting his imagination take over, he spoke of a world in the not too distant future where communication links will permit people to carry out many jobs from the comfort of their homes, conferences using closed-circuit television etc. For this, he said, reliable links capable of bit rates of the order of 10^9 or 10^{10} bits will be required. Light is the most probable answer. At present the loss in glass-fibre guides is about 200 dB/km. The theoretical loss is of the order of 6 dB/km so that fibres with losses of only 30 to 40 dB/km should be practical in the near future. With these, repeatered cables using 30 or more fibres are possible for both land and transoceanic links. The repeaters will probably make use of gallium arsenide i.c. lasers.

He went on to predict that an electro-optical revolution is in the offing and that the sooner this was recognized and a start made the better, as it would be cheaper in the long run. His closing words were "I'm prepared to take a large bet that I'm right!"

Low Distortion Class B Output

New approach to the problem of cross-over distortion in transistor audio power amplifiers

FOR some time designers of transistor high-fidelity amplifiers have been restricted to a choice between three types of class B output circuit: (1) a pair of matched complementary transistors; (2) a pair of identical transistors in series cascade with a twin-secondary driver transformer; and (3) a quasi-complementary circuit using identical output transistors in series cascade but with complementary driver transistors. All three raise problems in design and manufacture, the best known ones being lack of circuit symmetry, difficulty of proper control of transistor quiescent currents and problems of the l.f. roll-off. Now a new type of output circuit has appeared which, the designers say, overcomes these problems and makes possible a transistor power amplifier of exceptionally high performance. The circuit, shown in Fig. 1 in slightly modified form, has been developed by The Acoustical Manufacturing Company for a new power amplifier.

As will be seen from Fig. 1 the circuit is really a development of the quasi-complementary arrangement, but each half of the class B system contains three directly coupled transistors instead of just the usual driver and output. The first two, Tr_1 and Tr_2 are low power complementary types, the second two, Tr_3 and Tr_4, medium power complementary types and the final two high power identical devices.

One reason for this arrangement is to avoid the distortion which normally occurs in the quasi-complementary circuit as a result of the asymmetry of the upper and lower halves of the output stage. In the Fig. 1 arrangement each of the transistor "triples" can be considered as an "emitter follower", as brought out in the much simplified form of Fig. 2. And each of these "emitter followers" has the usual characteristics of this device: high input impedance, low output impedance, and the voltage across the emitter resistor (and hence the current through it) following the base voltage independently of the characteristics of the active device. For these conditions to hold, of course, the loop gain of the "emitter follower" must be very high, and this is assured by the use of the three transistors—the overall current gain approaching the product of the three individual β values. The two units shown shaded in Fig. 2 can be considered as two "black boxes" exactly equivalent to a complementary pair of output transistors of very high current gain. The arrangement has, however, a very important advantage over a complementary pair when we come to consider quiescent current and temperature effects.

Ideally in a class B amplifier the two transistors should be biased so that one is completely cut off while the other is conducting. In practice this cannot be done because it results in cross-over distortion. It is necessary in fact to apply a small forward bias to the transistors to obtain a suitable value of quiescent current that will reduce this distortion to a minimum. The required quiescent current should be kept constant, but in many power amplifier circuits this is difficult to achieve because the quiescent current depends on the temperature of the base-emitter junction of the power transistors and this in turn varies from moment to moment due to variations of audio power and thermal storage time constants.

In the Quad circuit the voltage developed across the 0.3Ω resistors by the quiescent current is compared with a fixed reference voltage at the Tr_1 and Tr_2 base-emitter junctions. Since these are operating at very low power there is negligible change due to temperature resulting from varying audio power. Ambient temperature changes are exactly compensated by the same temperature changes in the diodes D_1 and D_2 providing the reference voltage. Thus the two "black boxes" can be seen to be the equivalent of a complementary pair with thermally isolated base emitter junctions.

The other two diodes, D_3 and D_4, are limiting devices which prevent the output transistors from exceeding their current ratings. If, in either half of the class B circuit, the current through the 0.3Ω resistor attempts to exceed a given safe upper limit (approx. 3A) the increased voltage across the resistor will cause the corresponding diode to conduct and thus prevent the corresponding transistor (Tr_1 or Tr_2 from being turned on further by the incoming signal. As can be seen, the arrangement is symmetrical, providing limiting for both directions of output current swing.

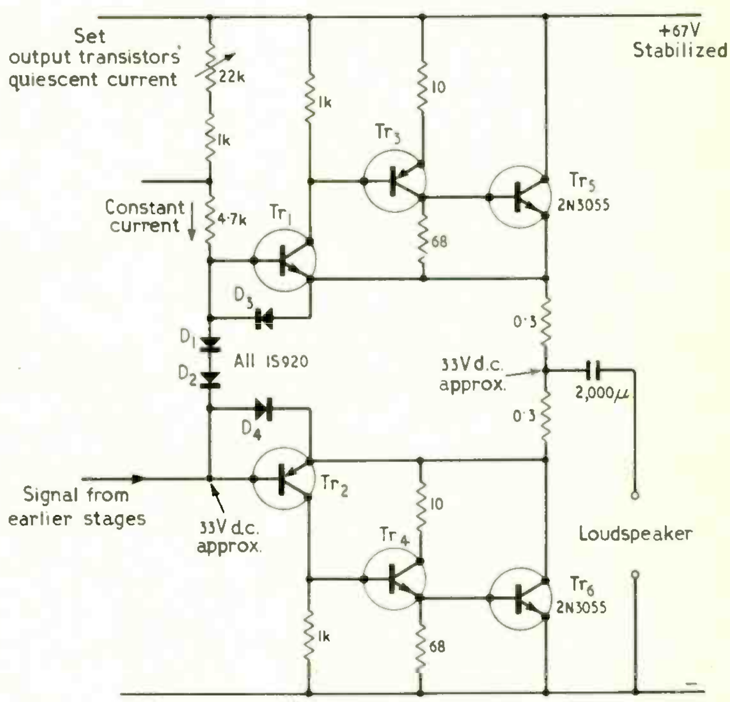


Fig. 1. (Above) The output section of the Quad 303 power amplifier (slightly simplified) showing the two transistor triples.

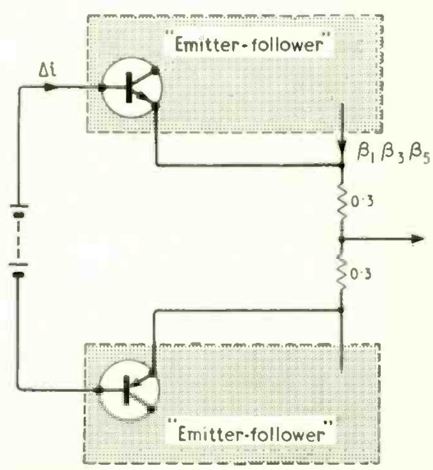


Fig. 2. (Right) Simplified representation of the Fig. 1 circuit as two "emitter followers".

News of the Month

Numerical Control Advisory Service

"The use of numerically controlled machines in this country is growing but not nearly fast enough. This is partly due to the genuine difficulty of many firms in assessing the technical and economic value of numerical control for their machining requirements in comparison with conventional methods, and making the necessary investment appraisal. To assist industry in this I am establishing a Numerical Control Advisory Service," said the Minister of Technology, Mr. Anthony Wedgwood Benn, in reply to a written Parliamentary question. He went on to give brief details of the service. "The service will be provided by the Production Engineering Research Association under contract to my department and by the Royal Aircraft Establishment, Farnborough. P.E.R.A. will concentrate on the economic, investment and production planning aspects of the adoption of numerical control, and will provide courses for senior management. It will also have the important task of providing a consultancy service for firms by carrying out appraisals of the suitability of numerical control in their works.

"The Royal Aircraft Establishment will provide courses with a technical bias for designers and production and planning engineers. It will also provide facilities and technical support for individual firms in the programming, machining and inspection of components."

It has been estimated that the cost of this service to the Government over the next three years will be £685,000. This includes £350,000 for the provision of numerically controlled machine tools and associated equipment at R.A.E. and P.E.R.A., the remaining sum being used to offset the major part of the cost of the courses at P.E.R.A. and for meeting 50% to 90% of the cost of appraisals.

The Ministry is also supporting a complimentary establishment at High Wycombe set up by Airmec—A.E.I. Ltd. This centre is equipped with machine tools fitted with Airmec-AEI control systems that will be used for educational purposes and for subcontract work on a commercial basis.

Ministry Contracts aid Microelectronic Research

The Ministry of Technology has placed contracts with Elliott-Automation Microelectronics Ltd and Ferranti Ltd under the Government's policy of support for the U.K. microelectronics industry. The Ministry will contribute half of the £82,700 which Elliotts are spending on their development programme and half of the £175,000 being devoted to development at Ferranti's Gem Mill plant near Oldham. The Elliott contract is for developing a new method of making connections to m.o.s.t. microcircuit arrays. The method, known as the beam lead technique, has already been used by Elliotts for normal bi-polar microcircuits. It is a very much more reliable method of making external connections to microcircuit contact pads than the conventional fine wire methods currently employed. The first part of the contract covers a feasibility study of the technique as applied to a range of circuits associated with computer applications. The second part includes the subsequent development of suitable production equipment, the production of trial quantities of circuits and field testing in a computer environment. Work on this new technique is to start immediately at the company's Glenrothes research establishment and the company hope to be producing beam lead, single chip, large m.o.s.t. arrays by 1969. The standard method of linking circuit connection pads with output wires is to use fine wires bonded to the appropriate interconnection points. The new process forms part of the manufacture of the circuit itself and is a mass-production operation. A strip of gold is deposited on top of a layer of dielectric material covering the microcircuit; breaks in the dielectric layer being used to allow the gold strip to make contact with the correct circuit connection point. The dielectric layer can now be etched away from underneath the gold strip to provide a free connecting lead that can be bonded to the output terminal in the final microcircuit package. Each beam lead is formed in a fixed position and it is hoped to develop production equipment which will bond all such leads on a chip to appropriate terminals in a single automatic process.

The Ferranti contract will enable the company to improve yields and to further develop automatic production processes. The work that will be carried out includes the automation of slice handling in the photo-etch and diffusion processes for slices up to three inches in diameter. This will involve the development of new metallization techniques and the automation of assembly and interconnection methods.

The successful completion of this work will make equipment available so that the present ranges of integrated circuits can be manufactured at higher yield rates and lower prices also it will lead to more complex circuits becoming available.

Exhibition Control Room

Part of the £70,000 control room on the stand of Radio Rentals at the Ideal Home Exhibition (Olympia, London) where demonstrations of colour and monochrome television transmissions and locally generated material are being given

Research Scheme

To encourage collaboration between universities and industry a proportion of the Science Research Council's awards for research studentships in pure research during 1968–9 will again be reserved for specific co-operative projects. The awards—in biology, chemistry, mathematics and physics—are intended to provide an opportunity for graduates to undertake research of direct interest to industry and to become aquainted with industrial problems and people. In all, 130 awards will be made to university departments. To secure an award a member of the university staff is required to submit proposals for a joint project to the Science Research Council, State House, High Holborn, London W.C.1, by April 1st. The project should be suitable for a graduate studying for a Ph.D. and the proposal should give details of the degree of industrial collaboration; which is hoped will be substantial and could take many forms. For instance, the student could spend a proportion of his time with industry or a straight cash payment or equipment could be provided, facilities not normally available to a university could be made available by industry or industrial staff could take part in, or supervise, the project. Any firm interested in participating in the scheme should get in touch with those members of university departments most likely to be working in the field. Further information may be obtained from the Science Research Council.

Skynet Station

A fixed satellite communications terminal is to be installed in Southern England to operate in the British military Skynet satellite network. In addition, as part of the same programme, two existing stations in the Middle and Far East are to be modified. The two stations were part of a three-terminal network supplied by Marconi to a Ministry of Technology order for operation in the Anglo-American Initial Defence Communications Satellite Programme (I.D.C.S.P.). They were partly experimental and represented the first U.K. practical examination of satellite communications for military purposes. The third terminal station of this I.D.C.S.P. network is in Christchurch, Hants, but this will not be used in the present skynet set-up although it will still be used for satellite work. A feature of the overseas stations is the ease with which they can be moved, each is capable of being rapidly dismantled, transported by aircraft, re-assembled and operational again within 24 hours.

The construction of the new U.K. terminal and the modification of the existing stations will be carried out by the Marconi Company who, following the collapse of World Satellite Terminals* seem to have completely cornered the U.K.-placed contracts of this type. The U.K. station, which will also be capable of being dismantled quickly, will consist of a 42-ft diameter dish employing the now usual aluminium honeycomb and sheet method of construction. The aerial will have 90° freedom in elevation and 270° in azimuth; signals will be conveyed from the aerial to ground equipment at i.f.

*Consortium consisting of A.E.I., G.E.C. and Plessey.

Post Office Domestic Relay System

A new village, Barmston, to be built as part of Washington New Town, Durham, is the site of the Post Office's first entry into the domestic radio relay business. Twin cables will be laid for this pilot scheme to each of the 300 houses under construction, one cable will be for normal telephone services and the other will carry radio and television signals from aerials mounted on a new telephone exchange. With an eye to possible future developments wideband cables have been used throughout the extensible system. Perhaps these cables will eventually provide the long foreseen domestic, educational and closed circuit television systems, video-phone services, remote reading of gas and electricity meters, facsimile apparatus and computer access facilities.

Export Design Exhibition

Some details of the Design for Export project jointly organized by the British National Export Council and the Council of Industrial Design have been announced. It is to include an exhibition occupying the whole of the Design Centre and a series of seminars. The exhibition will be held between June 10th and July 13th and will include more than a thousand items. A special exhibition on a separate floor will trace the correlation between good design and successful export performance. Of the nineteen items selected for these case studies the electronics industry will supply five as follows: D-Mac Ltd—cartographic digitizer; Elliott Flight Automation—*Concorde* autopilot control panel (see *Wireless World* March 1968, page 11); Pye TVT Ltd—television equipment; Wayne Kerr Co. Ltd—B331 autobalance precision bridge (as part of a range); BSR Ltd—Ua70 automatic/manual turntable unit and UA50 minichanger.

Programmed Instruction

Four schools belonging to the school district of Philadelphia in America have installed a computer network that provides a source of programmed instruction enabling tutorial staff to concentrate on backward students. The network has been installed by the Philco-Ford Corporation under a contract worth $1.3m. Teachers co-operated with computer programmers to write the programmes for the installation and, to assist in this, a language known as INFORM was produced. Using this language teachers can write programmes without having to study computer programming.

Each student has an electric typewriter and a television-type monitor, designated a SAVI, for Students Audio Visual Interface, equipped with a light pen. At the start of the day's work he types in an identification number that has been assigned to him and the computer starts presenting him with information in the curriculum from the point at which he finished the day before. This information can take the form of straight textual matter, diagrams, animated cartoons, or television pictures and is liberally punctuated with questions. The student may indicate his answer on the screen with the light pen or by using the typewriter. If the student is particularly fast and accurate he will be taken into the subject in greater depth than one who is just managing to cope. In the event of a wrong answer being given the computer will branch into a sub-routine and present the information in a different way until the student has understood the point. If this stage is not reached then the assistance of a human instructor is requested. At the end of a lesson a typewriter accessible to the teacher prints out a detailed record of the student's progress.

Each school has a "computer cluster"

A student about to answer, using the light pen on the SAVI, a question presented to her by the computer

consisting of a central processor, data storage and student terminals. These "clusters" communicate directly with a remotely situated computer which contains all the lesson programmes, school curricula and school and students records. The detailed records of individual class and student progress are transmitted to the central computer at convenient times and are used to update student and school files. At the start of each day each school "cluster" receives details of the day's work from the central computer and records them on a large disc memory with a 1 M bit capacity, this can be expanded to 16 M bits if required. The central computer is similar to several large scale machines developed and manufactured by the Communications and Electronics Division of Philco-Ford to form the basic processing power from the U.S. North American Air Defence Command (NORAD). It has a core memory of 32k, words of 48 bits each and employs sixteen magnetic tape stores. The use of this large machine frees the smaller "clusters" from a large amount of control and storage work so they can concentrate purely on tutorial matter.

The system as a whole has the advantage over a "fixed wire" system of being completely flexible—for instance, instruction may be carried out on practically any subject in any language with appropriate programming.

Domestic Receiver Sales Up

Figures prepared by the British Radio Equipment Manufacturers' Association show that although the total radio and television receiver disposals to the trade was higher in 1967 than in 1966, it was well below that achieved in 1965. The Government's partial relaxation of rental and hire purchase terms during August coupled with the introduction of colour television are factors that combined to increase the 1967 figure. Rounded off totals show that of the 1.348 M television receivers delivered to the trade 30,000 of them were colour sets. TV sets showed an increase of 56,000 over 1966, but a reduction of 339,000 when compared to 1965. The combined figures for radio receivers and radiograms tell a similar story, the total delivered during 1967 was

1.632 M, 87,000 higher than 1966, but 337,000 lower than 1965.

British Company Receives American Award

The sales director of Decca Radar Ltd accepted two awards on behalf of his company from the American National Marine Electronics Association. The first award, which Decca have won for three consecutive years, was for the best single product or model of equipment at the New York Boat Show based on performance and reliability. In 1966 and 1967 this award was received by the company for its D202 marine radar equipment. This year the award was made for the type 101 small boat radar. The second award, for continued excellence of design, performance and reliability for the main product line, was made for the Decca Transar series of marine radars. It is believed that this is the first time that both awards have been made to one company in a single year.

Applications are invited from **students for a scholarship** in the Department of Electronics at Southampton University by Advance Electronics Ltd., Roebuck Road, Hainault, Ilford, Essex. The successful applicant will receive a grant of £1,000 per annum for two years (not subject to any post-graduate conditions) to carry out research into a branch of electronics associated with instrumentation or control. Students who wish to apply should graduate this year and should expect to obtain at least a second class honours degree. This is the second scholarship to be granted by Advance Electronics. The first was awarded to a student who is engaged in evolving a new form of algebra for solving problems in digital circuits.

A flight INformation Display (FIND) system is to be installed at London's Heathrow airport by R.C.A. Great Britain Ltd., which has been developed by the company in collaboration with British European Airways. The system displays flight arrival and departure information on some 200 television monitors located at strategic points in B.E.A's offices. The input of a complete day's schedules is fed into the FIND store using punched tape that has been prepared on B.E.A's main computer complex. The information is read out of the store to an R.C.A. Divicon display system where it is converted into standard video format and modulated with an h.f. carrier prior to being distributed to the various television monitors. The main store can hold 1,000 lines of 56 characters and spaces of which 20 lines can be displayed at one time. Five keyboard inputs are provided for updating the stores and displays, and provision is made for new or altered information to flash on the screens for a period of time.

Further to our report last month on the preparations made to utilize the **Intelsat network** we understand that another station is to be built in Germany by Siemens. The existing earth station, also built by Siemens, at Raisting will also be expanded to enable it to handle Intelsat communications.

"WIRELESS WORLD" INDEX

The Index to Volume 73 (Jan. 1967-Feb. 1968) is now available price 1s. (postage 3d.). Cloth binding cases with index cost 9s. 6d., including postage and packing. Our publishers will undertake the binding of readers' issues, the cost being 35s per volume including binding case, index and return postage. Copies should be sent to Associated Iliffe Press Ltd., Binding Department, c/o 4 Iliffe Yard, London, S.E.17, with a note of the sender's name and address. A separate note confirming despatch, and enclosing the remittance, should be sent to the Publishing Department, Dorset House, Stamford Street, London, S.E.1.

The European Space Research Organization has ordered from Elliott Automation two mobile check-out stations to test the control and experimental payloads of satellites. Elliotts will be responsible for the assembly of the various parts of the check-out system, for the manufacture of the necessary interface equipment and for providing the complete system. SONECTRO of France are co-operating with Elliotts in the integration of the system. The trailers, housing the equipment, will accompany the satellites from the factory to the test establishments in Europe and finally to the launching site where they will continue measurement and analysis throughout the count-down. The first trailer will be delivered to the European Space Technology Centre at Noordwijk in the Netherlands in time for the testing of the TD satellites in the spring (see *Wireless World*, February 1968, page 682.)

Apprentice Awards Each member company of the Telecommunication Engineering & Manufacturing Association may enter one candidate in each of the three classes—graduate-in-training, student apprentice, and technician apprentice—for the Association's annual competition. Each entrant has to write a technical essay on some personal aspect of his training or work relating directly or indirectly to the T.E.M.A. side of his company's activities. This year's winners, who were presented with cheques and certificates at the annual dinner on February 6th, were A. J. W. Jackson, B.A., Marconi graduate-in-training; M. R. Collyer, S.T.C. student apprentice; and P. G. O'Donovan, technician apprentice with Automatic Telephone & Electric Co.

ANNOUNCEMENTS

A residential vacation school on **"Electrical measurement practice"** will be held from 15th to 26th July at the University of Manchester Institute of Science and Technology. The school has been arranged by the I.E.E. joint professional group on measurements in collaboration with the British Calibration Service and the I.E.R.E. Inquiries should be sent to the Secretary, I.E.E., Savoy Place, London, W.C.2.

A three-day conference entitled **"Modern aspects of research and development"** will be held at Southall College of Technology commencing 8th April. Registration forms are available from The Department of Electrical Engineering, Southall College of Technology, Beaconsfield Road, Southall, Middx. (Fee 7 gn).

"An introduction to some aspects of **digital computer design"** is the title of a specialist short course of lectures to be held at Norwood Technical College. The six weekly lectures commence on 23rd April. Enrolment forms can be obtained from the Secretary, Norwood Technical College, Knight's Hill, London, S.E.27. (Fee 15s).

A series of short lecture courses in **selected mathematical topics** are to be held at Twickenham College of Technology. These will take place on Mondays, Wednesdays and Fridays from 13th May to 28th June. Enrolment forms may be obtained from the Principal, Twickenham College of Technology, Egerton Road, Twickenham, Middlesex.

A colour television receiver has been installed in the **Science Museum's Radio Demonstration** Room. It forms part of a continuous demonstration of radio communications equipment.

Hand-soldered Joints in Electronics is the title of an eight-minute Mullard training film, in colour, now available for hire from the C.O.I., Central Film Library, Bromyard Avenue, London, W.3.

Seven films produced by Educational Services Inc., U.S.A., as part of their advanced college physics film programme, are now available for hire through the Central Office of Information, Bromyard Avenue, London, W.3. The titles include (1) "Photo-emission of electrons", (2) "Thermionic emission of electrons" and (3) "Positron-electron annihilation".

A short-wave communication system is to be built by Marconi to be used in controlling the new oil pipe-line between Dar-es-Salaam in Tanzania and Ndola in Zambia. Effective communications by day and night are required, to achieve this log periodic arrays will be used at each end of the 1,000-mile line in conjunction with intermediary broadband dipoles.

Two unmanned radar stations, part of the NADGE (Nato Air Defence Ground Environment) radar chain, are to be equipped with transmitters from the Marconi S600 series. The contract is worth £350,000.

The Ministry of Technology has granted **test house facilities approval** to Transitron Electronic Ltd., Gardner Road, Maidenhead, Berks. This approval refers to the test and inspection of semiconductor devices to CV specifications.

Six companies active in the research, development and production of military infra-red equipment and components have formed the **British Infra-Red Manufacturers Organization** (B.I.R M.O.). The companies are: Barr & Stroud Ltd., EMI Electronics Ltd., Hawker Siddeley Dynamics Ltd., Hymatic Engineering Co. Ltd., Mullard Ltd. and Standard Telephones & Cables Ltd.

The British National Export Council have decided to co-operate with Kompass Register, an INI company, in publishing an **export marketing guide** entitled "British Exports '69". Designed for use by overseas buyers, the first edition is scheduled for publication in the Autumn.

Crompton Parkinson Ltd., a Hawker Siddeley company, have agreed to acquire the plant, **equipment and stocks of Vidor Ltd. and Burndept Ltd.,** part of the Royston Industries Group.

The **Wired TV product** group of Thorn Bendix have moved its sales offices and laboratories to the Industrial Electronics division at High Church Street, New Basford, Nottingham. Thorn Bendix manufacture transistor wired television distribution systems.

Personalities

R. D. A. Maurice, Dr. Ing., F.I.E.E., assistant head of the B.B.C. Research Department since 1961, has become head of the Designs Department in succession to **S. N. Watson,** F.I.E.E. who as recently announced, has been appointed chief engineer, television. Dr. Maurice joined the B.B.C. Research Department in 1939 and after some

Dr. R. D. A. Maurice

years in the receiver and measurements section transferred to the television group, of which he became head in 1958. Dr. Maurice has served for many years on the television study group of the C.C.I.R. and was chairman of the general characteristics sub-group of the European Broadcasting Union's ad-hoc group on colour television.

W. P. Williams, Ph.D., B.Sc. (Eng.), who joined the Marconi International Marine Company in 1964 as leader of a group working on echo-sounding and ultrasonic techniques and just over a year ago became assistant technical manager responsible for new product engineering, has been appointed deputy technical manager. A graduate of Nottingham University, Dr. Williams was awarded a research scholarship while studying for his doctorate. In 1963 he received the first Baird travelling scholarship from the Royal Television Society under which he toured Europe studying the Eurovision television network. He is 29.

T. H. Bridgewater, O.B.E., F.I.E.E., who retires this month from the B.B.C. joined the Corporation in 1932 before which he worked for four years with John Logie Baird. When the B.B.C. television service started in 1936 Mr. Bridgewater was appointed senior maintenance engineer at the Alexandra Palace station. After war service in the R.A.F. he returned to the B.B.C. in 1946 and was at one time superintendent engineer O.Bs. He has been chief engineer (television) since 1962.

F.C. Loveless, A.Inst.P., has been appointed to the Board of 20th Century Electronics Ltd., but will continue as head of technical services having responsibility for all sales activities. Mr. Loveless, who is 38, joined the Company in 1952 as a junior physicist to work on radiation detectors. After completing two years as assistant to the general manager he took over responsibility for the Company's technical sales in 1961.

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 are made from time to time by the Paul Instrument Fund Committee which is composed of representatives of the Royal Society, the Institute of Physics & Physical Society and the I.E.E. Among the recent recipients are **Dr. A. P. Anderson,** lecturer in the department of electronic and electrical engineering in the University of Sheffield, who receives £2,000 for the construction of an instrument for the measurement of energy in laser beams; **Dr. W. J. Jones,** demonstrator in the department of physical chemistry, University of Cambridge, £1,500 for the construction of a spectrometer employing frequency selective intensity modulation; **Professor J. D. McGee,** O.B.E., F.R.S., professor of applied physics at the Imperial College of Science and Technology, London, £6,250 for continuation of his work on the development of a photo-electronic image device for time images for which in 1964 he received a grant of £8,100 over three years; and **Dr. K. I. Mayne,** senior lecturer in the department of natural philosophy in the University of Edinburgh, £4,000 for the construction of a polarized electron source.

A. G. J. Holt, Ph.D., M.I.E.E., reader in electrical engineering in the Department of Electrical Engineer, the University of Newcastle-upon-Tyne, has received grants totalling £8,779 from the Ministry of Technology in aid of research work on computer methods in active network design and on thin-film RC communications networks. Dr. Holt has also received a contract worth £2,100 from the G.P.O. for work on the design of RC-active electrical filter networks.

The appointment of two associate directors is announced by Gardners Transformers. They are **R. P. Henegan,** Assoc.I.E.R.E., who joined the company in 1964 becomes director and general manager and **J. W. McPherson,** B.Sc.(Eng.), M.I.E.E., who joined as technical manager in 1964 is now technical director.

Stanley Baker, B.Eng., A.M.I.E.E., has joined the magnetic recording head division of the Gresham Lion Group as a senior development engineer. A graduate of the University of New South Wales, Mr. Baker has submitted a thesis on "an investigation of crosstalk in multitrack recording heads" as part of his studies for a doctorate of philosophy. His University professor was **Dr. C. B. Speedy** who was technical director of Gresham before joining the staff of the University.

H. Stern, B.Sc., who contributed an article on digital voltmeter techniques to our November 1967 issue, has joined Fluke International Corp., as U.K. sales manager. A graduate of Queen Mary College, London University, he was at one time sales manager of Cawkell Research and Electronics and was latterly product manager for test instruments with Honeywell.

H. Stern

J. M. Tompsett, B.Sc., M.I.E.E., who has been with the English Electric Valve Company since 1952, has been appointed quality assurance manager. A graduate of Bristol University he began his career with the Admiralty Signals Establishment, Haslemere, in 1944. From 1948

J. M. Tompsett

until joining E.E.V. he was with Standard Telephones & Cables. Mr. Tompsett was initially in the gas tube department of E.E.V. but later transferred to the travelling wave tube department of which he has been head since 1962.

Group Captain T. C. Imrie, M.I.E.R.E., who is to become air officer in charge of engineering, R.A.F. Coastal Command (with the acting rank of Air Commodore), at one time commanded No. 30 Maintenance Unit at Sealand, Cheshire, and later the Radio Engineering Unit at Henlow, Beds.

W. A. Jackson, B.B.C., engineer-in-charge, operations, Scotland, is to be head of engineering, Scotland, in succession to **J. A. G. Mitchell** who is retiring on 31st May, after more than 40 years of service. Mr. Jackson joined the B.B.C. in 1937 as a junior maintenance engineer at the Alexandra Palace television station. From 1941 he was engineer-in-charge of the Whitehaven transmitting station and in 1944 he joined the B.B.C. War Reporting Unit as engineer-in-charge of a mobile transmitter which served in France and Germany. After the war he re-joined the B.B.C. television service in London. For six months during 1967 Mr. Jackson was seconded to the Government of Iran in an advisory capacity to assist in the setting-up of a national television service. Mr. Mitchell joined the B.B.C. in 1927. He was appointed assistant engineer-in-charge of the B.B.C's war-time centre at Wood Norton, near Evesham, Worcestershire, in 1941, and later held a similar post in Birmingham. From 1950 he was regional engineer, Northern Ireland, and has been head of engineering, Scotland, since September 1961.

Simple F.E.T. Pre-amplifier

Equalizing circuit for microgroove recordings

*by D. B. G. James** B.Sc.

THE higher input impedance and lower noise figure of the field effect transistor[1] compared with the normal bi-polar transistor suggests that one of its applications could be in the input stage of an audio pre-amplifier circuit for the reproduction of disc records.

An equalization circuit has to boost the bass frequencies and attenuate the high frequencies to produce a frequency characteristic which is the inverse of the recording characteristic. (The recording characteristic which has been used by most of the recording companies since 1954 is the R.I.A.A. characteristic[2].) This assumes that the output frequency characteristic of the pickup used is identical with that of the recording characteristic, this is the case for most of the high-quality magnetic pickups now available[3]. It is for this form of output voltage-frequency characteristic that the f.e.t. equalization circuit which follows has been produced.

The gain of the basic f.e.t. amplifier of Fig. 1 is approximately ten, so it should just be possible to obtain the required bass boost using a feedback network over one stage, if the gain at 1 kHz is arranged to be approximately unity. Above 1 kHz the attenuation should increase until at 15 kHz it is approximately −17 dB. The values for the equalizing components to give the necessary equalization were found experimentally, and are shown in Fig. 2. The circuit gave a response which was within ±1 dB of the ideal replay characteristic over the frequency range 50 Hz to 15 kHz. The first stage gain is approximately unity at 1 kHz and in order to increase the output voltage to a suitable value for input to a power amplifier, an additional f.e.t. stage is used. This second stage is similar to the basic amplifier stage of Fig. 1, but the gate resistor has been increased from 1 MΩ to 4.7 MΩ. With an input of 15 mV the output of the second stage at 1 kHz was 195 mV, i.e., a gain of about 13 times.

*University College, Swansea.

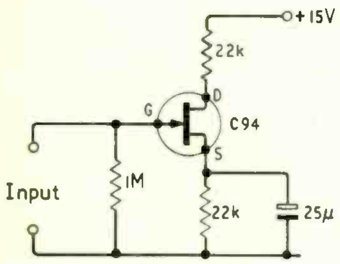
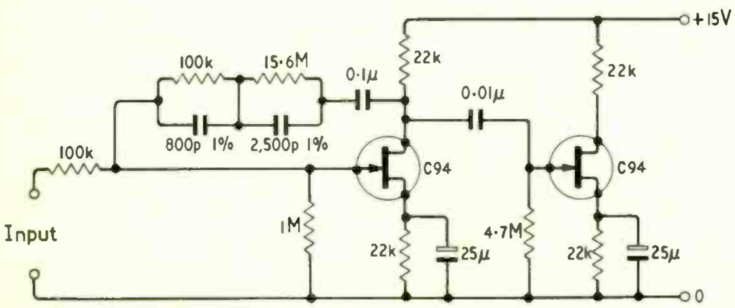


Fig. 1. The basic f.e.t. amplier. All resistors of 10% tolerance.

Fig. 2. Two-stage amplifier with equalization. All resistors are of 10% tolerance.



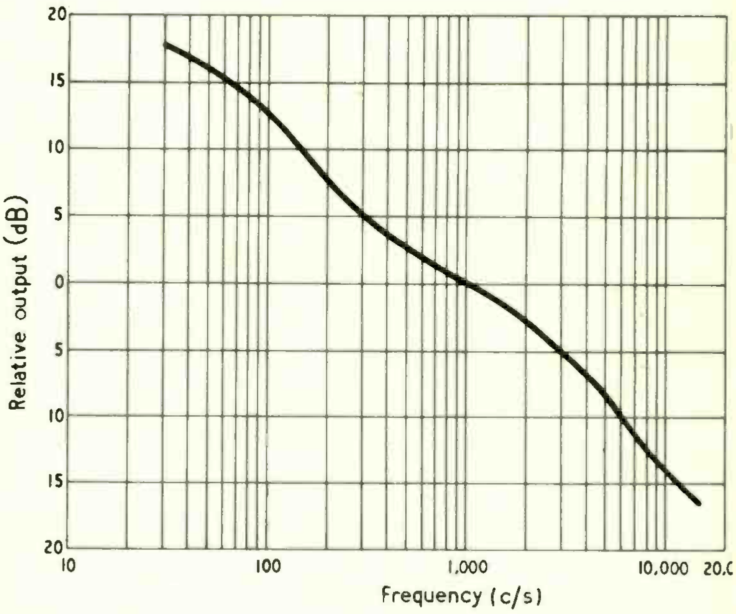


Fig. 3. Frequency response of Fig. 2.

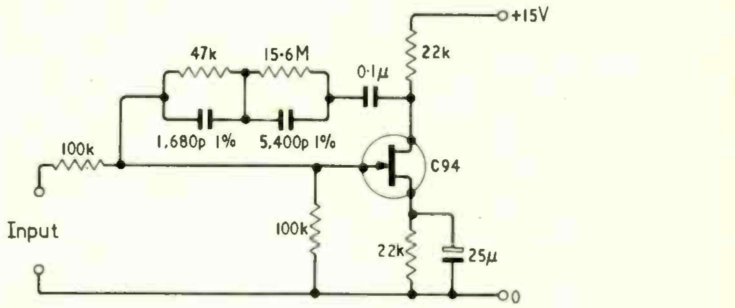


Fig. 4. Alternative equalization circuit using 100 kΩ gate resistor. All resistors are of 10% tolerance.

The results obtained with this circuit are shown in Fig. 3. It was found that varying the 15.6 MΩ within its ±10% tolerance resulted in a change of only 0.2 dB and varying the 100 kΩ within the same limits caused an 0.6 dB change.

An alternative circuit is shown in Fig. 4 using a gate resistor of 100 kΩ instead of 1 MΩ. This circuit should be suitable for pickups having an impedance of the order of 100 kΩ and again has a frequency response within 1 dB of the required equalization characteristic for micro-groove recordings.

References

1. "Field Effect Transistors" by L. J. Sevin. McGraw Hill.
2. BS 1928.
3. "High Quality Sound Reproduction" by James Moir. Chapman and Hall, second edition (1961) p. 199.

Microphone Supplement

The following tables are intended to help the prospective buyer in making comparisons between microphones available in the U.K. To allow quick and easy comparison it has been necessary to restrict the information given on each type to the most important characteristics, such as physical structure, transducer type, directional properties and price.

The tables have been compiled with the co-operation of those suppliers who have responded to a questionnaire sent out by *Wireless World*.

One point about the " sensitivity " column in the tables: A common method of specifying sensitivity is in decibels relative to a sensitivity reference value, and a reference frequently used by manufacturers is 1V/dyne/cm² (or, with an equivalent unit of pressure, 1V/μb). Since *Wireless World* has now adopted SI units, the pressure part of the reference value is shown in the tables in newtons per square metre, and 1V/dyne/cm² = 10V/N/m². Some microphone suppliers prefer to use other methods of specifying sensitivity, and these will be noticed in the tables. Where several sensitivity values are listed for a microphone it will be seen that these correspond with the alternative impedances available.

Type No.	Type	Transducer	Impedance Values (ohms)	Directional Characteristics	Front-to-Back ratio (dB)	Sensitivity (dB) at 1 kHz (ref. 10V/N/m²)	Pin Connections	Output Connector	Application	Price	Accessories not included in price
A.K.G. (Politechna Ltd., 182/4 Campden Hill Road, London, W.8.)											
D11D	Pencil	M.C.	500 & 50k	Cardioid (3 variations)	15	−72.5 −54	1-2 High Z 3-2 Low Z	3 pole DIN	Stereo version also available	£7 15s	Sa.14 Swivel stand adaptor
D12	Stand	M.C.	60 or 200	Cardioid (3 variations)	18	−81 −75	Free end cable	—	P.A.	£30	—
D14S	Stand	M.C.	60 & 50k	Cardioid (3 variations)	14	−80 −52	Free end cable	—	P.A. and tape recording	£10 15s	St.2 desk stand
D19C	Pencil	M.C.	60 or 200	Cardioid (3 variations)	16	−80 −75	1-3 Microphone 2 Earth	3 pole DIN	P.A.	£18	St.1. desk stand
D19E	Pencil	M.C.	60, 200 & 50k	Cardioid (3 variations)	16	−80 −75 −54	3-4 60Ω 2-4 200Ω 5-4/1 50kΩ 1 Screen	5 pole Cannon XLR 5-11C	P.A.	£22 10s	St.1. desk stand
D24B	Pencil	M.C.	60 or 200	Cardioid (3 variations)	18	−80 −75	1-3 Mic. } B 2 Earth }	3 pole DIN	Recording and studios	£48 10s	
D25B	Boom or stand	M.C.	60	Cardioid (3 variations)	18	−81	Free end cable	—	Broadcasting and film	£55	—
D58	Miniature	M.C.	60 or 200	Fig. of 8. Close talk	—	−88 −82	1-3 Microphone 2 Screen	3 pole DIN	Speech in noisy surr.	£11 15s	MSH.21 Flexible shaft
D66 Stereo	Stand	M.C.	200	Cardioid	14	−73	5-4 1st mic. 3-1 2nd mic.	5 pole DIN	Stereo tape recorders	£12 15s	—
D109/60	Lavalier or hand	M.C.	60 or 200	Omni	—	−84 −78	—	Free end cable	—	£12	—
D119CS	Pencil	M.C.	200	Cardioid	16	−75	1-3 mic. 2 Screen	3 pole DIN	P.A.	£22	St.2. desk stand
D119ES	Pencil	M.C.	60, 200, 50k	Cardioid	16	−80 −75 −54	3-4 60Ω 2-4 200Ω 5-4/1 50kΩ 1 Screen	5 pole Cannon XLR 5-11C	P.A.	£26	St.2. desk stand
D200C	Pencil	M.C.	200	Cardioid	18	−77	1-3 Mic. 2 Screen	3 pole DIN	Musicians	£23	W4 windscreen
D202E	Pencil	M.C.	200	Cardioid	20	−76	2-3 Mic. 1 Earth	3 pole Cannon XLR 3-11C	Recording/ Studio	£32	St.4. table stand
D501	Reporter	M.C.	60 or 200	Cardioid & omni (switched)	15	−73	4 pole cable 2 for Mic. 2 for remote - control sw.	Free end cable	Reporting, P.A.	£13 10s	St.2. table stand
D503	Flexible shaft	M.C.	60 or 200	Cardioid	15	−73	2 pole screened	Free end cable	Paging	£16	—
D505	Hand or stand	M.C.	200	Hyper-cardioid	15	−74	4 pole cable 2 for Mic. 2 for remote cont. sw.	Free end cable	P.A. & close-talk reporting	£13 10s	—
D507	Flexible shaft	M.C.	200	Hyper-cardioid	15	−74	2 pole screened	Free end cable	P.A., paging close talk	£16	
D1000C	Pencil	M.C.	60 or 200	Cardioid	20	−78 −72	1-3 Mic. 2 Earth	3 pole DIN socket	Musicians, stage	£29	Jack plug matching transformer
C61	—	Capacitor M.C.	50 or 200	Cardioid. Change capsule for omni	20	−64	—	—	Recording/ Bdcasting	£85	Omni-directional capsule
C12A	Stand	Capacitor M.C.	50 or 200	Cardioid, omni, Fig. 8 & 6. Intermediate pos.	20	−68	—	—	Studio Bdcst. Recording	£130	Separate selector unit
C24 Stereo	Stand	Capacitor M.C. Stereo	50 or 200	Cardioid, omni, Fig. 8 & 6. Intermediate pos.	20	−68	—	—	Recording, Bdcasting	£250	—
DX11	Stand	M.C.	200 & high	Cardioid	14	−74 −52	Twin screened	Free end termination	Musicians, reverb. Mic.	£30 10s	—

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Chapman Transistorised Stereo Tuners

3 outstanding microphones from the RESLO range

For the Hi-Fi enthusiast

VHF/FM Tuner type FM 1000A/B—Fully Transistorised FM 86-108 M/cs only.

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Shown mounted on MS175 'boom' arm. Uni-directional pick-up well maintained through the audio frequency spectrum. Very suitable for high quality music recording and relay purposes.

Impedances & Prices: Low: **£15/15/-**. Medium and High **£16/16/-**. (Non-switched version available.)

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(Type PDS Switched) For high quality music and speech recording completely free from breath 'pops', etc.

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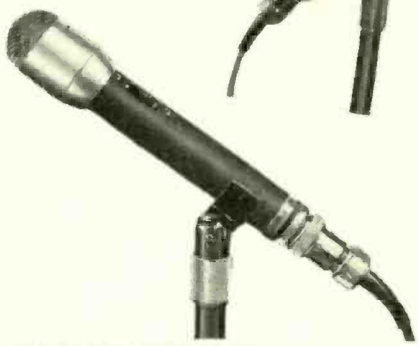

CARDIOID DYNAMIC TYPE ECI

Specially designed for entertainment use. (Registered design No. 926589. Pronounced uni-directional pick-up, 'presence' peak and bass roll-off, detachable foam nylon acoustic resistance hood.

Low, Med. and High Impedances. **£18.**

- ★ PRECISION ENGINEERED
- ★ REALISTIC REPRODUCTION
- ★ LOW, MED. & HIGH IMPEDANCES
- ★ REASONABLY PRICED
- ★ FINEST OF THEIR KIND AT THESE PRICES
- ★ BRITISH MADE

Reslo also manufacture a complete range of public address amplifiers and loudspeakers, cabinet, line source and reflex horns.

Chapman

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RESLOSOUND LTD

Reslo Works, Spring Gardens, London Road, Romford, Essex: Romford 61926 (3 lines)

Reslo

WW—201 FOR FURTHER DETAILS

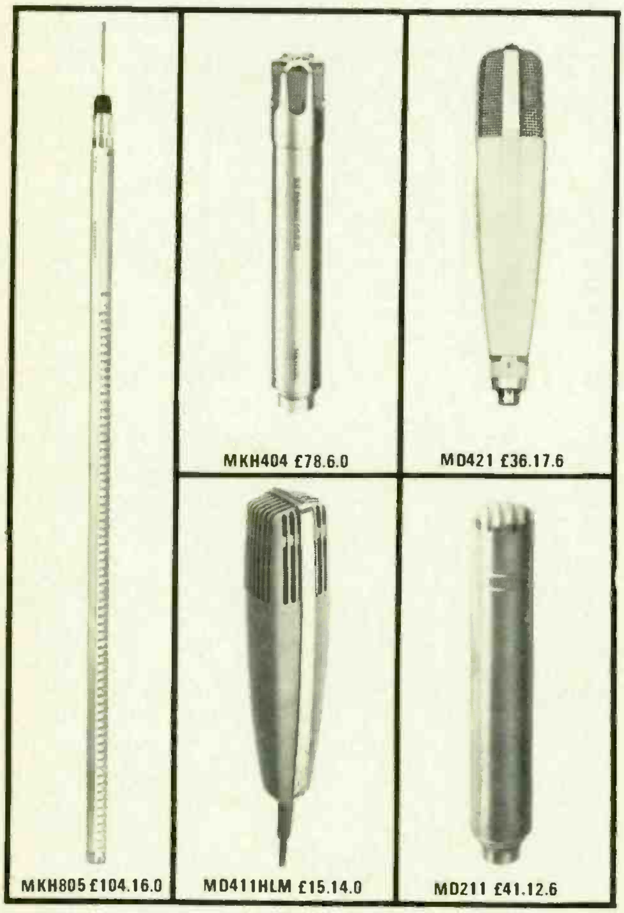
Type No.	Type	Transducer	Impedance Values (ohms)	Directional Characteristics	Front-to-Back ratio (dB)	Sensitivity (dB) at 1 kHz (ref. 10V/N/m²)	Pin Connections	Output Connector	Application	Price	Accessories not included in price
Acos—Cosmocord Ltd., Eleanor Cross Road, Waltham Cross, Herts.											
Mic. 91	H/Table	Crystal	1M	Omni.	—	-50	—	Lead	—	£2	
Mic. 93	H/Table	Ceramic	2M	Omni.	—	-51	—	Lead	—	£2 5s 0d	
Mic. 95/15	H/Table	M.C.	500-20k	Omni.	—	-74	—	Lead	—	£2 12s 6d	
Mic. 95/50	H/Table	M.C.	50k-2M	Omni.	—	-54	—	Lead	—	£3 3s 0d	
Mic. 39	Stk./Neck	Crystal	2M	Omni.	—	-61	—	Lead	—	£3 3s 0d	
Mic. 70/1	Stk./Neck	M.C.	200-10k	Omni.	—	-80	—	Lead	—	£7 10s 0d	
Mic 70/4	Stk./Neck	M.C.	50k-2M	Omni.	—	-57	—	Lead	—	£8 8s 0d	
Mic. 45	Hand	Crystal	1M	Omni.	—	-50	—	Lead	—	£2	
Mic. 60	Stick	Crystal	1M	Omni.	—	-57	—	Lead	—	£2 2s 0d	
Ampex (Gt. Britain) Ltd., 72 Berkeley Avenue, Reading, Berks.											
3001	Stand	M.C.	50-250 100k	Omni	15	—	—	—	Recording, P.A.	£16 16s	—
Audac Marketing Co., Ltd., Forest Works, Carey Road, Wareham, Dorset											
TX/M	Radio Mic.	M.C.	600	Omni	—	-55	—	—	—	£35	—
TX/MN	Radio Mic	M.C.	600	Omni	—	-55	—	—	—	£35	—
TX/D	Radio Mic.	M.C.	600	Omni	—	-55	—	—	—	£35	—
TX/IN	Radio Mic.	M.C.	200	Omni	—	-70	—	—	—	£60	—
TX/I	Radio Mic.	M.C.	200	Omni	—	-70	—	—	—	£60	—
TX/C	Radio Mic.	M.C.	200	Omni	—	-70	—	—	—	£60	—
TX/CN	Radio Mic.	M.C.	200	Omni	—	-70	—	—	—	£60	—
TX/45	Radio Mic.	M.C.	30	Cardioid	18	-78	—	—	—	£70	—
TX/65	Radio Mic	M.C.	30	Cardioid	18	-77	—	—	—	£80	—
560 F	Lavalier	—	200	Omni	—	-70	Centre & outer screen	Min. jack plug	—	£12	Wind Shield £1 1s 0d. POP Filter £2 10s 0d
570 F	Lavalier	—	200	Omni	—	-80	Centre and outer screen	Min. jack plug	—	£37	—
Audix B.B. Ltd., Stansted, Essex											
S-500	Hand	M.C.	High or 150	Cardioid	—	—	1 & 2 signal 3 & case screen	Cannon XLR-3-11C	Broadcasting, P.A., recording	—	—
602	Hand	M.C.	Low	Cardioid	22	—	Flying lead	—	P.A.	—	—
355-C	Hand	M.C.	600	Omni.	—	—	Coiled flying lead	—	Mobile comm.	—	—
+2	Desk	—	5k	Cardioid	—	—	Coiled flying lead	—	P.A.	—	—
254X	Desk	M.C.	600	Cardioid	—	—	Flying lead	—	P.A.	—	—
252	Desk	M.C.	High	Cardioid	—	—	Flying lead	—	Paging	—	—
+50	Desk	—	150 or 600	Cardioid	—	—	Flying lead	—	P.A.	—	—
44D	Stand	M.C.	50 or 250	Omni.	—	—	Flying lead	—	—	—	—
58	Lavalier	M.C.	High or 150	Omni.	—	—	Flying lead	—	P.A.	—	—
B. & K. Laboratories Ltd., Cross Lances Road, Hounslow, Middx.											
4131	Measrmt.	Capacitor	57pF	Omni.	—	-46	1+guard ring+case	Centre pin	20Hz-20kHz	£47	Cathode follower and power supply
4133	Measrmt.	Capacitor	20pF	Omni.	—	-60	1+guard ring+case	Centre pin	20Hz-40kHz	£47	Cathode follower and power supply
4135	Measrmt.	Capacitor	6.4pF	Omni.	—	-74	1+guard ring+case	Centre pin	30Hz-100kHz	£47	Cathode follower and power supply
4138	Measrmt.	Capacitor	3.5pF	Omni.	—	-86	1+guard ring+case	Centre pin	30Hz-140kHz	£54	Cathode follower and power supply
A. P. Besson & Partner Ltd., St. Joseph's Close, Hove, Sussex											
10	Insert	M.C.	2k	—	—	-77	—	Wire tails	—	—	—
11	Insert	M.C.	2k	—	—	-71	—	Wire tails	—	—	—
12	Insert	M.C.	2k	—	—	-73	—	Wire tails	—	—	—
387	Insert	M.C.	4k	—	—	-77	—	P/C board	—	—	—
Beyer (Fi-Cord International, Charlwoods Road, East Grinstead, Sussex)											
M23	Lavalier	M.C.	200	Cardioid	—	1.2mV/N/m²	1 & 3 signal 2 earth	DIN	Close talking	£9 7s	—
M64	Lavalier	M.C.	37.5-200	Cardioid	—	2mV/N/m² -52dB	1 & 3 signal 2 earth	DIN	P.A., lecturing	£19 2s £18 3s	Goose neck and stand
M64SH	Stand	M.C.	37.5-200	Cardioid	—	2mV/N/m² -52dB	1 and 3 signal 2 earth	DIN	P.A., lecturing Studio	£26 £25 1s	
M67	Hand	M.C.	37.5-200	Cardioid	16	2.2mV/N/m² -51dBm	1 & 3 signal 2 earth	DIN	Studio	£39 9s £38 10s	
M69	Hand	M.C.	37.5-200	Cardioid	16	2.4mV/N/m² -50dBm	1 & 3 signal 2 earth	DIN	Studio	£29 4s £28 5s	
M88	Hand	M.C.	37.5-200	Cardioid	20	2.8mV/N/m² -59dBm	1 & 3 signal 2 earth	DIN DIN	Studio, etc.	£61 4s £60 5s	
M100	Hand	M.C.	37.5-200	Omni	—	1mV/N/m²	1 & 3 signal 2 earth	DIN	Studio, etc.	£61 4s £60 5s	
M110	Lavalier	M.C.	200	Omni	—	1mV/N/m²	1 & 3 signal 2 earth	DIN	—	£28 11s	
M119	Hand	M.C.	200	Omni	—	2.2mV/N/m² -73dBm	1 & 3 signal 2 earth	DIN	Studio	£15 14s	KTR145/147—Clamps, stands, clips, etc.
M130	Hand	Double Ribbon	200	Bi-directional	Equal	0.9mV/N/m² -59dBm	1 & 3 signal 2 earth	DIN	Studio	£61 16s	
M160	Hand	Double Ribbon	37.5-200	Super Cardioid	12-25	1mV/N/m²	1 & 3 signal 2 earth	DIN	Studio	£62 18s £61 19s	
M260	Hand	Ribbon	37.5-200	Super Cardioid Uni.	12-20	0.9mV/N/m² -59dBm	1 & 3 signal 2 earth	DIN	Tape recording, Amateurs	£24 11s £23 12s	
M610	Hand	M.C.	37.5-200	Cardioid	15	2mV/N/m² -52dBm	1 & 3 signal 2 earth	DIN	Voice/music switch	£24 13s £23 14s	
Soundstar XI version 'N'	Stand	M.C.	200	Cardioid	—	2mV/N/m² -52dBm	1 & 3 signal 2 earth	DIN	Studio or Amateur	£19 15s 6d	
Soundstar version HLM	Stand	M.C.	200-500-50k	Cardioid	—	2mV/N/m² -52dBm	2 & 3 200Ω 2 & 1 500Ω & 25k, 2-ground	DIN	Studio or Amateur. Impedance selector switch	£21 18s	—

Type No.	Type	Transducer	Impedance Values (ohms)	Directional Characteristics	Front-to-Back ratio (dB)	Sensitivity (dB) at 1 kHz (ref. 10V/N/m^2)	Pin Connections	Output Connector	Application	Price	Accessories not included in price
Beyer (Contd.)											
M55	Stand	M.C.	200-80k	Omni	—	1.2mV/N/m^2 —56dBm 20mV/N/m^2 —54dBm	3 & 2 High Z 1 & 2 Low Z	DIN	Tape Recording.	£8 5s	—
M80	Stand	M.C.	200-80k	Cardioid	15	1.8mV/N/m^2 56dBm 31mV/N/m^2 —54dBm	3 & 2 High Z 1 & 2 Low Z	DIN	Tape Recording.	£12 18s	—
M808	Stand	M.C.	200-80k	—	—	—	2 & 2 High Z 1 & 2 Low Z	DIN	Stereo Recording	£25	—
M57	Hand	M.C.	200	Omni	—	2mV/N/m^2-52dBm	Wire ended	Wire ended	—	£13 16s	—
M320	Stand	Ribbon	200	Super Cardioid	20	1.4mV/N/m^2 —58dBm	1 & 3 earth 2	DIN	—	£37 10s	—
M360	Stand	Ribbon	200	—	—	—	1 & 3 earth 2	DIN	Studio	£87 10s	—
M410	Hand	M.C.	200	Cardioid	20	—	1 & 3 earth 2	DIN	P.A. noisy sits	£16 15s	—
M410S	Hand	M.C.	200	Cardioid	—	—	1 & 3 earth 2	DIN	P.A. noisy sits	£17 10s	—
Bouyer (Douglas A. Lyons & Associates Ltd., 32 Grenville Court, London, S.E.19)											
709	H or Std.	M.C.	20	Cardioid	20	0.7mV/N/m^2	1 & 2 signal 3 screen	—	Speech	£12 10s 0d	Flexible stem, switch handle fitting
710	H or Std.	M.C.	200	Super-cardioid	20	1.5mV/N/m^2		—	Speech & music	£25 10s 0d	
Danavox (Gt. Britain) Ltd., 186 Wardour Street, London, W.1											
5411-23	Capsule	M.C.	5k	—	—	-74	—	—	—	—	
5411-24	Capsule	M.C.	5k	—	—	-74	—	—	—	—	
5410-01	Capsule	M.C.	2k	—	—	-80	—	—	—	—	
5410-12	Capsule	M.C.	2k	—	—	-78	—	—	—	—	
5410-14	Capsule	M.C.	5k	—	—	-74	—	—	—	—	
5411-13	Capsule	M.C.	5k	—	—	-74	—	—	—	—	
5411-14	Capsule	M.C.	5.5k	—	—	-72	—	—	—	—	
9250-04	Throat	M.C.	250	—	—	1-2mV	Coax. lead	—	—	—	
9250-06	Throat	M.C.	500	—	—	1-2mV	Coax. lead	—	—	—	
5250-07	Throat	M.C.	1k	—	—	1-2mV	Coax. lead	—	—	—	
5250-08	Throat	M.C.	2k	—	—	1-2mV	Coax. lead	—	—	—	
Eagle Products (B. Adler & Sons Ltd., 32A Coptic Street, London, W.C.1)											
DM.38C	H/Lavalier	M.C.	50k	Cardioid	—	-52	1 s. 1 sig.	Single contact U.S.A. connector	—	£5 5s 0d	
DM.31C	Hand	M.C.	50k	Cardioid	—	-52	1 s. 1 sig.		—	£7 7s 0d	
DM.22	Pencil	M.C.	50k	Omni.	—	-52	1 s. 1 sig.		—	£3 7s 6d	
DM.34C	Hand	M.C.	50k	Cardioid	—	-55	1 s. 1 sig.		—	£6 6s 0d	
DM.18HL	Hand	M.C.	600/50k	Omni.	—	-58	1 signal, 2 screen, 3 & 4 impedance		—	£6 19s 6d	
DM.14S	Pencil	M.C.	50k	Omni.	—	-52	1 s. 1 sig.		—	£3 3s 0d	

Type No.	Type	Transducer	Impedance Values (ohms)	Directional Characteristics	Front-to-Back ratio (dB)	Sensitivity (dB) at 1 kHz (ref. 10V/N/m^2)	Pin Connections	Output Connector	Application	Price	Accessories not included in price
Electro-Voice (KEF Electronics, Tovil, Maidstone, Kent)											
643	Stand/gun	M.C.	50/150/250	Super-card.	25	−48dB (1mW/N/m^2)	3 + screen	Cannon UA-3-11	Prof. broadcast & record.	—	—
642	Gun	M.C.	50/150/250	Cardiline	23	−48dB (1mW/N/m^2)	3 + screen	Cannon UA-3-11	Prof. broadcast & record.	—	326 windshield, 324 shockmount, 513 100Hz high-pass filter, 356 shockmount 419 desk stand
644	Gun	M.C.	150/High	Super Card.	20	Hi Z −53 Lo Z −53 (1mW/N/m^2)	2 + screen	Amphenol MC4F	—	—	
668	Boom	M.C.	50/150/250	Cardioid	20	−51dB (1mW)	3 + screen	Cannon UA-3-11	Prof. broadcast & record.	—	—
RE15	Stu. boom/H	M.C.	150	Super Cardi.	24	−56dB (1mW/N/m^2	2 + screen	Cannon XLR-3-11	Prof. broadcast & record.	—	307 shockmount, 314 windshield
676	Hand/stand	M.C.	150/High	Cardioid	18	Hi Z −57 Lo Z −57 (1mW/N/m^2)	2 + screen	Amphenol MC4F	P.A.	—	355 windscreen
627	Hand/stand	M.C.	150 or High	Cardioid	18	Hi Z −58 Lo Z −58 (1mW/N/m^2)	2 + screen	Amphenol 80/MC-2M	P.A.	—	—
655c	Studio/hand	M.C.	50/150/250	Omni	—	−55dB (1mW/N/m^2)	3 + screen	Cannon UA-3-12	Prof. Broadcast & record	—	355 windscreen
654A	Studio/hand	M.C.	Nom. 150	Omni	—	−57dB (1mW/N/m^2)	3 + screen	Cannon XLR-3-11	Prof. broadcast & record.	—	355 windscreen
635A	Hand/stand	M.C.	Nom. 150	Omni	—	−55dB (1mW/N/m^2)	2 + screen	Cannon XLR-3-11	Prof. broadcast & record.	—	—
623	Stand	M.C.	150/High Z	Omni	—	Hi Z −56 Lo Z −56 (1mW/N/m^2)	2 + screen	Amphenol MC4F	—	—	—
636	Stand	M.C.	150/High Z	Omni	—	Hi Z −55 Lo Z −55 (1mW/N/m^2)	2 + screen	Amphenol MC4F	—	—	—
649B	Lavalier	M.C.	Nom. 150	Omni	—	−61dB (1mV/N/m^2)	2 + screen	Fitted cable	Broadcast	—	—
647A	Lavalier	M.C.	150 or High Z	Omni	—	−60dB (1mV/N/m^2)	2 + screen	Fitted cable	—	—	—
602TR	Hand	M.C.	100 to 500	N.C. pressure gradient	—	up to 2V output	—	Fitted cable	Comm. & air-line use	—	—
Endevco, The Sycamores, Kneesworth Street, Royston, Herts.											
2510	High intensity	Piezo	—	Incorps. vibration cancelling accelerometer	—	37pk pC*	—	Min. coax.	High intensity sound testing	£205	—
Fi-Cord International, Charlwoods Road, East Grinstead, Sussex											
FC1200	Hand	Capacitor	300-30	Cardioid or Omni	20	10mV/N/m^2 (30Ω) 60dB relative 1V/m mb	2 & 3 signal 1 earth & screen	Cannon	—	£98	—
FC1200A	Hand	Capacitor	300-30	Cardioid	15-20	15mV/N/m^2	2 & 3 signal 1 earth & s.	Cannon	—	£57 17s	—

*at 140dB—37dB ref 1pC at 0.1 N/m^2 (charge sensitivity) 5mV r.m.s. at 140dB—112dB ref. 1V at 0.4 N/m^2 (voltage sensitivity)

Sounds Original



In Room 355 at the Audio Fair, visitors will hear **original stereo recordings.** These stereo recordings were made under **domestic conditions** using various pairs of Sennheiser microphones with a B and O tape recorder. By changing the microphones at regular intervals during the recordings sensible comparisons can be made regarding the quality and characteristics of these microphones. Microphones such as the **MD 421** studio cardioid microphone, the **MD 211** studio omni microphone (probably the finest moving coil omni-directional microphone in the world), the **MKH 405** RF condenser microphone and the **MD 411** triple impedance dynamic microphone were used to make comparisons in these stereo recordings. **All questions** regarding microphone technique, acoustics and sound recording in general, relating to these recordings will be answered in the above room by our sound engineers.

Audio Engineering Ltd

33 Endell Street London WC2 TEM 0033

WW—205 FOR FURTHER DETAILS

one switch ....to give you two mikes

The Philips P33 is a superb, professional microphone at a medium price, which provides cardioid or omni-directional characteristics—at the click of a switch.

The frequency response is 80 Hz to 15 Kc/s $\pm$3db. It is flat over a wide range and remains flat in the low frequency range when used close up. In the cardioid mode sensitivity at the rear is 17db less than at the front. Impedance is 500 ohms.

The P33 is mounted in a quick-release holder and can instantly be used as a hand-held microphone complete with a detachable, twin screened cable 16 feet in length. In addition an anti-vibration mounting is available, preventing transmission of rumble from the stand.

WW—206 FOR FURTHER DETAILS

Type No.	Type	Transducer	Impedance Values (ohms)	Directional Characteristics	Front-to-Back ratio (dB)	Sensitivity (dB) at 1 kHz (ref. 10V/N/m²)	Pin Connections	Output Connector	Application	Price	Accessories not included in price
Film Industries Ltd., Station Avenue, Kew Gardens, Surrey											
M8	Pencil	Ribbon	Low, med. or high	Fig. of 8	—	−85	1 & 2 signal 3 & case screen	—	Matched pairs for stereo	£9 9s	On/Off switch unit. Std. matching in-line transformer
M8A and M8S	Desk	Ribbon	Low, med. or high	Fig. of 8	—	−85	1 & 2 signal 3 & case screen	—	Matched pairs for stereo	£9 9s	Filter pads supplied at no charge on request
General Radio Co. (U.K.) Ltd., Bourne End, Bucks.											
1560-P5	—	Piezo ceramic	Capacitive 390pF	Omni	—	−60	—	—	Sound level measurement	£33	—
Grampian Reproducers Ltd., Hanworth Trading Estate, Feltham, Middx.											
DP4/L	Hand	M.C.	25	Omni	—	−85		—	—	£9	—
DP4/X	Hand	M.C.	200	Omni	—	−77		—	—	£10 5s	—
DP4/M	Hand	M.C.	600	Omni	—	−72		—	—	£10 5s	—
DP4/H	Hand	M.C.	50k	Omni	—	−53		—	—	£10 5s	—
DP6/L	Lavalier	M.C.	25	Omni	—	−85		—	—	£9	—
DP6/X	Lavalier	M.C.	200	Omni	—	−77		—	—	£10 5s	—
DP6/M	Lavalier	M.C.	600	Omni	—	−72		—	—	£10 5s	—
DP6/H	Lavalier	M.C.	50k	Omni	—	−53	Two-core screened cable; screen connects to Microphone case	—	—	£10 5s	—
GR1/L	Studio	Ribbon	25	Semi-card.	10	−90		—	—	£11 10s	—
GR1/X	Studio	Ribbon	200	Semi-card.	10	−82		—	—	£11 10s	—
GR1/M	Studio	Ribbon	600	Semi-card.	10	−77		—	—	£11 10s	—
GR1/H	Studio	Ribbon	50k	Semi-card.	10	−58		—	—	£11 10s	—
GR2/L	Studio	Ribbon	25	Bi-direct	—	−90		—	—	£11 10s	—
GR2/X	Studio	Ribbon	200	Bi-direct	—	−82		—	—	£11 10s	—
GR2/M	Studio	Ribbon	600	Bi-direct	—	−77		—	—	£11 10s	—
GR2/H	Studio	Ribbon	50k	Bi-direct	—	−58		—	—	£11 10s	—
GC1/L	Hand	M.C.	25	Cardioid	15	−85		—	—	£14	—
GC1/X	Hand	M.C.	200	Cardioid	15	−77		—	—	£15 5s	—
GC1/M	Hand	M.C.	600	Cardioid	15	−72		—	—	£15 5s	—
GC1/H	Hand	M.C.	50k	Cardioid	15	−53		—	—	£15 5s	—
Grundig (Gt. Britain) Ltd., Newlands Park, London, S.E.26											
GDM304	H or Std.	M.C.	700	Omni	—	—	1 & 2 signal case screen	DIN	—	£5 5s	Lightweight floor stand £4 14s 6d
GDM305	Stand	M.C.	700	Omni	—	—	1 & 2 signal case screen	DIN	—	£6 6s	—
GDM312	H or Std.	M.C.	200 & 22k	Omni	—	−45		DIN	—	£7 7s	Lightweight floor stand £4 14s 6d
GDM317	H or Std.	M.C.	200 & 22k	Cardioid	—	—		DIN	Recording	£10 10s	Lightweight floor stand £4 14s 6d
GDSM330	Stand	M.C.	200 & 22k	Cardioid	—	−45	1 & 2 high imp 3 & 2 low imp case screen	DIN	Stereo recording	£11 11s	Lightweight floor stand £4 14s 6d
GDM321	H or Std.	M.C.	200 & 70k	Omni	—	−45		DIN	Recording	£17 17s	Lightweight floor stand £4 14s 6d
GDM322	H or Std.	M.C.	200 & 80k	Cardioid	—	−45		DIN	—	£19 19s	Lightweight floor stand £4 14s 6d
GHM328	Hand	M.C.	250 & 10k	Cardioid	—	—		DIN	Reverb.	£37 16s	—
Hartley Electromotives, Ltd., Monkmoor, Shrewsbury, Salop.											
TS212A	Hand	M.C.	200	Omni	—	−77	1 & 2 sig., 3 & 4 screen/earth, 5 back-space, 6 start-stop, 7 record	—	—	£8 10s	—
Knowles Electronics, Ltd., Victoria Road, Burgess Hill, Sussex											
AJ Series	Micro-phone/speaker	Magnetic	65-2k	Various	—	−75 to −85	—	Solder tags			
AO series	Micro-phone/speaker	Magnetic	2k-5k	Various	—	−75	—	Solder tags	Dictating machines, paging, tape recorders, light-weight head sets	Subject to quantity	
BA Series	Miniature equip-ment mounting	Magnetic	150-3.5k	Various	—	−75	—	Solder tags			
BH series	Miniature equip-ment mounting	Magnetic	5k	Various	—	−75	—	Solder tags	Communica-tion devices, hearing aids		
BJ series	Miniature equip-ment mounting	Magnetic	5k	Various	—	−75	—	Solder tags			
LEM (Douglas A. Lyons & Associates Ltd., 32 Grenville Court, London, S.E.19)											
DO-20	H or Std.	M.C.	50 200	Omni.	—	0.6mV/N/m² 1.2mV/N/m²	1 & 2 signal 3 screen	Continental	—	£12 10s. 0d	
DO-21B	H or Std.	M.C.	200	Omni.	—	1.3mV/N/m²		Continental	—	£18 15s 0d	
DO-35	Lavalier	M.C.	200	Omni.	—	0.7mV/N/m²	—	Thin cable	Broadcasting	£18 10s 0d	
DD-1	Hand	M.C.	50	Omni. N.C.	—	20mV/N/m²	—	Cable (re-tractable)	—	—	
Lennard Developments Ltd., 7 Slades Hill, Enfield, Middx.											
LD1	Stick/H	Crystal	High	Omni	—	—	—	—	P.A., Amateur	£1 1s 6d	Keyhole stand
LD2	Stick/H.	Crystal	High	Omni	—	—	—	—	P.A., Amateur	£1 0s 0d	Keyhole stand
LD3	Table/H.	Crystal	High	Omni	—	—	—	—	P.A., Amateur	18s 0d	—
London Microphone Co., Ltd., 182/4 Campden Hill Road, London, W.8											
LM.100	Desk std.	M.C.	50 200 500 200/50k	Omni	—	−80 −74 −66 −50	—	—	Amateur recording	£3 3s 0d Dual £3 18s 0d	Wire stand and wind-shield
LM.200	Desk or floor std.	M.C.	50 200 500 200/50k	Cardioid	15	−80 −74 −66 −50	—	—	Amateur recording	£4 19s 6d Dual £5 15s 0d	Stand adaptor, swivel std. adaptor, table stand, windshield. Also available (LM200/S) with on/off switch.

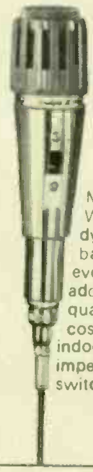
SHURE Micropho

Public Address

Model **545SF** Unidyne III Remarkably compact unidirectional dynamic cardioid microphone with truly uniform cardioid pickup pattern. Particularly recommended for recording, stage and public address applications. 25 ohms impedance.

Model **533SF** This small rugged omnidirectional dynamic microphone features flat response for faithful reproduction of voice and music. Ideal for close-to-mouth operation, protects against 'pop' and can be used on stand or in the hand. On-off switch can be locked in 'on' position. Low impedance.

Model **419B** Ranger II. A small-size noise-cancelling controlled-magnetic microphone specially designed to give superior speech intelligibility and rejection of unwanted noise. Ideal for outdoor and indoor public address and call systems in noisy areas. Low impedance.



Model **581SF** Unidyne With this unidirectional dynamic microphone, feec back problems can be solv even in low-budget public address systems. Gives quality reproduction at low cost. For hand or stand use, indoors or out. 25 ohm impedance, built-in on-off switch, detachable cable.

Communications

Model **450** Controlled magnetic 'Dispatcher'. New modern design fits every decor for paging use. Telescoping height adjustment for maximum convenience. Switchable to low impedance or high, push-to-talk switch bar.

Model **414A** Ranger II. A hand microphone about half the size or weight of a conventional microphone, yet giving even better performance for miniaturized or portable outdoor-indoor communications. High impedance. Recommended load 100,000 ohms or more.

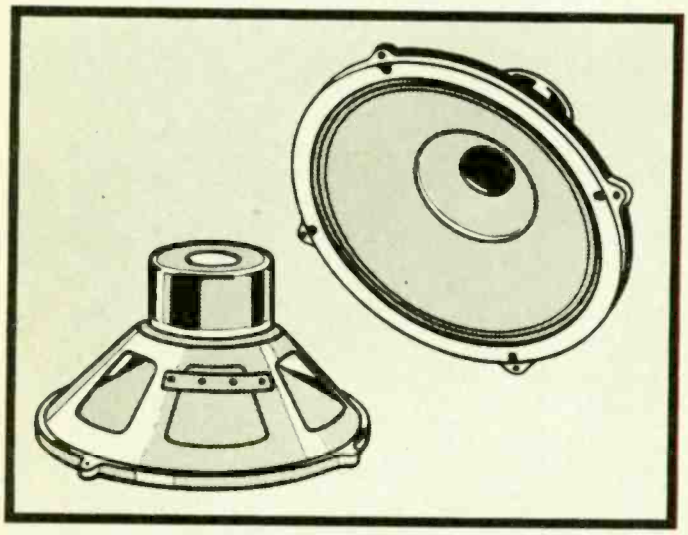
Model **TH100** A controlled magnetic mobile telephone handset which allows the operator to expand or upgrade his equipment and to obtain a degree of privacy in radio communications and two-way conversations. Transmitter is high impedance, receiver low.

Model **401A** Controlled magnetic palm microphone for fixed station or mobile uses. 'Shaped' voice response assures maximum intelligibility. Long-life slide switch. Professional design and construction.

Model **M62** Audio Level Controller. A transistorized variable gain amplifier designed to keep electrical output constant even though the input signal from the microphone varies considerably. Permits greater freedom of distance when using a microphone, eliminates blasting and fadeouts, upgrades recording systems, reduces loud vibration noises.

WW—207 FOR FURTHER DETAILS

Faithful Reproduction



with the Grampian TC12 loudspeaker

The Grampian TC12 loudspeaker is a high quality twin cone unit at a reasonable price. The loudspeaker is built of high quality materials to a rigid specification and is eminently suitable for good quality sound reproduction. Let us send you full details or better still go and hear one at your local dealers now.

Design for suitable cabinet available.

Grampian manufacture high grade microphones, parabolic reflectors, windshields and accessories, also mixers and amplifiers.

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WW—209 FOR FURTHER DETAILS

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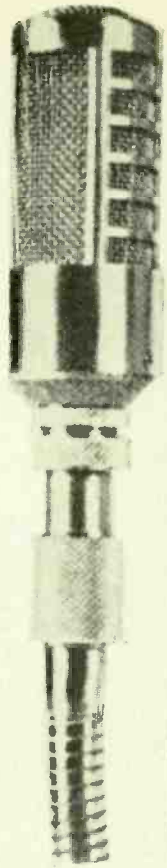
FILM INDUSTRIES RIBBON MICROPHONES



Reprinted from a technical review of the Model M8.

"... this microphone shows evidence of careful design, and the workmanship, technical performance, and styling are excellent. It can be thoroughly recommended for studio or semi-professional use, or for home use where the associated equipment can do justice to its very wide range of response."

From a review of the Model M8A.

"... The Film Industries M8A ribbon microphone has a most attractive appearance coupled with a performance which, in many respects, can stand comparison with the best designs at three or four times its price.

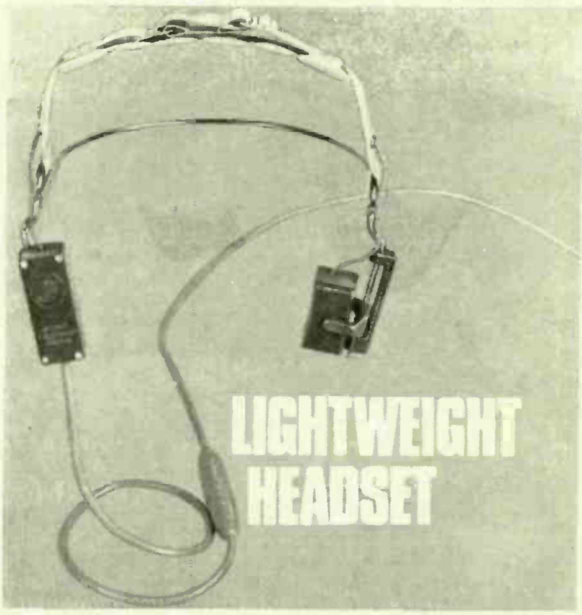
Type M8 Microphone

Write for full details

FILM INDUSTRIES LTD.

STATION AVENUE,
KEW GARDENS, SURREY.
Telephone: RICHMOND 8078

WW—210 FOR FURTHER DETAILS



New from Spembly—the HS.4 lightweight headset with bone transducer microphone and miniature loud speaker unit. Excellent reproduction—for airborne or ground use. Can be worn under most types of protective helmets. Send for leaflet to:
Sales Department,

SPEMBLY ELECTRONICS

Enham Arch, Newbury Road, Andover, Hampshire.
Telephone: Andover 5741/2/3 Telex: 47272

WW—211 FOR FURTHER DETAILS

Type No.	Type	Transducer	Impedance Values (ohms)	Directional Characteristics	Front-to-Back ratio (dB)	Sensitivity (dB) at 1 kHz (ref. 10V/N/m²)	Pin Connections	Output Connector	Application	Price	Accessories not included in price
.ustraphone Ltd., St. George's Works, Regents Park Road, London, N.W.1											
.FV 59	Hand/ Stand	M.C.	Low. Line High	Omni	—	-54 high Z	—	Integ. cable	—	£9 9s 0d (low Z) £9 19s 6d	Stands and various housings. (high Z)
.FV 59	Lavalier	M.C.	Low. Line High	Omni	—	-54 high Z	—	Integ. cable	—	£9 9s 0d £9 19s 6d	(low Z) (high Z)
/R 64	Studio	Ribbon	Low. Line high	Fig. of 8	—	-56 high Z	—	Integ. cable	Recording	£8 18s 6d	Cable exit and quick release stands
/R 65/NS	Stereo	Twin Ribbons	20, 200 & 600	Twin variable. Fig. of 8	—	-74 (600Ω)	—	Integ. cable	Stereo recording	£17 17s 0d	Stands, matching transformers
/C 52/TH5B	N.C.	M.C.	25	—	—	—	—	Integ. cable	Noisy locations	£10 10s 0d	Various housings and mountings
4-20	Hand/ Stand	M.C.	20, 200, 600 & 50k	Omni	—	-54 high Z	3screen, 2 & 4 for 25Ω, 1 & 2 for 200Ω, 1 & 4 for 600Ω, 5 & 3 for 50kΩ	5-pin DIN	Speech and Music	—	Stands
4-30	Hand/ Stand	M.C.	Multi Z; 20, 200, 600 & 50k	Cardioid	—	-54 high Z		5-pin DIN	Speech and Music	—	Stands
4-40	Studio	Ribbon	20, 200, 600 & 50k	Fig. of 8	—	-56 high Z		5-pin DIN	Recording	—	Stands
4-50	Pencil Studio	Ribbon	20, 200, 600 & 50k	Fig. of 8	—	46 high Z		5-pin DIN	Prof. recording	—	Stands, matched pre-amp
Mikrofonbau (Denham & Morley Ltd., 173/5 Cleveland Street, London, W.1.)											
MB150TR	Stick/Std.	M.C.	200/50k	Omni	—	1.2mV/N/m² @ 200Ω 18mV/N/m² @ 50k	2 & 3. 200Ω 2 & 1, 50k plug case, earth	DIN	Amateur recording	£3 3s	—
MB250TR	Stick/Std.	M.C.	200/50k	Cardioid	12-15	1.1mV/ 22.5mV as above	2 & 3, 200Ω 2 & 1, 50k plug case, earth	DIN	Amateur recording	£4 14s 6d	—
MB160F	—	M.C.	—	Omni	—	—	—	—	—	£4 4s	(Includes switch)
MB160	—	M.C.	—	Omni	—	—	—	—	—	£3 13s 6d	(Without switch)
MB170S	Stick/Std.	M.C.	700	Omni	—	2.4mV/N/m²	1 & 2, signal plug case, earth	DIN	Amateur	£5 5s	
MB170	Stick/Std.	M.C.	700	Omni	—	2.4mV/N/m²			Amateur	£4 14s 6d	(Without switch)
MB170TR	Stick/Std.	M.C.	700/50k	Omni	—	2.4mV/18mV as above			Amateur	£6 6s	(Without switch)
MB270S	Stick/Std.	M.C.	200	Cardioid	15	1.5mV/N/m²	2 & 3, signal plug case, earth	DIN	Amateur	£15 15s	(Includes switch)
MB270	Stick/Std.	M.C.	200	Cardioid	15	1.5mV/N/m²			Amateur	£14 14s	(Without switch)
MB270TR	Stick/Std.	M.C.	200/50k	Cardioid	15	1.5mV/30mV as above			Amateur	£16 16s	(Without switch)
MB220	Twin, stereo	M.C.	200	Cardioid	15	1.5mV/N/m²	2 & 3 left 5 right	2×DIN	Amateur stereo record.	£12 12s	—
MB220TR	Twin, stereo	M.C.	200/50k	Cardioid	15	1.5mV/30mV as above	2 & 3 left 5 right	2×DIN	Amateur stereo record.	£14 14s	—
MB101	Studio	M.C.	200	Omni	—	2mV/N/m²	1 & 3, signal 2, earth	DIN	Broadcasting. Amateur	£14 14s	Stand, Clamp. 6ft 6in lead. Plug.
MB201	Studio	M.C.	200	Cardioid	15-18	1.5mV/N/m²			Music recording	£15 15s	Stand, Clamp. 6ft 6in lead. Plug
MB215	Studio	M.C.	200	Cardioid	15-18	1.5mV/N/m²			Broadcasting. Amateur	£16 16s	Stand, Clamp. 6ft 6in lead. Plug
MB301	Studio/ Stick	Ribbon	200	Cardioid	20	1.2mV/N/m²			Broadcasting. Recording	£22 1s	Stand, Clamp. 6ft 6in lead. Plug
MB190	Fountain-pen	M.C.	500	Omni	—	2.2mV/N/m²	Cable with flying leads	—	Recording	£12 12s	—
Neumann (F.W.O. Bauch Ltd., Holbrook House, Cockfosters, Barnet, Herts.)											
KM73	Studio	Capacitor	50 or 200	Omni	—	30mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3261	—	£87 6s 0d £78 16s 6d £73 18s 0d	According to ancillary equipment
KM74 or 75	Studio	Capacitor	50 or 200	Cardioid	25	30mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3261	—	£92 9s 0d £83 19s 6d £79 1s 0d	According to ancillary equipment
KM76	Studio	Capacitor	50 or 200	Omni, card, Fig. of 8	—	26mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3261	—	£110 6s 0d £101 16s 6d £96 18s 0d	According to ancillary equipment
U77	Studio	Capacitor	50 or 200	Omni, card, Fig. of 8	—	50mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3261	—	£118 4s 0d £109 14s 6d £104 16s 0d £99 18s 6d	According to ancillary equipment
KM83	Studio	Capacitor	50 or 200	Omni	—	5mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3261	—	£82 14s 0d £74 7s 0d £67 1s 0d	According to ancillary equipment
KM84 or 85	Studio	Capacitor	50 or 200	Cardioid	25	5mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3261	—	£86 14s 0d £78 7s 0d £71 1s 0d	According to ancillary equipment
KM86	Studio	Capacitor	50 or 200	Omni, card, Fig. of 8	—	7mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3261	—	£101 13s 0d £93 6s 0d £86 0s 0d	According to ancillary equipment
U87	Studio	Capacitor	50 or 200	Omni, card, Fig. of 8	—	8mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3261	—	£106 14s 0d £98 7s 0d £91 1s 0d £88 11s 0d	According to ancillary equipment
KML	Lavalier	Capacitor	50	Cardioid	25	10mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3261	—	£71 16s 0d	—
U67	Studio	Capacitor	50 or 200	Omni Cardioid Fig. of 8	—	11mV/N/m² 20mV/N/m² 14mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3080	—	£138	R.F.-proof type £146 14s
M269C	Studio	Capacitor	50 or 200	Omni Cardioid Fig. of 8	—	9mV/N/m² 15mV/N/m² 11mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3080	—	£158 18s	—
M49C	Studio	Capacitor	50 or 200	Omni Cardioid Fig. of 8	—	4.5mV/N/m² 6.0mV/N/m² 8.0mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3080	—	£158 7s	—
M50C	Studio	Capacitor	50 or 200	Omni	—	15mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3080	—	£156 13s	—
KM53C	Studio	Capacitor	50 or 200	Omni	—	15mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3080	—	£128 18s £139 14s	According to power supply
KM253C	Studio	Capacitor	50 or 200	Omni	—	15mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3080	—	£148 18s £156 13s	According to power supply

Type No.	Type	Transducer	Impedance Values (ohms)	Directional Characteristics	Front-to-Back ratio (dB)	Sensitivity (dB) at 1 kHz (ref. 10V/N/m²)	Pin Connections	Output Connector	Application	Price	Accessories not included in price
Neumann (Contd.)											
KM54C	Studio	Capacitor	50 or 200	Cardioid	25	12mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3080	—	£131 14s £142 11s	According to power supply
KM254C	Studio	Capacitor	50 or 200	Cardioid	25	12mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3080	—	£151 13s £159 10s	According to power supply
KM56C	Studio	Capacitor	50 or 200	Omni, Card., fig. of 8	—	9mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3080	—	£146 2s £157 5s	According to power supply
KM63	Studio	Capacitor	50 or 200	Omni	—	9mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3080	—	£127 5s £138 0s	According to power supply
KM64 or 65	Studio	Capacitor	50 or 200	Cardioid	25	9mV/N/m²	1 & 2 signal 3 screen	Tuchel T3080	—	£130 12s £141 8s	According to power supply
KM64P	Studio	Capacitor	50 or 200	Cardioid	25	9mV/N/m²	1 & 2 signal 3 screen	Tuchel T3080	—	£155 11s	
SRM64 or 65	Studio	Capacitor	50 or 200	Cardioid	25	8mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3080	—	£165 11s	—
KM66	Studio	Capacitor	50 or 200	Omni, Card., fig. of 8	—	10mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3080	—	£143 18s £154 19s	According to power supply
U64 or 65	Studio	Capacitor	50 or 200	Cardioid	25	11mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3080	—	£107 2s	—
SM2C	Stu. Stereo	Capacitor	50 or 200	Omni, card., fig. of 8	—	10mV/N/m²	1 & 2, 4 & 5 signal, 3 screen	Tuchel T3084	—	£258 5s	—
SM23C	Stu. Double	Capacitor	50 or 200	Omni, card., fig. of 8	—	10mV/N/m²	1 & 2, 4 & 5 signal, 3 screen	Tuchel T3084	—	£267 1s	—
SM69	Stu. Double	Capacitor	50 or 200	Omni, card., fig. of 8	—	15mV/N/m²	1 & 2, 4 & 5 signal, 3 screen	Tuchel T3084	—	£272 11s	—
MM5	Measurmt.	Capacitor	50 or 200	Omni	—	5.5mV/N/m²	1 & 2 signal, 3 screen	Tuchel T3080	—	£267 4s	—
Peto Scott Ltd., Addlestone Road, Weybridge, Surrey											
LBB9001/05	Lavalier	M.C.	200	Omni	—	−79dB	1&2 Signal 3 Screen	Cable		£12	
EL6015/10	Hand/Stand	M.C.	500	Cardioid	17	−71	1&2 Signal 3 Screen	Cable		£15 10	—
EL6016/10	Hand/Stand	M.C.	500	Omni	—	−71	1&2 Signal 3 Screen	Cable		£12	—
EL6025/00	Stand	M.C.	500/25k	Cardioid	17	−71/−54	1&2 Signal 3 Screen	Cable		£20	—
EL6026/10	Panel/Stand	M.C.	500	Cardioid	17	−71	1&2 Signal 3 Screen	Cable		£16 10 0	—
EL6033/00	Hand/Stand	M.C.	50	Cardioid/ Omni	17	−82	1&2 Signal 3&Case Screen	Tuchel		£26	Stand Adapter Vibration Damper
EL6033/10	Hand/Stand	M.C.	500	Cardioid/ Omni	17	−76	1&2 Signal 3&Case Screen	Tuchel		£26	Vibration Damper
EL6035/10	Hand/Stand	M.C.	500	Cardioid	18	−71.5	1&2 Signal 3&Case Screen	Tuchel		£26	—
EL6036/10	Hand/Stand	M.C.	500	Omni	—	−71	1&2 Signal 3&Case Screen	Tuchel		£20	—
EL6037	Hand/Stand	M.C.	500/25k	Cardioid	18	−71.5/−55.5	1&2 Sig. (500Ω) 3&4 Sig. (25k) 5 Screen	Cable		£28	—
EL6042/05	Hand/Stand	M.C.	200	Omni	—	−79	1&2 Signal 3&Cs-Sn	Tuchel		£32	—
EL6061/02	Hand	M.C.	500	N.C. Cardioid	—	—	1&2 Signal 3&4 Switch 5 Screen	Cable		£10	—

Type No.	Type	Transducer	Impedance Values (ohms)	Directional Characteristics	Front-to-Back ratio (dB)	Sensitivity (dB) at 1 kHz (ref. 1V/0.1N/m²)	Pin Connections	Output Connector	Application	Price	Accessories not included in price
Philips Electrical Ltd., Century House, Shaftesbury Avenue, London, W.C.2											
EL1976	Hand/ table	M.C.	500	Omni	—	−69	1 Signal 2 Screen 3 Blank	3-pole DIN 180°	Use with Cassette Recorder	£3 12 6	—
EL1979	Stereo- table	2 × M.C.	2 × 500	Cardioid	16	−69	1 L.H. Channel, 2 Screen, 4 R.H. Chann	5-pole DIN 180°	Use with EL3312, EL3575 TR	£10 17 6	—
EL1980	Stick/ table	M.C.	500	Omni	—	−70	1 Signal, 2 Screen, 3 Blank	3-pole DIN 180°	Use with Recorders N4305, N4306	£3 15 0	—
EL3797/50	Hand	M.C.	500	Omni	—	−71	1 Signal, 2 Screen, 3 Blank 1 Switch, 5 Switch	3-pole DIN 180° 5-pole DIN 240°	Use with Batt. Cassette Recorders	£4 10 0	—
N8302	Stick/ table	M.C.	500	Cardioid	13dB	−72	1 Signal, 2 Screen, 3 Blank	3-pole DIN 180°	Use with Stereo Recorder N4408	£5 5 0	—
Reslosound Ltd., Spring Gardens, London Road, Romford, Essex											
CHM/1	Hand	Crystal	High	Cardioid	—	—	4 core + S.	Cable	Com. record.	£3 8s	Various stands
CPD	Hand	M.C.	40-250-600	Cardioid	10 to 20	−88	1+2 L, 1+2 M, H coaxial	Cable	Recording	£15 15s L £16 16s	Various stands
EC.1	Hand	M.C.	40-250-600	Omni	10 to 20	−88	1+2 L, 1+2 M, H coaxial	Cable	'Close' singing	£18	Various stands
PD	Pencil- Stand	M.C.	40-250-600	Omni	—	−88	1+2 L, 1+2 M, H coaxial	Cable	Recording	£8 15s L £9 15s	Boom
MMD1	Lavalier	M.C.	40	Omni	—	−89	1+2	DIN	Radio mic.	—	—
MPD	Lavalier hand	M.C.	40	Omni	—	−88	1+2	Cable	Broadcast (voice)	£9 8s	F.m. transmitter
MPD2	Hand	M.C.	40	Omni	—	−88	1+2	Cable	—	£5 10s	—
VMC2	Stand	M.C.	15	Omni	—	—	1+2	Cable	Public address	£9 14s	—
THM1/L	Hand	M.C.	40	Omni	—	—	4 core + S.	Cable	Public address	£6 11s	Twin mount for stereo
THM1/M	Hand	Moving iron	1000	Omni	—	—	4 core + screen	Cable	Coms	£7 7s	Flexible stems
CR2	Stand	Ribbon	40-250-600	Cardioid	15 to 20	−58		—	Recording Public address	£13 5s L £13 10s	Boom
RBT	Stand	Ribbon	40-250-600	Bi-direct	—	−58	A+B L, A+B 250, A+C 600 A+C H	Reslo plug cable	Recording public address	£12 10s L £12 15s	Flexible stems
RBTS	Stand	Ribbon	40-250-600	Bi-direct	—	−58		Cable	Recording public address	£15 5s L £15 10s	Flexible stems
VRT	Stand	Ribbon	40-300	Bi-direct	—	−81		Cable	Broadcast	£18	Weather proof mount
S.R1	Stand	Ribbon	40-300	Bi-direct	—	−73		Cable	Broadcast	£29 10s	—
Sennheiser (Audio Engineering Ltd., 33 Endell Street, London, W.C.2.)											
MKH105	Studio Hand	Capacitor	200 balanced	Omni	—	1mW/N/m² −37dB		Tuchel	High quality music record.	£68 15s 6d	Battery pack, windshield, shockmount, cable
MKH405	Studio Boom	Capacitor	200 balanced	Cardioid	18	1mW/N/m² −37dB	1 & 3 signal, 2 & case screen	Tuchel	High quality speech & music record.	£79 18s 0d	Battery pack, windshield, shockmount, cable
MKH805	Studio	Capacitor	200 balanced	Uni	25	1mW/N/m² −31dB		Tuchel	High quality speech & music record.	£104 16s 0d	Battery pack, windshield, shockmount, cable
MD421	Studio Hand	M.C.	200 balanced	Cardioid	18	2mV/N/m² ±3dB		Tuchel	High quality speech & music record.	£36 17s 6d	Desk stand, windshield
MD411	General	M.C.	200 1000 25k	Super Card.	20	1.2mV/N/m² 2.5mV/N/m² 2.5mV/N/m²	L = 2+3 HL M = 1+2 M H = 1+2 HL	DIN	Speech & music	£15 14s 0d	Windshield
MD408	Stand	M.C.	200	Super-Card.	20	1.3mV/N/m²		Tuchel	Speech	£22 5s 6d	—
MD21	Hand	M.C.	200	Omni	—	2mV/N/m²	1 & 3 signal, 2 & case screen	Tuchel	Speech & effects	£25 10s 6d	Windshield
MD211	Hand	M.C.	200	Omni	—	1.3mV/N/m²		Tuchel	High quality speech & music	£41 12s 6d	Windshield
MD214	Lavalier	M.C.	200	Omni	—	1.0mV/N/m²		Tuchel	Speech	£34 17s 6d	—
MD420	Hand N.C.	M.C.	200	N.C. Super- Card.	20	1.6mV/N/m²	1 & 2 signal, 3 & case screen	Tuchel	Speech	£18 18s 6d	—
MDS1N	Stereo	M.C.	200 per capsule	Super-Card.	20	1.3mV/N/m²	1 & 3 signal 3 & case screen	DIN	Music, speech	£30 11s 9d	—
MD722	Hand	M.C.	500	Super-Card.	18	1.2mV/N/m²	1 & 3 signal 3 & case screen	DIN	Music, speech	£6 16s 0d	—
Shure Electronics Ltd., 84 Blackfriars Road, London, S.E.1.											
SM5A	Studio	M.C.	50	Cardioid	18-20	−84	2 & 3 signal 1 screen	Cannon XL-3-11	Recording, Radio & TV	£140	Desk stand S33C
SM5B	Boom	M.C.	150	Cardioid	18-20	−79.5					
SM33	Studio	Ribbon	30-50 150-250	Super- Cardioid	15-20	−87 @ 50Ω −81 @ 150Ω	2 & 3 signal 1 screen	Cannon XL-3-11	Recording, stage, broad- casting	£80	Desk stand S33P
SM50	Studio	M.C.	30-50 150-250	Omni	—	−85 @ 50Ω −79 @ 150Ω	2 & 3 signal 1 case, screen	Cannon XL-3-[illegible]	Recording, stage, broad- casting	£45	Desk stand S33P
SM51	Studio Lavalier	M.C.	50-250	Omni	—	−81.5	Cable	—	Recording, stage, broad- casting	£38	—
555W	Stand/ Boom	M.C.	30-50 150-250 35k	Cardioid	15-20	−84 −78 −57	2 & 3 signal 1 screen	Amphenol MC3M	P.A., stage	£32	Desk stand S36A
SM56	Studio	M.C.	30-50 150-250	Cardioid	15-20	−83.5 @ 50Ω −76.5 @ 150Ω	2 & 3 signal 1 screen	Cannon XL-3-11	Recording, broadcasting	£50	—
SM57	Studio	M.C.	30-50 150-250	Cardioid	15-20	−83.5 @ 50Ω −76.5 @ 150Ω	2 & 3 signal 1 screen	Cannon XL-3-11	Recording, broadcasting	£38	—
SM58	Studio	M.C.	30-50 150-250	Cardioid	15-20	−83.5 @ 50Ω −76.5 @ 150Ω	2 & 3 signal 1 screen	Cannon XL-3-11	Recording, broadcasting	£50	—
SM60	Studio	M.C.	50-250	Omni	—	−81.5	2 & 3 signal 1 screen	Cannon XL-3-11	TV interview, recording	£30	—

Type No.	Type	Transducer	Impedance Values (ohms)	Directional Characteristics	Front-to-Back ratio (dB)	Sensitivity (dB) at 1 kHz (ref. 1V/0.1N/m²)	Pin Connections	Output Connector	Application	Price	Accessories not included in pric
Shure Electronics Ltd. (Cont.)											
SM76	Studio Pencil	M.C.	50-250	Omni	—	−80.5	2 & 3 signal 1 screen	Cannon XL-3-11	Radio, TV, recording	£65	—
201	Hand	Ceramic	Load imp. 1-5M	Omni	—	−55.5	Cable	—	Mobile communications	£5 10s	—
202	Hand	M.C.	Load imp. 1-5M	N.C.	—	−50.5	Cable	—	P.A., call systems	£6	—
245S	Hand/ Stand	M.C.	Load imp. 1-5M	Cardioid	15	−59	Pin-signal Case-screen	Amphenol MCIF	Low-cost P.A.	£13 15s	—
275SK	Hand	M.C.	Load imp. 1-5M	Omni	—	−59.5	Cable	—	Communications, amateur radio	£5	—
300	Studio	Ribbon	30-50 150-250 High	Bi-direct	At sides down 15-20dB from front & rear	−87 −79.5 −57.5	2 & 3 signal 1 screen	Cannon XL-3-11	Broadcasting, recording	£56	—
315S	St./hand	Ribbon	30-50 150-250 High	Bi-direct	At sides down 15-20dB from front & rear	−89 −82 −59	2 & 3 signal 1 case, screen	Amphenol MC3M	P.A., recording	£34	—
330	St./hand	Ribbon	30-50 150 250	Super cardioid	15-20	−86 −80 −78	2 & 3 signal 1 case, screen	Cannon XL-3-11	P.A., recording	£45	—
401A 401B	Hand-held	Controlled magnetic	100 150-250	Omni	— —	−49 −68	Cable attached but replaceable	—	Comm.	£6 10s £6 10s	—
404B 404C	Hand-held	Controlled magnetic	150-250 100k	Omni	—	−70.5 −50.5	Cable	—	Comm.	£12 £12	—
414A 414B	Hand-held	Controlled magnetic	100k 150-250	Omni	—	−14.5 −33.5 Ref. 1V/10N/m²	Cable	—	Comm.	£12 £12	— —
419A 419B	Hand-held	Controlled magnetic	100k 150-250	N.C.	—	−17 −36 Ref 1V/10N/m²	Cable	—	P.A., comm.	£23 £23	— —
430SLF	Hnd./Std.	Controlled magnetic	250 or high	Omni	—	Low, −82 High, −52	Cable	—	P.A., lecturing	£22	—
444	Comm.	Controlled magnetic	High	Semi-direct.	—	−53	Cable	—	S.S.B. comm.	£12	—
444T	Comm.	Controlled magnetic	1000	Semi-direct.	—	2mV to 45mV for 0.1N/m² input	Coiled cord attached but replaceable	—	Transmitters lacking audio gain	£14 10s	—
450	Comm.	Controlled magnetic	50-250 or high	Semi-direct.	—	Low, −73 High, −54	Cable attached but replaceable	—	Paging	£18 10s	—
488B	Comm.	Controlled reluctance	50-250	N.C.	—	−37	Coiled cable attached but replaceable	—	Comm. where high background noise	£21 10s	—
533SA	Hnd./Std.	M.C.	High	Omni	—	−54.5	Pin, signal Case, screen	Amphenol MCIF	Paging, Interviewing	£18 10s	—

Type No.	Type	Transducer	Impedance Values (ohms)	Directional Characteristics	Front-to-Back ratio (dB)	Sensitivity (dB) at 1 kHz (ref. 10V/N/m²)	Pin Connections	Output Connector	Application	Price	Accessories not included in price
Shure Electronics Ltd. (Contd.)											
533SF	Hnd./Std.	M.C.	25	Omni	—	−85	1 & 2 signal Case, screen	Amphenol MC2M	Paging, interviewing	£16 10s	—
540S	Stand	M.C.	50-250 or high	Omni.	—	−77 low −52.5 high	2 & 3 signal 1 screen	Amphenol MC3M	Paging. Low cost P.A.	£19	—
544	Pencil	M.C.	50-250 or high	Cardioid	15-20	−77 low −55 high	Cable attached but replble.	—	—	£30	G6A, G12a, G18A, mounting flange. Adaptor AD12
544F	Pencil	M.C.	25	Cardioid	15-20	−89	2 & 3 signal 1 screen	MC3M	Quality P.A. Paging	£28	A95A Cable transformer
545	Pencil Hnd./Std.	M.C.	50-250 and high	Cardioid	15-20	−78 low −55 high	*Low.* 3+4 signal, 1 screen & case (Balanced line). *High.* 2 signal, 1 screen & case (Unbalanced)	MC4M	Recording, P.A., theatre sound systems	£32	S33B & S39A table stands
545F	Pencil Hnd./Std.	M.C.	25	Cardioid	15-20	−89	2+3 signal, 1 case & screen	MC3M	Recording, P.A., theatre sound systems	£30	S33B & S39A table stands
545S	Stand	M.C.	50-250 & high	Cardioid	15-20	−78 low −55 high	*Low.* 3+4 signal, 1 case & screen (balanced line). *High.* 2 signal, 1 case & screen (Unbalanced)	MC4M	Theatre sound systems. P.A.	£34	—
545SF	Stand	M.C.	25	Cardioid	15-20	−89	2+3 signal, 1 case & screen	MC3M	Theatre sound systems. P.A.	£32	A95A Cable transformer
550S	Stand	M.C.	50-250 & high	Omni.	—	−79 low −57.5 high	2+3 signal, 1 case & screen	MC3M	Professional recording.	£26	—
556S	Stand	M.C.	30-50 50-250 40k	Cardioid	15	−84 −78 −57	2+3 signal, 1 case & screen	Cannon XL-3-11	Professional recording. Radio interviewing	£50	—
560	Lavalier	M.C.	150-250 or high	Omni.	—	−80 low −57 high	Cable attached but replaceable	—	Lecturers. Demonstrators Teachers	£15	—
560F	Stand	M.C.	25	Omni.	—	−85	Cable attached but replaceable	—	Lecturers Demonstrators Teachers	£13	—
561F	Goose-neck	M.C.	25	Omni.	—	−85	Cable attached but replaceable	—	Language labs. Paging	£12	G6A, G12A, G18A, AD12, Mounting flange
565	Hnd./Std.	M.C.	50-250 & high	Cardioid	18-20	−78 low −55 high	*Low.* 3+4 signal, case & screen *High.* 2 signal, 1 case & screen	MC4M	P.A. Recording Entertainers	£36	—
565S	Stand	M.C.	50-250 & high	Cardioid	18-20	−78 low −55 high	*Low.* 3+4 signal, case & screen. *High.* 2 signal, 1 case & screen	MC4M	P.A. Recording Entertainers	£38	—
566	Stand	M.C.	30-50, 150-250	Cardioid	18-20	−75	2+3 signal, 1 case & screen	Cannon XL-3-11	Entertainers, Recording, P.A.	£50	—
PE566	Stand	M.C.	30-50 & high	Cardioid	15-20	−75 low −55 high	2+3 signal, 1 case & screen	Cannon XL-3-11	Entertainers, Churches, State occasions	£52	—
570	Lavalier	M.C.	50-250	Omni.	—	−80	30ft. cable attached but replaceable	—	Film & broadcast. P.A.	£35	—
570F	Lavalier	M.C.	25	Omni.	—	−85	30ft. cable attached but replaceable	—	Film & broadcast. P.A.	£35	—
570S						−80	30ft. cable attached but replaceable	—	Film & broadcast. P.A.	£38	—
571	Hnd./Std.	M.C.	50-250	Omni.	—	−81	30ft. cable attached but replaceable	—	Broadcasting. Theatres. Interviews	£35	—
572G	Goose-neck	M.C.	50-250	Omni.	—	−81	30ft. cable attached but replaceable	—	Lectern mtg., Studios. P.A.	£40	—
574SA	H/Stand. Pencil std. adaptor & cord inc.	M.C.	100k	Omni	—	−56	1 & 2 signal, outer case & screen	Amphenol MC2M	Home recording, P.A., paging	£12	—
574SF	H/Stand. Pencil std. adaptor & cord inc.	M.C.	25	Omni	—	−85	1 & 2 signal, outer case & screen	Amphenol MC2M	Home recording, P.A., paging	£11	—
578	Switched pencil	M.C.	50-250 or high	Omni	—	−80 low −59 high	18ft cable att.	—	Entertaining, P.A., interviewing	£30	—
578F	Switched pencil	M.C.	25	Omni	—	−92	18ft cable att.	—	Entertaining, P.A., interviewing	£30	—
578S	Switched pencil	M.C.	50-250 or high	Omni	—	−80 low −59 high	18ft cable att.	—	Entertaining, P.A., interviewing	£32	—
581SA	Hnd./Std.	M.C.	High	Cardioid	15-20	−56.5	Centre signal, outer screen	Amphenol MC1F	Home recording, P.A., entertaining	£23 10s	—
581SF	Hnd./Std.	M.C.	25	Cardioid	15-20	−87.5	2 & 3 signal, 1 case & screen	Amphenol MC3M	P.A., recording	£21	A95A cable transformer. S33B desk stand
585SA	Hnd./Std.	M.C.	High	Cardioid	15-20	−56.5	Centre signal, 1 case & screen	Amphenol MC1F	P.A., paging	£25	—
585SAV	Hnd./Std.	M.C.	High	Cardioid	15-20	−56.5	Centre signal, 1 case & screen	Amphenol MC1F	Entertaining, P.A.	£27	—
585SB	Hnd./Std.	M.C.	50-250	Cardioid	15-20	−79.5	1 & 2 signal, outer case & screen	Amphenol MC2M	Entertaining, P.A., where long cables	£22	—
CASA	Rectangular miniature	Ceramic	Equivalent to 400pF	Omni	—	−70	2 × 1in. wires soldered to cartridge	—	Hearing aids. Small headpce. microphones.	£7 10s	—
MC11-J	Circular Miniature	Controlled Magnetic	1,000	Omni	—	−73	Eyelet Solder terminals	—	Hearing aids, and similar	£4 10s	—
MC 20A-J	Rectangular Miniature	Controlled Magnetic	2,000	Omni	—	−72	1½in flexible lead	—		£5	—
MC 30-J	Square Miniature	Controlled Magnetic	1,850	Omni	—	−77	Eyelet solder terminals	—		£7 10s	—

Type No.	Type	Transducer	Impedance Values (ohms)	Directional Characteristics	Front-to-Back ratio (dB)	Sensitivity (dB) at 1 kHz (ref. 10V/N/m²)	Pin Connections	Output Connector	Application	Price	Accessories not included in price
Shure Electronics Ltd. (Cont.)											
T.H.100	Telephone handset	Controlled Magnetic	Trans.-High Rec.-125	Omni	—	−13 Ref. 0·1V/N/m²	Coiled 4ft Four conductor cable	—	Two-way conversations & privacy required	£22	—
61 CP	Vibration Pick-up	Crystal	High	—	—	—	—	—	Research and development,	—	—
62 CP.	Accelerometer	Ceramic	High	—	—	—	—	—	Measuring low accel.	—	—
98A108A	Sound Level	Ceramic	High	Omni	—	−59·5	—	—	Sound measurement.		
Spembly Electronics, Enham Arch, Newbury Road, Andover, Hants.											
Bone Conduction	Contact	Var. reluctance	300	—	—	100μV	Twisted pair	—	—	£22 4s 6d	Solid-state in-line amplifiers.
Standard Telephones & Cables Ltd., West Road, Temple Fields, Harlow, Essex.											
4136	Stu. Std. Boom	Capacitor	30 300	Cardioid	32	−60 −50	1 earth 2 & 3 signal	Cannon XLR	Broadcasting	£110	
4126	Stand Boom	Capacitor	30 300	Cardioid	32	−84 −74	1 & 5 signal 3 earth	Tuchel 5 pin	Broadcasting	£96	Battery pack £19. Carrying cases
4037A/C	Hand	M.C.	30	Omni	—	−76	1 & 2 signal Earth "G"	STC 4069A jack	Broadcasting	£26	Wooden transit case £3 17s Wind shield £1 2s 5d
4021 J	Stand	M.C.	300	Omni	—	−81	1 & 2 signal Earth "G"	STC 4069A jack	Measurement	£20	Wooden transit case £3 17s STC 4069A Jack £1 4s 9d
4105	Stand	M.C.	30	Cardioid	15	−83	1 & 2 signal Earth "G"	STC 4069A jack	P.A.	£25	4069A jack £1 4s 9d
4038	Stu. Std. B. Sus.	Ribbon	30 300	Fig. of 8	—	−84 −76	1 & 2 signal Earth "G"	4069A jack	Broadcasting	£60	Wooden transit case
4104	N.C.	Ribbon	30 300	N.C. Fig. of 8	—	−72 −62	2 conductor + screen bal.	Flying leads	Broadcasting	£75	Thin film amplifier £25
4115	P.A./ N.C.	Ribbon	30 300	N.C. Fig. of 8	—	−72 −62	2 conductor + screen bal.	Flying leads	P.A.	£30	Thin film amplifier £20
4112	Lavalier	M.C.	30	Omni	—	−84	2 conductor + screen bal.	Flying leads	P.A.	£24	
4119	Hand Stand	Dbl. ribbon	30 300 50k	Hyper Cardioid	17	−90 −78 −54		5 pin Tuchel at mic.		£29	On/off switch on 30/300Ω version £1
4113	H. Std. Sus.	Ribbon	30 50k	Cardioid Fig. of 8	15		1 & 2 signal 2 earth	3 Pin "PREH"	P.A., Amateur recording	£11 11s	Stand adaptor £1 10s Desk stand £1 10s
Vitavox Ltd., Westmoreland Road, London, N.W.9.											
B50 CN 173	Hand	M.C.	25	Uni	—	−85	—	Lead			CN 168A Panel cradle
B50 CN 174	Hand	M.C.	25	Uni	—	−85	—	Lead			CN 169 Suspension fitting
B54 CN 277	Hand	M.C.	200	Uni	—	−85	—	Lead			CN 184 Desk cradle
B54 CN 278	Hand	M.C.	500	Uni	—	−85	—	Lead			CN 331 Lip guard
B54 CN 279	Hand	M.C.	10k	Uni	—	−85	—	Lead			
B54 CN 280	Hand	M.C.	High Z	Uni	—	−85	—	Lead	Indoor P.A.		
B54 CN 281	Hand	M.C.	200	Uni	—	−85	—	Lead			
B54 CN 282	Hand	M.C.	500	Uni	—	−85	—	Lead			
B54 CN 283	Hand	M.C.	10k	Uni	—	−85	—	Lead			
B54 CN 284	Hand	M.C.	High Z	Uni	—	−85	—	Lead			
							—	Lead			
B60 CN 403	Hand	M.C.	25	Uni	—	−85	—	Lead			
B60 CN 404	Hand	M.C.	25	Uni	—	−85	—	Lead			
B64 CN 417	Hand	M.C.	200	Uni	—	−85	—	Lead			
B64 CN 418	Hand	M.C.	500	Uni	—	−85	—	Lead			
B64 CN 419	Hand	M.C.	10k	Uni	—	−85	—	Lead			
B64 CN 420	Hand	M.C.	High Z	Uni	—	−85	—	Lead	Outdoor P.A., marine		CN 219 Stowage housing
B64 CN 421	Hand	M.C.	200	Uni	—	−85	—	Lead			
B64 CN 422	Hand	M.C.	500	Uni	—	−85	—	Lead			
B64 CN 423	Hand	M.C.	10k	Uni	—	−85	—	Lead			
B64 CN 424	Hand	M.C.	High Z	Uni	—	−85	—	Lead			
							—	Lead			
B80 CN 240	Bracket	M.C.	25	Uni	—	−85	Terminal panel	—	Heavy duty weatherproof		
M100 CN 335	Studio	M.C.	25 200 10k High Z	Uni	—	−80 −71 −54 −44	—	Lead			
Vox (Jennings Musical Industries, Ltd., Unity House, Dartford Road, Dartford, Kent)											
VL 1	Pencil H/Std.	M.C.	30-50 50k	Omni	—	−76 −54	—	—	—	£14 14s.	—
VL 2	Pencil H/Std	M.C.	30-50 50k	Omni	—	−76 −54	—	—	—	£16 16s 0d	—
VL 3	Stick H/Std.	M.C.	30-50 50k	Uni	18 at 4 kHz	−91 −58	—	—	Reverberant conditions	£18 18s.	—

Stu. = studio, Std. = stand, B = boom, N.C. = noise cancelling, Sus. = suspended, Stk. = stick, H = hand, P.A. = public address

The Technician Engineering Scene

What are the prospects for 'non-chartered' engineers?

A strong spotlight is being thrown just now upon technician engineering manpower; recruitment, education, training, qualifications and status. Government departments, educational authorities and establishments, and industry in general, are devoting much time to these matters. Why should this be so? For many years industry has been perplexed over the "technician problem", so why only recently has it emerged as a frontline consideration?

In the electrical and electronics engineering industries there appear to be four main reasons for this:

(1) The growing concern expressed over the present shortage of technician engineering personnel, and the seemingly discouraging future recruitment prospects.

(2) The poor "image" of engineering as a career seen by school-leavers and parents.

(3) The part-time study route to corporate membership of institutions for chartered engineers having gradually been closing, soon to be blocked altogether (the I.E.E. and I.E.R.E. now setting their corporate membership standards at degree level will mean the end of H.N.C.–chartered engineers).

(4) The emergence of the concept of technician engineers and technicians as being people pursuing distinct careers of their own; with their own qualifications and status; their own qualifying bodies and learned societies.

The setting up of the Council of Engineering Institutions by 14 organizations for "professional" engineers, whose 150,000 members may now use the designatory "C.Eng." denoting a chartered engineer, has helped to bring things to a head. In our Editorial of last June, "Engineers—Professional and Technician", we drew attention to the need for recognition to be given to the status, work and qualifications of technician engineering personnel and letters subsequently received showed how much our view was shared by industry.

Until three years ago the future for non-chartered engineers, and technicians, appeared unenviable, to say the least. For many the path to chartered status was impracticable, yet often being well qualified to H.N.C. level, and having good practical experience, they were the Cinderellas of the electrical, electronics and radio industries. Questions concerning their status, qualifications and career expectations were dealt with piecemeal: they had nowhere to go: nobody seemed to care. At the beginning of 1965, however, two new organizations for technician engineers and technicians were set up; the Society of Electronic and Radio Technicians and the Institution of Electrical and Electronics Technician Engineers each acting as a qualifying body.

These organizations hold differing views on the identification of technician engineering personnel. The I.E.E.T.E., contending that the H.N.C.-man is as much entitled to the description "engineer" as is the chartered engineer, recognizes two grades, the technician engineer and technician, but admits to membership only the first of these. The S.E.R.T. says that two classes are not required; only the technician being identifiable within the whole span of manpower between the chartered engineer and the craftsman. Both bodies have made good progress, and the qualifications derived from membership are becoming well recognized.

Last December the C.E.I., on the basis of non-commitment, called together 31 organizations wholly or partly having technician engineering grades of membership, to explore the possibility of establishing for them a common national qualification and title. On first consideration it appeared to be a hopelessly complicated business: 31 separate bodies covering a wide field of engineering interests (from agriculture to quarrying, building to lighting, automobiles to welding) and all manner of qualification standards for entry and grading of their members who total some 75,000. However, the organizations split up into three groups thought to have like interests; each being asked to meet informally, and to offer conclusions to another C.E.I.-convened general meeting held on 23rd February. As a result of this meeting it was unanimously resolved that: "A Qualification Committee be formed to establish the qualifications of non-chartered engineers (a name to be determined) and that this Committee be formed of representatives of the bodies taking part in the discussions, together with representatives of the C.E.I., and such other members and observers as the Committee may co-opt". This resolution has now been referred back for consideration and ratification by the councils of the participating bodies.

One of the questions under discussion has been a technician counterpart to the C.E.I. Reaction apparent so far indicates that opinion is divided on whether or not such a new body is required, though many recognize a need for unification; but some concede that if a national qualification for technician engineering people emerges from the present tangled skein of opinions and theories, then there must be an independent authority to maintain the general standards.

Against the background of all this, there have been two announcements of considerable significance: first the intention of the Engineering Industry Training Board to publish a report next Autumn on technician engineering training, and secondly the setting up by the National Advisory Council on Education for Industry and Commerce on Technician Courses and Examinations of a committee, under the chairmanship of Dr. H. L. Haslegrave, to examine the whole question of courses and examinations for technicians.

A closely related question, which undoubtedly will be examined by these bodies, is that of definitions (what is a Technician Engineer, or a Technician?): a number of attempts have been made, dating from the one* produced by the Conference of Engineering Societies of Western Europe and the United States (E.U.S.E.C.) in 1954 but, so far, none has been found fully acceptable.

The importance to industry of an adequate force of technician engineering personnel is now being "brought home" on all sides. Employers are becoming most concerned over where the trained and experienced manpower is coming from, both now and in the future. As more and more electronic and instrumentation techniques are introduced so, employers rightly say, more and more young people should be encouraged to enter technician engineering; but they realize that the sophisticated school-leavers of today will not do so unless they, their parents, and their advisors see good career prospects and status before them.

* An engineering technician is one who can apply in a responsible manner proven techniques which are commonly understood by those who are expert in a branch of engineering, or those techniques specially prescribed by professional engineers. . . . The techniques employed demand acquired experience and knowledge of a particular branch of engineering, combined with the ability to work out the details of the task in the light of well-established practice. An engineering technician requires an education and training sufficient to enable him to understand the reasons for and purposes of the operation for which he is responsible.

New B.B.C. Monitoring Loudspeaker

2. Bass equalization: The cabinet: Frequency response characteristics of the units

by H. D. Harwood,* B.Sc.

IN a modern monitoring loudspeaker the choice lies in practice between two- and three-unit designs. In a two-unit loudspeaker one of the difficulties is that the high-frequency units available at present cannot be operated below approximately 1.5 kHz, so that the low-frequency unit must operate in a predictable manner up to about 2 kHz. In the past, reproducible operation of a low-frequency unit above about 500 Hz was not possible but the situation has been changed by the advent of the 305 mm plastic cone described in the March issue.

It is still difficult, however, to maintain the required frequency characteristics away from the axis of a two-unit design. At 1.5 kHz the wavelength of sound is about 220 mm and thus a 305 mm cone has a diameter considerably larger than a wavelength. It follows that the radiation will be directional at such frequencies and that even when the axial frequency characteristic is made uniform the off-axis curves will depart from this condition. On the other hand the high-frequency units used in B.B.C. monitoring loudspeakers, 58 mm in diameter, are small compared with a wavelength, and therefore nearly omnidirectional, up to about 6 kHz. The resulting axial and off-axis characteristics are typified by the curves in Fig. 10. To some extent the difference between the curves can be reduced by fitting a slot in front of the low-frequency unit, but, as will be shown later, this device is by no means wholly successful in overcoming the trouble.

The use of a three-unit system with crossover frequencies in the region of 500 Hz and 3 kHz allows these difficulties to be largely overcome, provided a suitable type of middle-frequency unit can be found. There is the extra advantage that, with a frequency range restricted to the band from 3 kHz upwards, the high-frequency unit will be able to handle a larger programme level than if it had to operate at 1.5 kHz. On the other hand an additional unit and a more expensive and elaborate crossover network are required.

Bass Equalization

In practice the axial frequency characteristics of low-frequency loudspeaker units are not uniform. The reasons for this are that in the middle-frequency range the unit becomes directional, concentrating the sound energy increasingly in the axial direction, while at low frequencies over-damping of the bass resonance takes place, thus producing a bass cut; the resulting rise in axial response above the resonance frequency usually amounts to between 6 and 10 dB. This rise must be equalized electrically and in past B.B.C. designs, e.g. the type LS3/1A loudspeaker, it has been carried out in the crossover network, thus enabling a standard amplifier with a

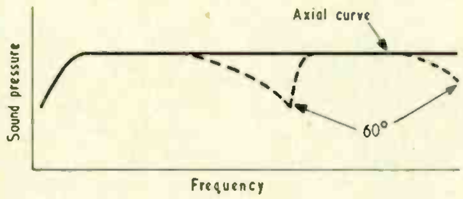


Fig. 10. Typical frequency characteristics of a two-unit loudspeaker on axis and at 60° from axis.

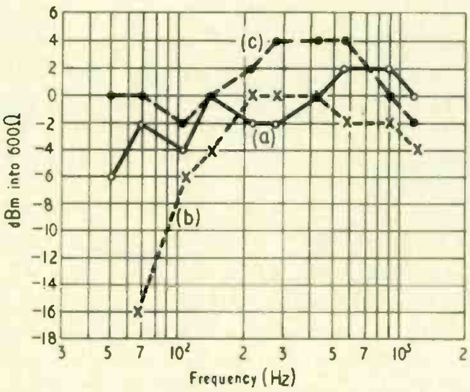


Fig. 11. Peak levels in octave analysis of programme. Item (a) Kramer with Dakotas, (b) Mars 1, (c) Organ Prelude in G.

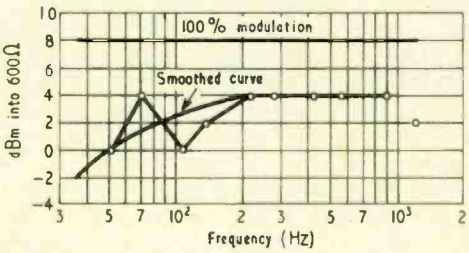


Fig. 12. Peak octave analysis of programmes, all items.

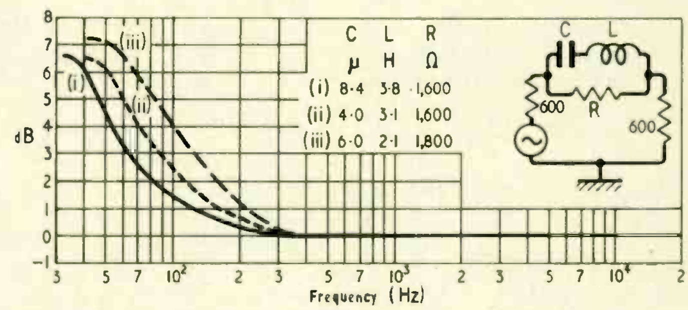
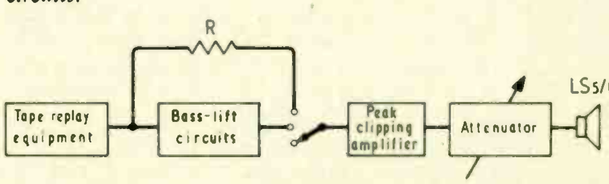


Fig. 13. Response/frequency characteristics of bass-lift circuits.

Fig. 14. Circuit used for determination of acceptable distortion with bass-lift circuits.



* B.B.C. Research Department.

uniform response frequency characteristic to be used. This method involves a considerable loss of power in the mid-band region: for example, if a 20 watt amplifier is employed and 10 dB of bass equalization is required, only 2 watts are available to drive the loudspeaker in the mid-band region.

An alternative method is to use equalization ahead of the power amplifier, but if an excessive degree of equalization is applied, over-loading of the amplifier will occur first in the bass and once again the usable mid-band power will be reduced. The question therefore arises as to whether the programme spectrum is such that it is possible to apply equalization before the amplifier without causing overloading in the bass. Experiments were accordingly designed to explore this possibility and to determine the optimum shape for the pre-emphasis curve. It will be seen that, in effect, the object of the experiment was to obtain the low-frequency equivalent of the high-frequency pre-emphasis employed in f.m. broadcasting.

Experimental details.—Various types of programme were examined to find those which had the highest power levels in the bass. Eleven recorded items were finally chosen, two of which were organ solos, three were light (pop) music and the remainder orchestral music, the total playing time amounting to about 13 minutes; details of the items are given in the appendix. In all cases the recording was arranged to peak to 6 on a peak programme meter, the peak occurring usually, although not necessarily, during the excerpt chosen.

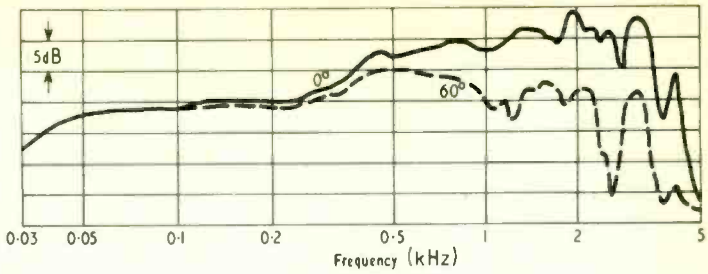
The spectrum was examined by means of octave filters centred on frequencies ranging from 1 kHz down to about 50-Hz, the peaks in each band of frequencies being recorded by a peak counter reading in steps of 2 dB, due allowance being made for the insertion loss of the filters. Typical analyses are given in Fig. 11 and the overall peak levels for the whole range of items is plotted in Fig. 12; a smoothed curve of the peak spectrum is also shown in this figure. It will be noted that the smoothed curve passes below the point plotted for 68 Hz. This point represents a single note from a bass guitar which stood out considerably above the rest and was therefore ignored in drawing the smoothed curve as it was felt not to be representative.

Equalization was designed for the smoothed curve and for two similar but progressively more extreme conditions as shown in Fig. 13. The recordings were then replayed through the different circuits to see by how much the equalization increased the peak level of the complete programme as read on a peak programme meter; the results are given in Table 1.

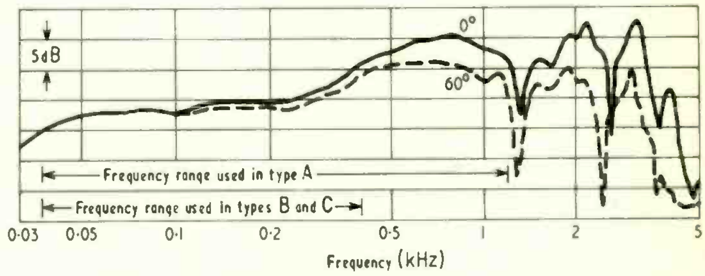
TABLE 1

Effect of Bass Equalization on Peak Level of Programme

programme item	peak levels on p.p. meter. (dB above '6')			
	circuit condition (see Fig. 13)			
(see appendix)	no bass boost	circuit (i)	circuit (ii)	circuit (iii)
a	−½	−½	−½	−½
b	−½	−½	0	+1
c	0	+1	+2	+3½
d	0	0	0	+1½
e	−1½	−2	−2	−1½
f	−2	−1½	+½	+2
g	−1½	−1	−½	+½
h	−3	−3	−3	−2½
i	−4	−4	−4	−3½
j	−2	−2	−2	−1½
k	0	+½	+1	+1



(a)



(b)

Fig. 15. (a) Response/frequency characteristic of unequalized low-frequency unit without slit at 0° and 60° to the axis. (b) Response/frequency characteristic of unequalized low-frequency unit with 100 mm slit at 0° and 60° to the axis.

It will be seen that the level of item (c) is increased by 1 dB even by circuit (i) and it was decided to determine whether this degree of overload at low frequencies would be audible with a typical amplifier using a considerable degree of negative feedback.

A circuit was set up as shown in Fig. 14, in which the peak clipping is arranged to occur in a separate amplifier followed by an attenuator which feeds a loudspeaker amplifier. The gain of the peak clipping amplifier was adjusted so that a 1 kHz signal of +8 dBm from the source was just clipped at the peaks. The bass-lift circuits were inserted in turn ahead of the amplifier and the programme items played through the system, allowance being made for the insertion loss of the circuits. It was found that when using circuit (iii) of Fig. 13 distortion was clearly audible on items (c) and (d), i.e. the organ passages, none being noticed on the remainder; when circuit (ii) of Fig. 13 was inserted, distortion was only just detectable on item (c) and it was therefore concluded that this degree of bass pre-emphasis is permissible. Any equalization required in excess of this must therefore be applied after the power amplifier.

The Cabinet

Experience with the earlier B.B.C. monitoring loudspeaker type LS5/1A had shown that it had an adequate bass range. Calculations indicated that a similar range would be obtained with the new 305mm plastic cone unit by employing a cabinet of only $0.085 m^3$ internal capacity, that is 60% of the volume used for the LS5/1A.

Measurements were then made with an experimental cabinet to determine the vent resonance frequency giving the best combination of power handling capacity and frequency characteristic; this frequency was found to be 38 Hz, close to that employed for the type LS5/1A. Two types of cabinet were made, one floor-standing and the other for hanging from the ceiling, corresponding to the LS5/1A and the LS5/2A† respectively. The volume and front dimensions of each model were the same.

†Version designed to hang above picture monitors in television control rooms.

Use of Slit.—The next factor to be dealt with was the directivity of the units. Fig. 15 (a) shows the response on the axis and at 60° from it for the unequalized bass unit in the cabinet. It will be noted that there is an appreciable difference between the two at the higher frequencies. This difference can be reduced by placing a slit in front of the unit; the diffraction from the edges of the slit will make the radiation more nearly omnidirectional in the horizontal plane. There is, however, a limitation to this device: the Helmholtz resonator formed by the mass reactance of the slit and the compliance of the air enclosed between the slit and the cone increases the output to an undesirable extent in the region of the resonance frequency, but acts as a low-pass filter above the resonance, severely reducing the output at high frequencies. The minimum slit width which could be employed without either of these two effects becoming excessive was found to be 100 mm and it would appear at first sight that this width, which amounts to only a third of a wavelength at 1 kHz, should be quite small enough for this purpose.

In the first instance the slit may be regarded as a source having uniform sound pressure all over its area, but with conditions of radiation intermediate between those for free space and those for an infinite baffle and there are three possible configurations which may be regarded as approximations to these conditions. Of these, a line source and a circular piston in a baffle may be shown[1] to have directional patterns given respectively by

$$R_\alpha = \frac{\sin\left(\frac{\pi l}{\lambda}\sin\alpha\right)}{\frac{\pi l}{\lambda}\sin\alpha}$$

where R_α is the sound pressure radiated at an angle α between the direction of radiation and the axis, l is the length of the source and λ is the wavelength

and

$$R_\alpha = \frac{2J_1\left(\frac{2\pi r}{\lambda}\sin\alpha\right)}{\frac{2\pi r\sin\alpha}{\lambda}}$$

where r is the radius of the piston and J_1 is a Bessel function of the first order and first kind. The directional pattern for a piston in the end of a semi-infinite pipe is more complicated[2] viz.:

$$R_\alpha = \frac{4}{\pi\sin^2\alpha}\cdot\frac{J_1\,kr\sin\alpha}{[(J_1(kr\sin\alpha))^2 + (Y_1(kr\sin\alpha))^2]^{\frac{1}{2}}} \times \frac{|R|}{1-|R|^2}$$
$$\times \exp\left[\frac{2\,kr\cos\alpha}{\pi}\,P\times\int_0^{kr}\frac{x\tan^{-1}(-J_1(x)/Y_1(x))\,dx}{[x^2-(kr\sin\alpha)^2][x^2+(kr)^2]^{\frac{1}{2}}}\right]$$

where $|R| = \exp\left(-\frac{2kr}{\pi}\int_0^{kr}\frac{\tan^{-1}(-J_1(x)/Y_1(x))}{x[(kr)^2-x^2]^{\frac{1}{2}}}\,dx\right)$

and J and Y are real first order Bessel functions of the first and second kind respectively, according to the usual notation†† and $k = 2\pi/\lambda$.

The calculated response at 60° with respect to that on the axis is shown in Fig. 16 for these cases. As expected it will be noted that for slit widths up to 0.6λ there is not much difference between them (curves (*a*), (*b*) and (*c*)), and for the proposed slit width of $\lambda/3$ considered at 1 kHz, the mean difference between the axial and 60° responses is not more than about $1\frac{1}{2}$ dB

In contrast to this the actual frequency characteristics obtained with a 100mm slit are shown in Fig. 15 (*b*). It may be observed by comparison with Fig. 15 (*a*) that, with the slit, the deviation from the axial response is almost unaltered up to about 700 Hz, although beyond this frequency there is an appreciable change; furthermore at 1 kHz the deviation with the slit is not $1\frac{1}{2}$ dB as calculated but nearly 6 dB. The measured deviation is replotted as curve (*d*) in Fig. 16 and it will be seen that it does not correspond to any of the three calculated cases.

This lack of improvement in directivity with the use of a slit was first noticed during the design of the LS5/1A, when it was found that, reducing below 180mm, the width of the slit in front of the 380mm cone did not bring about a corresponding improvement in the off-axis curves.

One possible explanation which has been examined is that the distribution of energy across the slit is not uniform and the extreme case when all the energy has been concentrated at the two edges has been calculated and is shown in Fig. 16 as curve (*e*). Even under these conditions the directivity is not nearly as great as that experienced in practice with the low-frequency unit for small values of d/λ, where d is the width of the slit; furthermore, measurements show that although the pressure across the slit is not quite uniform it is actually higher in the centre by about 2 dB; in addition the phase change across the slit is also small.

The further possibility arises that re-radiation from the edges of the cabinet might be responsible for the directivity. Taking the width of the front baffle as 350mm, the actual values obtained for the deviation of the 60° curve from the axial for the new values of d/λ are plotted as crosses in Fig. 16. It will be seen that in fact the agreement with the theoretical curves is quite good up to a value of d/λ of 0.75 after

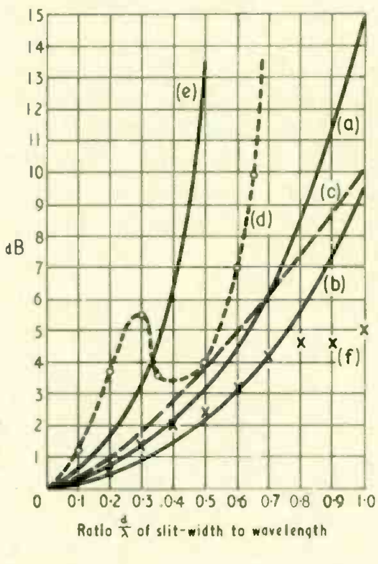
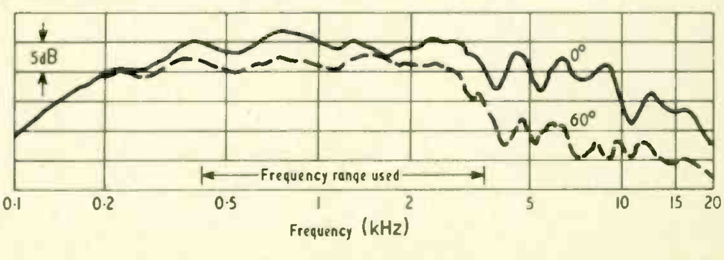


Fig.16 Deviation of 60° characteristics from axial characteristics for differing types of source: (a) line source (calculated); (b) piston source in infinite plane (calculated); (c) piston source at end of pipe (calculated); (d) measured values obtained with slit on low-frequency unit; (e) sound pressure concentrated at edges of slit (calculated); (f) measured values taking d *as front of cabinet.*

Fig.17. Response/frequency characteristics of 110 mm diameter middle/frequency unit at 1° and 60° to the axis.



††In Reference 2 $Y_1(x)$ is denoted by $N_1(x)$ throughout.

which the loudspeaker is less directional. This value of d/λ corresponds to a frequency of about 700 Hz, the frequency above which it was observed that the slit has an appreciable effect.

It appears therefore that up to 700 Hz** the directivity is largely determined by the width of the cabinet but that above this frequency the width of the slit plays a large part. That it does not fully determine the directivity even then is shown by the fact that the upper part of curve (*d*) of Fig. 16 does not lie in the region of the calculated curves. This discrepancy is further emphasized by the fact that in the final design the smaller middle-frequency unit employs the same width of slit, 100mm, in the same baffle, yet the deviation of the 60° curve from the axial curve at 1 kHz is different from that of the low-frequency unit, the value being 3 dB closer to the theoretical figure. Unexpectedly it appears therefore as though the size of the unit still affects the directional properties in spite of the slit and the exact mechanism accounting for the directivity for the values of d/λ greater than 0.75 is obscure.

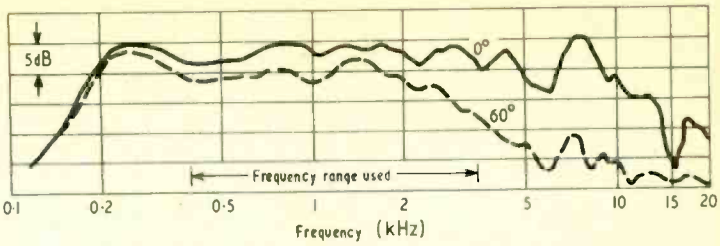
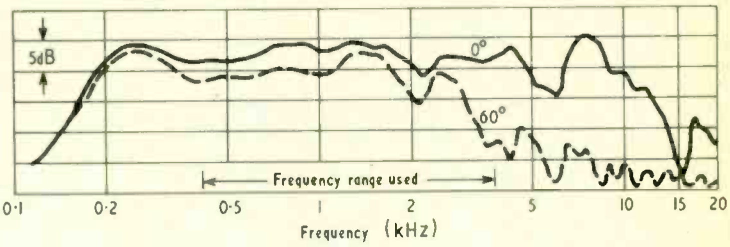


Fig.18. Response/frequency characteristic of 200 mm diameter middle-frequency unit without slit at 1° and 60° to the axis.

Fig.19. Response/frequency characteristics of 200 mm diameter middle-frequency unit with 100 mm slit at 0° and 60° to the axis.



Details of units

As already mentioned, the bass unit employed is the 305mm plastic cone unit described last month. A chassis with a more powerful magnet is now available and an increase in sensitivity of about 2 dB is thus possible. Further experience with the unit revealed a slight colouration in the 1.5 kHz region, and this is accentuated with a later material manufactured as a replacement for the type of Bextrene formerly used. It is however completely removed by painting the cone with a layer of polyvinyl acetate damping compound known as Plastiflex type 1200 P, even though this treatment does not cause any appreciable change in the frequency response. (The effect on colouration can easily be demonstrated by applying pink noise (i.e. random noise with equal power per octave) to the unit in a free-field room and making a tape recording of the output before and after painting the cone. The two conditions can then be compared sequentially and the improvement obtained by the treatment is evident.)

In spite of the use of the vent mentioned earlier some electrical low-frequency equalization is also necessary. As explained previously, it is best to apply this equalization mainly as pre-emphasis ahead of the power amplifier and to introduce the remainder in the crossover network. It is expected that, as with the LS5/2A loudspeaker, a further bass lift, amounting to about 3 dB at 40 Hz over that required for the floor-standing model, will be required for the hanging model, and this lift also is conveniently applied ahead of the amplifier. It will be seen from curve (ii) of Fig. 13 that this leaves about 4 dB available for the floor-standing model before the permissible amount of pre-emphasis is exceeded.

The frequency characteristics of the bass unit on the axis and at 60° from it are those already shown in Fig. 15 (*b*).

Middle-Frequency Units.—No satisfactory commercially-produced middle-frequency unit is available, but at the time when the new loudspeakers were commissioned experiments on a 110mm diameter unit were already proceeding in the B.B.C. Research Department. This unit used a 25.4mm voice coil and a flared cone of Bextrene type 237, 0.4mm thick, together with a surround made of p.v.c. 0.5mm thick. The bass resonance, at about 400 Hz, was well damped, the intention being to employ this unit over the frequency range 450 Hz to 3.5 kHz. The frequency characteristics on the axis and at 60° from it are shown in Fig. 17, and it will be seen that over the required frequency range the two are smooth and nearly parallel. Listening tests, however, showed a noticeable colouration in the 1.5 kHz region and chopped-tone tests were therefore applied. In the region 1.2 kHz to 1.7 kHz these tests revealed three resonances with Q-factors of the order of 500, some 40 dB below the steady-state condition. If in phase with the steady-state condition, these resonances represent irregularities of no more than 0.1 dB on the axial curve and can only therefore be measured by chopped-tone techniques. It was however shown that the application of a layer of Plastiflex type 1200P damping compound to both sides of the cone reduced the resonances to a marked extent; furthermore, the use of pink noise and the recording technique mentioned for the bass unit demonstrated a great improvement in the reproduction and the colouration was reduced to a very low level.

The sensitivity of the 110mm unit is comparable with that of the bass unit described last month, but there is a growing demand for even greater sound levels from monitoring loudspeakers; whereas the sensitivity of the low-frequency unit could be increased, that of this middle-frequency unit could not, and it was therefore decided to make a 200mm diameter unit of increased sensitivity as an alternative design.

The cone of the 200mm unit is made from 0.4mm thick Bextrene type 730 and, as with the 110mm diameter unit, employs a surround of 0.5mm thick p.v.c. The experience obtained in the design of the surround of the 305mm unit was applied to this unit and in addition a heavily flared cone was used. The bass resonance frequency in free air is about 50 Hz, but to avoid reaction with the cabinet vent resonance the rear of the unit is confined in a small enclosure. The resulting frequency characteristics on axis and at 60° are shown in Fig. 18; with this unit the operational frequency range is 400 Hz to 3.5 kHz. It will be seen that the axial frequency characteristic over this range is smooth, but that the 60° response diverges from it. As mentioned earlier a slit of 100mm width is used to effect an improvement in this respect; the resulting characteristics are shown in Fig. 19. The cone was coated on both sides with Plastiflex 1200P to reduce slight colouration in the 2 kHz region and in this

**At the vent resonance frequency the output from the vent is in quadrature with that from the cone but, as most of the energy is radiated from the vent and both sources are very close together, the loudspeaker is omnidirectional. Above this frequency the sound radiated from the vent is rapidly attenuated and the phase difference between the two outputs becomes zero. The vent therefore has little influence on the directivity at any frequency.

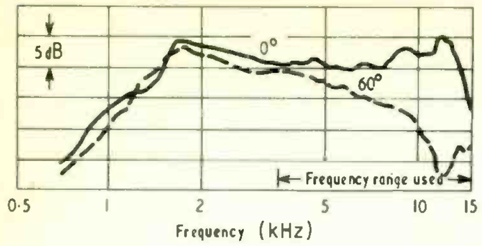


Fig.20. Response/frequency characteristics of high flux density 58 mm high-frequency unit at 0° and 60° to the axis.

regard listening tests show that the reproduction from the coated unit is remarkably " clean."

High-Frequency Units.—The 58mm high-frequency unit employed in the LS5/1A has a smooth response/frequency characteristic and has proved to be very repeatable in production. At the request of the B.B.C. a further model has been produced employing the same diaphragm, and therefore having similar frequency characteristics, but with a stronger magnet giving an increase in sensitivity of nearly 2 dB.

A horn-loaded unit designed for the high fidelity market was also examined but was found to be inferior to the 58mm unit mentioned above. A larger direct radiator was also tested and although this had a more extended axial frequency range than the 58mm unit, the corresponding response curve was not so smooth and the increased size made the unit appreciably more directional at high frequencies.

The frequency characteristics of the improved but unequalized 58mm unit mounted in the cabinet are shown in Fig. 20 at 0° and 60° to the axis.

With the units available three designs were possible. Design A was similar to the type LS5/1A construction and employed the plastic cone 305mm unit and two of the 58mm units; type B used the 305mm unit for the bass, the 200mm unit for the middle frequencies and a single 58mm improved unit for the high frequencies; type C was similar to type B but used the 110mm unit for the middle-frequency range. As it was not possible to determine from a study of the units which would give the best reproduction it was decided to build a prototype of each and carry out final listening tests. The characteristics of the three designs will be discussed in the final part of the article next month.

References

1. " Acoustical Engineering " by H. F. Olson, pp. 39 and 44. Van Nostrand, New York (1957).

2. H. Levine and J. Schwinger. *Physical Review*, 73, No. 4, 1948, pp. 383-406.

APPENDIX

Musical Excerpts used for the Experiment on Bass Equalization

Item No.	Title	Type of Music	Length of Excerpt
a	Götterdämmerung (Wagner)	Orchestral	35 sec
b	Schwanda (Weinberger)	Orchestral	55 sec
c	Prelude in G (Pierné)	Organ	1 min 41 sec
d	Fiat Lux (Dubois)	Organ	1 min 30 sec
e	The Gee Men (Swinger from Seville)	Saturday Club (pop)	1 min 41 sec
f	Billy J. Kramer with Dakotas (It's all over now baby blue)	Saturday Club (pop)	1 min 12 sec
g	Billy J. Kramer with Dakotas (We're doing fine)	Saturday Club (pop)	1 min 30 sec
h	Mars from Planets Suite (Holst)	Orchestral	52 sec
i	Mars from Planets Suite (Holst)	Orchestral	25 sec
j	Jupiter from Planets Suite (Holst)	Orchestral	51 sec
k	Overture: Scapino (Walton)	Orchestral	1 min 30 sec

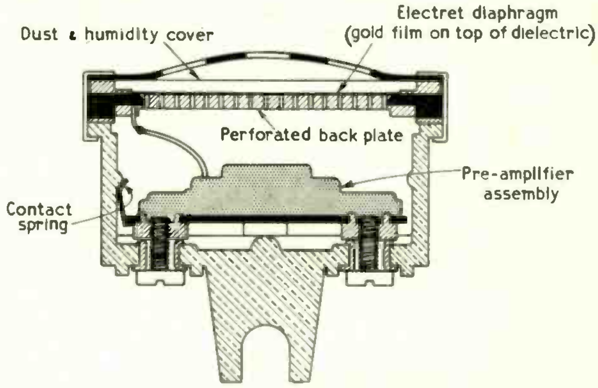
Electret Microphone

A capacitor microphone with a permanent electric charge built in has been developed as an experimental telephone transmitter by Northern Electric Laboratories of Ottawa, Canada. In conventional capacitor microphones the charge is, of course, produced by some kind of voltage source, but in this new transducer it is provided by an electret—that is a dielectric material to which a permanent electric charge has been applied during manufacture. (Electrets can be considered as electrostatic analogues of permanent magnets.) Here the electret takes the form of a 7.6 μm film of a granular polycarbonate material (the capacitor dielectric) metallized on one side with a 0.89 μm layer of gold (one plate of the capacitor). In the microphone this metallized film is placed with its insulating side in contact with the roughened surface of a rigid perforated backplate, which forms the other plate of the capacitor. The film has just enough tension to prevent wrinkles. Thus, when the air pressure on this diaphragm is varied the capacitance is changed and, since the charge is constant and $V = Q/C$, there is a corresponding variation of voltage across the capacitor—the output signal.

The transducer is a high impedance device, so its output is matched to the low impedance of the telephone line, and at the same time amplified, by a 20 dB solid-state pre-amplifier built into the microphone.

One advantage of this technique, regarding its application to telephones is, of course, that no voltage generator is needed for the capacitor microphone. And, because electrets can be made from very thin dielectric films, a higher capacitance per unit area than with conventional capacitor microphones is possible. The rate of decay of the charge is very slow, and the developers say that measurements at temperatures ranging from 90°C to 170°C have indicated that an electret life in excess of 100 years can be expected at normal temperatures. As a competitor to the carbon microphone used in telephones, the experimental microphone has the advantage, according to Northern Electric, that the built-in pre-amplifier requires less current than a carbon transducer.

Construction of the electret microphone.



Protecting Meters with Semiconductors

A selection of simple circuits using transistors or diodes to protect moving-coil meters from electrical overloads

by T. D. Towers, M.B.E., M.I.E.E.*

MOVING-COIL meters are expensive. They are easily damaged by accidental current overload from such things as wrong circuit connections, component failures or test prods slipping. An unprotected meter may not actually burn out on overload; it may end up with a bent pointer or, even worse, it may show no visible damage but have a gross reading error.

Modern semiconductors make it easy and cheap to protect your meters against current overloads. So much so, that in well run labs nowadays it is becoming the rule to fit to any meter, before putting it into service, a protection circuit similar to those to be described. It is simple insurance. A diode costing less than 2s can protect a meter costing several pounds.

Moving-coil meter characteristics.—A moving-coil meter is a coil of very fine wire (down to 0.001 in. dia., 50 s.w.g.) which is suspended in the field of a strong permanent magnet and balanced on a pivot. In measurements, current passes through the coil and deflects it against the reaction of a spring. A pointer or "needle", affixed to the coil, indicates the magnitude of the current by the position it takes up over the scale. The coil, pivot, spring and pointer can each be damaged by current overload.

A meter coil must have some resistance and, at full scale deflection, the voltage drop across it usually lies somewhere in the range of 30-300 mV. Very exceptionally, values as low as 5 mV or as high as 500 mV may be met with. For ordinary, general-purpose meters used in laboratories you will find a 1 mA meter has something like a 75-ohm coil resistance (i.e. 75 mV f.s.d. voltage drop), a 100 μA meter 1,250 ohms (125 mV f.s.d.) and a 50 μA meter 2,500 ohms (125 mV f.s.d.). Typical of this is the Avometer 8 with 125 mV f.s.d. in its lowest, 50 μA f.s.d., range.

Overload current limits.—Meter failures can arise either from extremely high current pulses of short duration or from continuous high overloads. The short pulse rotates the moving-coil assembly so violently that the assembly or the pointer is damaged. The continuous overload leads to overheating under which the restoring spring or the fine coil wire melts and opens up like a fuse wire.

How much overload can you apply to a meter without materially affecting its accuracy? Little information has been published on this subject. One authority found an overload of 140-225 times f.s.d. necessary to bend the pointer detectably in sample microammeters. I am not aware of any commonly agreed acceptable overload limit. My own practice, based on years of sometimes-bitter experience, is to try to keep meter currents down to less than 20 × f.s.d. value.

For typical 75 mV, 1 mA meters, this "20 × f.s.d. current" overload limit sets a maximum of 1.5 V permissible across the meter terminals. A good rule of thumb is thus: "Never let meter terminals see more than a volt."

Basic meter protection methods.—In essence you can shunt-or series-protect a meter. In shunt-protection you connect across its terminals an element that passes negligible current while the needle is on scale, and bypasses most of the excess current when the meter tries to travel off scale. In series-protection you fit in one lead to the meter an element which passes current up to the meter limit with negligible voltage drop, but presents a high resistance to excess currents. Of course, there is nothing to prevent you using both methods together in "belt-and-braces style".

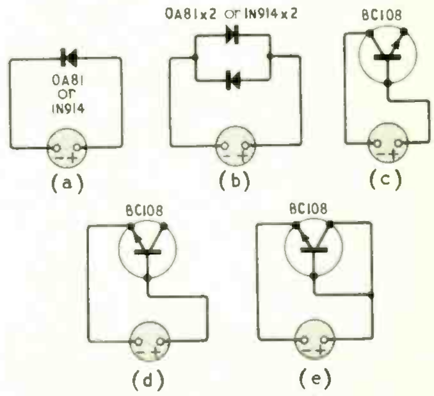


Fig. 1 Forward-biased diode shunt protection of moving-coil meter movements:—(a) single-diode for forward overload; (b) double-diode (for forward or reverse overload); (c) transistor collector-base junction as diode; (d) transistor emitter-base as diode; and (e) transistor with collector and base strapped together.

Shunt-Protection Circuits

A simple, cheap and effective way to protect a moving-coil meter against reasonable electrical overloads is to connect a semiconductor diode across its terminals, polarized as indicated in Fig. 1(a). When the meter is used to read current, the voltage drop across its coil forward biases the diode. Diodes can be selected whose forward current is negligible compared with the meter current up to the f.s.d. voltage of the meter (30-150 mV as noted above). Beyond full-scale the meter current continues to increase linearly with voltage, but the bleeder current through the diode increases exponentially. Thus the diode safely shunts more and more of the applied current progressively away from the meter coil.

Shunt diode selection.—In the days before transistors, meter protection diodes were usually copper-oxide or selenium rectifiers, whose basic leakage currents were too high for low-current meters. Nowadays, germanium and silicon diodes, with their intrinsic low leakage currents, can be used with even the most sensitive microammeters.

In modern silicon and germanium small diodes, the forward current, I_F, rises with voltage, V_F, roughly as shown in the table. This shows that germanium can give better overload protection than silicon. For example, when the voltage across the meter coil builds up to 0.45 V, a germanium shunt diode will bleed off 10 mA, but a silicon one only 10 μA. Again on 100 mA overload, the voltage across the meter will be 0.55 V with germanium against 0.85 V for silicon.

On the other hand, on scale the higher leakage current of the germanium shunt diode is liable to give a greater error than silicon, particularly with sensitive, high-resistance microammeters. In a 50 μA meter with 125 mV f.s.d., at 10 μA reading the voltage drop across the meter terminals would be 12.5 mV. At this level, the germanium diode could have about 1 μA leakage, significantly affecting the 10 μA reading. By

V_F	0.05	0.10	0.15	0.25	0.35	0.45	0.55	0.65	0.75	0.85 V
I_F (Si)	0.00001	0.00001	0.00001	0.0001	0.001	0.01	0.1	1.0	10.0	100.0 mA
I_F (Ge)	0.001	0.001	0.01	0.1	1.0	10.0	100.0	—	—	— mA

*Newmarket Transistors Ltd.

contrast, the silicon diode would pass only 10 nA (0.01 μA) and would produce no visible error. With less sensitive meters, such as standard 1 mA movements, it is usually immaterial whether you use germanium or silicon.

Diode data sheets are oddly uninformative about forward currents at voltages below 250 mV. When you are contemplating using a shunt protection diode, you might go to the trouble of measuring the low voltage characteristics if you had suitable equipment, but this is hardly worth while. The practical answer is to pass about 1/10th full scale current through your meter and see whether the reading changes perceptibly when you connect the diode across it. Then increase to f.s.d. current and check once again by connecting and disconnecting the diode.

For any given forward voltage, the diode current rises with temperature. For most lab. requirements where meters are normally used near room temperature, generally this can be ignored. Typical readily available diodes used for simple shunt meter protection are OA81 germanium and 1N914 silicon.

Shunt protection against reverse overloads.—The simple diode circuit of Fig. 1(a) protects the meter only against forward overloads. It is equally important to protect against reverse overloads. You can do this quite simply by paralleling the first diode with a second diode oppositely polarized as shown in Fig. 1(b). This is just as important with a left-hand zero meter (where a reverse overload only drives the needle a short distance to the stop) as it is with a centre-zero meter (where overload in either direction drives full across the scale to the stop).

Transistors as shunt protection diodes.—Silicon transistors are now nearly as cheap as diodes and more plentiful around the bench, so engineers sometimes use one of the junctions in a transistor as a diode. Fig. 1(c) shows the collector-base junction of the popular BC108 used as a subsititute for the diode of Fig. 1(a). In Fig. 1(d) the emitter-base junction is used. These substitutes are useful when you have some reject transistors to hand.

Another arrangement sometimes adopted is the "tridode" connection of a transistor shown in Fig. 1(e). Here the collector and base are strapped together and the emitter-base junction used. This has the advantage that the device has a lower voltage drop at high current than the emitter-base diode on its own.

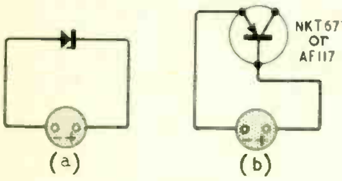
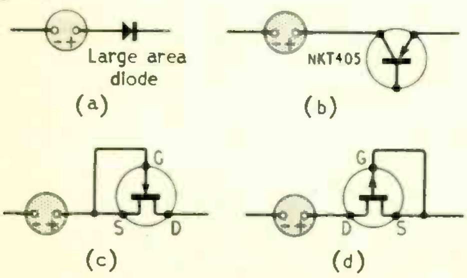


Fig. 2 Reverse-biased "breakdown" diode meter shunt protection:—(a) low-voltage Zener diode; and (b) emitter-base diode of diffused transistor.

Fig. 3 Series current limiting elements protecting meter against overloads:—(a) reverse-biased large-junction-area germanium rectifier; (b) Base-open-circuit high-gain germanium power transistor; (c) n-channel f.e.t.; and (d) p-channel f.e.t.



"Breakdown" (Zener) shunt diodes.—So far, we have looked at forward-biased diode shunt protection circuits. But it is also possible to use reverse-biased shunt diodes.

In Fig. 2(a) a Zener diode is shown shunted across a meter. When the forward voltage across the meter is below the Zener breakdown voltage there is negligible leakage through the diode. When the meter voltage exceeds the Zener voltage most of the overload current is shunted away from the meter through the Zener. The main practical difficulty of this circuit is that Zeners working at less than about 3 V are unusual and expensive.

To get round this, I use the emitter-base junction of a p-n-p germanium post-alloy-diffused v.h.f. transistor such as the NKT677F or AF117, whose emitter breakdown voltage is usually between 1 and 1.5 V. The circuit is shown in Fig. 2(b). The emitter breakdown characteristic is very similar to a Zener diode, but at a lower voltage.

Using a Zener or a reverse-biased transistor emitter junction for meter protection has an additional advantage. In the earlier shunt-diode protection, a second oppositely polarized shunt diode had to be used to protect against reverse overloads. With the Zener, or Zener-substitute, if a reverse current is applied to the meter, the device acts as a conventional forward biased shunt protection diode. Therefore the one element provides both forward and reverse overload shunt protection.

Series Protection Circuits

The shunt protection circuits dealt with so far present to the meter a high resistance at shunt at low voltage and low resistance at high voltages. An alternative approach is to use a series element which presents a low resistance at low current and high resistance at high current. There are a number of ways of doing this.

Simple series diode meter protection.—Fig. 3(a) shows a simple and effective meter protection circuit I have used for years in transistor test instruments where a high voltage can fall directly on a current meter if the transistor under test fails. This uses a large-area germanium power diode junction with a high reverse saturation current. Arranged in the reverse-biased direction in series with the meter as shown, the diode acts like a low resistance up to about 1 V. Thereafter the diode current begins to saturate and remains relatively constant as the applied voltage increases. The main difficulty in using this circuit is to find a suitable diode whose saturation current is about ten times the f.s.d. current of the meter to be protected.

Working in a transistor factory, I get round this by selecting a very high-gain power transistor such as the NKT405 and connecting it with base open circuit in series with the meter as shown in Fig. 3(b). Up to 60 V the leakage current of the 405 lies in the mA region, so that it is adequate to protect standard 25 to 100 μA meters.

You are probably not lucky enough to have a transistor factory at your back, and may be forced to turn to one of the f.e.t. current limiting series circuits described below.

Simple f.e.t series meter protection.—If the source and gate of an f.e.t. transistor are strapped together, the output current—voltage characteristics are such that up to near the pinch-off voltage, V_P it acts like a simple resistance. Above V_P it acts like a constant current device up to the drain breakdown voltage. These quasi-pentode characteristics are most useful, particularly nowadays, when with low V_P and low series resistance, *r*ds, are readily available.

Fig. 3(c) shows an n-channel f.e.t. (with its gate and source strapped) in series with the meter to be protected. Fig. 3(d) shows a similar arrangement for a *p*-channel f.e.t. In the second case you will note that the source connection is to the right instead of to the left.

The characteristic requirements for such series-protection f.e.ts are that the pinch-off voltage should be less than 1 V and the I_{DSS} approximately ten times the meter f.s.d. current. The higher the drain voltage rating the better, because the f.e.t. protects the meter only up to the rated drain voltage. As an example, to protect a 25 μA meter, I use an NKT0213 n-channel f.e.t. (I_{DSS} = 200-600 μA and V_P = 1 V typical). With this protection I have been able to connect the meter directly across 12-V car battery terminals without damage.

Multiple series element protection.—In the case of diode or f.e.t. series circuits above, if you wish to protect against reverse overloads, you can add another diode or f.e.t. *in series* with the first but with opposite polarization. This corresponds to adding an opposite-polarity device in parallel in shunt protection circuits.

For one-way protection, other multiple series element arrangements are possible. Fig. 4(a) shows as f.e.t. with an adjustable resistance in the source lead by which you can preset the limiting current in the f.e.t instead of having to select a suitable f.e.t. with the right I_{DDS}.

Fig. 4(b) shows an arrangement of a transistor biased in a constant current mode by means of a battery which fixes the emitter current to a constant value given approximately by the battery voltage divided by the emitter resistance, always provided that the collector-base voltage is more than a fraction of a volt positive. As soon, therefore, as the total voltage across the circuit exceeds V_{ref} by about 250 mV, the emitter (and therefore the meter) current limits to V_{ref}/R_E. For a sensitive 25 μA meter movement, for example, a 1 V mercury cell can be used limiting the emitter current to around 200 μA. If this is done, the drain on the battery is so low that no on/off switch need be provided. A practical multirange circuit using the above technique was described in "Meter Protection Circuit"

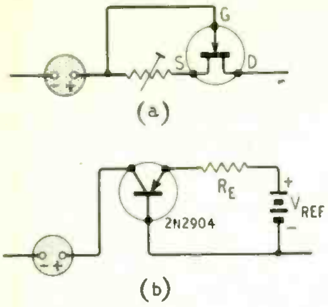
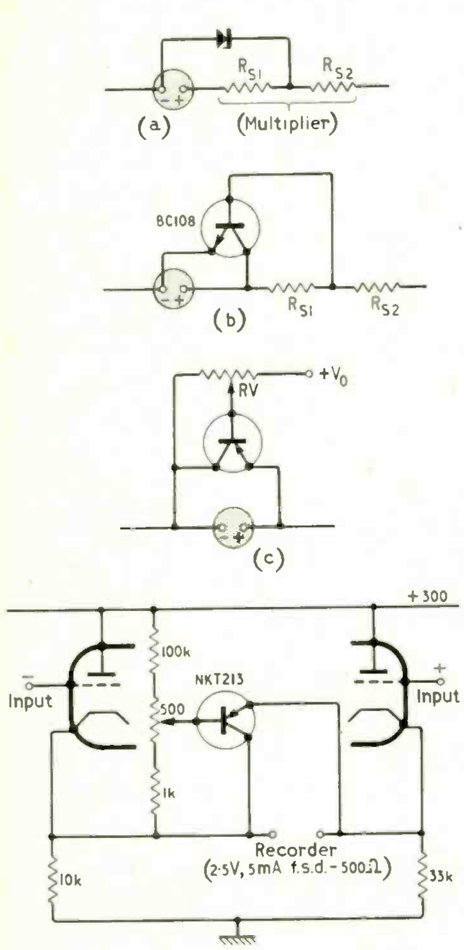


Fig. 4 Multiple series element protection circuits:—(a) f.e.t. with preset I_{DS}; and (b) fixed-bias transistor.

Fig. 5 Voltmeter protection circuits:—(a) Zener inserted im multiplier resistance; (b) basic transistor protection circuit; (c) pen recorder basic protection circuit using a p-n-p Ge-alloy transistor; and (d) pen recorder practical protection circuit.



by A. A. Mangieri in *Electronics World*, January, 1965, p.48.

Voltmeter Protection Circuits

So far we have been looking at semiconductor protection circuits for a moving-coil meter where it is used to measure current. Frequently, however, meters are used to measure voltage by inserting a multiplier resistance in series with the meter. Several arrangements are possible to protect a voltmeter additional to the circuits described above for the moving-coil meter on its own. In essence, in these we take the series multiplier resistor and split it to insert some protection device at the junction of the two resistors.

Zener voltmeter protection.—One example of this is shown in Fig. 5(a) where the series resistor is made up of R_{S1}, R_{S2}, and a Zener is connected from their common point to the negative meter terminal. The necessary resistance and Zener values can be calculated quite simply. Firstly $R_{S1}+R_{S2}=E_M/I_M-R_M$, where E_M=f.s.d. voltage to be measured, I_M=f.s.d. current of the meter and R_M= meter coil resistance. Select a Zener of approximately E_M breakdown voltage. Make R_{S2} approximately 20% of $R_{S1}+R_{S2}$. This will mean that when the voltage applied to the voltmeter is more than about 25% above the voltmeter f.s.d. voltage, the Zener will begin to conduct and limit the current through the meter to some 25% above its f.s.d. value. Of course, when the meter is used without a series multiplier resistor in the lowest voltage range of the voltmeter (e.g. 125 mV in the 50 μA range of the Avo 8), this method of protection cannot be used as it clearly depends on having a multiplier resistance that can be split to insert the Zener.

Transistor voltmeter protection.—Fig. 5(b) shows another voltmeter protection circuit that I use which depends on the fact that a silicon transistor does not begin to conduct until its base-emitter voltage approaches 500 mV. Here again $R_{S1}+R_{S2}$ represents the voltmeter series-multiplier resistance whose total value is fixed as in the previous example. The individual resistor values are chosen so that the voltage across R_{S1} is about 400 mV for the f.s.d. meter current. Beyond this current, the BC108 transistor is biased more and more fully on and shunts off most of the excess current away from the meter movement on an overload.

An interesting meter protection arrangement used by Yates for pen recorder protection is shown in Fig. 5(c). In this the base of the transistor, whose collector and emitter are placed across the recorder terminals, is held at a small positive voltage. So long as the f.s.d. voltage of the recorder is not exceeded, the base-emitter junction of the transistor is reverse biased and the transistor is cut off. When the positive terminal of the recorder rises above this threshold voltage, the transistor begins to conduct and bypass excess current away from the movement. In Fig. 5(d) the arrangement is shown fitted as a protective measure to a common type of pen recorder valve drive circuit.

Miscellaneous Matters

The various protective circuits have been shown above in circuit diagram form, but there are some practical points to be considered.

Mounting meter protection circuits.—With modern semiconductors, the devices are so small that in the case of passive networks (with no separate power supplies required) the circuits can be easily fitted permanently inside the meter case. An alternative is to mount them on a small printed circuit board with holes to fit the meter terminal spacings, so that the board can merely be slipped over the terminal screws and bolted into place. Another approach is to "pot" the elements in some compound leaving only the two meter lead wires exposed. In the case of the commonest protection circuit, two parallelled opposite-polarity shunt diodes, "potting" can consist merely of strapping the two diodes together with Sellotape and twisting the leads together.

Other protection methods.—All or any of the various circuits described earlier can be used singly or together. However, they can all fail in the end if a sufficiently high voltage overload is applied. The only sure way of fail-safe protection is to incorporate either a mechanical cut-out or a fuse in series with the meter. Unfortunately, it is difficult to find readily available fuses below about 60 mA, but, provided a shunt diode is used across the meter with such a fuse, it can be most effective.

If you wish to go into more detail on semiconductor meter protection circuitry, you will find much relevant material in the following references:

"How to Specify Panel Meters" by A. D. Stephens, *International Electronics*, July, 1966, pp.26-32.

"An Overload Protection Circuit" (Pen Recorder) by C. G. Yates, *Electronic Engineering*, March, 1960, pp.172-173.

"Meter Overload Protection" (with metal rectifiers) by J. de Gruchy *Wireless World*, September, 1953, pp. 425-427 and December, 1953, p. 582, and by T. H. Francis, *Wireless World*, November, 1953, p. 529.

"Meter Protection—Design and Performance of Fine Wire Fuses" by F. R. W. Strafford, *Wireless World*, February, 1953, pp.90-92.

Books Received

Precision Electronics by G. Klein and J. J. Zaalberg van Zelst (from the Philips Technical Library). The reader is presented with the basic principles of electronics design and with a number of worked examples. The most common components, methods of calculation and basic circuits in electronics are described and general principles and methods are dealt with, particular attention being given to the limits in the design of electronic measuring equipment. Pp. 466. Price 138s. Macmillan & Co. Ltd., Little Essex Street, London W.C.2.

Electrical and Electronic Trader Year Book, prepared in collaboration with the staff of our sister journal *Electrical and Electronic Trader.* All sections of this, the thirty-ninth edition of the year book, have been revised and brought up to date and provide a wealth of information for all in the radio, television and domestic electrical fields. The first section of the book gives principal trade organization addresses, licence details, legal information, addresses of electricity boards, intermediate frequencies of commercial receivers, a comprehensive guide to the field strengths of f.m. and television transmissions and much other information. Other sections separately cover valve base diagrams, trade addresses and telephone numbers and the manufacturer's or agent's names of proprietary equipments and components. The technical literature section contains an index of all the Trader Service Sheets available and brief details of the contents of about 250 books are given. Other sections include classified buyers' guides for components and domestic radio, televison and electrical equipment. Pp. 495. Price 35s. Iliffe Technical Publications Ltd., Dorset House, Stamford Street, London, S.E.1.

Letters to the Editor

The Editor does not necessarily endorse opinions expressed by his correspondents

"Portable 1-MHz Frequency Standard"

The recent article by L. Nelson-Jones (February issue) has been studied with interest. Although the instrument described is a useful one, its performance could perhaps be improved with the consideration of several factors.

In the receiver circuitry itself, limiting is used to "remove residual modulation". This, in fact, cannot be done generally. No matter how much one limits, one retains an amplitude-limited function which will have a time-varying nature due to the amplitude modulation imposed upon the original carrier. For that matter, amplitude variations in the entire signal due to variable propagation factors will also exhibit much the same effect. The time variation of the cyclic function after limiting can only approach zero if the points in time when the waveform first limits symmetrically approach the time when the value of the original function is zero. This may be seen in Fig. A.

The time-response of a phase-locked loop—particularly one in which a quartz resonator is included—is not, in fact, arbitrarily small due to the narrow bandwidth of the piezoelectric element.

The precise behaviour of an arbitrarily-defined phase-locked system is not generally known; in any case, an approximate analysis would involve many pages. However, this is not to say one cannot combine the rudiments of servomechanism theory and quartz resonator behaviour to a useful end.

The oscillator used in the standard described is a Colpitts type, with the typical inductor replaced by a quartz resonator and its associated series tuning capacitor. One could therefore argue that the resonator is operating in a quasi-parallel mode. However, using conventional circuit theory, the resonator and its associated circuitry may be represented as a series equivalent circuit as shown in Fig. B, where L_c, R_c, and C_c represent the time-invariant elements in the oscillator circuitry and C_T represents the time-variable tuning capacitor. Since the crystal Q is very high and its series motional arm capacitance is very small, it is in keeping with an approximate analysis to assume the values of L_c and C_c are within perhaps an order of magnitude of the resonator values alone.

The resonant angular frequency may be shown to be

$$\omega_0 = \left[\frac{1/C_c + 1/C_T}{L_c} \right]^{\frac{1}{2}} \quad \text{......(1)}$$

To examine the time response of the circuit to a time variation in the value of C_T, it is, of course, only necessary to partially differentiate the frequency expression with respect to time. Considering C_T the only component which has a time-variable value, then

$$\frac{\delta\omega_0}{\delta t} = -\left[\frac{1}{2\,\omega_0\, L_c\, C_T^2} \right] \frac{\delta C_T}{\delta t} \quad \text{......(2)}$$

The condition for the change in angular frequency with time to be a function of only slow changes in the value of C_T is that the constant term be very small; certainly less than 1. This implies that the denominator is large. For a circuit dominated by a high Q resonator with a very large L_c/C_c ratio, the demoninator is, in fact, very small. In the case under consideration here, perhaps 10^{-16} or so, depending on the crystal, is a realistic figure. Hence the rate of change of angular frequency is not only considerable for a corresponding change in tuning capacitance, but what is most important of all, directly proportional to the rate of change of tuning capacitance.

The application of this analysis here establishes that the quartz resonator will not, in fact, remove much of the time-varying component of the locking signal fed to the tuning element in the oscillator.

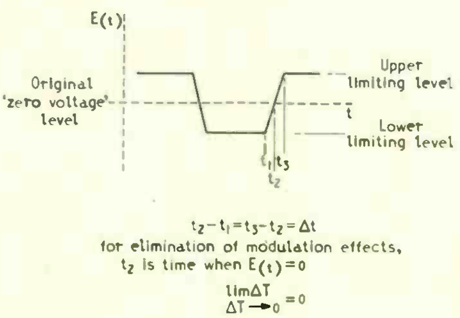
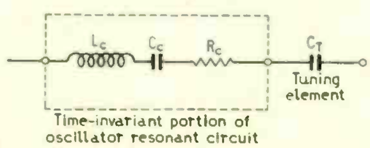


Fig. A. Condition for elimination of a.m. effects.

Fig. B. Oscillator equivalent circuit



Philosophically, this is what one would expect; the quartz resonator, when held at a fixed frequency and presented with an input of varying frequency, will remove much of the time-varying components of the waveform (they may be regarded as sidebands which are "filtered out"). However, when the quartz resonator is placed in a circuit with a varying reactive component, the entire oscillatory circuit surely can be only as stable as the most unstable element.

If one considers the d.c. amplifier portion of the phase-lock loop one may deduce the open-loop time constant to be of the order of five to fifteen milliseconds; thus, when the loop is closed, if the gain is sufficient and the transfer function of the time-variable capacitor allows, the crystal resonator will be subject to perturbations in its frequency at a maximum rate of, say, rather more than five or ten hertz and to an extent determined by the capacitor.

The suggestion that this does, in fact, happen is reflected in the performance of the unit. The author quotes, during the condition of phase lock, a short-term stability (one second) of less than one part per million. In fact, a crystal resonator alone should, if placed in an oscillatory circuit with perhaps drive not exceeding five microwatts or so, exhibit a figure of the order of 0.01 part per million.

It is perhaps a pity that Mr. Nelson-Jones did not include a simple filter in the receiver portion of the device to remove the sidebands which, when present, perturb the frequency of the phase-lock loop. The device, however, achieves a most useful end in that the output has a long-term stability which is roughly that of the received signal.

A similar device was constructed here a year or so ago; it uses an LC oscillator locked to Droitwich via a ± 5 hertz bandwidth receiver. Its short-term stability (one second) is less than 0.01 part per million.

LEWIS E. SCHNURR
Mid-Essex Technical College,
Chelmsford.

The author replies:

I agree with much of what Mr. Schnurr has said, and indeed it is mostly in accord with my own understanding of the operation of the type of circuit described.

With regard to the ability of the crystal resonator to reject sideband interference in such a phase-lock loop system, I would agree that the degree of filtering is much less than would be expected from consideration of the crystal response bandwidth alone.

I think it is important to define the time scale within which one is speaking when talking about accuracies with this type of instrument, for instance, if one were to consider the pulse-to-pulse accuracy then the time scale would be 1 μs, and say a 10-ns shift of a single pulse would represent an accuracy of only 1 in 100 parts. However, such a shift of a single pulse in a period of 1 second would represent an accuracy of 1 in 10^8. It is therefore true that Mr. Schnurr's mathematical treatment may how an instantaneous frequency shift of many Hz, but averaged over 10^6 or more cycles this may not represent any great error as measured say on a digital frequency meter.

Assuming that limiting is taking place as shown in Fig. 4 of my article (Fig. A of Mr. Schnurr's letter), the sampling pulse will stay within the time duration of the rise time of the trapezium waveform if phase lock is to be retained. In fact the pulse does stay within this time interval in practice despite residual modulation. The total rise time of this waveform is approximately $1\mu s$; therefore the maximum error that can occur in one second is 1 part in 10^6.

I agree with Mr. Schnurr that a very narrow band filter would achieve the desired effect if placed in the receiving chain, but I would not agree that such filters are necessarily simple (or cheap) if a bandwidth of only a few Hz is to be obtained at 200 kHz. The suggested modification shown in Fig. 6 of my article achieves the same end, since it increases the time constant of the phase-lock loop from a few milliseconds to around 1 second. With such a long time constant the phase-lock loop is not disturbed by frequencies above 1 to 2 Hz.

As I said in the article it is not possible to achieve automatic phase lock with a long time constant when switching on, so that it is necessary to switch this extra capacitor into circuit after the phase lock is established.

The only comparable commercial equipment to my own uses a phase-lock loop with such a large time constant. The loop is opened on switching on, and the lock indicator is used to show the difference frequency between the crystal oscillator and the received carrier. This frequency has to be reduced to a very low value (less than the cut-off rate of the phase-lock loop) or phase lock cannot be established. With respect to the makers of an otherwise excellent instrument, I personally found it to be a very "fiddling" method of setting up the equipment. To set up my own instrument it is only necessary to switch on and set the phase lock (if it has been disturbed)—only a few seconds is taken to do this. A period of 30 seconds is allowed for the time constant to charge up and then the switch is closed bringing in the larger capacitance.

My thanks to Mr. Schnurr for his most interesting comments, but we must agree to differ: he prefers to use a narrow band filter, and I prefer to use a long time constant. "You pays your money—you takes your choice." I think, however, that you will pay less my way.

L. NELSON-JONES.

Bournemouth, Hants.

Supply of Components to the Home Constructor

For three years I have been trying, without success, to obtain certain components, in particular dual potentiometers with particular resistance values. At last an apparent source came into view through a Distributor's advertisement in *Wireless World*. Neither the catalogue nor the advertisement offering it mentioned anything about restrictions on the type of would-be customer to be supplied. However, my order and cheque were returned with a printed letter suggesting that I obtain the parts via my 'local television/radio dealer who will be pleased to help!' A letter to the firm in question produced an apologetic reply with the information that certain retailers will be glad to order the components for me.

When searching for components, retailers have offered me from stock parts distributed by a service and distribution organization, but of unknown origin, at times dubious quality, and, I feel, at high prices. Manufacturers and importers are reluctant to supply small quantities to large account customers and small cash customers alike; this is reasonable. It seems that the stockist/distributor has grown up to fill the gap thus created, carrying extensive stocks of branded, high-quality components, and distributing them quickly to large areas of the country by post or van at reasonable prices. Most of these firms are very co-operative when asked to supply in small quantities to a private individual components not normally found in retail shops.

When faced with an unco-operative distributor of British components, what am I to do? Should I try to persuade my reluctant retailer to order the parts (and thus make it more expensive for me to buy them, yet probably not giving the retailer an adequate recompense for the trouble involved in dealing with a 'special'), or should I turn once again to the Americans and have the parts imported because a distributor is clinging to distinctions between trade and general public, which to most people are as out-dated and restrictive as resale price maintenance and 'who does what?' industrial disputes? It would at least be some help if advertisers would indicate if they are 'Trade only', but it would be much more helpful if they would be willing to supply to private individuals catalogues and a list of retailers who regularly deal with them.

P. W. TOMLINSON

Leeds 16, Yorks.

Electronic Music

I was surprised and pleased to see a review of the Queen Elizabeth Hall electronic music concert in the March issue of *Wireless World*. It is encouraging to find the subject treated seriously in a scientific journal; the people who are generally the most reactionary with regard to electronic music are electronics experts and musicians.

Your reviewer mentioned that the Royal College of Music is starting a pilot course on electronic music. I should like to add that we have already set up an Electronic Music Workshop at Goldsmiths' College, and that some 40 people have been attending courses here since January; these include established composers, students from the main London music colleges and people from other arts and sciences.

The workshop is designed both for the production of electronic music on tape and for the performance of live electronic music (which has so far been scarcely explored in this country). This latter genre was not represented at the above-mentioned concert, but a concert of electronic music to be given at the London Planetarium on March 22nd (organized jointly by the Society for the Promotion of New Music and the Park Lane Group) will include a new composition combining tapes with live electronic performance, the first work realized in our workshop.

HUGH DAVIES

Electronic Music Workshop,
University of London Goldsmiths' College

Corrections

Under our new printing arrangements the final checking of material is one stage earlier than under the old system and it is regretted that several errors crept into the March issue. Some cannot mislead, as for instance the "geranium" transistor on p. 6 (which one reader has suggested was for "flower power") but others must be corrected.

It is ironical that a major error occurred in Mr. Southall's article "Electronics in Typesetting"! In the fifth paragraph from the end the sentence beginning "One, from the width tables stored in the" should continue "main part of the memory, gives the character's width in half relative units (713 does all its calculations in half relative units)."

In Mr. Short's article (pp. 24/5) the end of the paragraph following the heading "oscillators" should read "measurements in a working low-frequency circuit showed $V_{in}/V_{out} \approx 100$." It will be obvious from Fig. 1 that the low-pass switch connection to the common input-output line was omitted in preparing the drawing for Fig. 5.

The upper frequency limit of the d.c. converters and inverters described by Mr. Nowicki (p. 38) should, of course, have been given as 50 kHz in the subtitle and introduction. In equation (3) the term V_C should read $V_{CE(SAT)}$. Square brackets were omitted from the expression $|I_{1(pk)}+I_{1(min)}|$ in equation 8 and the author omitted to define $I_{1(pk)}$ which is five times $I_{1(min)}$. In Fig. 11 component references R_2 and R_3 should be transposed, and, correspondingly, in the text describing the circuit. Definitions of R_o, and I_M are given in the author's earlier papers (References Nos. 3 and 4).

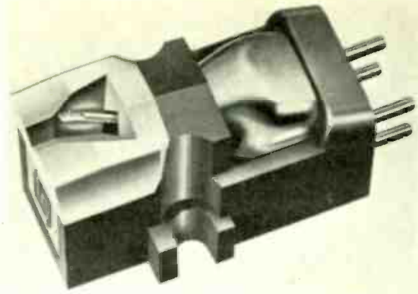
In the first line of the caption to the flight deck mock-up (p. 12) for "left" read "right".

A Disclaimer

Mr. D. W. Stebbings has asked us to let it be known that he is not the author of the article "Doctoring Recorded Sound" published in the March issue (p.9).

London Audio Festival

Hotel Russell, April 18—21



Audio & Design are introducing this induced-field cartridge at the Fair. It has an output of 0.9 mV/cm/sec.

The annual festival of sound, which opens at the Hotel Russell, London, on April 18th for four days, has attracted even more exhibitors than last year's record breaking Fair. An additional area of the Hotel is being used to accommodate the extra booths necessary for the 98 exhibitors, the majority of whom will also mount demonstrations in private rooms. These demonstrations, many of which are given in rooms furnished to simulate the domestic atmosphere, are an essential part of the International Audio Festival & Fair which has become the Mecca of the ever-growing number of audio enthusiasts.

As is usual, the Fair will hold some interesting surprises for visitors. First, the number of new participants; secondly that several manufacturers have diversified their interests—as for instance Audio & Design who have entered the pickup cartridge field; and thirdly the considerable quantity of imported equipment which will be on show. The Fair has indeed become international; about a third of the exhibitors will be showing or demonstrating equipment from overseas.

We list below the names of the exhibitors and where overseas manufacturers are represented by their U.K. agents we give the latter's name in parentheses. We plan to include in our June issue a review of some of the latest developments in audio equipment as seen by members of the staff of *Wireless World* at the Fair. As a preliminary we illustrate on these pages some of the equipment which will be seen or demonstrated.

The Fair will open daily at 11.00 but admission on the opening day will be restricted to specially invited guests until 16.00. It will close at 21.00 except on the last day when it will end an hour earlier.

Tickets, which will admit two people at any time after 16.00 on the opening day, are obtainable from exhibitors, audio dealers or the editorial offices of *Wireless World*. Please send a stamped addressed envelope large enough to accommodate the 5 × 3-inch tickets.

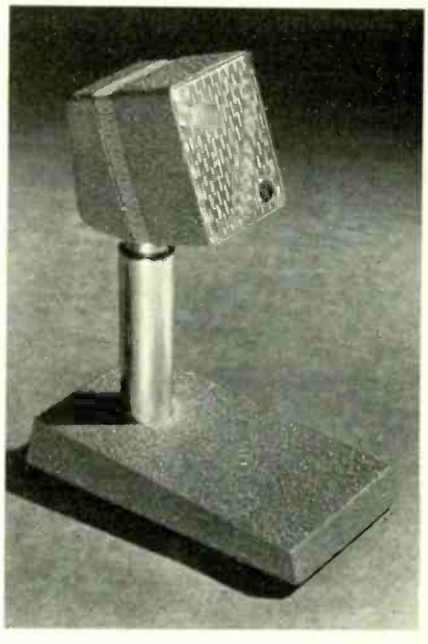
As with all major shows some companies, for one reason or another, prefer to hold their own exhibition and during the Audio Fair there will be independent shows at the Tavistock Hotel, Tavistock Square (B & O, Radford and Sony) and the Grand Hotel, Southampton Row (Heathkit).

The module (Mk II) used in the Jordan-Watts loudspeakers to be shown by Boosey & Hawkes. The aluminium diaphragm, with plastic surround, is mounted in a 6-in. square frame.

LIST OF EXHIBITORS

A.K.G. (Politechna)
Acoustical Mftg. Co.
Agfa-Gevaert
Akai (Pullin)
Allan. Richard. Radio
Ampex Corporation
Arena (Highgate Acoustics)
Armstrong Audio
Audio & Design
Audio & Record Review
Audio Technica (Shriro)
B.A.S.F.
B.B.C.
B.S.R.
Beyer (Fi-Cord)
Boosey & Hawkes
Bosch
Braun (Fi-Cord)
Brenell Engineering Co.
Celestion
Cosmocord
Decca Record Co.
Design Furniture
Diamond Stylus
Dual Electronics
Dynatron
E.M.I.
Elcom
Elizabethan
Euphonics (Elstone Electronics)
Fed. of Brit. Tape Recording Clubs
Ferranti
Ferrograph Co.
Field. N. & S. B., & Co.
Fisher Radio
Garrard Engineering
Goldring Mftg. Co.
Goodmans Loudspeakers
Gramophone
Grampian Reproducers
Grundig
Hi-Fi News
Hi-Fi Sound
High Fidelity Magazine
KEF Electronics
Leak. H. J., & Co.
Lowther Manufacturing Co.
Lugton & Co.
Lustraphone
Magnetic Tapes
Medley Musical
Mikrofonbau (Denham & Morley)
Minnesota Mining & Mftg. Co.
Mullard
Multicore
Oki (Denham & Morley)
Ortofon (Metro-Sound)
Parmeko
Philips Hi-Fi
Philips Tape Recorders
Pioneer Electronics (Swisstone)
Radionette (Denham & Morley)
Rank Wharfedale
Recordaway
Records & Recording
Reslosound
Richardson Electronics
Rogers Developments
S.M.E.
Sansui Electric Co. (Technical Ceramics)
Sanyo (Marubeni-Lida)
Sennheiser (Audio Engineering)
Shure Bros.
Sinclair
Sonotone (Metro-Sound)
Standard Telephones & Cables
Stereosound Productions
Sugden & Co.
Tandbergs (Elstone Electronics)
Tannoy Products
Tape Recorder Developments
Tape Recorder Spares
Tape Recording Magazine
Teac (C. E. Hammond)
Telefunken
Teleton Elektro
Thorens (Metro-Sound)
Transcriptors
Trio (Arnhold Trading Co.)
Truvox
University Recording
Vortexion
Whiteley Electrical Radio Co.
Williman. K. H., & Co.
Willi-Studer (C. E. Hammond)
Wilmex
Wireless World and *Electrical & Electronic Trader*
Yamaha Europa

The S.T.C. type 4113 ribbon cardioid microphone which is available with a 30-ohm or 50k-ohm impedance.



One of the new Series 7 Ferrograph tape recorders. F.E.T. input stages are employed in the all-transistor amplifier. Separate motors are provided for each of three speeds.

Sansui stereo tuner-amplifier model 3000A. One of four new pieces of equipment to be shown by the U.K. agents, Technical Ceramics Ltd. of Swindon.

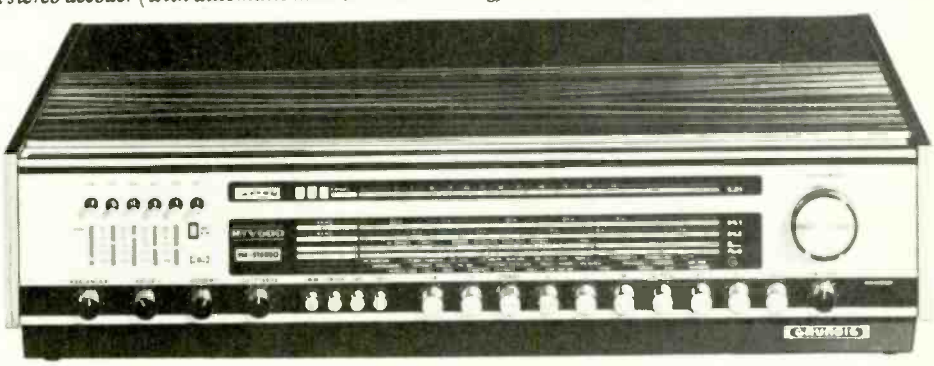
The pickup arm on the Goldring GL 75 turntable unit (right) is fitted with calibrated stylus pressure adjustment, bias compensation and is raised and lowered hydraulically.

A new single record playing unit (AP 75) introduced by Garrard Engineering. Fitted with a non-magnetic turntable and aluminium pickup arm with slide-in cartridge carrier.

Sennheiser MD 409 super-cardioid microphoe, introduced by Audio Engineering, provides steep attenuation at the sides as well as the back.

Rogers Developments' Ravensbourne 2 f.m. receiver, featuring an f.e.t. front end, is available with or without decoder

Grundig's RTV600 tuner-amplifier, which employs 53 transistors and 31 diodes, covers the v.h.f./f.m. band, the s.w. bands from 3.15-22.5 MHz, and the m.w. and l.w. bands. It incorporates a stereo decoder (with automatic mono/stereo switching) and has an output of 20 W per channel.



World of Amateur Radio

Illegal Walkie-Talkies

IN agreement with the Board of Trade, the Postmaster General has made an Order under Section 7 of the Wireless Telegraphy Act 1967, the effect of which is that the authority of the P.M.G. will be required, as from April 1st, by any person who wishes to manufacture or import radio equipment capable of transmitting on any frequency between 26.1 and 29.7 MHz or between 88 and 108 MHz. Some of the frequencies covered by the Order are used by radio amateurs and they will be authorized to build their own apparatus for use within the terms of their licence. The Order is aimed at putting an end to the indiscriminate sale to the public of small imported transmitters such as the 27 MHz walkie-talkies. The Post Office has warned in the past that the use of these sets cannot be approved in the United Kingdom because they are liable to interfere with authorized services and numerous people have been prosecuted for using them without a licence. The purpose of the Order is to deal with the matter at source and to protect the public from being offered sets which they cannot legally use.

E-M-E Test.—An Earth-Moon-Earth Test is due to take place during the period April 12th-14th, on 1296 MHz $\pm$ 5 Hz when the Crawford Hill V.H.F. Club station W2NFA, located at Holmdel, New Jersey, U.S.A., will transmit with an output power of at least 200 watts into a 60-ft parabolic reflector. The aerial has an estimated gain of 44 dB. Echo-testing will commence at moon-rise and continue for 30 minutes prior to any schedules. Moon-rise to moon-set times (G.M.T.) at W2NFA during the test period are 23.00 April 12th to 10.28 April 13th, and 00.18 April 14th to 10.57 April 14th. All correspondence concerning the tests is to be sent to Mr. R. Turrin, W2IMU, Box 45, R.R.2 Colts Neck, New Jersey, U.S.A. 07722. The official liaison station WB2NDH will operate on 14.235, 21.385 and 28.690 MHz.

U.K. Successes in International V.H.F. Contest.—The German National Amateur Radio Society (D.A.R.C.), organizers of the 1967 I.A.R.U. Region I V.H.F. Contest held last September, report the receipt of 924 logs, including 831 from 2-metre stations, 81 from 70-cm stations and 12 from 24-cm stations. Section 1, for 2-metre fixed station operation, was won by I1CZE (Italy) with a score of 44563 points and Section 2, for 2-metre portable operation, by GC3WMS/P (Channel Islands) with a score of 52340 points. Another U.K. operator G3CMS (Leicester) with a score of 4022 points led in the section for 70-cm fixed stations, while in the section for 70-cm portables, U.K. operators occupied the first three places—GC3VXK/P (Channel Islands), 12118 points, G3NNG/P (Berkshire), 6991 points and G3MAR/P (Birmingham), 6419 points. In the section for 24-cm fixed stations, G3CMS (Leicester) achieved his second success of the Contest by leading the field with a score of 1351 points. In the section for 24-cm portables, U.K. operators—G3NNG/P (1003 points), G3MAR/P (878 points) and G3OBD/P of Dorset (845 points)—occupied the first three places.

Amateur Radio Licences.—At the end of December the number of amateur radio transmitting licences in force in the U.K. was as follows: Type A sound licences 15034 (including 2407 mobile); B licences for telephony only on 420 MHz 722 (22 mobile); and 177 television licences making a total of 15933—an increase of 535 during the preceding six months. At the end of the year there were 12658 model radio control licences in force; a 1037 increase in six months.

Amateur Facsimile now Authorized.—Following discussions between the Radio Society of Great Britain and the Post Office it has been decided that any licensed U.K. radio amateur may apply to the Radio and Broadcast Dept., G.P.O., Armour House, London, E.C.1, for permission to transmit facsimile (A4, F4 and allied modes). In the past this mode of transmission has not been among those permitted by the terms of Amateur Sound Licences. Recently there has been increasing interest in facsimile brought about by the availability of reproduction equipment.

Derby and District Amateur Radio Society, which incorporates the Derby Wireless Club, now boasts 178 members including 86 holders of transmitting licences. The first wireless club in the United Kingdom was formed in Derby during 1911 and an experimental station was established that year in Old Bank Chambers, Irongate, with the call sign QIX. Mr. Fred Ward, G2CVV, secretary of the present go-ahead society, has produced a short history of the original Derby Wireless Club, a copy of which he will send on receipt of a stamp for postage to anyone interested in the early days of wireless and the club movement. Mr. Ward's address is 5 Uplands Avenue, Littleover, Derby, DE3 7GE.

Iceland on 2 metres.—Mr. D. B. Collins, K2LME, of Paramus, New Jersey, has set up a 2-metre amateur radio station in Keflavik on the south west coast of Iceland from where he hopes to maintain schedules with amateur stations in the U.K. and other parts of Europe. The aerial is a 7-element horizontally polarized Yagi, 30 feet above ground. The station is operating from a site close to the ocean with no obstructions looking east south-east. The transmit frequency is within 50 Hz of 144.1 MHz. Telegraphy will be used unless propagation supports the use of the single sideband mode. Mr. Collins is monitoring as much as possible for auroral occurrences and will appreciate receiving information on aerial headings used by U.K. operators during auroral QSOs. Transmissions take place for 15 minutes each evening from 20.00 G.M.T. on 144.1 MHz followed by a listening period for the next 15 minutes. The array is beamed on the U.K. and schedules for any hour of the day or night will be welcomed by Mr. Collins whose full address is c/o F.E.C./DYE 5, Box 4, U.S.N.S., Keflavik, Iceland.

R.F.C. Wireless Operators' Reunion.—The Annual Reunion of Royal Flying Corps Wireless Operators will be held at the Victory Ex-Services Club, Edgware Road, on Saturday, March 30th. Information is obtainable from Mr. E. J. Hogg, M.B.E., 57 Hendham Road, London, S.W.17.

The Tenth Annual Reunion of the Radio Amateur Old Timers' Association is to be held at The Horse Shoe Hotel, Tottenham Court Road, London, W.1, on Friday, May 3rd. Membership of the Association is open to any radio amateur who has held a United Kingdom amateur transmitting licence for an unbroken period of 25 years (including the war years) at the time of his application for membership. Further information from the Founder-Secretary, 16 Ashridge Gardens, London, N.13.

Amateur Radio Teleprinting is well catered for in the U.K. by the British Amateur Radio Teleprinter Group who, through the medium of a quarterly News Letter, provide members (315 at the last A.G.M.) with up-to-date information on all aspects of the subject. Editor of the News Letter is Mr. A. W. Owen, G2FUD, 184 Hale Road, Hale, Cheshire, and the secretary is Mr. D. J. Goacher, G3LLZ, 51 Norman Road, Swindon, Wilts. The annual subscription is 15s.

Look out for EA6ITU.—During the Interim Meetings of the International Radio Consultative Committee (C.C.I.R.) to be held in Palma, Majorca, from April 29th to May 10th, an amateur radio station will be operated under the call sign EA6ITU.

New Products

Toggle Switch

Rated at 30,000 operations at 24 V d.c. 3 A this single-pole changeover switch (type TS/1) combines small physical size with high reliability. The body of the switch is 0.375 inches in diameter and protrudes 1 inch behind the panel on which it is mounted. It has an initial contact resistance of 5 m Ω and the insulation resistance between the contacts and other parts of the structure is 10 GΩ, the test voltage between open contacts is 1.5 kV and between contacts and structure 2 kV. When used in a.c. applications the maximum current that can be handled is 1.5 A. Rendar Instruments Ltd, Victoria Road, Burgess Hill, Sussex.

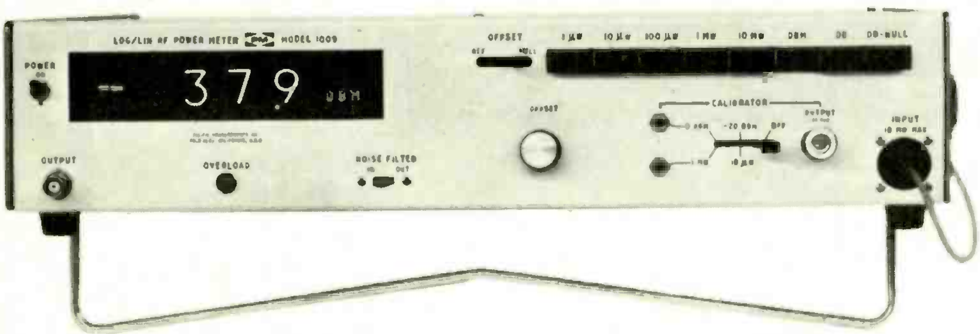
WW 335 for further details

Digital R. F. Power Meter

An instrument that offers an instantaneous digital display of r.f. power on a linear or logarithmic scale has been announced by Pacific Measurements Incorporated, Palo Alto, California. The new instrument (Model PM 1009) is designed for both swept- and single-frequency power measurements from 10 MHz to 12.4 GHz. The three-digit standard readout is augmented by an over-range numeral, a unit annunciator and decimal-point indicator that minimize the likelihood of operator error. An analogue output is available for driving either an oscilloscope or X–Y recorder. Five linear and three logarithmic operating modes are provided. Linear ranges are from 1 μW to 10mW full scale. Logarithmic modes are DBM, DB, and DB NULL. All are selected using pushbuttons. In the DB and DB NULL modes an offset control allows the analogue output to be adjusted to zero for any input power level. Thus, any desired reference level can be established so that the gain of the oscilloscope or recorder can be increased to permit a very small signal riding a large signal to be expanded and analysed in detail. The DB NULL mode is used for swept-frequency measurements where a d.c. coupled oscilloscope is used to display the response curve. Digital readout indicates the difference in dB between the REFERENCE and NULL OFFSET. These two offsets can be used to bracket perturbations on the swept display and the digital readout will indicate directly in dB the magnitude of these perturbations. Outputs on the rear panel coded in b.c.d. are available. For computer use, the digital display rate may be triggered from an external source over a range of zero to 1,000 readings/sec. An auxiliary input is provided so that frequency markers may be added to the swept-frequency display or two instruments may be connected together to make ratio measurements. An internal calibrator provides precise power levels of 1mW and 10 μW at 30 MHz for calibrating the instrument and verifying its operation. A thermistor in the detector mount provides temperature compensation from 15 to 45 °C.

The high-gain direct-coupled input amplifier is chopper stabilized and temperature-sensitive components are oven mounted to ensure negligible drift. A non-linear noise filter may be connected ahead of a "d.v.m." input by means of a front-panel switch. This filter insures a clean display of noisy signals, yet allows relatively rapid response for large changes in signal level.

WW 306 for further details.



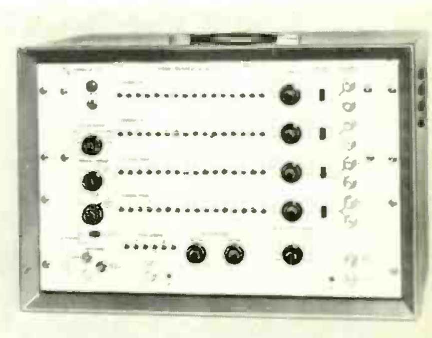
Ladder Network

The cermet thick-film Series 811 ladder networks are designed for digital-to-analogue conversion applications over a wide temperature range. Eight standard models are available, depending on accuracy and temperature range required, with standard resistance values of 5, 10, or 20 kΩ. Tracking is better than 1 p.p.m./°C and settling time is typically less than 50 ns. Maximum output voltage ratio error is ±122 p.p.m. over the operating temperature range of −55 to +125 °C. The units are less than 0.1 inch high, occupy one square inch of board space, and are fully sealed. The networks are constructed of cermet thick-film resistors of glass and precious metal fused to a 96% alumina substrate at temperatures above 1500 °F. The identical material and processing for all resistors ensures uniform electrical characteristics and high stability. Because of the high thermal conductivity of the alumina substrate, low thermal gradients are maintained throughout the network. All the passive elements are protected from moisture by a polymer conformal coating. Beckman Instruments Ltd, Queensway, Glenrothes, Fife.

WW 318 for further details

Word Generator

Many digital systems can be tested using a repetitive pulse train which simulates the data normally handled by the system. The word generator WG 320 provides such pulse trains in a wide variety of different formats. Word length can be from one to sixty-four bits made up of four words of sixteen bits, or two words of thirty-two bits, or one word of sixty-four bits. Four channels each with two outputs are provided, the actual outputs being available in a number of different formats. (1) RZ fixed; return to zero after half basic bit spacing. (2) RZ variable; return to zero after a switch-selected interval, which must be less than 0.7 bit spacing; intervals available are 0.1, 0.5, 5 and 50 μs and 0.5, 5, 50 and 500 ms. (3) NRZ; Non-return to zero. Three operating modes are available and each may be used with



the internal or an external source of clock pulses. They are (A) Continuous mode; all outputs generated repeatedly. (B) Single bit mode; upon operation of a single-shot control or upon application of a negative pulse of 2 V minimum to the "EXT TRIGGER" socket, all words progress by one bit. Reset to first bit of word is achieved manually. (C) Single word mode; operation of the single-shot control or the application of a pulse to the "EXT TRIGGER" socket generates one complete word at all outputs. Output four may be delayed relative to the other outputs provided the delay is less than 0.7 bit spacing, delay intervals available are 0, 0.1, 0.2, 2 and 20 μs, and 0.2, 2, 20 and 200 ms. Individual data bits are set in to the registers by means of two-position toggle switches. The following internal clock rates are available (switch selected on front panel) 2 MHz, 1 MHz, 100, 10 and 1 kHz and 1 Hz. External clock inputs can be up to 2 MHz and can take the form of either sine or square waves. Output impedance is 50 Ω and the rise and fall times of the output pulses are less than 15 ns. Two versions of the instrument are available the difference being in the polarities of the various pulses available. Price £475. Feedback Ltd, Crowborough, Sussex.

WW 310 for further details

Phase-Sensitive Detector

A set of measuring equipments known as the 400 range, is being introduced by Brookdeal Electronics Ltd, Myron Place, London S.E.13, at the rate of one a month during 1968, following a two-and-a-half year feasibility study. Each instrument will be fully compatible with all the others and will take the form of a system building brick, each brick being a complete instrument in itself. The first of these instruments is the phase-sensitive detector type 411. This instrument is built around a full-wave balanced gate covering a frequency range of 1 Hz to 1 MHz. Zero drift has been kept to a low level and very linear operation ensures that zero errors due to asynchronous signals are no greater than the drift (d.c. drift of zero level referred to f.s.d. < 0.005%/°C and with an in-phase input d.c. zero drift is < 0.02%/°C). This has been achieved by employing error-compensating circuitry and by applying a high degree of feedback at d.c. and over the frequency range rendering tuning unnecessary and making swept measurements possible. The reference input signal can be varied over a 30-dB range (< 3 V peak-to-peak into < 10 kΩ) with an output change of less than 0.01% f.s.d. Mark-space ratio changes similarly have little effect on the output. The instrument requires 1 V r.m.s. input into 0.25 MΩ for a 10-V d.c. output that can be used for driving digital

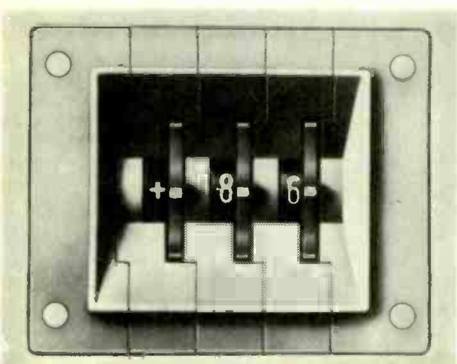
voltmeters, analogue-to-digital converters, potentiometric recorders, trigger units and galvometric recorders.

A wide range of fixed time constants is available (using plastic film capacitors) and zero offset is by a ten-turn potentiometer making slide-back measurements possible. Other features include a peak-reading overload indicator; two switched reference channels; a two-stage ladder filter for l.f. operation; provision for use as a balanced demodulator; sockets duplicated on rear panel for system use; and a reference-channel neon that indicates if sufficient amplitude of reference is being applied.

WW 328 for further details

Thumb-wheel Switches

A range of decimal and binary-coded thumb-wheel switches available with ten positions engraved 0–9 or intermediate numbers of positions, in straight decimal or with any binary code (standard or special) are available from Kynmore Engineering Co. Ltd, 19 Buckingham Street, London W.C.2. Stops are fitted to customers' specification. According to the manufacturers, an improvement has been made in the contact material. A layer of nickel is placed on the copper base and then a layer of gold, electrolytically bonded and stabilized. Thus a hard surface is combined with low and constant contact resistance. For computer programming circuits, special bridging or muting contacts are available as an overriding device. These contacts block the memory store during transient conditions and therefore prevent disruption of information when



switching from one position to another. Alternatively they may be used to initiate another process. The units are available with standard or extended 0.156-inch printed circuit board terminators, with or without provision for diodes. Roller-tinned terminations are available to order. The delivery time for special codes is within four weeks.

WW 319 for further details

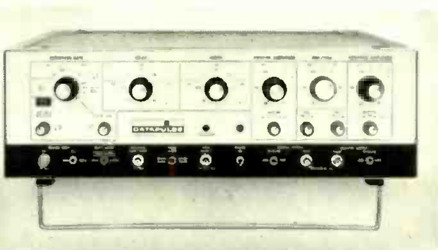
Gunn Effect Source

A GaAs Gunn effect X-band source that provides an output in the 7–12 GHz range is being manufactured by the Plessey Company, Edge Lane, Liverpool 7. The power output is 2mW minimum with a typical value of 5 mW. Current drain is approximately 70 mA and bias voltage may be varied to allow a maximum dissipation of 1 W. Operating temperature range is −55 to +85 °C.

WW 322 for further details

Pulse Generator

Repetition rates of 5 Hz to 50 MHz, positive or negative d.c. coupled outputs from 10 mV to more than 10 V and single- or double-pulse operation are features of the pulse generator model 110B being manufactured by Datapulse Inc., 10150 West Jefferson Blvd., Culver City, California, a subsidiary of the System-Donner Corporation. Rise and fall times of the instrument are independently variable from 4 ns, d.c. baseline offset is variable over a 12-V range and is held constant by a closed-loop system which detects and regulates the offset at the output of the instrument. The generator may be triggered externally or internally, synchronous and asynchronous gating is available and a synchronizing

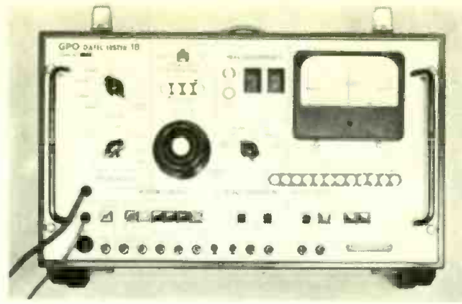


trigger output is supplied for all modes of operation. Pulse delay is variable from 15 ns advance to 50 ms delay, pulse width is variable from 10 ns to 5ms. Repetition rate, delay and width jitter errors are less than 0.05%, while overshoot, undershoot, ringing and top slope aberrations are less than ±3% at amplitudes of 300 mV and higher. Output stages cannot be damaged by any combination of panel-control settings, open or short circuits or back voltages of up to 10 V.

WW 327 for further details

Data Transmission Test Set

The Datel Tester 1B has been designed under contract to the G.P.O. and is used for testing modems in the Datel service, checking data-transmission equipment and computer data links. It comprises a transmitter and receiver of d.c. signals in which the transmitter generates a range of test patterns and the receiver synchronizes those patterns to display peak distortion, bias distortion and error count. Peak distortion is indicated on a digital display from 0 to 49% early or late with an accuracy of ±1% ±1 digit. Bias distortion is indicated on a separate meter to an accuracy ±3% with the scale indications in 2% steps. Any signal element greater than 49% is considered an



error. These are totalized and the stored count displayed up to a maximum of 2,047 counts. The error counter may be switched to display element counts or 511-bit pseudo random blocks in error. Trend Electronics Ltd, St. John's Works, Tylers Green, Nr. High Wycombe, Bucks.

WW 314 for further details

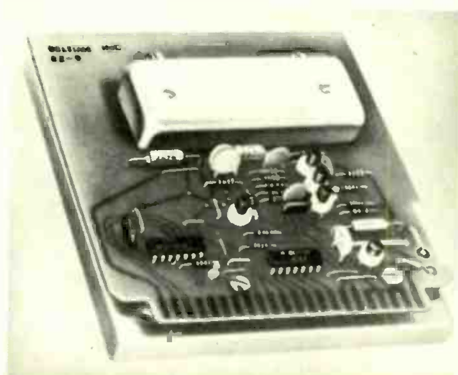
Microcircuit Matched Transistor Pairs

DIFFUSED on a single silicon chip, using the planar process, this temperature stabilized matched transistor pair is intended for low drift d.c. amplifier applications. The device (μA726) is held at a constant temperature by a built-in active temperature regulator circuit that obviates the need for external ovens and individual heaters. Input offset voltage, at collector currents from 10 to 100 μA, is 1 mV. Input offset current, at a collector current of 10 μA and a V_{CE} of 5 V, is 10 nA. Input voltage offset is 0.2 μV/°C: current offset drift being 10 pA/°C. The built-in temperature regulator consists of a transistor which acts as a heating element controlled by an amplified signal from a chip temperature sensing element. The system, which has a low standby dissipation, maintains the chip temperature at 130°C (±3°C) at ambient temperatures between 0 and 85°C. Applications of the μA726 include servo-amplifiers, instrumentation amplifiers, low level and low noise amplifiers and transducer amplifiers. It has been pointed out that the device may be used in conjunction with the SGS-Fairchild μA709 to produce a high performance amplifier with a gain in excess of 3,000,000. The μA726 is contained in a low-profile TO5 encapsulation. SGS-Fairchild, Planar House, Walton St., Aylesbury, Bucks.

WW 331 for further details

Delay-line Module

A small-capacity memory module for data processing applications with integrated-circuit compatibility has been developed by Sealectro Ltd, Farlington, Portsmouth, Hants. Designated Deltime Model 175A/RZ–90. The new module requires a gating signal, clock and power supply for operation. Information re-circulates serially, and in the absence of an erase signal, reads out



ɔntinuously. An address counter is not required ɔr sequential write-in and readout of data, mak- ıg the module suitable for c.r.t. display and uffer memory applications. The memory has a ıaximum storage of capacity of 10,000 bits at a elay of 10 ms and a clock rate of 1 MHz.

VW 307 for further details

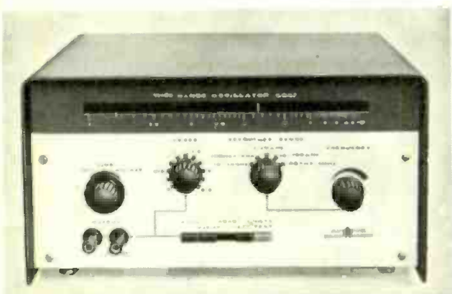
I.F. Amplifier

ᴧ transistor amplifier with a frequency response rom 10 to 400 MHz at ±1.5 dB capable of elivering 0.5 W into a 50-Ω load is available rom Walmore Electronics Ltd, 11–15 Betterton Street, Drury Lane, London W.C.2. The amplifier type AWP–400) is suitable for general laboratory ıse with signal generators and power splitters. It an be used as an intermediate drive stage for ransmitters or as a power stage in a local-oscillat- ɔr or harmonic-generator chain. Other applica- ions that suggest themselves are in wide-band eceiver and pulse systems. Significant figures rom the published specification are output ɔower at 1-dB gain compression point +27 dBm ninimum, temperature range −20 to +71 °C, power input is 28 V d.c. at 560 mA and the case size is 3.5 × 9 × 1.75 inches.

WW 315 for further details

Wide Range Oscillator

A low-cost (£35) oscillator that covers 10 Hz to 1 MHz in five ranges is being produced by Advance Instruments, Hainault, Essex. The generator, type SG67, will supply sine- or square-wave

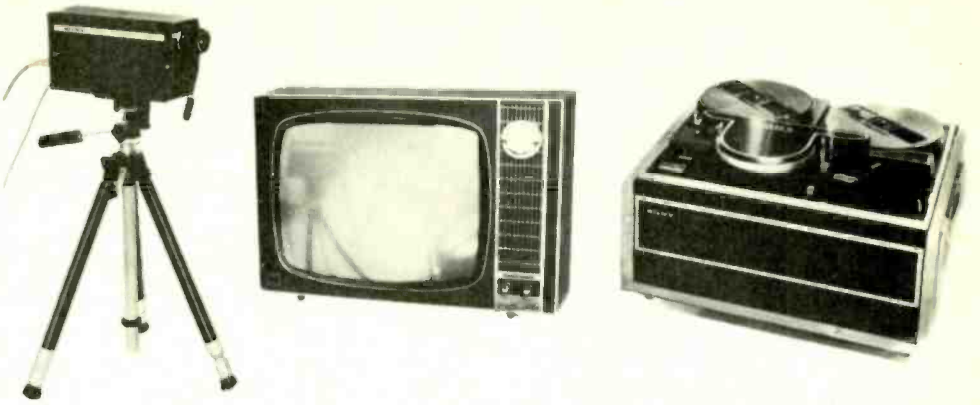


outputs at up to 2.5 V r.m.s.—the square-wave rise time is typically 50 ns. The output level is selected by a four-position push-button attenuator and a variable control, the output frequency being read on a horizontal "easy-to-read" scale. Two internal PP9 batteries provide the power and these can be checked by means of a front-panel push button. If mains operation is required a battery eliminator is available for £7 10s.

WW 311 for further details

Dual Standard V.T.R.

This outfit consists of a video tape recorder model CV–2100CE, a dual-standard 19-inch monitor model CVM2000, this also doubles as a normal dual-standard tv receiver, and a 625-line camera model CVC 2000 CE. The retail price of the complete system is £685. The tape deck uses 0.5-inch tape running at 11.25 i.p.s. (±2%) and employs helical scanning. One tape will run for 40 minutes and will rewind in 7 minutes. The tape speed settles down within six seconds of switch on. The recorder requires a composite video signal of 1.3 V peak-to-peak, negative sync. into 75 Ω. A choice of random or 2:1 interlace is available; signal-to-noise ratio is better than 40 dB and the resolution is better than 240 lines on 625 and 360 lines on 405. The audio section has two inputs, Mic, at 600 Ω unbalanced (−60 dB), and line—10 kΩ balanced (−20 dB). The output is 5 kΩ unbalanced (0 dB). Frequency response,



signal-to-noise ratio, and wow and flutter are: 80–10,000 Hz, ±6 dB, 5% and less than 0.25% r.m.s. respectively. The recorder incoporates 69 transistors and 34 diodes. Facilities include still frame, sound dubbing, duplication of tapes and automatic sound and vision level control. The camera is supplied with an f/1.9 25-mm lens and a tripod. Other accessories included are tape, carbioid microphone, desk stand, mains and microphone extension leads, lavallier cord and a carrying case. Sony U.K. Division, Eastbrook Road, Gloucester.

WW 320 for further details

Miniature Trimmers

Using a high-permittivity film dielectric, a new range of miniature trimmer capacitors, type 809, announced by Mullard have a maximum capacitance of 20 pF within a body only 6 × 7 × 8 mm. Connections to the rotor are made by self-cleaning, silver-plated contacts; and the rotor and stator tags are spaced to match a 2.54-mm (0.1-in.) grid on printed-circuit boards. An asymmetric outline ensures correct orientation. Change of capacitance is made via a slotted adjuster head. Three versions are available with maximum capacitances of 4, 10.8 and 20 pF, all have a 50-V d.c. rating and operate in the temperature range −40 to +120 °C. Mullard Ltd, Torrington Place, London, W.C.1.

WW 316 for further details

Standby Power Units

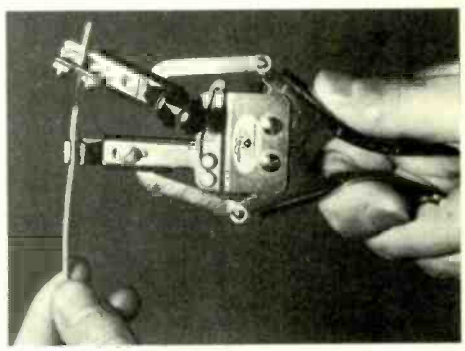
Two inverter standby power units for supplying 250 V at 50 Hz from 12- and 24-V batteries are being produced by Ekco Electronics Ltd, Southend-on-Sea, Essex. These units, which have sine-wave outputs, will supply signal generators, oscilloscope recorders and other laboratory equipment for mobile use. Provision is made for supplying the load directly from the mains with automatic changeover to inverter operation in the event of a mains-supply failure. Type E236 is available for 12- or 24-V battery operation, having a power output of 120 W. The 12-V unit will also reverse to operate as a battery charger with

manual selection of the charge rate. Type E239 operates from a 24-V battery and has a power output of 200 W. Current drawn from the batteries is switched by power transistors and fed to the mains output at any load up to full rating. The inverter circuit is protected against damage if the output is short-circuited.

WW 308 for further details

Wire Stripper

The stripper consists basically of two articulated levers, operating against a return spring, one of which manipulates the cutting and stripping blades, and the other the gripping jaws. The cutting and stripping blades can be infinitely adjusted to strip wires from 0.3 mm to 4.0 mm O.D. The setting, by trial and error, is achieved with a simple lock nut and screw. The stripping blades are of toughened steel and are replaceable. A stripped length of up to about 15 mm can be



obtained. The Six-In hand wire stripper weighs 5 oz and costs 50s. Henri Picard & Frere Ltd, 34/35 Furnival Street, London, E.C.4.

WW 313 for further details

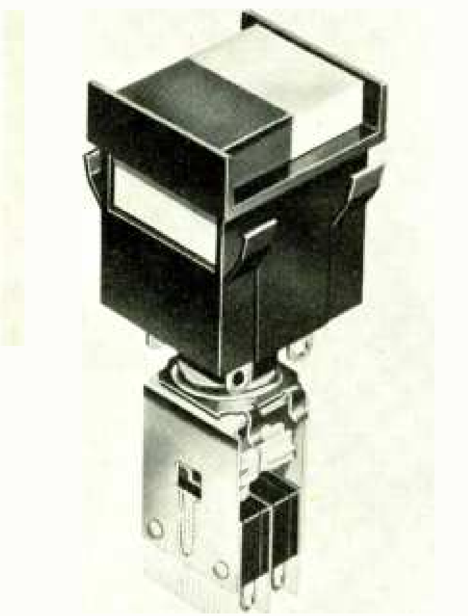
Oscillator and Selective Level Measuring Set

Two instruments have been introduced by the Testing Apparatus and Special Systems Division of Standard Telephones and Cables Ltd. Known as the 74308 Oscillator and 74309 Selective Measuring set, they are companion instruments for testing a wide range of telephone transmission systems. Spanning the frequency range 250 Hz to 1620 kHz they may be used on audio, open-wire, balanced-pair, and coaxial systems of up to 300 circuits. One of the aims of the design has been to eliminate unnecessary switching when testing a particular system, and the five frequency bands have been chosen for this purpose; thus, audio and broadcast frequencies are covered in one band, coaxial supergroup No 1 in another, basic supergroup No 2 in a third and so on. Similarly three output impedances are available to cater for the requirements of different systems. An automatic tracking signal from the oscillator can be used to obviate manual tuning of the s.l.m.s. when making loop measurements. During end-to-end measurements, or when an external signal source is used the automatic tracking facility is not available. In these circumstances, a slight change of frequency in the signal being measured would normally seriously affect the level as measured by the equipment in the selective condition, owing to the steep slope of the narrow-band filters in its input circuit. An automatic-frequency-control circuit is therefore provided. If this is selected and the equipment has been tuned to the signal, it will remain tuned even if the signal drifts by ± 300 Hz from its original frequency. In addition to making selective in-channel measurements in the presence of traffic in adjacent channels, the s.l.m.s. can also be used for making wideband measurements; e.g., for fault location on carrier systems taken out of service. An optional accessory is also available for making return-loss measurements. The oscillator has a slow-motion drive, and built-in frequency checking circuit for checking the calibration at intervals throughout the range. A further feature is the provision of an off-cycles facility which permits the frequency to be set accurately between the calibration points. Both instruments are portable and operate from either a.c. mains or an external d.c. supply of 19 to 21 V. Their dimensions are $22 \times 15 \times 8\frac{3}{4}$ inches ($559 \times 381 \times 222$ mm); their weights are 40 lb (18 kg) for the oscillator and 50 lb (22.7 kg) for the s.l.m.s. Standard Telephones and Cables Ltd., STC House, Strand, London W.C.2.

WW 317 for further details

Illuminated Pushbutton Switch

The Licon 02–800 range of illuminated push-button switches, manufactured by the Plessey Components Group's Microswitch Unit, Titchfield, Hampshire, is an extension of the 01–800 series, and offers four additional features. These are, two stationary lamps which can be independently connected if required; horizontally or vertically split lens caps; "snap-on" switch modules, with momentary or maintained action; and "snap-on" solenoid units. The new series will fit the panel cut-out for the type 01–800. The new push-button switch has snap-in mounting and a combination bezel-barrier presentation and a choice of seven screen colours is offered. The switches are

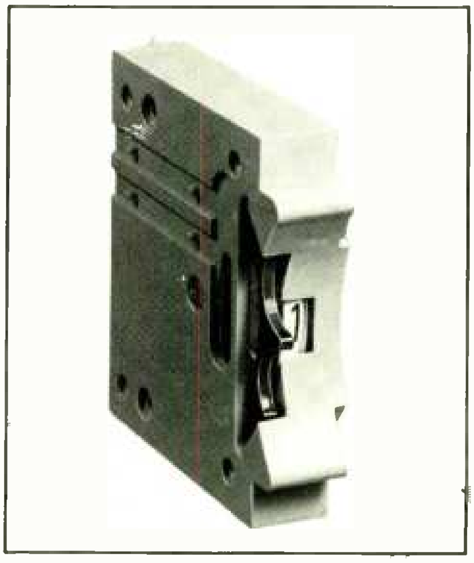


suitable for horizontal or vertical matrix mounting requiring individual rectangular holes 1.00 in. by 1.14 in. for single units and additional 1.250 in. per switch for matrix mounting. One- to four-pole momentary or maintained snap-on switch modules are available as standard, each pole being s.p.d.t. or two circuit. The basic two-circuit microswitches are rated at 10 A., 125/250 V a.c., 30 V d.c.

WW 324 for further details

Rotary Edge Switch

Low cost, coded in binary or decimal, legend to customers requirements, with or without internal illumination, modular design and simplicity of installation are features of a ten-way thumb-wheel switch announced by Argos Instruments Ltd. The body of the switch is moulded in Styron 45 and measures $2.09 \times 0.433 \times 2.09$ inches. It



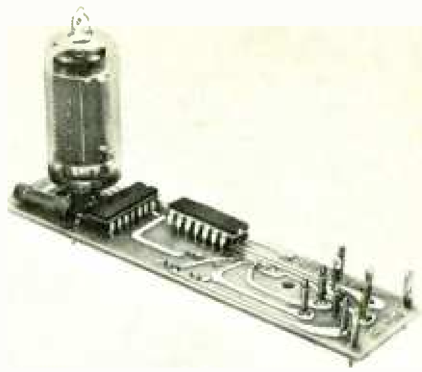
has a life expectancy in excess of 100,000 operations and a one-off price of 22s. Argos Switches Ltd., Island Farm Avenue, West Molesey Trading Estate, Molesey, Surrey.

5% Zener Range

A Family of zener diodes encapsulated in hard thermosetting epoxy resin, complementary to their glass encapsulated BZY88 series, has been recently introduced by Mullard. The diodes, BZX61 series, have a rating of 400 mW at temperatures up to 50°C and nominal voltages between 33 and 75 V following the logarithmic series of preferred values. With a junction temperature of 25°C the devices will withstand a surge of 50 W for a maximum of 100μ sec. Other maxima from the specification include a zener current of 250 mA and a junction temperature of 175°C. The case outline is similar to the DO-7 but with 0.03 inch diameter leads to reduce the thermal resistance, the cathode connection being at the "coned" end of the encapsulation. It is of interest to note that this type of package has recently been granted CV approval. Mullard Ltd, Mullard House, Torrington Place, London W.C.1.

Display Decade

Incorporating integrated circuits and operating at speeds of up to 2 MHz, this unit includes a decade counter, a decoder and an indicator tube on a printed board $4 \times 1 \times 2.25$ inches. Provision is made on the circuit board for a buffer store to allow the read-out to hold a



numeral while the decade is still counting. The binary information in n.b.c.d. is brought out to solder-pin connections as are the reset line, hold and sample line and all power supplies (+4 V and +250 V). Units may be cascaded indefinitely. A.S.R. Designs Ltd, 1 Vineyards, Bath, Somerset.

WW 312 for further details

Medium Torque Potentiometers

The Potentiometer Division of S.T.C. has announced a new range of medium torque potentiometers in six sizes ranging from 1.5 to 4.5 watts. Designed to conform fully with international frame size requirements, the new QR series makes use of a circular section former and offers many improvements over conventional types. A new dished slip-ring wiper contact is housed in an "L" shaped insulator which ensures rigidity and gives an operating life of better than 5×10^6 sweeps of the winding. Starting torque for the sealed types is 8.5 Ncm (12 oz. in.) and 0.305 Ncm (0.4 oz. in.) for unsealed types. Mounting is by means of servo, bush or three-hole fixing and a chromodized finish is standard. S.T.C. Potentiometer Division, Broad Lane, Leeds 13.

Digital Readout

A monolithic silicon integrated circuit performs the decoding and indicator driving functions in the type TNR 70A readout unit produced by Litton Precision Products International Inc., 503 Uxbridge Road, Hayes, Middx. Measuring only 1.75 inches high, 1 inch wide and requiring 1.4375 inches behind the panel, the unit requires an n.b.c.d. (1, 2, 4, 8) input using the negative logic convention, 0 to +0.4 V for a 1

nd + 1.5 V to + 4 V for an 0; the neon indicator equires a power supply of + 180 V d.c. ± 10 V t 2 to 3 mA. Small quantity price is in the region f £11 per unit.

VW 329 for further details

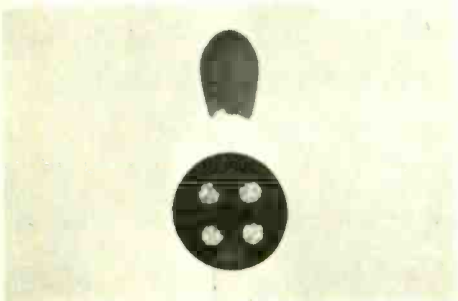
Logic Interface Elements

High voltage logic interface elements that ranslate standard 5 V logic levels to levels up o 30 V are available from the Microelectronics Division of Electrosil Ltd. The three elements, just introduced, consist of the 8T18 dual two-input NAND gate, the 8T80 quad two-input NAND gate and the 8T90 Hex inverter. All are available in either 14 leads glass flat packages in two temperature ranges, 0° to +75°C or −55 to +125°C. The 8T18 is a high input voltage element that will accept input voltage swings of between 8 and 30 V and provide an output in standard 5 V logic. This gate operates from two power supplies, 20–30 V for the input stages and 5 V for the output stage, which has the active pull-up pull-down type of circuit making it suitable for line driving applications. The ST80 and ST90 are the low to high voltage interface elements. Microelectronics Division, Electrosil Ltd., Lakeside Estate, Colnbrook By-pass, Slough, Bucks.

WW 330 for further details

Tell-tale Temperature Detector

A small disk, no larger than 0.25 inches in diameter, that turns permanently black if exposed to a temperature within 1% of given value is



available from A. Levermore & Co. Ltd, Broadway House, Broadway, Wimbledon, S.W.19. The disks, called Tem-plates, can easily be mounted within a product or externally as part of a nameplate, they are available in 42 increments between 100 and 500°F. Picture shows disk with a match-head.

WW 303 for further details

16-Bit Memory

Housed in a standard hermetically sealed dual-in-line flat-pack, the MμL 9033 micrologic memory cell consists of 16 r.s. flip flops arranged in an addressable four-by-four matrix. The main application for this device is in high-speed "scratch pad" memory systems. It has a typical access time of 15 ns and requires a write pulse of 25 ns duration. Delay between addressing and reading a previously stored bit is less than 20 ns and not greater than 35 ns between reading and writing. Up to four locations may be simultaneously addressed without destroying the stored information. The component dissipates 310 mW and the output is capable of sinking up to 40 mA. Word expansion is relatively easy as the wired OR connection is possible (one external resistor being required to "pull up" linked outputs). SGS-Fairchild Ltd., Planar House, Walton Street, Aylesbury, Bucks.

WW 333 for further details

April Meetings

Tickets are required for some meetings: readers are advised, therefore, to communicate with the society concerned

NEWCASTLE-UPON-TYNE
1st. I.E.E.—"Applications of electronics to medical automation" by H. S. Wolff at 18.30 at the Rutherford College of Technology.
10th. I.E.R.E.—"Half megabit data transmission system" by R. E. Ross at 18.00 at the Inst. of Mining and Mechanical Engrs., Neville Hall, Westgate Rd.

NORWICH
23rd. I.E.E.—"Blind landing of aircraft" by G. Harrison at 19.30 at the Assembly House.

READING
30th. I.E.R.E.—"Modern techniques in digital voltmeters" by G. W. Bolton at 19.00 at the J. J. Thomson Physical Lab., the University.

ST. AUSTELL
9th. I.E.E.T.E.—"Closed circuit television" by L. Baldwin at 19.30 at the Restaurant, English China Clay Co. Ltd., Cornwall.

SALISBURY
2nd. I.E.E.—"Electromagnetic levitation" by Prof. E. R. Laithwaite at 18.30 at the Salisbury & South Wilts College of Further Education.

SHEFFIELD
10th. I.E.E.—"The origins and growth of electronics" by F. A. Benson at 18.30 at the Royal Victoria Hotel.

STONE
22nd. I.E.E., I.E.R.E. & I.P.O.E.E.—"Translating & transcoding between different colour television systems having a common scanning standard" by S. M. Edwardson at 19.00 at the Post Office Engineering Training School.

WOLVERHAMPTON
3rd. I.E.R.E.—"Specialised applications of electronics in medicine" by J. G. Davies and R. L. Howard at 19.15 at the College of Technology, Wulfruna St.

LONDON
1st. I.E.E.—Colloquium on "Injection luminescence" at 14.30 at Savoy Pl., W.C.2.
2nd. I.E.E.—Discussion on "Microwave electrostatic wattmeter" opened by Prof. H. E. M. Barlow at 17.30 at Savoy Pl., W.C.2.
2nd. I.E.R.E. & I.E.E.—Discussion on "Assessing computer performance" at 18.000 at the London School of Hygiene & Tropical Medicine, Keppel St., W.C.1.
2nd. S.E.R.T.—"Field effect transistors" by E. F. Munroe at 19.00 at Carshalton College of Further Education, Nightingale Rd., Carshalton.
4th. I.E.E.—Graham Clark Lecture "Place of engineering in relation to society as a whole" by Lord Jackson of Burnley at 17.45 at Savoy Pl., W.C.2.
8th. I.E.E.T.E.—"Colour television" by G. G. Gouriet at 18.00 at the I.E.E., Savoy Pl., W.C.2.
9th. I.E.E.—Colloquium on "Gyrators — theory and practice" at 14.30 at Savoy Pl., W.C.2.
17th. I.E.E.—Discussion on "Views on relativity and gravitation" opened by Dr. L. Essen at 14.30 at Savoy Pl., W.C.2.
18th. I.E.E. & I. Meas. Control—Discussion on "What theories are needed for computer control?" at 17.30 at Savoy Pl., W.C.2.
18th. R.T.S.—Fleming Memorial Lecture "Digital methods in television" by A. V. Lord at 19.00 at the Royal Institution, Albemarle St., W.1.
23rd. I.E.E.—Colloquium on "Some aspects of speech recognition for man-machine communications" at 14.30 at Savoy Pl., W.C.2.
23rd. I.E.R.E.—"Simulation safety and the air traffic engineer" by P. C. Haines at 18.00 at 9 Bedford Sq., W.C.1.
25th. I.E.E.—"Recent developments in meteorology and the world weather watch" by Dr. B. J. Mason at 17.30 at Savoy Pl., W.C.2.
25th. I.E.R.E.—"A realistic appraisal of the higher national certificate" by Dr. H. L. Haslegrave at 18.00 at 9 Bedford Sq., W.C.1.
26th. I.E.E., I.E.R.E. & R.T.S.—Colloquium on "Aspects of colour television engineering" at 9.30 at Savoy Pl., W.C.2.
29th. I.E.E.—"Magnetic equivalent circuits for electrical machines" by Prof. E. R. Laithwaite at 17.30 at Savoy Pl., W.C.2.
29th. I.E.E.—"Reed relays" by Dr. D. E. N. King at 17.30 at Savoy Pl., W.C.2.
30th. I.E.E.—Discussion on "A renaissance in automation? The future of computers and control" at 17.30 at Savoy Pl., W.C.2.

ABERDEEN
10th. I.E.E.—"Post Office towers and trunks" by J. H. H. Merriman at 19.30 at Robert Gordon's Inst. of Technology.

BELFAST
26th. I.E.E.—Faraday Lecture "Medical Electronics" by D. W. Hill at 19.30 at the Sir William Whitla Hall, Queen's University.

BIRMINGHAM
17th. R.T.S.—"Further thoughts on colour telecine" by C. B. B. Wood, at 19.00 at the Medical Inst., Harborne Rd., Edgbaston.
18th. I.E.E.T.E.—"The Birmingham Post Office Tower" by J. R. Tipple at 19.30 at the University of Aston, Gosta Green.
29th. I.E.E.—"Current electronic developments in the deep sea fishing industry" by R. Bennett at 18.00 at the M.E.B. Offices, Summer Lane.

BRISTOL
9th. R.T.S.—"B.B.C. Colour TV—review of the first six months" by T. H. Bridgewater at 19.30 at the Reception Rooms BBC, Whiteladies Rd.
10th. I.E.R.E. & I.P.P.S.—"Gunn effect phenomenon" by B. R. Pamplin at 19.00 at the University.

CARDIFF
5th. S.E.R.T.—"Decca system of navigation" by J. Davies at 19.30 at Llandaff Technical College, Western Ave.

COLCHESTER
24th. I.E.R.E.—"M.O.S. transistors" by G. G. Bloodworth at 19.00 at the University of Essex, Wivenhoe Park.

CRAWLEY
25th. I.E.E.T.E.—"Electronic control in industry by M. C. Wooldridge at 19.30 at the Lecture Theatre, the College of Further Education, College Rd.

DUBLIN
24th. I.E.E.—Faraday Lecture "Medical electronics" by D. W. Hill at 18.00 at Trinity College.

DUNDEE
11th. I.E.E.—"Post Office towers and trunks" by J. H. H. Merriman at 19.00 at the University.

EDINBURGH
9th. I.E.R.E.—"Electronic testing and control in the wool industry" by B. Hegley at 19.00 at the Dept. of Natural Philosophy, the University.

EVESHAM
1st. I.E.E. Grads.—"Colour television" by G. M. Walker at 19.30 at the B.B.C. Engineering Training Centre.
22nd. I.E.E. & I.E.R.E.—"Stereo broadcasting" by J. H. Brooks at 19.30 at the B.B.C. Club.

GLASGOW
10th. I.E.R.E.—"Electronic testing and control in the wool industry" by B. Hegley at 19.00 at the Inst. of Engrs. and Shilbldrs., 39 Elmbank Cresc., C.2.

HARLOW
3rd. I.E.R.E.—"Industrial design in the electronics industry" by M. Rowlands at 19.00 at the Technical College, The High.

LINCOLN
2nd. I.E.E.—"SemiConductors in television receivers" by P. L. Mothersole at 19.15 at the E.M.E.B. Showrooms.

LIVERPOOL
1st. I.E.E.—Demonstration and lecture on "Colour television" by J. R. Sanders at 18.30 at the University.

MANCHESTER
24th. I.E.E. & I.E.R.E.—"Stereophonic transmission" by Dr. G. J. Phillips at 18.15 at the College of Science & Technology, Altrincham St.
29th. I.E.E.—Lecture/Discussion "The future education of electronic engineers" by Prof. G. D. Sims, Prof. W. A. Gambling and B. H. Venning at 18.15 at the College of Science & Technology, Altrincham St.

MIDDLESBROUGH
19th. I.E.E. Grads.—"Sound about the home" by D. Cook at 18.30 at the Cleveland Scientific Inst.

April Conferences and Exhibitions

Further details are obtainable from the addresses in parentheses

LONDON

Apr. 8 & 9 — Imperial College
Thick Film Technology
(I.E.R.E., 9 Bedford Sq., London W.C.1)

Apr. 18-21 — Hotel Russell
Audio Festival & Fair
(Rex Hassan, 42 Manchester Sq., London W.1)

Apr. 22-24 — I.E.E. Savoy Pl.
Interference Problems and Microwave Systems
(I.E.E., Savoy Pl., London, W.C.2)

BELFAST

Apr. 1-3 — Queen's University
Heavy Particle Collisions
(I.P.P.S., 47 Belgrave Sq., London S.W.1)

CARDIFF

Apr. 18 & 19 — Cathays Park
Audio-Visual Aids Conference and Exhibition
(National Committee for Audio & Visual Aids in Education, 33 Queen Anne St., London W.1)

DURHAM

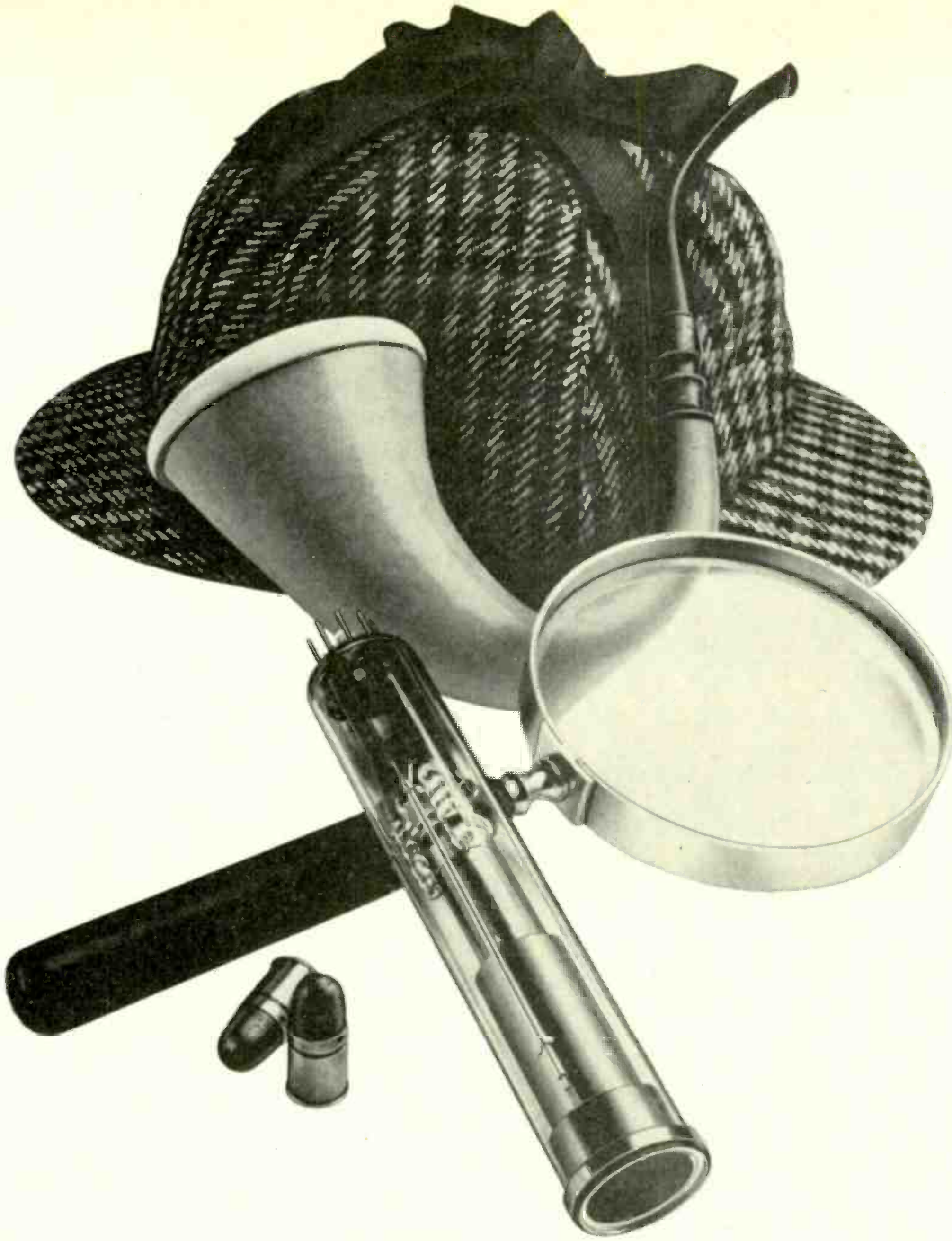
Apr. 2 & 3 — The University
Semimetals and Narrow Gap Semiconductors
(I.P.P.S., 47 Belgrave Sq., London S.W.1)

LOUGHBOROUGH

Apr. 16-19 — University of Technology
Modular Education for Industry
(I.E.E.T.E. Ltd., 26 Bloomsbury Sq., London W.C.1)

OXFORD

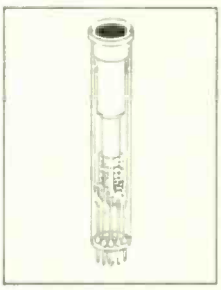
Apr. 1-4 — Playhouse Theatre
Properties and Metrology of Surfaces
(Inst. of Mech. Engrs., 1 Birdcage Walk, London S.W.1)



To catch a thief...

use EEV vidicons in CCTV

Closed circuit television is proving very sleuthful in keeping an eye on things. But when it comes to watching Rembrandts and Goyas it has to be reliable. This is where EEV high sensitivity vidicons should be used. These tubes can give up to 8000 hours viewing without dropping off in performance. They also provide unusually high resolution, high sensitivity and short lag. EEV vidicons are available with two different values of heater current, 6.3V/600mA and 6.3V/95mA, and with either separate mesh or integral mesh construction. For further information and the name and address of your nearest stockist write to:



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AP295

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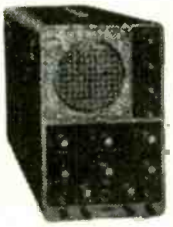
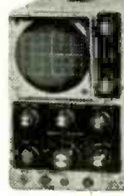


5in. GENERAL-PURPOSE OSCILLOSCOPE, 10-12U

● "Y" sensitivity 10 mV. r.m.s. per cm. at 1 kc/s. ● Bandwidth 3 c/s-4.5 Mc/s. ● Frequency compensated input attenuator X1, X10, X100. T/B, 10 c/s-500 kc/s. in 5 steps. ● Two extra switch selected pre-set sweep frequencies in T/B range. ● T/B output approx. 10 v. peak to peak. ● Built-in IV calibrator ● Facility for "Z" axis modulation ● Electronically stabilised power supply ● Power req. 200-250 v. A.C., 40-60 c/s., 80 watts ● Fused ● Front panel, silver and charcoal grey ● Cabinet, charcoal grey, size 8⅞ × 14 × 17in. deep. Net weight 23lb. 56-page construction and operation manual.

Kit £35.17.6. Ready-to-use £45.15.0

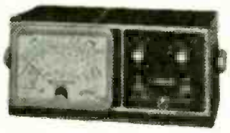
Attenuator and demodulator probes available as optional extras.



3in. PORTABLE GENERAL-PURPOSE SERVICE OSCILLOSCOPE, OS-2

● Modern styling. lightweight and compact size, make this the ideal 'scope for service man, laboratory technician, amateur radio enthusiast or hobbyist ● "Y" bandwidth 2 c/s-3 Mc/s ±3 dB. ● Sensitivity 100 mV/cm ● Push-pull vertical and horizontal amplifiers ● Wide range time-base generator 20 c/s-200 kc/s in four ranges. ● Automatic lock-in synchronisation ● Mu-metal c.r.t. shield ● Printed circuit board construction ● Power req. 200-250 v. 50-60 c/s A.C. 40 watts ● Fused ● Front panel silver and charcoal grey. Size 5in. w. × 7⅜in. h. × 12in. deep. Weight: 9¾lb.

Kit £23.18.0. Ready-to-use £31.18.0



6in. VALVE VOLTMETER, IM-13U

● Modern styling ● Extra features ● The ideal VVM for the Electronic Engineer ● 6in. Ernest Turner 200μA. meter with multi-coloured scales ● Unique gimbal bracket allows bench, shelf or wall mounting ● Measures A.C. (r.m.s.), D.C. volts 0-1.5, 5, 15, 50, 150, 500, 1,500 ● Resistance range 0.1 to 1,000MΩ with int. battery ● Vernier action zero and ohms adjustment ● Roller-tinned printed circuit ● High input resistance (11MΩ) ● Comprehensive assembly and operation manual ● Size 5 × 12$\frac{11}{16}$ × 4½in. Complete with test prod and leads.

Kit £18.18.0. Ready-to-use £26.18.0

4½in. Valve Voltmeter-V-7A (not illustrated). **Kit £13.18.6.**

Ready-to-use £19.18.6

GENERAL-PURPOSE SERVICE RF SIGNAL GENERATOR, RF-1U

● Ideal for the alignment and trouble shooting of RF, IF and audio circuits ● Large easy-to-read dial ● Pre-aligned coil and bandswitch assembly RF output of at least millivolts ● 100 kc/s-100 Mc/s. fundamentals up to 200 Mc/s harmonics ● 400 cycle audio signal with 4 v. output ● Dimensions 9½in. wide × 6½in. high × 5in. deep.

Kit £13.18.0. Ready-to-use £20.8.0

AUDIO SIGNAL GENERATOR, AG-9U (not illustrated)

Kit £23.15.0. Ready-to-use £31.15.0

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● ¼ track stereo or mono record and play-back at 7½, 3¾ and 1⅞ i.p.s. ● 18 transistor circuit ● Record level indicator ● Digital counter with zero reset ● Stereo mic and aux. inputs. ● Speaker/headphone outputs. ● Built-in audio amplifier gives 4 watts rms output per channel. ● Two high efficiency 8in. × 5in. speakers.

Versatile Recording facilities. So-easy-to-build. Outstanding performance for price.

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● Compact, economical stereo and mono record playing for the whole family ● Mains operated ● All "solid state" circuitry. Modern compact styling ● Detachable second loudspeaker gives optimum stereo effect ● Automatic playing of 16, 33, 45 and 78 rpm records ● Suitcase portability ● Two 8in. × 5in. speakers ● Controls: Volume, Balance and Tone. Dimensions: overall 27in. wide × 14⅜in. high × 7½in. deep.

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THE CAR RADIO TO COMPLETE YOUR MOTORING PLEASURE CR-1

Complete your motoring pleasure with this small, compact, high output unit. Superb long and medium wave entertainment whenever you drive. For 12v. positive or 12v. negative car earth systems.

● 8 latest semi-conductors (6 transistors, 2 diode circuit) ● Powerful output (4 watts) will drive two speakers. ● Styled to harmonise with most car colour schemes ● Supplied in two units, pre-assembled and aligned RF unit kit. £1.13.6 inc. P.T. IF/AF amplifier kit £11.3.6.

Total price kit (excl. LS)....£12.17.0 inc. P.T.

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"OXFORD" LUXURY TRANSISTOR PORTABLE, UXR-2

This superb transistor radio is the ideal domestic or personal portable Medium and Long Wave receiver ● Solid leather case and handle, in black or brown ● Easy-to-read tuning scale ● Extra large loudspeaker. Push button L, MW and tone ● 10 semi-conductors (7 transistors plus 3 diodes) ● Sockets for personal earphones, tape recorder, car aerial ● Internal 9-volt battery (not supplied) lasts for months ● Latest printed circuit techniques ● Comprehensive, easy-to-follow, fully illustrated Instruction Manual.

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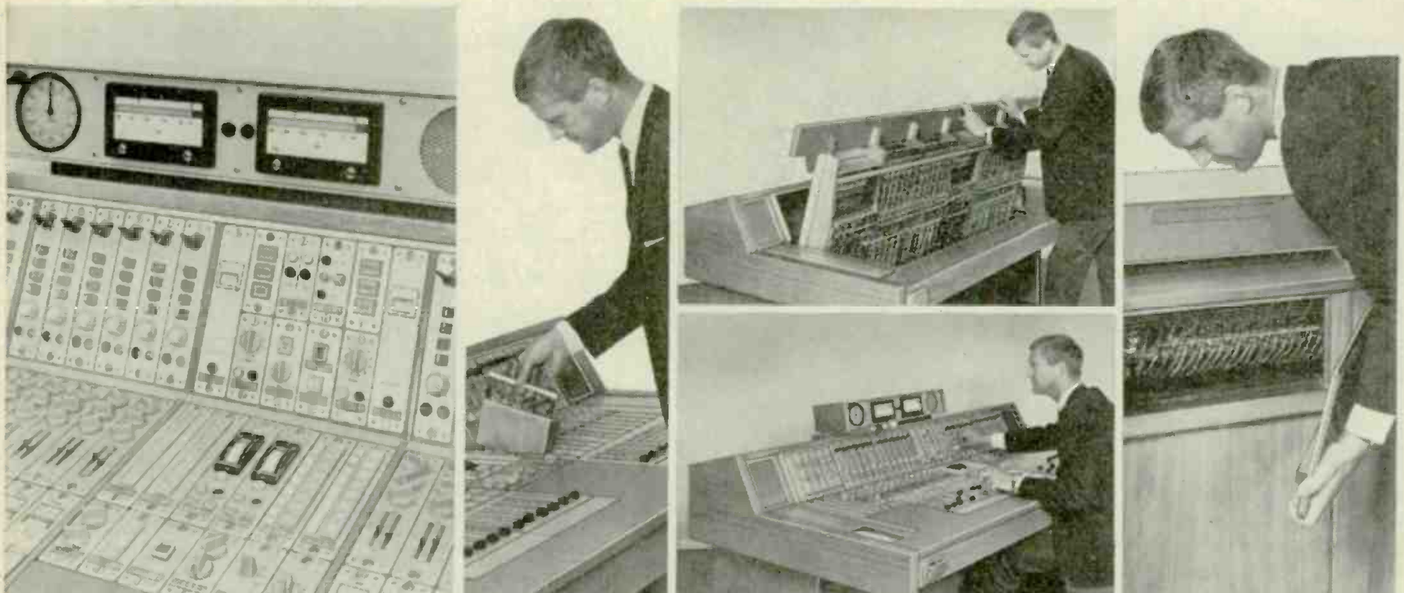

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LEVELL
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With DIGITAL or ANALOGUE frequency calibration

TYPE	TG66A	TG66B	TG150	TG150M	TG150D	TG150DM
FREQUENCY	0.2 Hz to 1.22 MHz.		1·5 Hz to 150 kHz			
ACCURACY	± 0.02 Hz below 6 Hz ± 0.3% from 6 Hz to 100 kHz ± 1% from 100 kHz to 300 kHz ± 3% above 300 kHz		± 3% ± 0.15 Hz			
DISTORTION	<0.15% from 15 Hz to 15 kHz <0.5% at 1.5 Hz and 150 kHz		<0.1% at 1 kHz, <0.3% from 50 Hz to 15 kHz, <1.5% below 50 Hz and above 15 kHz.			
SINE WAVE OUTPUT	Source voltage variable from 30μV to 5V. Output impedance 600Ω at all settings.		Source voltage variable from 250μV to 2.5V, Output impedance <250Ω above 250mV, 600Ω below 250mV. Less than 1% variation of amplitude throughout frequency range.			
SQUARE WAVE OUTPUT	None		None		Variable up to 2.5V peak. Rise time 1% of period + 0.2μS.	
OUTPUT METER	Expanded voltage scales and −2dB to + 4dB. Scale length 3.5″		None	0 to 2.5V and −10dB to +10dB	None	0 to 2.5V and −10dB to +10dB
POWER SUPPLY	4 type PP9 batteries, life 400 hours, or, A.C. Mains when: selected by panel control	batteries replaced by Power Unit	2 type PP9 batteries, life 400 hours, or, A.C. Mains when batteries are replaced by Levell Power Unit.			
SIZE	7″ × 10¼″ × 7″ Weight 12 lb.		10″ high × 6″ wide × 4″ deep. Weight 6 lb.			
PRICES	£150	£120	£32	£42	£35	£45
+ Mains Power Unit	included	£15	£7 10 0			
+ Leather Case	£5	£5	£4 10 0			

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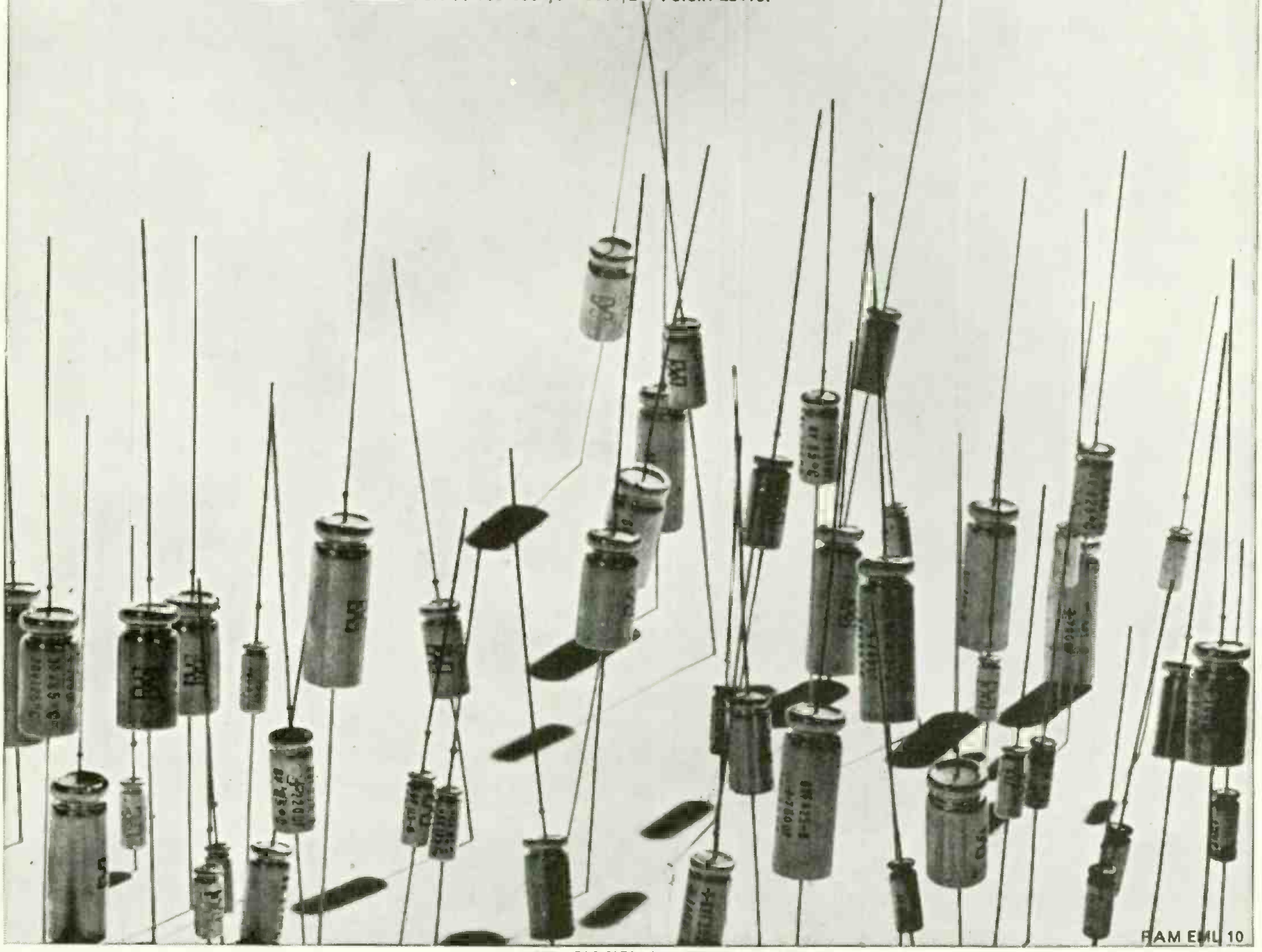

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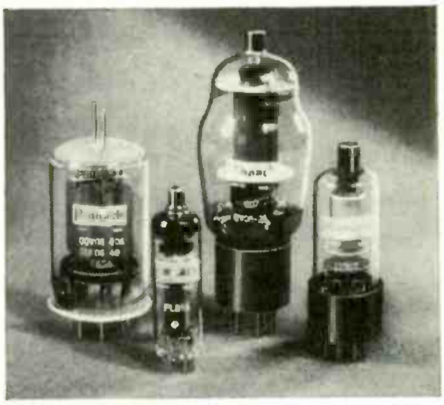

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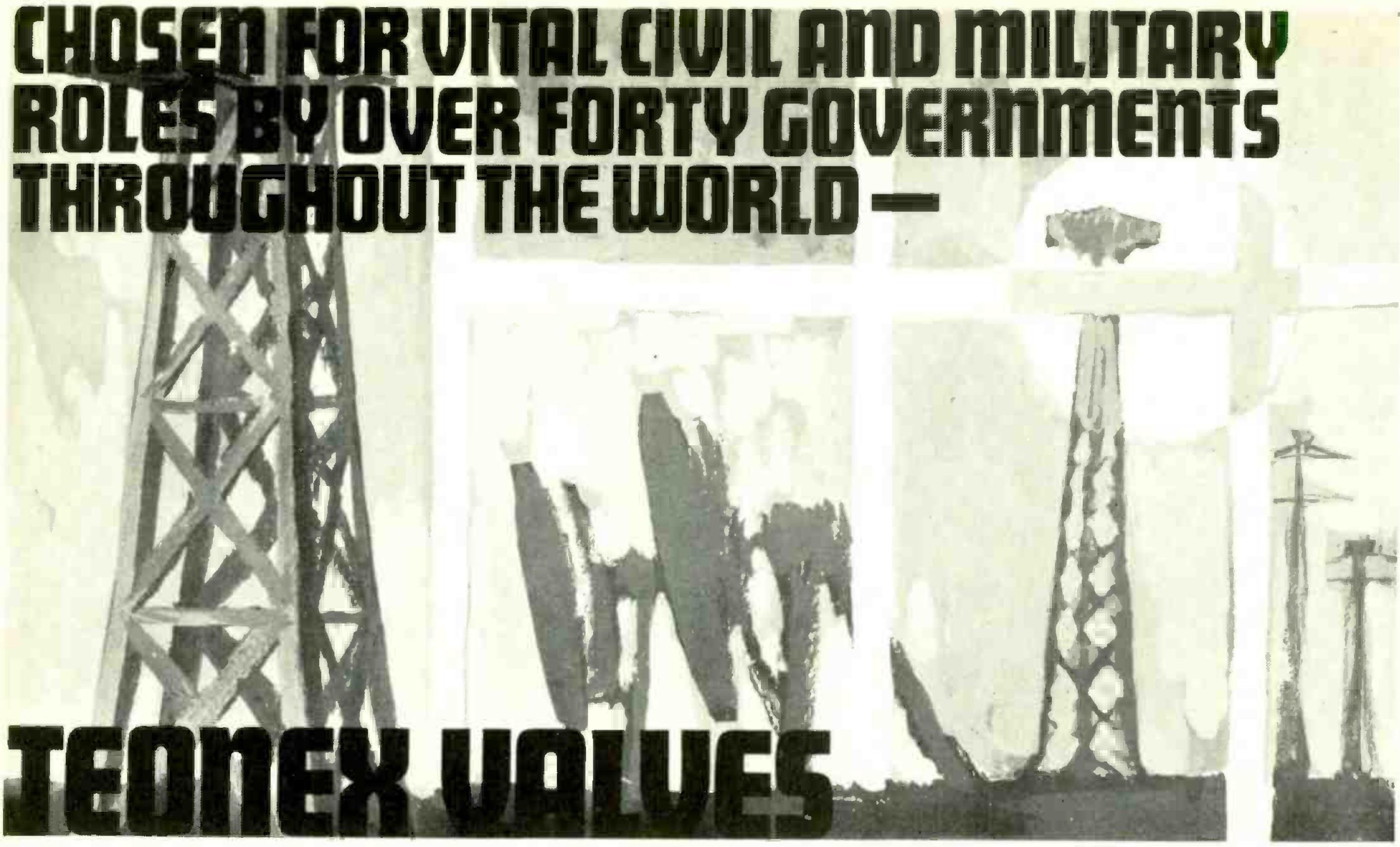

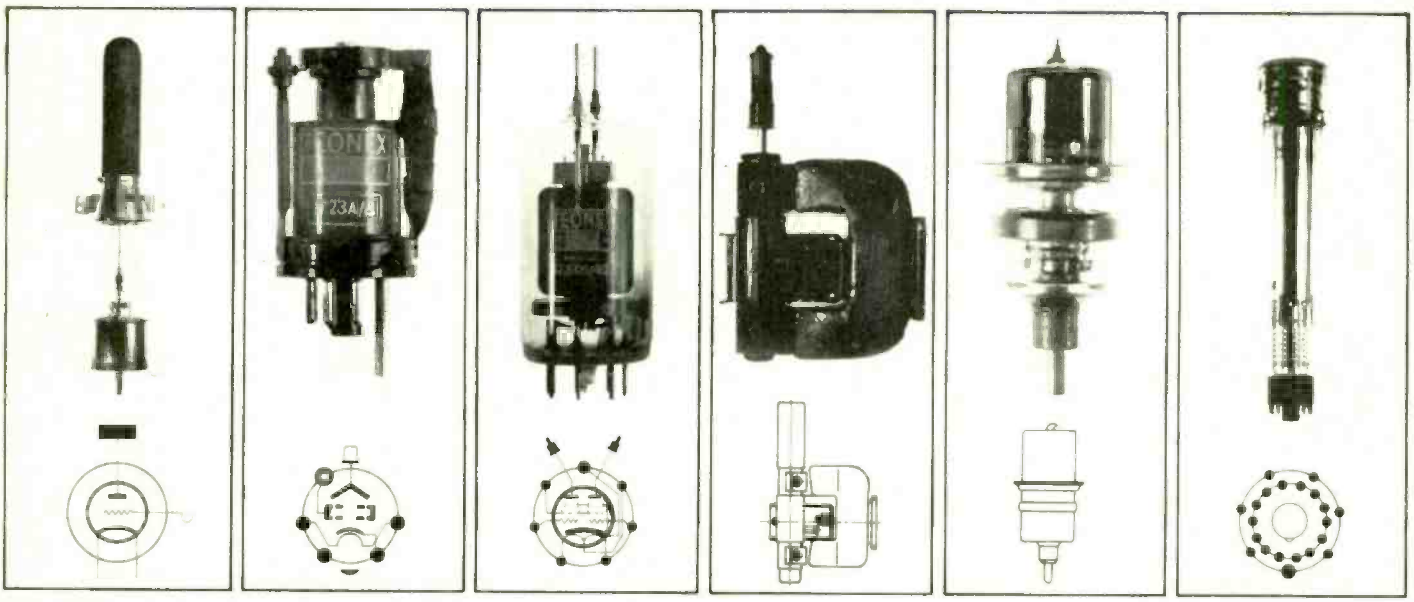

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If you have not had the stimulating experience of hearing either the Ditton 10 or 15 bookshelf loudspeakers, come and listen for yourself at this year's AUDIO FAIR. Hearing's believing! You'll be amazed at the sensitivity and range of response from such compact speakers.

DITTON 10

The most sophisticated mini-speaker on the market. Response from 35–15,000Hz, impedance 3/5 or 15 ohm versions, power handling 10 watts.
Truly bookshelf size: $12\frac{3}{4}'' \times 6\frac{3}{4}'' \times 8\frac{1}{4}''$.

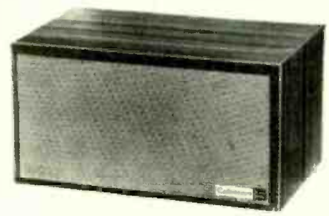
DITTON 15

Just listen to Gordon J. King's summary in a February 'Hi-Fi Sound' Review: "I have no reservations whatever in thoroughly recommending this outstanding loudspeaker to all wishing to obtain large-speaker sounds from a modest $21'' \times 9\frac{1}{2}'' \times 9\frac{1}{4}''$ of enclosure". Suffice it to add that this is a 3 drive unit incorporating the famous ABR (Auxiliary Bass Radiator), 8" bass unit and the HF 1300 for treble notes. Full power response from 15,000 right down to 30Hz–the threshold of audible sound.

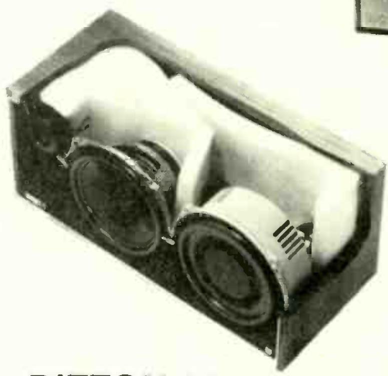
NEW FROM CELESTION –

We will be demonstrating a remarkable new loudspeaker at the Fair. Be sure not to miss the opportunity of being amongst the first to hear this superb new addition to the Ditton range.

So now you have an even greater choice of superb Ditton loudspeakers, from miniature bookshelf to professional standard. For the home constructor, Celestion offer a wide range of drive units.



DITTON 10



DITTON 15

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Celestion loudspeakers — for the perfectionist

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HOTEL RUSSELL, W.C.2. Booth 22. Demonstration Room 534

Celestion Studio Series

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GD208

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- ☐ Measures 10 Hz to 100 MHz
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- ☐ 2 parts in 10^9 daily stability
- ☐ 500 MHz Resolution with fully automatic heterodyne converter 802
- ☐ Remote control and BCD output options
- ☐ 8-digit latched display

RACAL 800 series

If you need any more convincing, get details and a demonstration by contacting.
Racal Instruments Ltd., Crowthorne, Berkshire, England.
Telephone Crowthorne 5652: Telex 84166

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what has changed?

Well, loudspeakers for one thing. Practically all loudspeakers designed in the last few years have (rightly) followed the trend towards lower efficiency and therefore require more power to drive them.

And pickups, too. The trend here is towards smaller and lighter moving parts producing lower outputs, requiring greater sensitivity and improved signal to noise ratio in the pre-amplifier.

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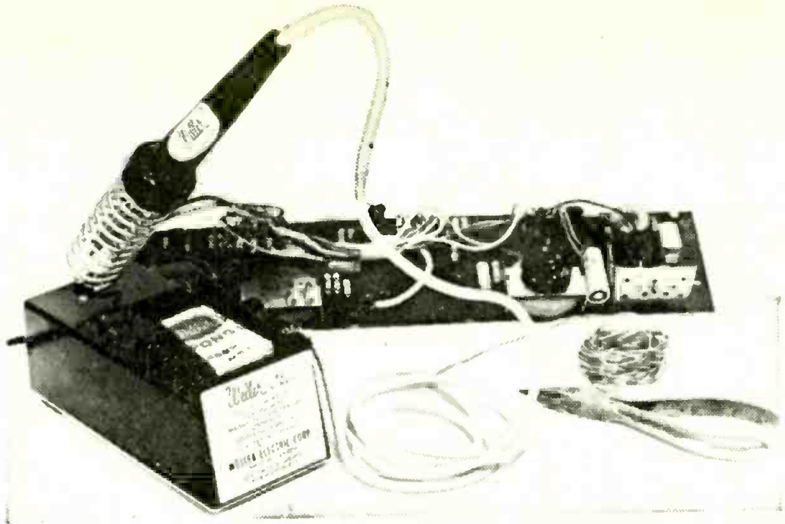

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Eddystone 990R

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A *NEW* SOLID-STATE V.H.F RECEIVER

The '990R' when used in conjunction with the matching '990S' provides continuous AM/FM coverage from 27 to 870MHz. A common Panoramic Display Unit is available for use with both receivers.

FEATURES

- The '990R' tunes 27 to 240MHz in four switched bands. 10MHz markers from crystal calibrator for scale checking.
- A.M, F.M, and C.W reception; video output available at A.M, and F.M.
- Provision for crystal-controlled working on up to eight switched channels. Socket permits connection of external synthesizer for applications requiring high-stability operation coupled with flexibility in frequency selection.
- Stability one part in 10^5 per °C or one part in 10^6 per °C with crystal control.
- Standard 10.7MHz I.F with 200kHz and 30kHz bandwidth—narrower bandwidths to order.
- Spurious responses 50dB down. (Three signal circuits prior to mixer stage).
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- Noise factor of the order of 10dB.
- Audio outputs for external speaker, headset and line. Built-in monitor speaker for convenience in rack installations.
- Audio response level within 6dB from 200Hz to 10kHz. Output 500 mW.
- Operates from 12V D.C or 100/130V and 200/260V 40-60Hz A.C supply.

Full technical specification available from:
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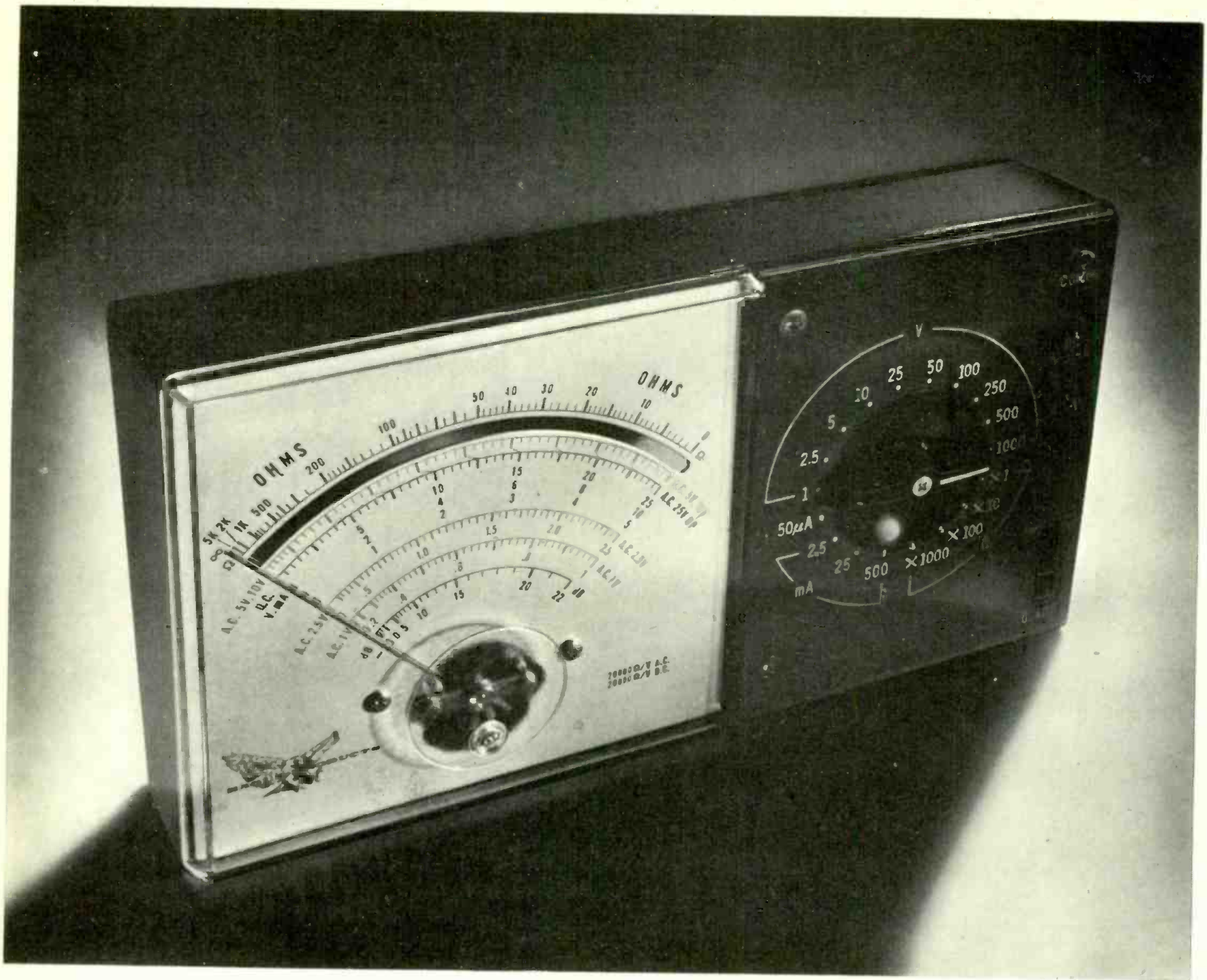

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asl ADVANCED STATE-OF-THE-ART PRODUCTS

2-Phase Sensitive Voltmeter

Phase-Locked Integrating Voltmeter Model 110

Applications for Model 110 include bridge measurements with simultaneous in-phase and quadrature null-detection. High sensitivity measurements are possible of inductance, capacitance and resistance and consequently of temperature, force, pressure, displacement, strain, creep etc.
There are also applications in radio astronomy, biological studies, oceanography, vibration analysis, pulsed nuclear resonance, thermal conductivity, Hall effect measurements, spectrum analysis and VSWR measurements.

Features

- ★ Recovery of signals 60dB below white noise
- ★ Hum rejection 100 dB
- ★ Simultaneous IN-PHASE and QUADRATURE indication
- ★ RC filters–no ringing–rapid recovery
- ★ Adjustable selectivity
- ★ Nuvistor input stage–low noise–high impedance
- ★ 0·1 nanovolt f.s.d. with input transformer (low temp.)
- ★ Total signal indication with warning of overload

The instrument can be useful in any application calling for the recovery of signals buried in noise and where a reference signal is available.
ASL also manufacture a range of automatic and hand-set precision bridges and potentiometers based on synchronous detection and high accuracy inductive ratio-arms.
ASL policy is to develop and manufacture advanced state-of-the-art measuring instruments and to maintain close liaison between the Company's Research and Development Department and National and University Research Establishments.
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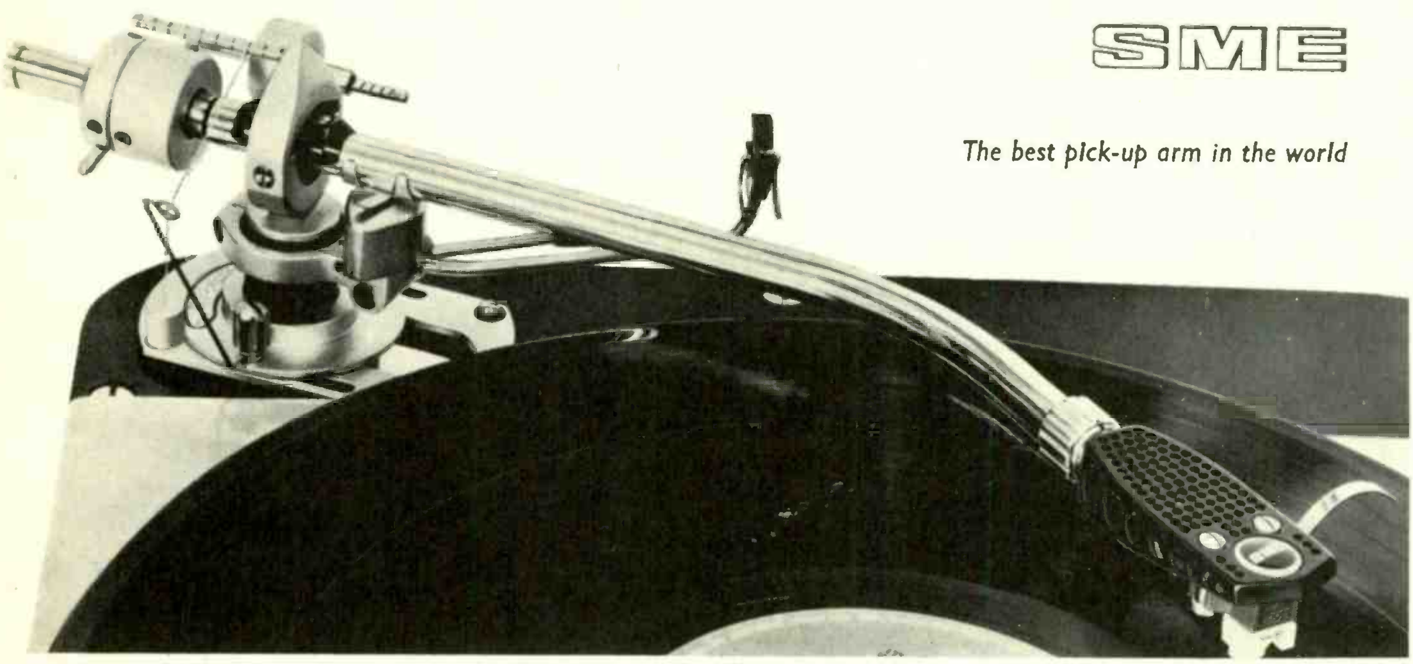
SME

The best pick-up arm in the world



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Goodmans welcome you...

...to Room 434 at the Hotel Russell at the London Audio Festival— 19th—21st April (Trade and Export on the 18th)

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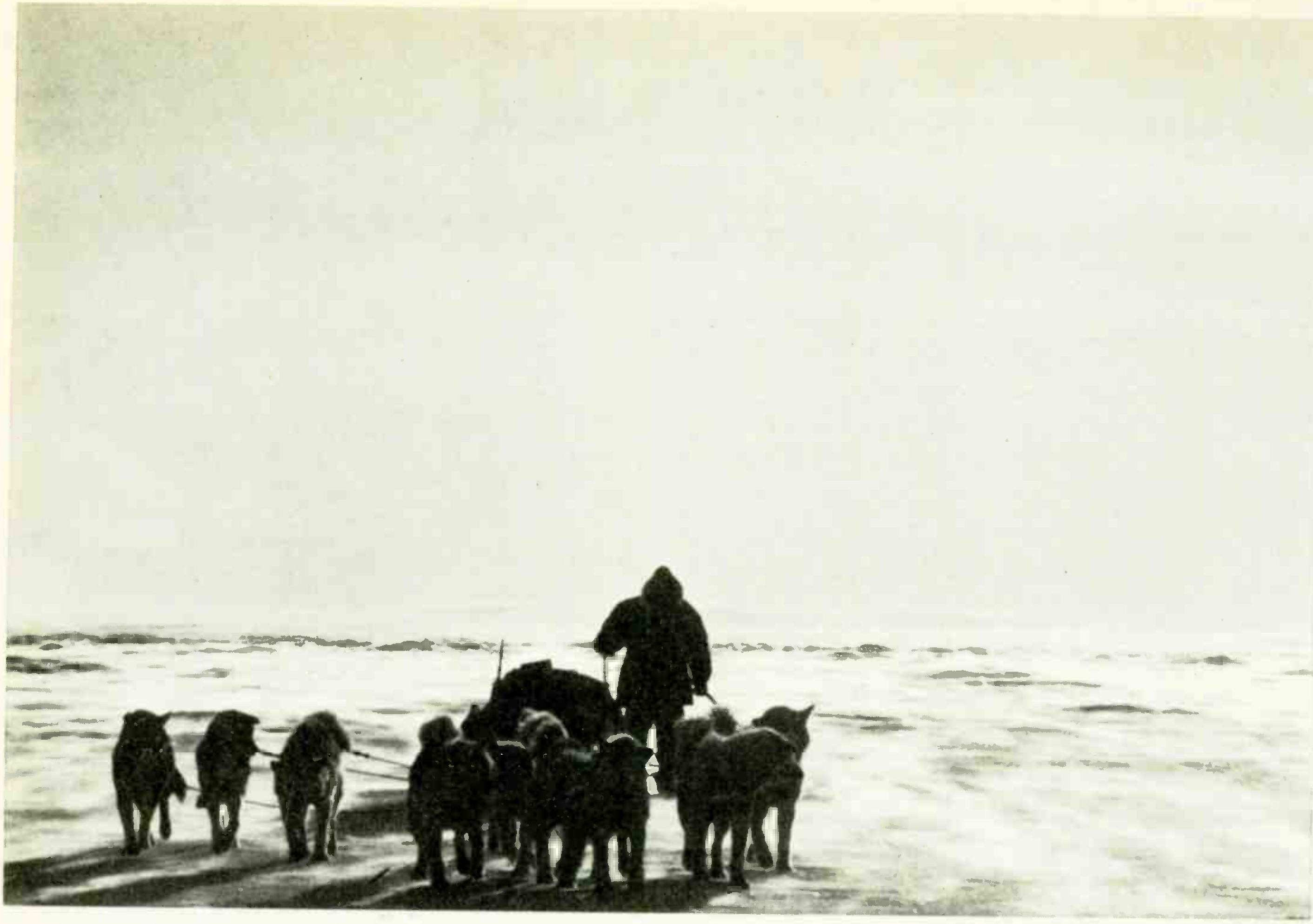

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The British Trans-Arctic Expedition needed an utterly reliable battery which would operate in the sub-zero temperatures of the first surface crossing of the Polar Cap.

Mallory made it.

What can we do for you?

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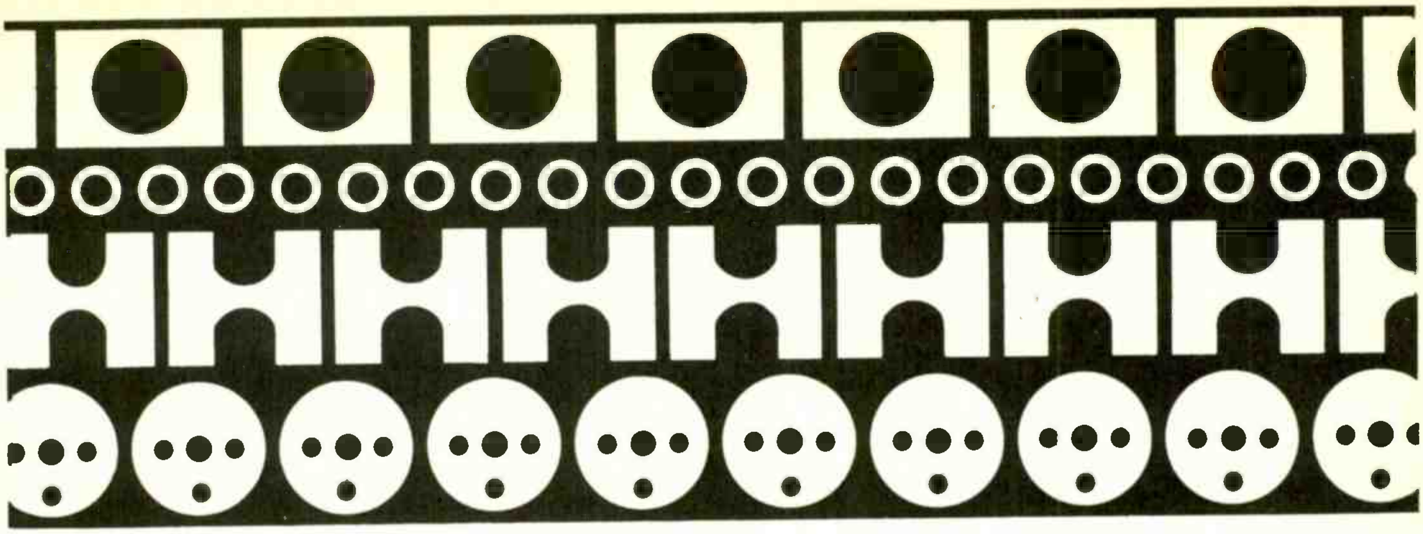

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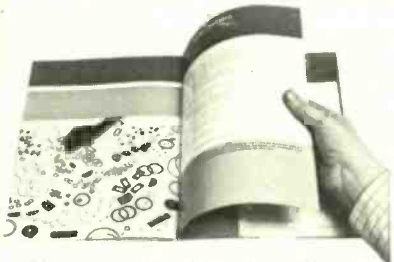

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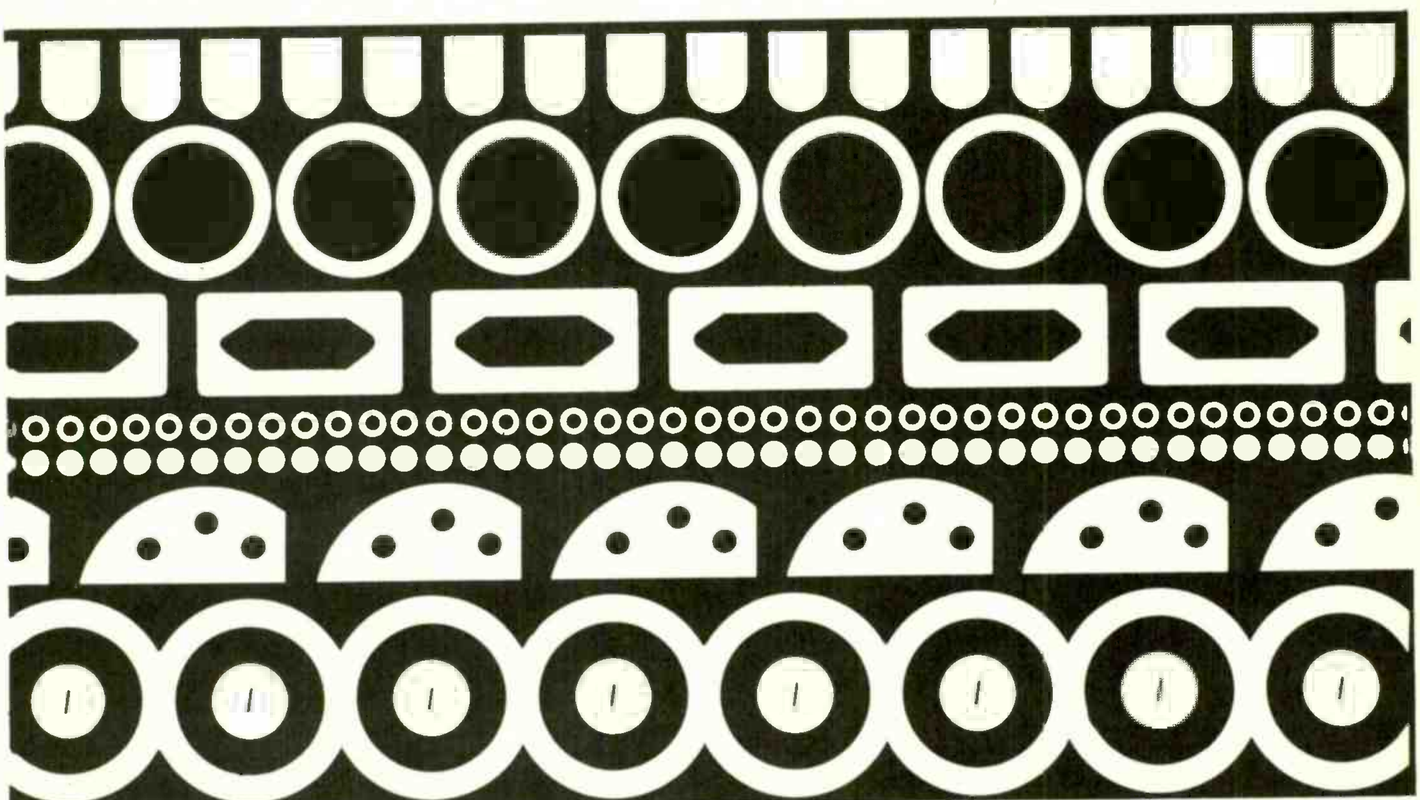

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Model MXT/6 Assemblies offer a combination that will fulfil every requirement for pre-amplifiers and mixing. From 4 to 22 channels can be utilised each with its own Independent Gain control and with overall Master Gain, Treble and Bass controls.

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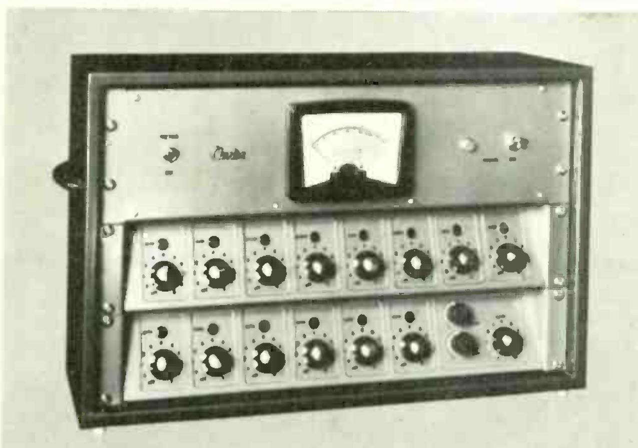
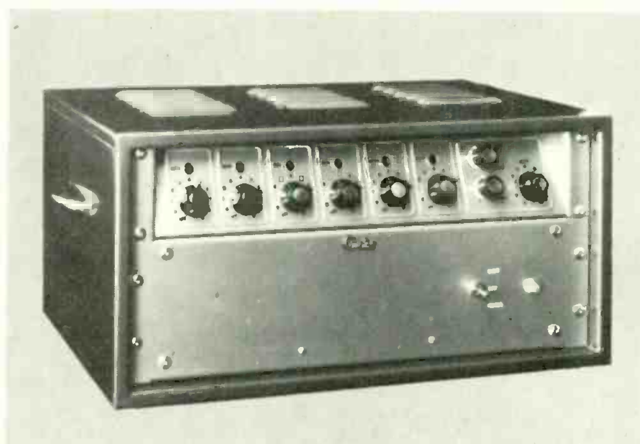
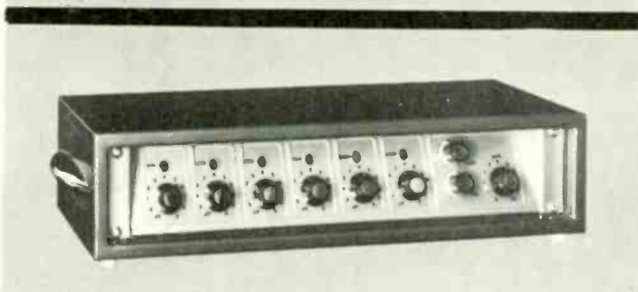
Audio Power Amplifiers having outputs of from 10 to 80 watts and to operate in conjunction with MXT/6 Mixing Assemblies. Silicon Transistorised throughout—stable—high performance—overload and output protection—distortion better than .5% 20 Hz to 15,000 Hz—output 15 ohm and 100 volt to line.







For mounting in Cabinet Rack or Console on 19" standard panels—finished gun metal two tone blue or to requirements—Microphone, Tape, Gramophone, Radio and Priority Tone Signal Modules.

Integrated Mixer/Amplifiers Models A25—30 watts, and A80—60 watts, having inputs for two Microphone Channels balanced at 30 ohm. Auxiliary inputs for Microphone, Gramophone and Tape, each channel independently controlled. Overall Master Gain Control. Treble and Bass tone controls giving ± 12db lift and cut.

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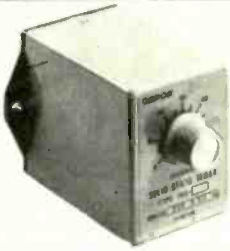
PROCESS TIMERS

MICRO SWITCHES
IMMEDIATE DESPATCH
LATEST ADDITION TO OMRON RANGE



Solid State Process Timer type TDS

Latest circuit provides prolonged accuracy

- 1% ACCURACY
- OCTAL BASE PLUG-IN
- CONTACTS
- CIRCUIT CONTAINS BUILT-IN VOLTAGE STABILISER

Timed out 5 amp C/O
Instantaneous 15 amp normally open
30 sec and 60 sec Linear dials
110 and 240 VAC operated
Approximately £10 dependent on quantity

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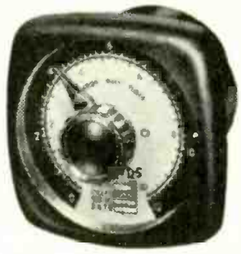

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★ 10 MILLION OPERATIONS

★ Instantaneous & Timed out 3 AMP contacts.

★ Repeat Accuracy $\pm\frac{1}{2}$%. 10 secs to 28 Hrs. May also be used as impulse start and automatic reset.

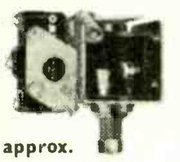
£9.15.0 approx. dependent on quantity.

TEMPERATURE CONTROLLER TYPE THP

- THERMISTOR OPERATED
- OCTALBASE PLUG IN
- COMPACT

Temperature ranges up to 240 C
Output contacts .4 amp
Accuracy 2% full scale
Approximately £15 dependant on quantity

611-T Delay Relay



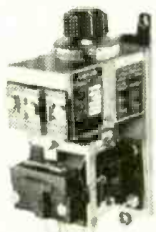
★ 2, 5, 15 & 25 secs. Delay.

★ 15 amp. c/o micro-switch fitted

★ LARGE RANGE OF A.C. & D.C. COILS.

approx. **40/-** each, dependent on quantity.

AT-10 PNEUMATIC TIMER - delay relay



★ Fully adjustable up to 200 seconds. Fitted with 15 amp. S.P.D.T. switch.

★ One model provides delay after energise or delay after de-energise.

approx. **£6.0.0** dependent on quantity.

STP Sub-Mini Process Timer
SYNCHRONOUS MOTOR & CLUTCH

Matchbox size frontal area.
Automatic re-set.

★ PLUG-IN OCTAL BASE

★ INSTANTANEOUS AND TIMED OUT 2 AMP CONTACTS

★ RANGES: 10 SECS. TO 36 MINS.

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MAINS OPERATED YL2 GPA **PROXIMITY SWITCH**

★ FOR BATCHING, CONVEYORS, MACHINE TOOL CONTROL, PACKAGING, SORTING, etc.

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★ SOLID STATE SENSING HEAD INCLUDES CONSTANT VOLTAGE CIRCUIT

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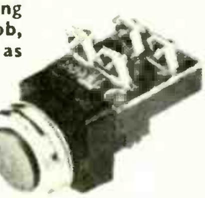
7 different panel mounting actuators including; knob, key, and lever, as well as push on/push off. Up to 4 switch blocks can be fitted. Dust and splash proof, D/P slow make and break, 5 amp rating. Full literature on request.



VV-15-1A

★ 15/10 AMPS. c/o

★ 100,000 ops.

1/8 each per 1,000
Single Throw 1/4 each

LIMIT SWITCH
WL 10 FNJ

★ 10 AMP 2 CIRCUIT

★ 5 INCH FLEXIBLE ACTUATOR AS ILLUSTRATED

AS LOW AS **47/7** EACH.
FIVE OTHER STANDARD TYPES AVAILABLE

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★ 1 MILLION OPERATIONS.

★ 10 amp. c/o.

★ COMPARE OUR SPEC. & OUR PRICES WITH OTHER SIMILAR TYPES.

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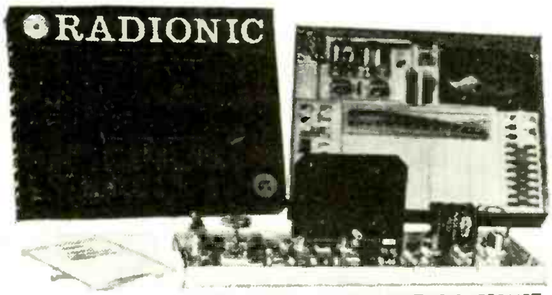

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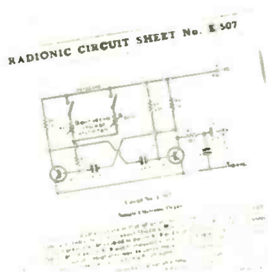
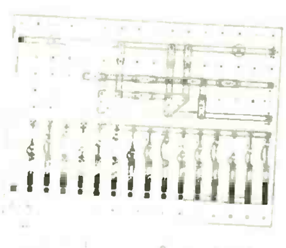
Prices (Post Free)



Theoretical Circuit.



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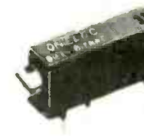

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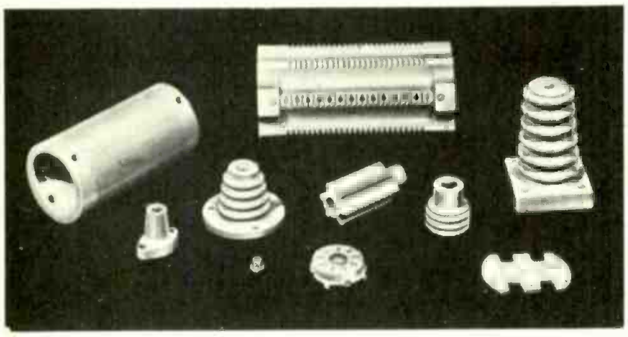

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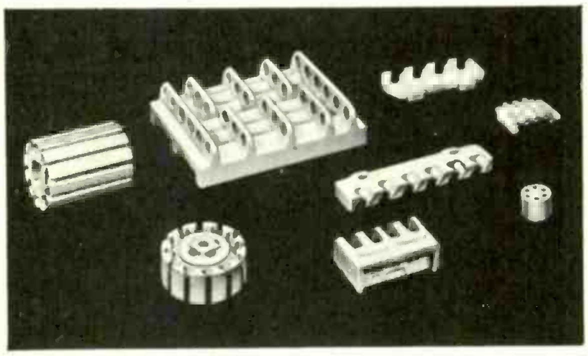

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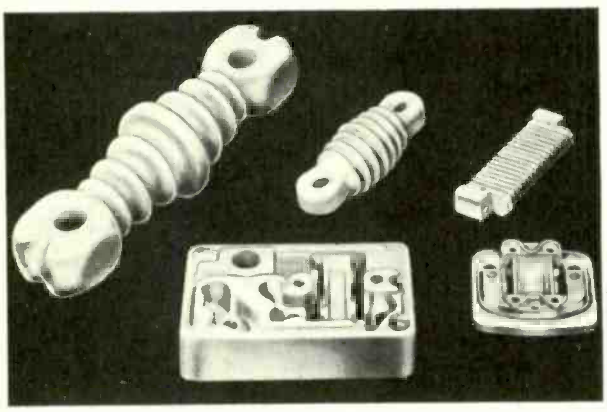

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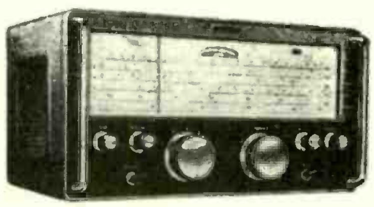

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SMALL GEARED MOTORS. In addition to our well-known range (List GM.564), we offer small open type S.P. Units. 200/250 v. A.C., 1, 6, 12, 24, 60 r.p.m., approx. 5in. long, with 1in. shaft projection each side and enclosed gearbox. Suitable for display work and many industrial uses. Only **69/6** (des. 3/-).

SYNCHRONOUS TIME SWITCHES. (Our very popular speciality). 200/250 v. 50 c. for accurate pre-set switching operations. Sangamo S.254 providing up to 3 on-off operations per 24 hours at any chosen time, with day-omitting device (use optional). Capacity 20 amps. Compactly housed 4in. dia., 3¼in. deep. **£5/18/6** (des. 4/6). Also same excellent make new Domestic Model, no wiring and easy setting and installation. Portable with lead and 13-amp. plug same duty as above (less Day-omitting). **£4/9/6** (des. 4/6). Full instructions sent with each.

MINIATURE COOLING FANS. 200/250 v. A.C. With open type induction motor (no interference). Overall 4in. × 3¼in. × 2½in. Fitted 6-bladed metal impeller. Ideal for projection lamp cooling, light duty extractors, etc., still only **28/6** (des. 4/6).

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AIR BLOWERS. Highly efficient units fitted induction totally enclosed motor 230/260 v. 50 c. 1 ph. Model SD.26, 60 CFM (free air) to 11.5 CFM at .15 WG (size approx.) 6 × 6 × 7in. Outlets 2¼in. square, **£8/10/-** (des. 5/-). Model SD27, 120 CFM (free air) to 40 CFM at 1.2 WG, 8 × 7 × 9in., outlet 2¼in. sq., **£11/15/6** (des. 5/-). Model SD28, 260 CFM (free air) to 127 CFM at 1.5 WG, 11 × 8 × 9in., outlet 3in. sq., **£13/17/6** (des. U.K. 7/6).

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Output Impedance:	600 Ohms.
Output Voltage:	10 Volts r.m.s. max.
Output Attenuation:	0-110 dB continuously variable.
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Square Wave Rise Time:	Less than 0.1 microseconds.
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Mains Input:	100 V.-250 V. 50/60 Hz.
Size:	17¼ x 11 x 8in.
Weight:	25 lb.
Price:	£150.

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A sensitive instrument for the measurement of total harmonic distortion, designed for speedy and accurate use. Capable of measuring distortion products as low as 0.002%. Direct reading from calibrated meter scale.

Specification

Frequency Range:	20 Hz-20 kHz (6 ranges).
Distortion Range:	0.01%-100% f.s.d. (9 ranges).
Sensitivity:	100 mV.-100 V. (3 ranges).
Meter:	Square law r.m.s. reading.
Input Resistance:	100 kOhms.
High Pass Filter:	3 dB down to 350 Hz. 3 dB down to 35 Hz.
Frequency Response:	±1 dB from second harmonic of rejection frequency to 250 kHz
Power Requirements:	Included battery.
Size:	17¼ x 11 x 8in.
Weight:	15 lb.
Price	£120.

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A transistor operated voltmeter satisfying the requirements for audio frequency measurement.

Specification

Sensitivity:	1 mV.-300 V. f.s.d. (12 ranges).
Calibration Accuracy:	2% f.s.d.
Frequency Response:	±1 dB. 10 Hz-500 kHz.
Input Impedance:	1 MOhm. 1 mV.-300 mV. 10 MOhm. 1 V.-300 V.
Meter Scaled:	0-3, 0-10, and dBm.
Power Requirements:	Included battery.
Size:	11¼ x 6¼ x 6in.
Weight:	7 lb.
Price:	£35.

RADFORD LABORATORY INSTRUMENTS LTD

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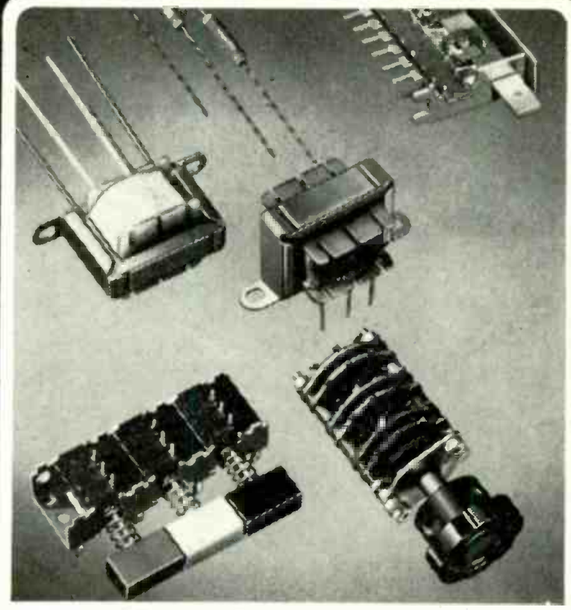
Bristol 3

WW—051 FOR FURTHER DETAILS



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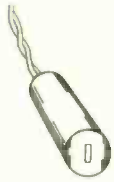
Company ____________
Address ____________
____________ Tel. No. ____________

WW—052 FOR FURTHER DETAILS

MAGNETIC RECORDING

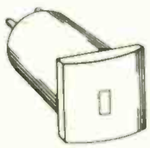
HEADS

TYPE "A"



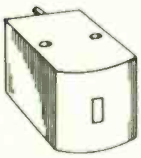
Standard 1/2 track, Record/Playback and Erase. Many special versions can be made to customers' requirements such as narrow track—raised track—or cut-away for cine use. Ideal head for dictating machines, etc. Size $\frac{3}{8}$in. dia. by $\frac{5}{8}$in. long. The round body makes for easy azimuth adjustment and takes up a minimum of space. Head has internal screen and fly leads for easy wiring.

TYPE "R"



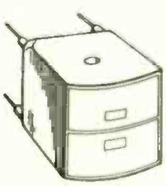
Size is $\frac{7}{16}$in. square at the front with body $\frac{3}{8}$in. dia. by $\frac{5}{8}$in. long. Curved front $1\frac{1}{4}$in. radius. This head is available in a wide range of Record/Playback impedances. Also available as Erase. This novel design possesses many advantages over comparable types — higher output — lower losses—extremely good H.F. response—very low noise pick up—has internal mumetal screen. Round body aids mounting arrangements—easy azimuth alignment.

TYPE "DR"



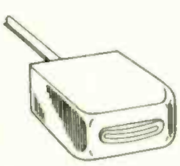
Exactly as Type R except body is $\frac{7}{16}$in. square along its length providing simple mounting arrangements. The Erase versions of R and DR types are double field heads. These are not just double gaps but two Erase heads in one, giving better than 60dB erasure of a saturation (+6dB on full record level), 1 k/c recording at $3\frac{3}{4}$ i.p.s.

TYPE "X"



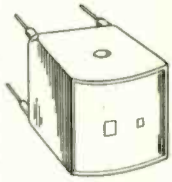
1/1 — 1/2 — 2/2 and 2/4 Heads for $\frac{1}{4}$in. tape. Record/Playback and Erase Heads for high quality tape recorders. Size only $\frac{1}{2}$in. cube and available in a whole range of impedances. Excellent HF performance, efficient screening and very low crosstalk are features of the R/P head, Mounting brackets are available for twin or triple head assemblies.

TYPE "T"



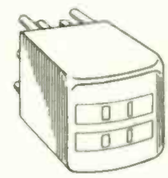
Built into a deep drawn mumetal case ensures complete shielding. Type T is the protruding pole type with special narrow track (as narrow as .002in.) and can be made as a Record/Playback or Erase Head, or combined Record / Playback / Erase Head, or even Record/Playback and self-oscillatory Erase Head. The Erase track can be made wider than the R/P track on the Combo Head, a fully screened lead is incorporated as part of the head.

SINGLE TRACK COMBO TYPE "X"



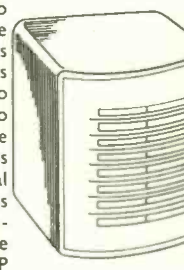
Designed as a combined Record/Playback/Erase Head for the commercial market. such as telephone answering machines. Built into $\frac{1}{2}$in. cube deep drawn mumetal case it incorporates the R/P features of R-Type head. The Erase track is made wider than the R/P track to ensure complete erasure and to overcome machine to machine alignment tolerances.

TYPE "Z"



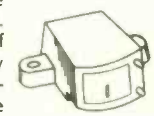
A brand new concept in combination head design incorporating all the best features of the X-Type Head combined with integral erase facilities. Accurate gap alignment between tracks makes this head eminently suitable for high quality stereo use. The one-piece deep drawn mumetal case (only $\frac{1}{2}$in. cube) ensures complete screening across the front as well as the sides.

MULTITRACK



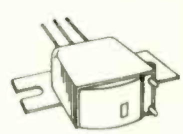
Available to special order in Two-Four-Eight or Sixteen tracks, or to specification. These tracks are located by precision machined slots and track dimensions and positions remain consistent. The track to fixing base dimensions are held to tight limits and any tolerances are non-cumulative as each track is indexed from the base. Special purpose optical equipment ensures a high order of accuracy in the alignment of the head halves. Erase heads, identically sized to the R/P head are available to special order.

TYPE "W" ERASE



Designed especially for the Cassette Type Recorder using .15in. wide tape. Built-in tape guides are a feature of this head. The Standard type now in production is $\frac{1}{2}$-track but a compatible Stereo version will soon be available. The high Q factor of Type W Erase gives maximum economy in battery applications.

TYPE "W" R/P.



The Record/Playback Head for Cassette Recorder incorporated in a deep drawn mumetal case ensuring complete screening. As an integral part of the head the mounting plate is of tempered Beryllium copper to provide a simple azimuth adjustment. The winding is centre tapped to give the option of presenting a lower impedance to bias and signal sources during recording.

BY

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SPECIALISTS IN ALL TYPES OF HEADS FROM THE ECONOMY MASS-PRODUCED ARTICLE TO THE VERY HIGH QUALITY PROFESSIONAL HEAD FOR SOUND RECORDERS AND COMPUTERS. OUR TECHNICAL KNOWLEDGE MAKES IT POSSIBLE TO DEVISE, PLAN AND PRODUCE THE MOST VERSATILE RANGE OF HEADS IN BRITAIN—FOR EITHER TAILOR-MADE OR MASS-PRODUCED DEVICES IN ALL DIVISIONS OF RECORDING.

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Vero

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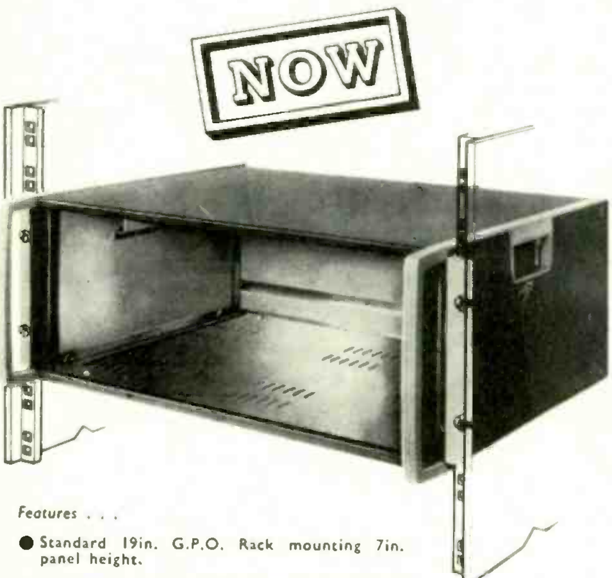
of Instrument Cases available for rack mounting



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- Standard 19in. G.P.O. Rack mounting 7in. panel height.
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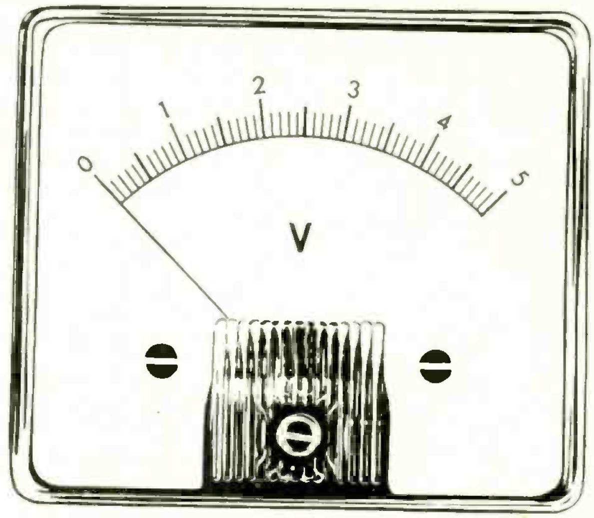
METER PROBLEMS?



A very wide range of modern design instruments is available for 10/14 days delivery.

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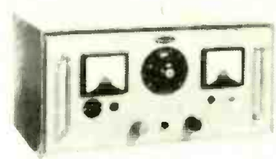

TYPES
250VRU 30/20
250VRU/60/10
250VRU/120/5
250VRU/240/2.5

PRICE: £131.5.0

TYPE 250VRU/30/20 provides outputs of 0-30 v. D.C. continuously variable, up to 20A. Overload capacity 200% for short periods Ripple Content, impedance and regulation equivalent to accumulator performance. Output protected.

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Avoid the extra expense of super regulation you may never need.

PRICES: from £31/4/- up to £88/4/-.

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CP50 AMPLIFIER. An all silicon transistor 50 watt amplifier for mains and 12 volt battery operation, charging its own battery and automatically going to battery if mains fail. Protected inputs, and overload and short circuit protected outputs for 8 Ω-15 Ω and 100 volt line. Bass and treble controls fitted.

1 gram and 2 low mic. inputs. Price £84 0 0

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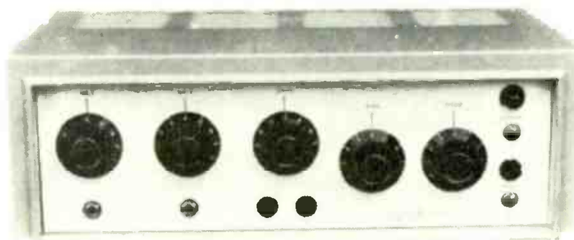
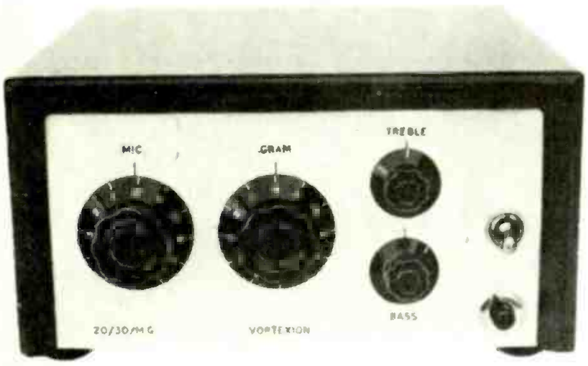
4 low mic. inputs ...... Price £92 0 0



100 WATT ALL SILICON AMPLIFIER. A high quality amplifier with 8 Ω-15 Ω and 100 volt line output for A.C. Mains. Protection is given for short and open circuit output over driving and over temperature. Input 0.4v. on 100K Ω. Price £70 0 0.



20/30 WATT MIXER AMPLIFIER. High fidelity all silicon model with F.E.T. input stages to reduce intermodulation distortion to a fraction of normal transistor input circuits. The response is level 20 to 20,000 cps within 2db and over 30 times damping factor. At 20 watts output there is less than 0.2% intermodulation even over the microphone stage at full gain with the treble and bass controls set level. Standard model 1-low mic. balanced input and HiZ gram. Price £35/0 0.

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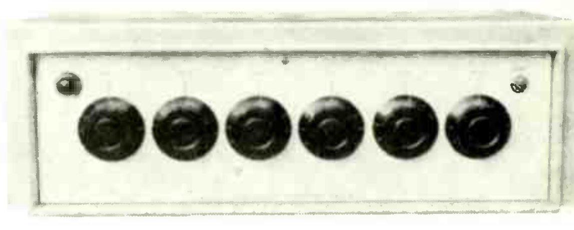
200 WATT AMPLIFIER. Can deliver its full audio power at any frequency in the range of 30 c/s-20Kc/s ± 1db. Less than 0.2% distortion at 1Kc/s. Can be used to drive mechanical devices for which power is over 120 watts on continuous sine wave. Input 1 mW 600 Ω. Output 110-120v. or 200-240v. Additional matching transformers for other impedances are available.

30/50 WATT AMPLIFIER. With 4 mixed inputs, and bass and treble tone controls. Can deliver 50 watts of speech and music or over 30 watts on continuous sine wave. Main amplifier has a response of 30 c/s-20Kc/s ± 1db. 0.15% distortion. Outputs 4, 7.5, 15 Ω and 100 volt line. Models are available with two, three or four mixed inputs for low impedance balanced line microphones, pick-up or guitar.

10/15 watt ELECTRONIC MIXER/AMPLIFIER. This high fidelity 10/15 watt Ultra Linear Amplifier has a built-in mixer and Baxandall tone controls. The standard model has 4 inputs, two for balanced 30 Ω microphones, one for pick-up C.C.I.R. compensated and one for tape or radio input. Alternative inputs are available to special order. A feed direct out from the mixer is standard and output impedance of 4, 7.5, 15 Ω or 100 volt line are to choice. Designed for continuous operation on 19in. × 7in. rack panel form or standard ventilated steel case.



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Telephones: LIBerty 2814 and 6242-3-4 Telegrams: "Vortexion, London, S.W.19."

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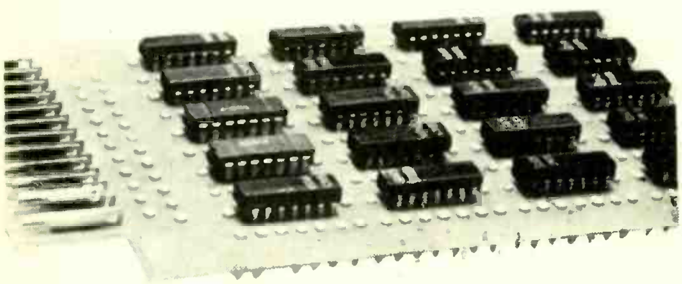
TREND cards



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***Recording Ammeter and Recording Milliammeter at £47**

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* Milliammeters, Voltmeters, Resistance Boxes, Wheatstone Bridges & Potentiometers.

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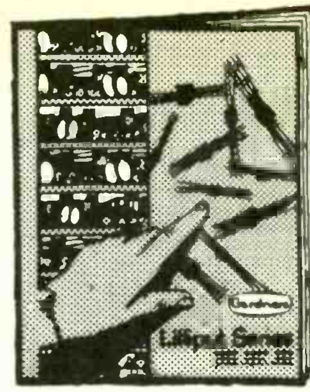
The Lilliput Series



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***GT 12A.** Describes the Lilliput series of Ultra Miniature transformers and gives useful information and data on their application in transistor converter/inverter, wide band communication and high speed pulse circuits.*

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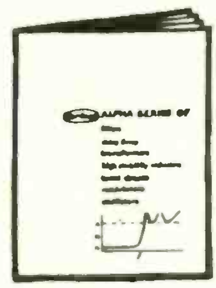
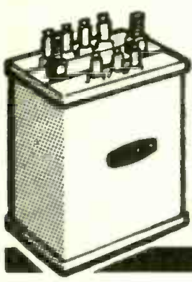
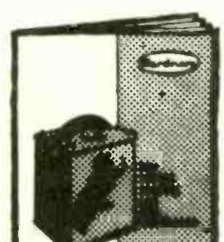


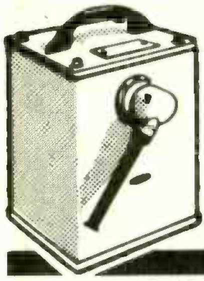


A range of custom built components from simple or hybrid transformers and modulators to highly complex multi-section filters or complete active networks of exceptional stability hermetically sealed to DEF. 5214 Humidity Class H1.

***GT 16.** Gives a general description of the Alpha series assemblies and describes their suitability for wound components where a high degree of stability is required.*

Low Voltage Isolating and Auto Transformers





A comprehensive range of conventional double wound and auto transformers for applications in industry and in the home. Nearly 200 types are available in six different styles and with outputs from 6 volts to 240 volts and from 5VA rating to 2 kilowatts. All types are normally held in stock in reasonable quantities for immediate delivery.

***GT 17.** Everyone in the electronics industry uses low voltage, isolating and auto transformers at some time or other and this booklet describes the complete Gardner range of this type of transformer in a convenient and presentable form.*

Gardners

GARDNERS TRANSFORMERS LIMITED
Christchurch, Hampshire
Telephone: Christchurch 1734 Telex 41276

Complete coupon and post indicating publication(s) required ☒

Lilliput Series ☐ Alpha Series ☐

Low Voltage Isolating, Auto Transformers ☐

Name ....

Designation ....

Company ....

Address ....

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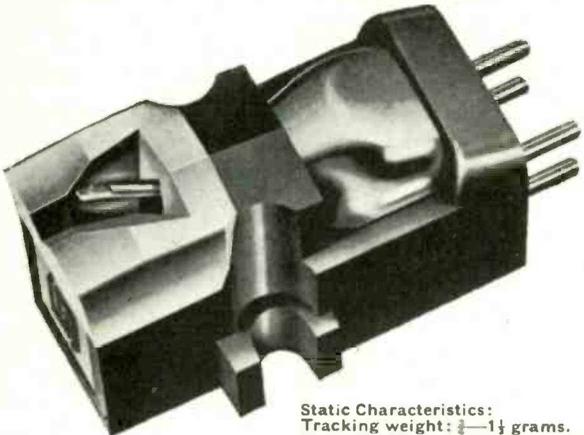
WW—065 FOR FURTHER DETAILS

INDUCED FIELD CARTRIDGE



Static Characteristics:
Tracking weight: ¾—1½ grams.
Output: 0.9 mV cm/sec (measured on Decca SXL2057).
Lateral static compliance: 1 gram: 30 x 10-6 cm/dyne.
Vertical tracking angle: 15°.
Stylus radii: 0.0003" x 0.0008" elliptical.
Inductance: 340 mH. Recommended load: 47—100K.
Mounting centres: standard ½".
Weight of cartridge: 7.5 grams.
Termination: gold plated electrodes colour coded to B.S 1928—1965.

Come and see the cartridge as well as our other High Definition Products at

AUDIO FAIR '68

Hotel Russell, London, W.C.1.

April 18th, 19th, 20th, 21st

Booth 65—Room 356

We are reserving a certain amount of seats—drop us a line and we will send you a ticket—please state Friday, Saturday, Sunday and approximate time.

AUDIO & DESIGN LIMITED

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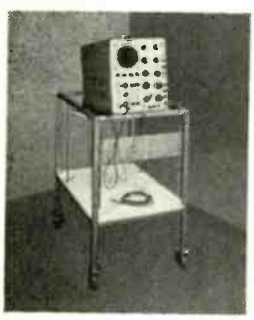

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OTHER MODELS AVAILABLE—

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WW—069 FOR FURTHER DETAILS

New from Garrard–the AP 75 a high-fidelity single record-playing unit for less than £23*

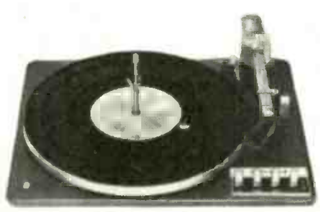
You get all these advanced features with this elegant unit:

- Diecast aluminium pick-up arm.
- Manual or automatic playing of single records.
- Single lever selects *both* record size *and* turntable speed.
- Slide-in cartridge carrier.
- Non-magnetic turntable.
- Calibrated, fine stylus-force adjustment.
- Calibrated pick-up arm bias compensation.
- Cue and pause facility.

As well as manual control, this unit offers the additional facility of automatic play of single records. A single operation starts the turntable, lifts the pick-up arm and lowers it on to the record, and when playing is finished, returns the pick-up arm to rest and stops the turntable. A single control lever selects both record size and turntable speed for 12" records (78 rpm), 7" (45 rpm) and 12", 10" and 7" ($33\frac{1}{3}$ rpm).*£19.3.0d.+P.T. 68/6d. Optional extras: teak-finish base WB4; rigid, clear plastic cover SPC4.

and just for the record

Garrard 401 is the ultimate in transcription turntables—magnetically shielded 4-pole induction motor; gear-cut stroboscopic markings illuminated by an integral, high-intensity neon lamp; variable speed control; heavy non-magnetic diecast turntable; anti-static mat; functional styling. *£25.9.7d.+P.T. 91/2d.



Garrard LAB 80 Mk II is a transcription turntable with the facilities of an automatic record changer when desired—low resonance wood pick-up arm; pick-up arm bias compensator; calibrated, fine stylus-force adjustment; record-repeat adaptor; automatic play of single records, cue and pause facility. *£25.15.1d.+P.T. 92/1d Optional extras: teak-finish base WB2; rigid, clear plastic cover SPC2.

Garrard SP 25 Mk II a single-record playing unit giving exceptional performance at moderate cost. With pick-up arm bias compensator and calibrated, fine stylus-force adjustment. Cue-and-pause control allows pick-up to be raised or lowered at any point. *£12.10.8d.+P.T. 44/10d. Optional extras: teak-finish base WB1; rigid, clear plastic cover SPC1.

Recommended retail prices.

Garrard looks after your records

Ask for illustrated leaflets on the complete Garrard range.

GARRARD ENGINEERING LIMITED, NEWCASTLE STREET, SWINDON, WILTSHIRE, ENGLAND. TELEPHONE: SWINDON 5381

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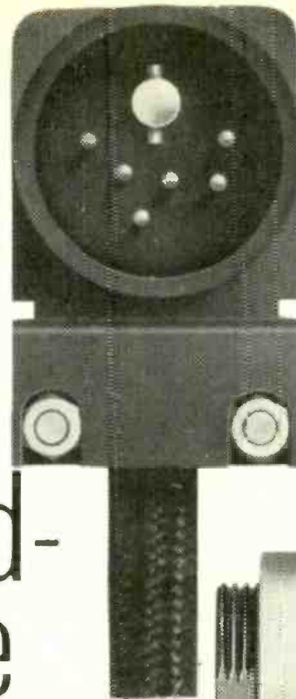
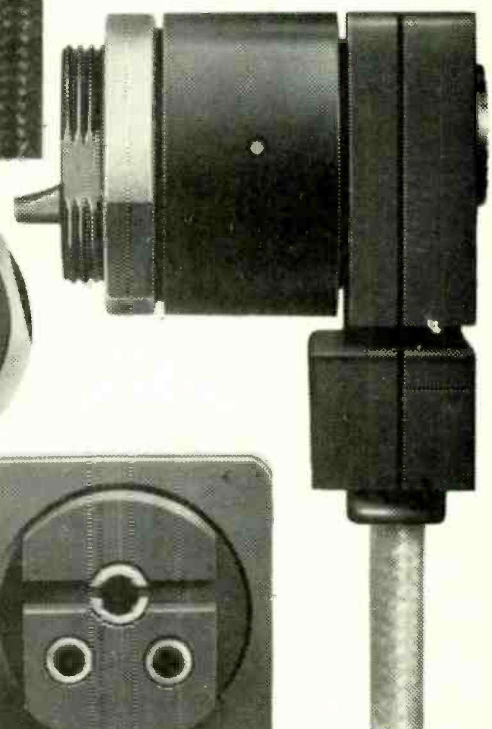
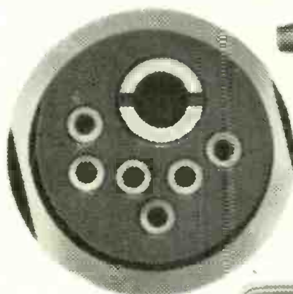
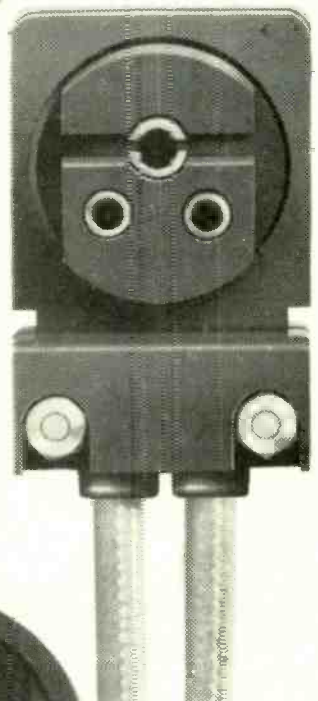
STUMPI
a new connector for the weight-and-space race









— a new connector specifically designed for a new Military project and for the race toward ever lighter, smaller equipment. It uses the very latest materials to achieve brand new standards in compact, efficient design. Just look at these features:

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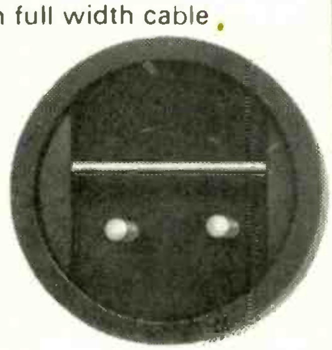

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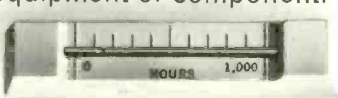
An MEC Elapsed Time Meter records the actual hours of use of your circuit, equipment or component.



This enables you to programme calibration and maintenance, perform use analysis, mean-time-to-failure tests and show warranty validation by actual use.

Range 2 to 25000 hours direct reading. Reversible, easily re-set, small and inexpensive.

Full details from—
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Transformers for 20W Transistor Amplifier (W.W., Nov. 1966).

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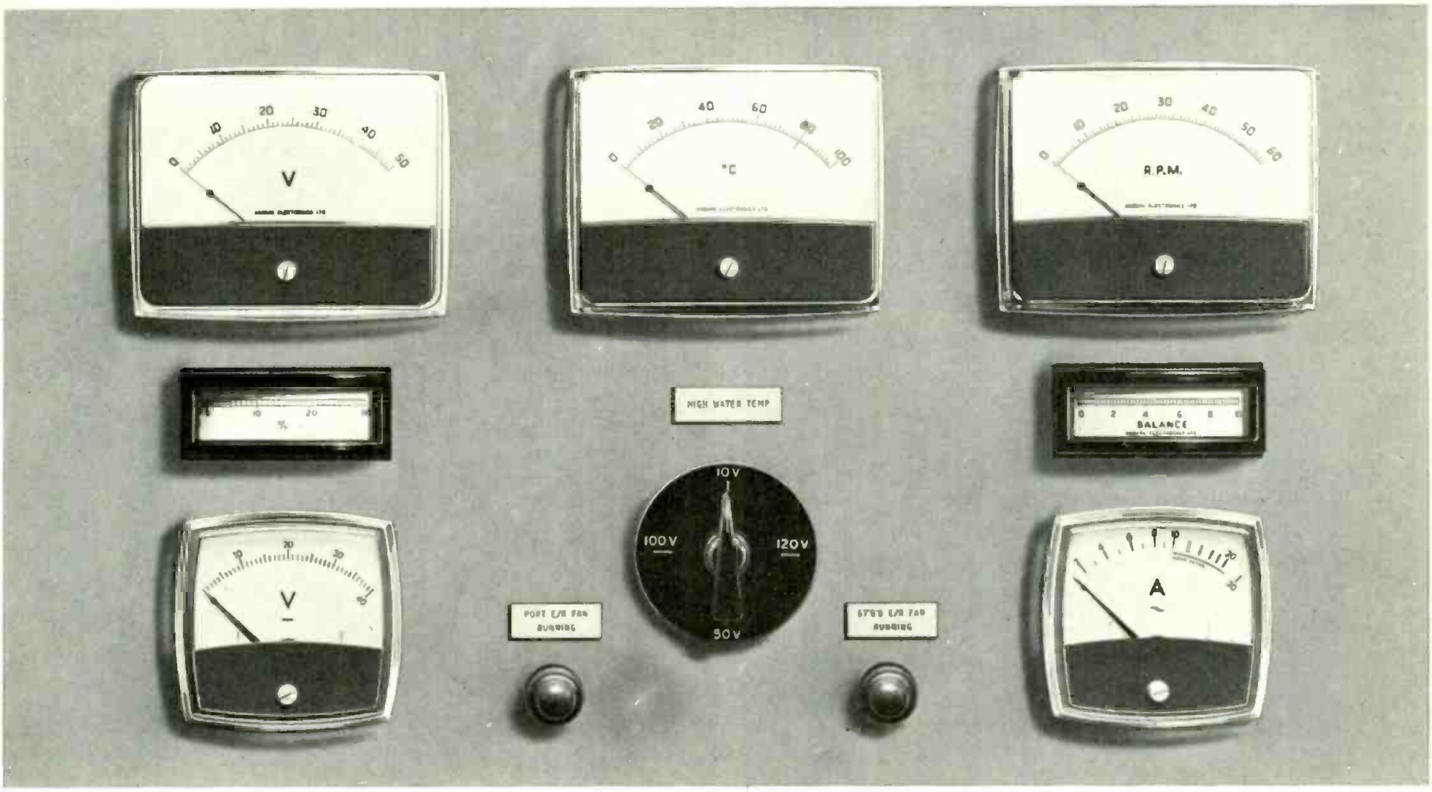
Meter panel of specialists



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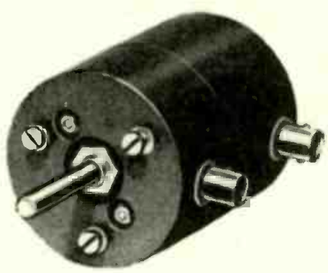
FOR LOW COST RELIABLE ATTENUATION UP TO 100 MHz

NEW
HATFIELD
ROTARY
SWITCHED
ATTENUATOR
TYPE 708



Despite its low cost, this new Hatfield Attenuator will operate efficiently from DC to 100 MHz. The design features individual resistive sections, each selected in turn by a rotary switch mechanism. Careful attention to screening and the elimination of earth loops results in good accuracy being maintained throughout the frequency range.

Since individual T1 sections are used it follows that the attenuators in this range maintain a constant level of input and output impedance irrespective of setting. They may be used equally well, therefore, in equipment or inserted in lines without mismatch. Available Types: 708A (50 ohms) 708B (75 ohms) and 708C (600 ohms, under development).

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MINIATURE IRON (Half Size)

HIGH PRODUCTION MINIATURE MODEL D. 50 WATT

Weight ..	2 oz.	
Heating time	50 secs.	
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Nickel or Iron Plated		
Voltage ..	250 to 12 volts	
Price		55/-

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Weight ..	6 oz.	
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Price		69/6

OTHER VARI-STAT IRONS:—

Miniature Model M 50 watt Push-in Bits 1/32", 1/16", 3/32"
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CARDROSS ENGINEERING CO., LTD.
Woodyard Road, Dumbarton
Phone: Dumbarton 2655

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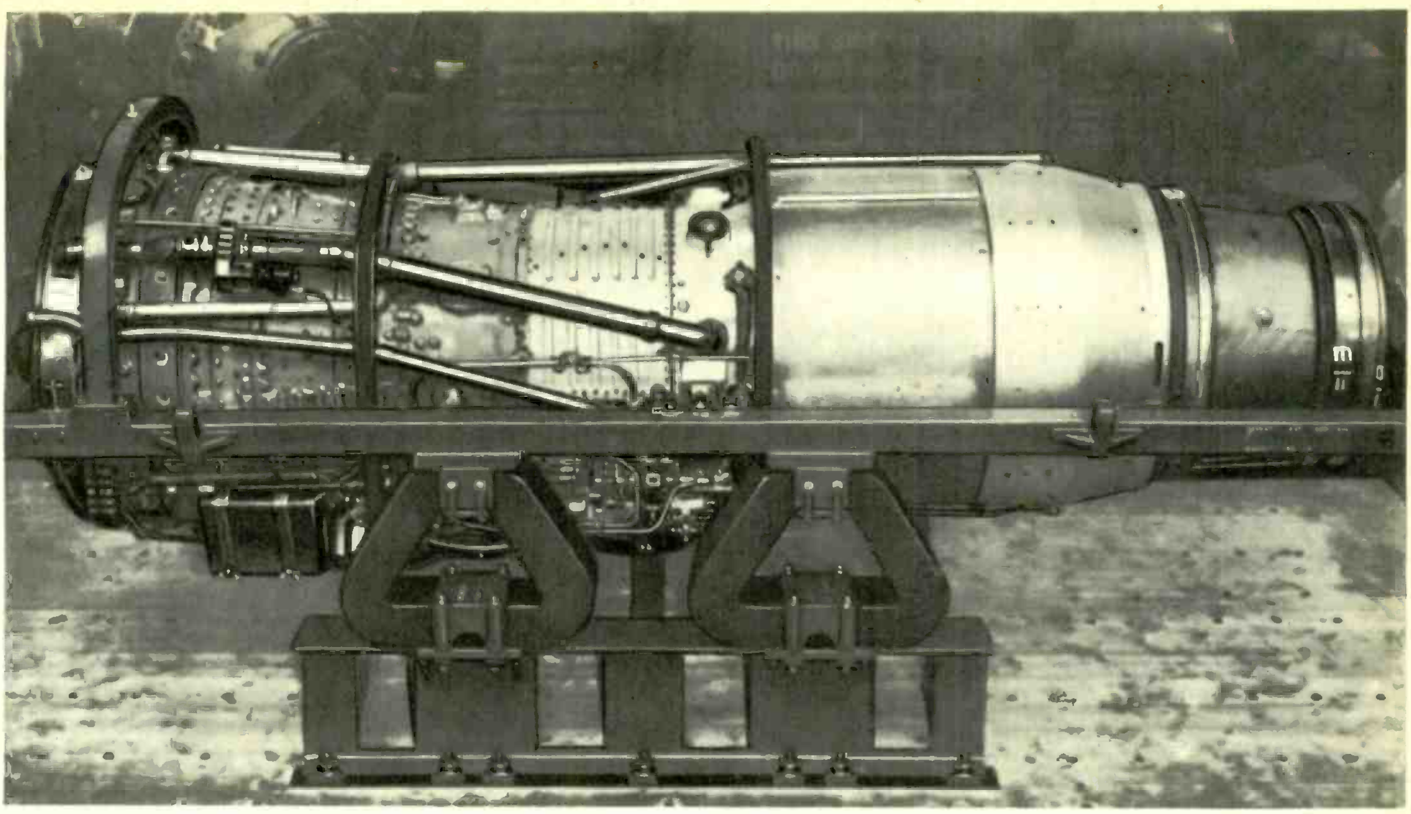

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THE *Monitor* **GOLD***

TANNOY PRODUCTS LTD
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Telephone: 01-670 1131.
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TANNOY ®

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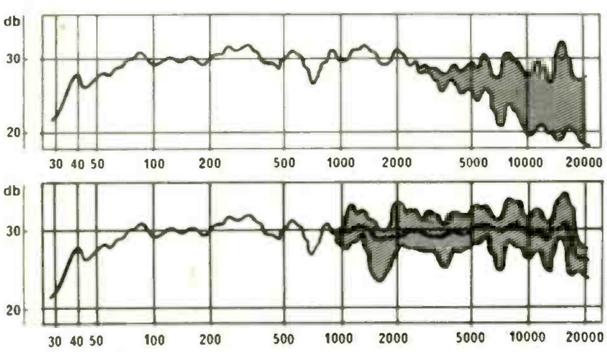
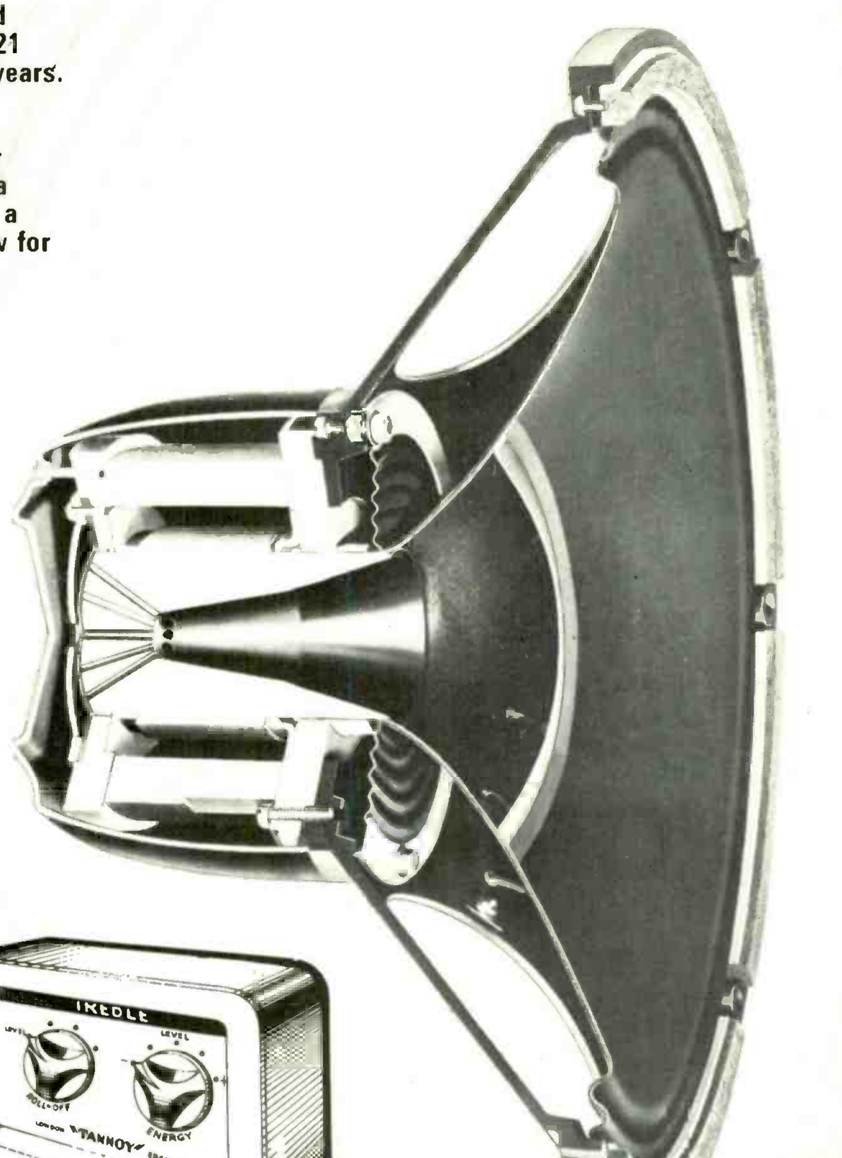


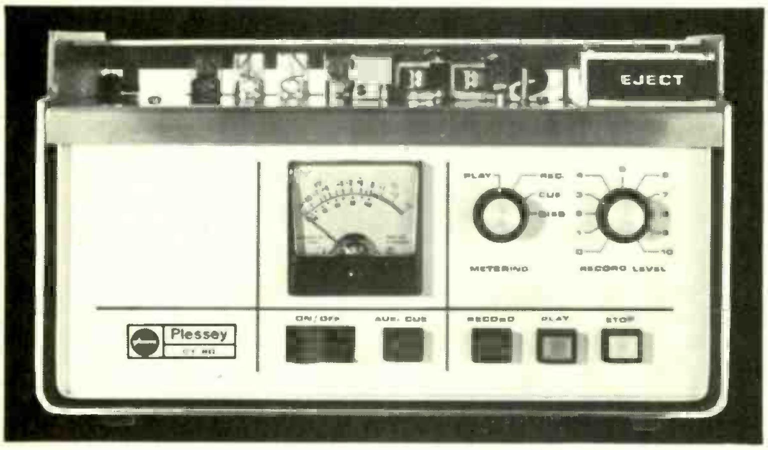


The new Monitor Gold now incorporates a Treble Roll Off Control and Treble Energy Control enabling precise adjustments to be made for room acoustics and programme material.

Frequency Response	*30—20,000 cps*
Power Handling Capacity	*15" 50 watts*
	12" 30 watts
	III LZ 15 watts
Impedance	*8Ω Nominal*
	5Ω Minimum

PLESSEY
Broadcast standard

CT80 Series Cartridge equipment



Heavy duty modular constructed units for endless-loop cartridge operation are available in Record and/or Replay models for desk-top, recessed or standard rack mounting. Instant one-hand cartridge loading and unloading allows fast, simple operation. Tape drive is direct from the capstan motor which is modular constructed with the actuating solenoid and puck wheel assembly. Individual plug-in epoxy circuit boards are fully silicon solid state with telecommunication grade components. Head assemblies with vernier azimuth adjustment are pre-aligned plug-in modules. The modular construction of the CT80 Series allows fast, simple changeover of assemblies for maintenance purposes. Further details are available from your local Plessey office or agent.

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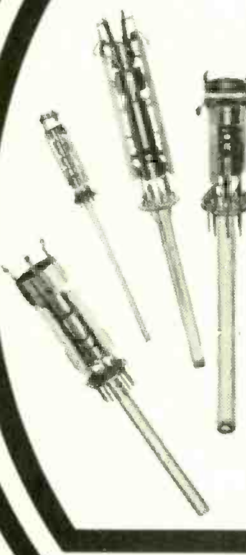

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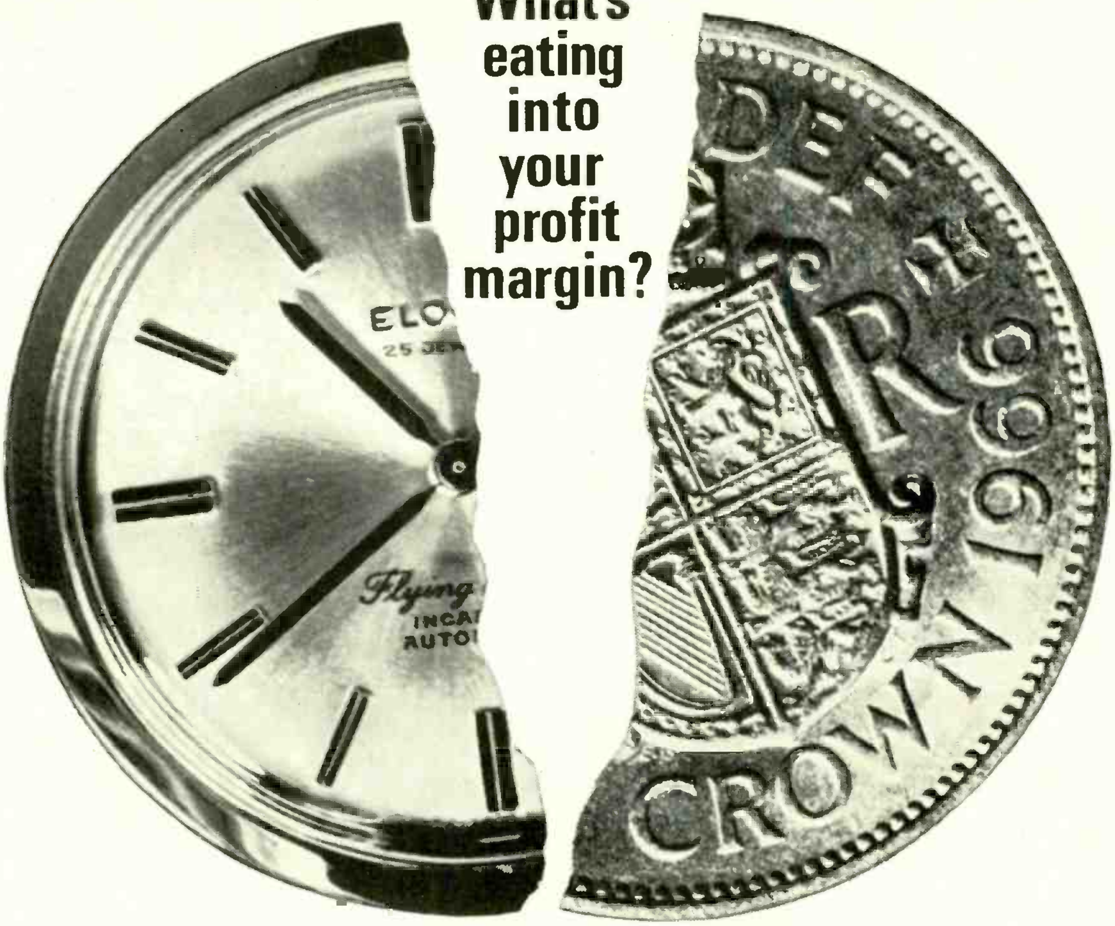
What's eating into your profit margin?



mechanized handling can halve your operating costs!

Are you hit by rising production costs and shrinking profit margins? Is competition getting steadily tougher? Sales prospects bleaker? If these are your problems, can you ignore the productivity improvements resulting from systemized mechanization? There will be a multitude of new ideas and methods at the International Mechanical Handling Exhibition for boosting profits and increasing efficiency. It will be much more than just the world's biggest display of mechanical handling equipment — 500,000 square feet and 300 exhibitors — It will be a unique presentation of handling technology; new systems, equipment and practical ideas. An unrivalled opportunity for evaluating the latest developments in receiving goods and materials; storage inventory control; in-processing; packaging; transport; distribution; and ancillary services and equipment. Whether your company is large or small, you will find much of interest and value at this important event. Mail the enquiry now and note the date in your diary.

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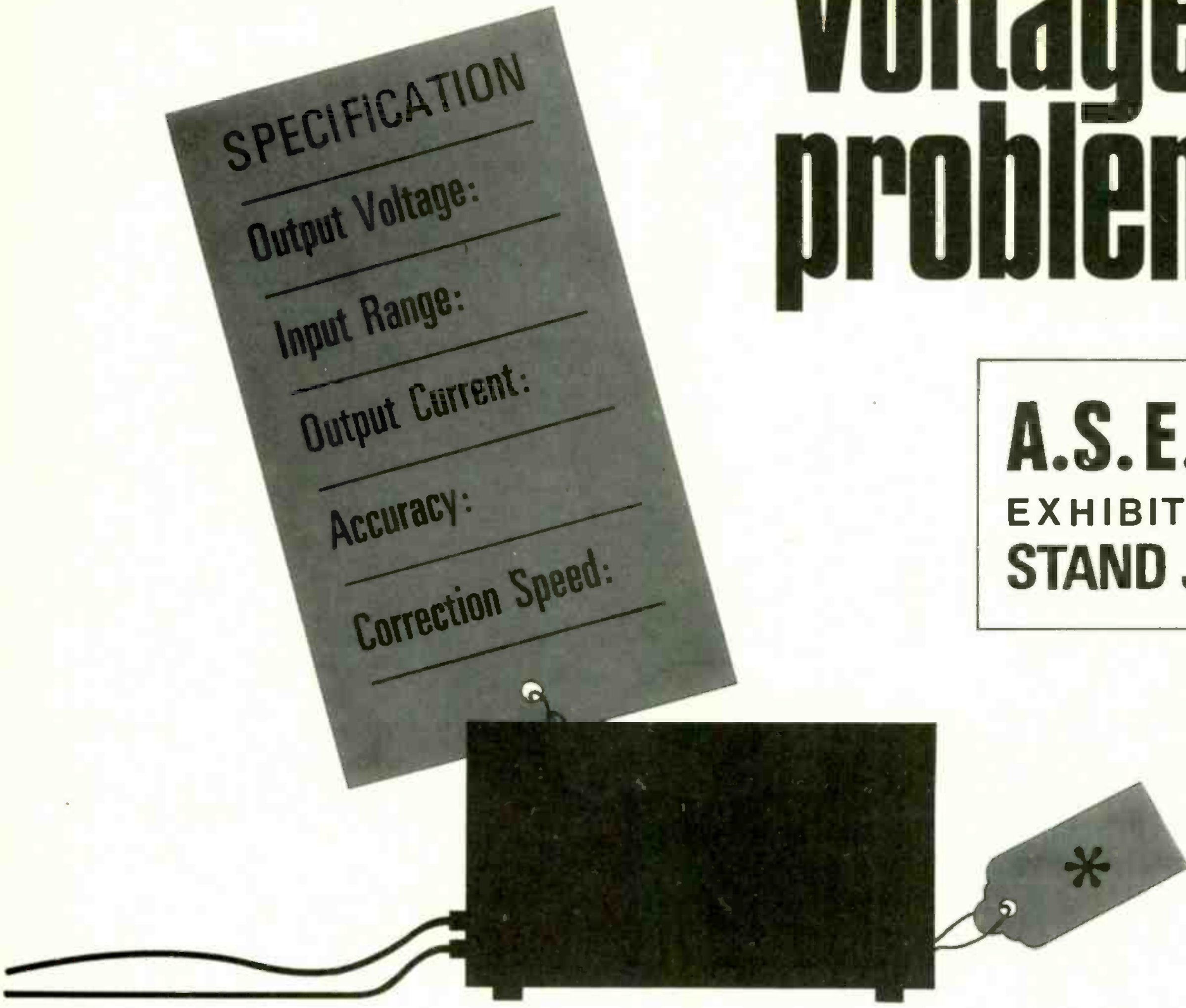
voltage problems?



A.S.E.E.
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STAND J25

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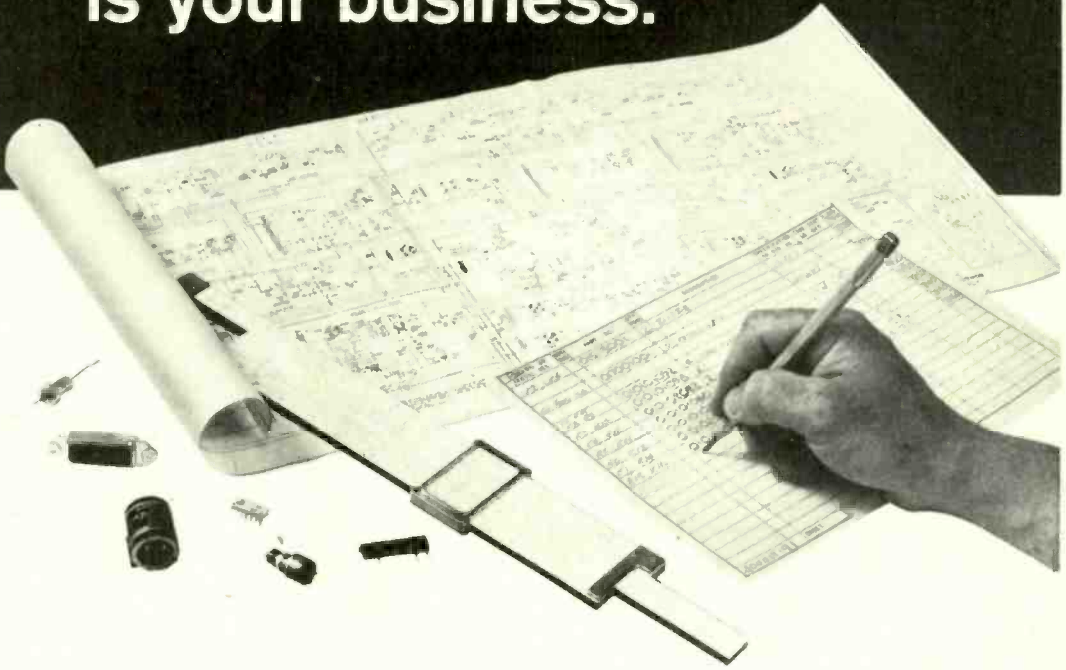

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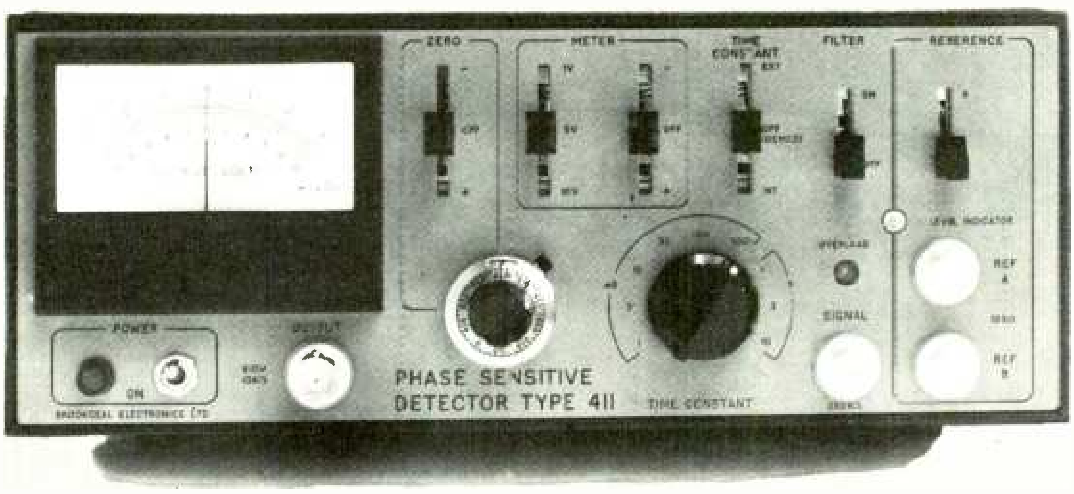

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as selected for the DESIGN CENTRE LONDON

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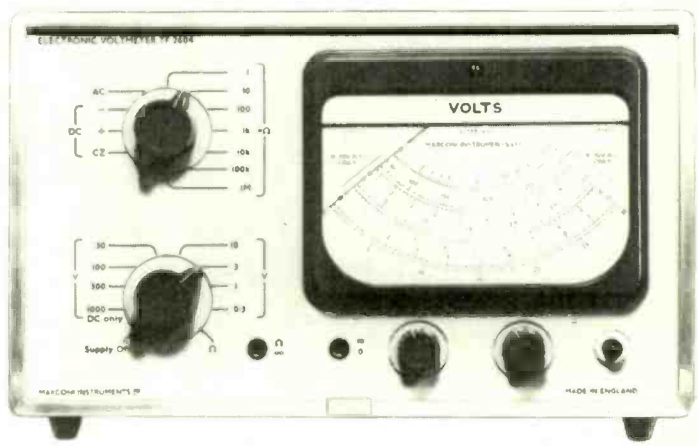

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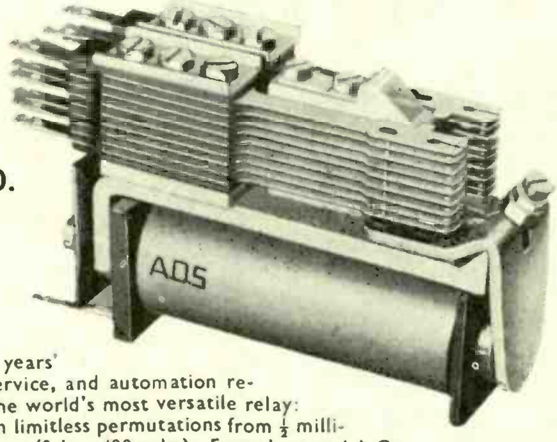

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Through 30 years' telephone service, and automation refinements, the world's most versatile relay: 1 to 4 coils in limitless permutations from ½ milliamp to 20 amps (0.1 to 400 volts); Fast, slow, and A.C. versions; 1 to 16 contact units (36 springs max.); Standard contacts 0.3 to 1 amp; Alternatives for switching Dry-state, Inductive, and 10 amp circuits. Insulation from 100 to 4,000 volts; Life up to 100 million operations; Plain or tropical finishes; Approx. dimensions $1\frac{1}{32}$" × 3¾" × 2½" max. An A.D.S. 3000 Type to meet all specifications-G.P.O., E.I.D., C.E.G.B., ADMIRALTY, U.K.A.E.A., ALL COMMERCIAL, ETC.

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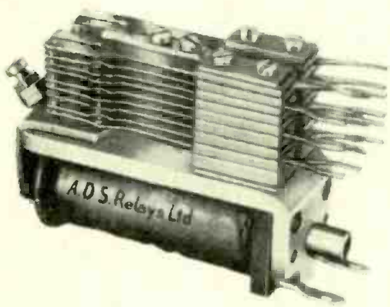

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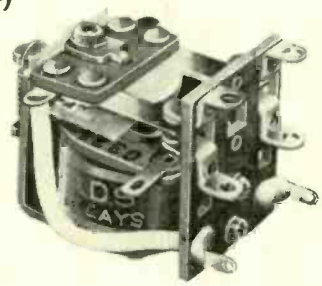

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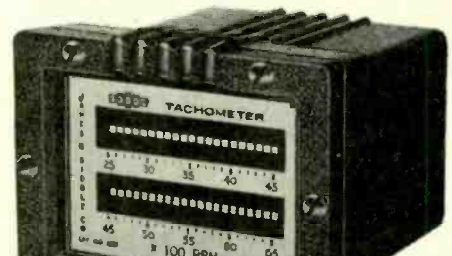

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Resonant Reed TACHOMETERS

for hand use or permanent mounting.

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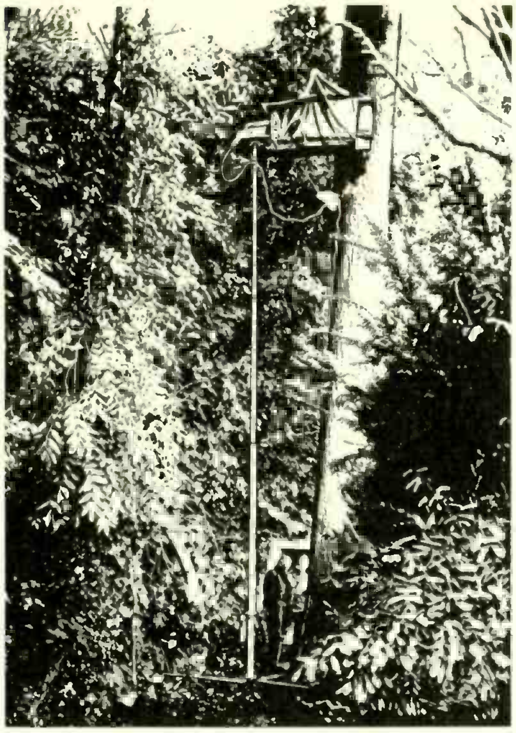

CLARK

AIR OPERATED TELESCOPIC MASTS

A.N. CLARK (ENGINEERS) LTD. BINSTEAD, ISLE OF WIGHT, ENGLAND.

But if you DO want to raise an aerial of 200 lbs. or to heights in excess of 100' CLARK Air Operated Telescopic Masts can help you do the job. The photograph on the left shows a nine pound TV camera supported by a CLARK QT series mast looking in on a fruit bat's night life. Should you have a telescopic mast requirement CLARK offer you the world's most versatile range of vehicle born, free-standing or trailer mounted masts.

Thirty countries use our masts and users range from airport authorities, police and armed forces to . . . fruit bat watchers.

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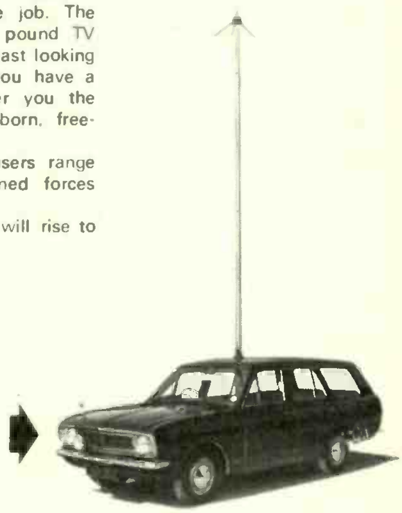

so who wants to study fruit bats?

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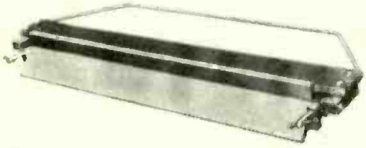
BENCH MODEL BY PARKER



Forms channels and angles down to 45 degrees which can be flattened to give safe edge. Depth of fold according to height of bench.

48" × 18 gauge capacity	£40 0 0
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Carriage Free

Also the well-known vice models of

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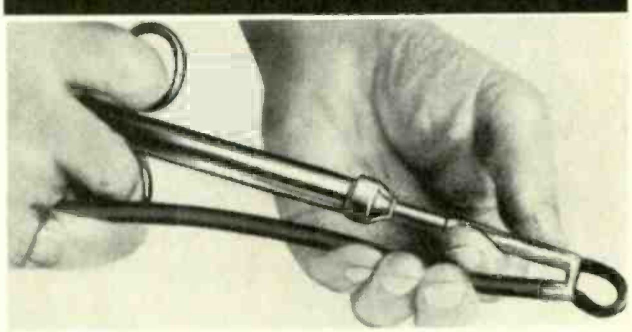

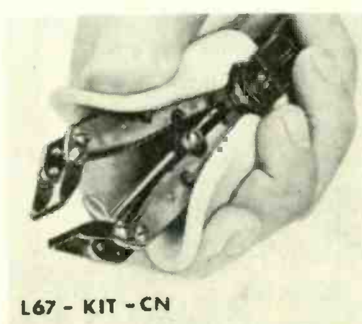

L67 - KIT - CN

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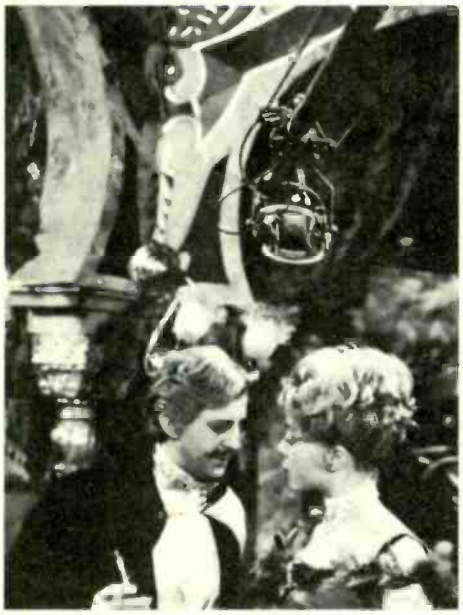
Wireless World

Electronics, Television, Radio, Audio

Fifty-eighth year of publication

April 1968

Volume 74 Number 1390



This month's cover. *The tête-à-tête being overheard by a microphone, a scene from a production at the B.B.C. Television Centre, prettily introduces two features in this issue: 'Developments in Microphones' by H. D. Harwood (p. 58) and a microphone supplement. The microphone on the boom is a moving-coil type with a cardioid characteristic, a kind used extensively in television work.*

Iliffe Technical Publications Ltd.,
Managing Director: Kenneth Tett
Editorial Director: George H. Mansell
Dorset House, Stamford Street, London, SE1

Contents

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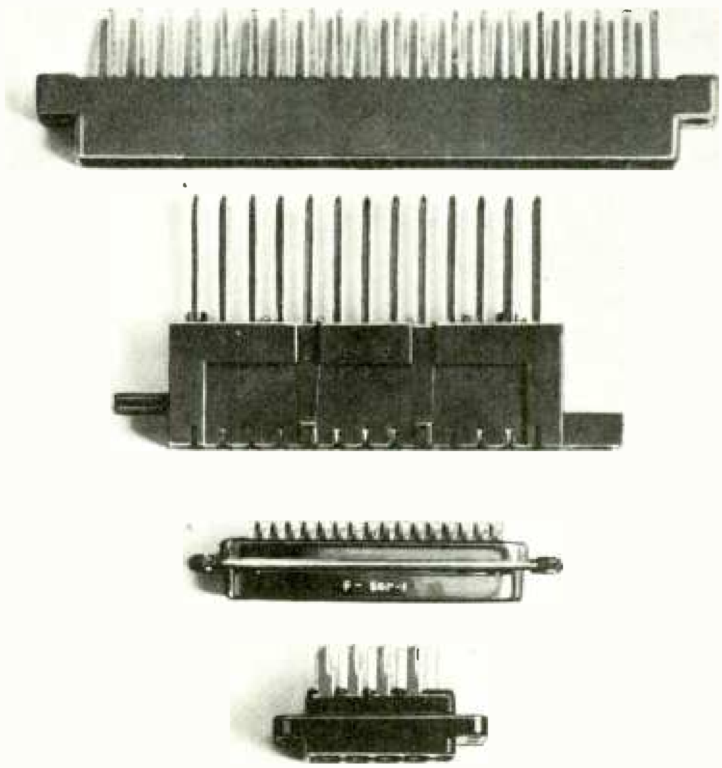

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–pioneers
of S.S.B and I.S.B
–announce the
newest in an
extensive range
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The new HYDRUS high quality low-cost H.F receiver for international point-to-point services

FREQUENCY RANGE 1.5 TO 30 MHz
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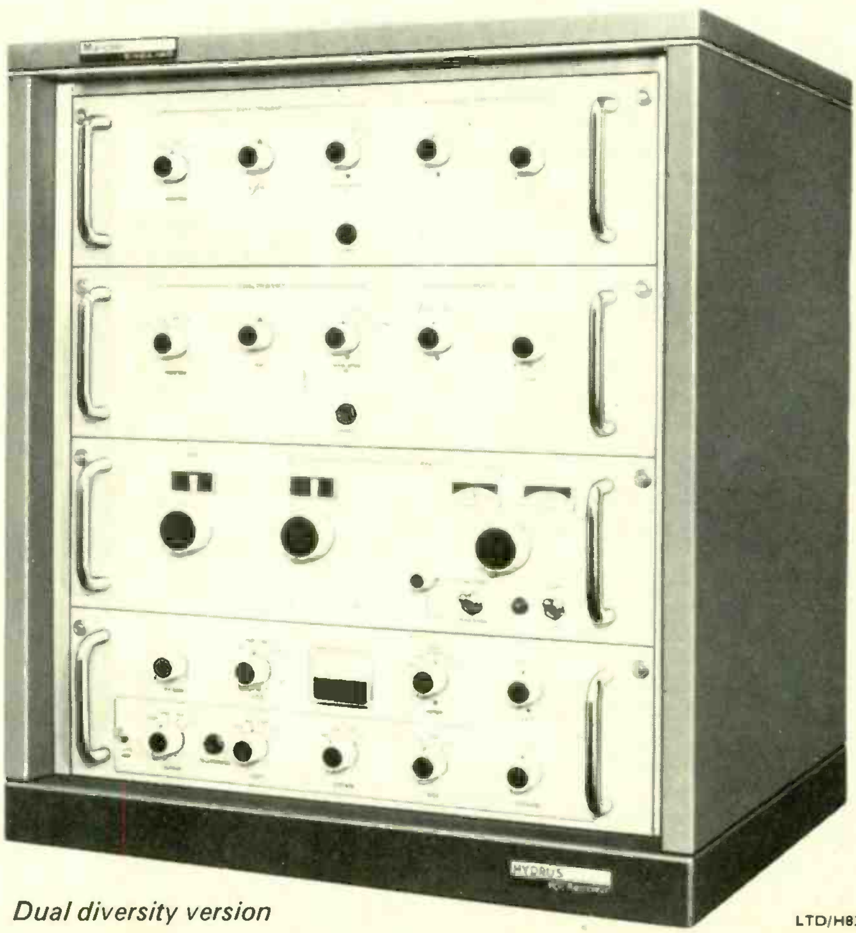

Dual diversity version

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HYDRUS offers

★ Exceptional versatility
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AN 'ENGLISH ELECTRIC' COMPANY

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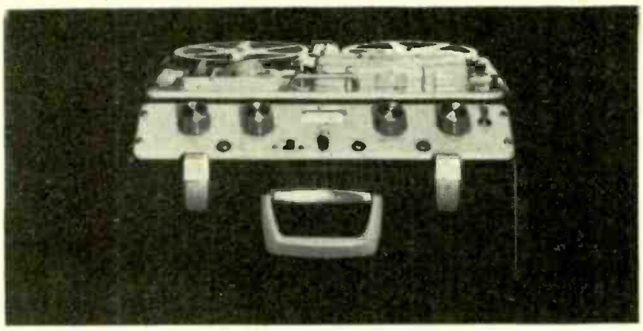
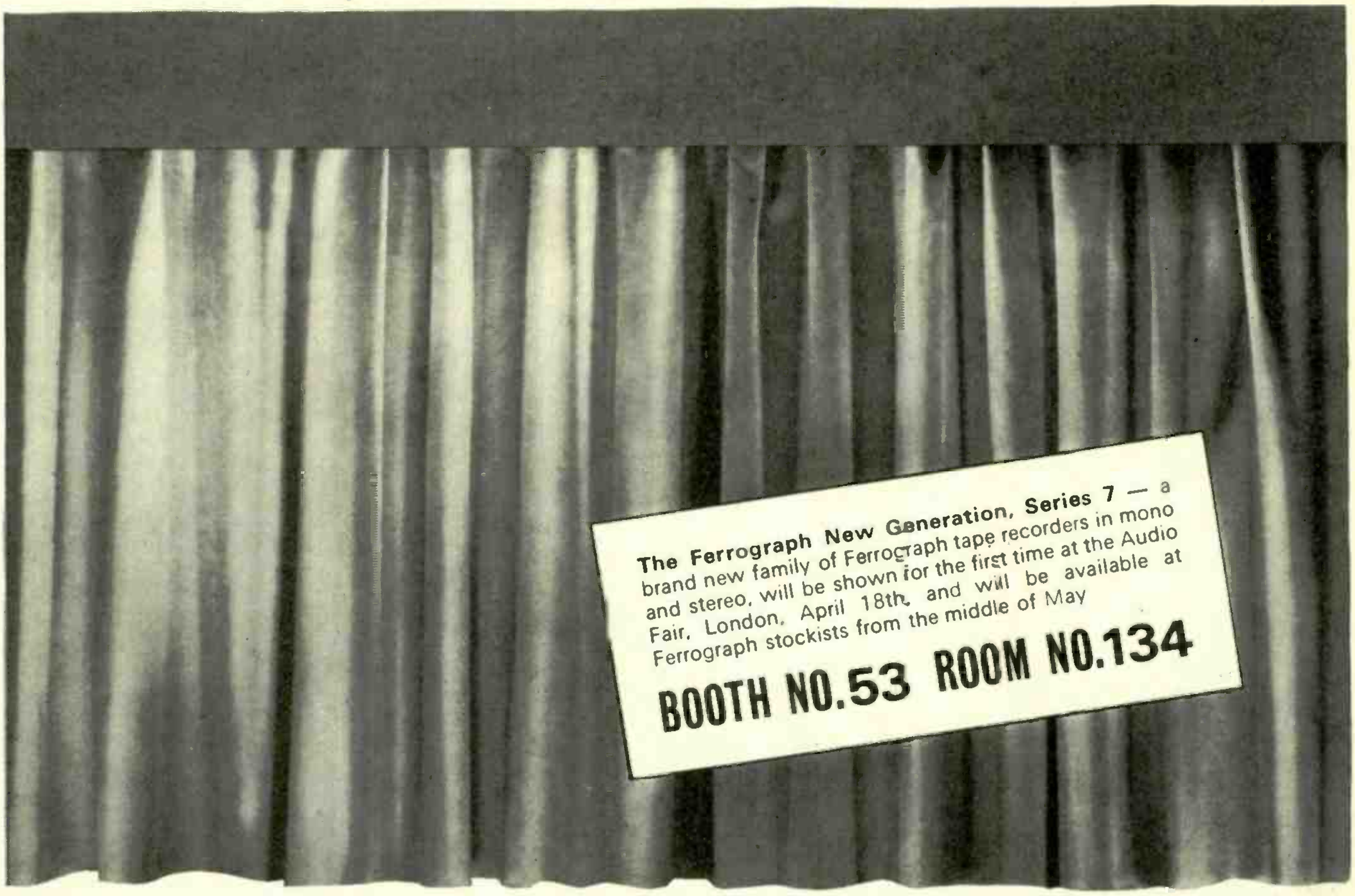
Ferrograph, 1949-1967



Now, another major event



See the new Ferrographs unveiled at the Audio Fair

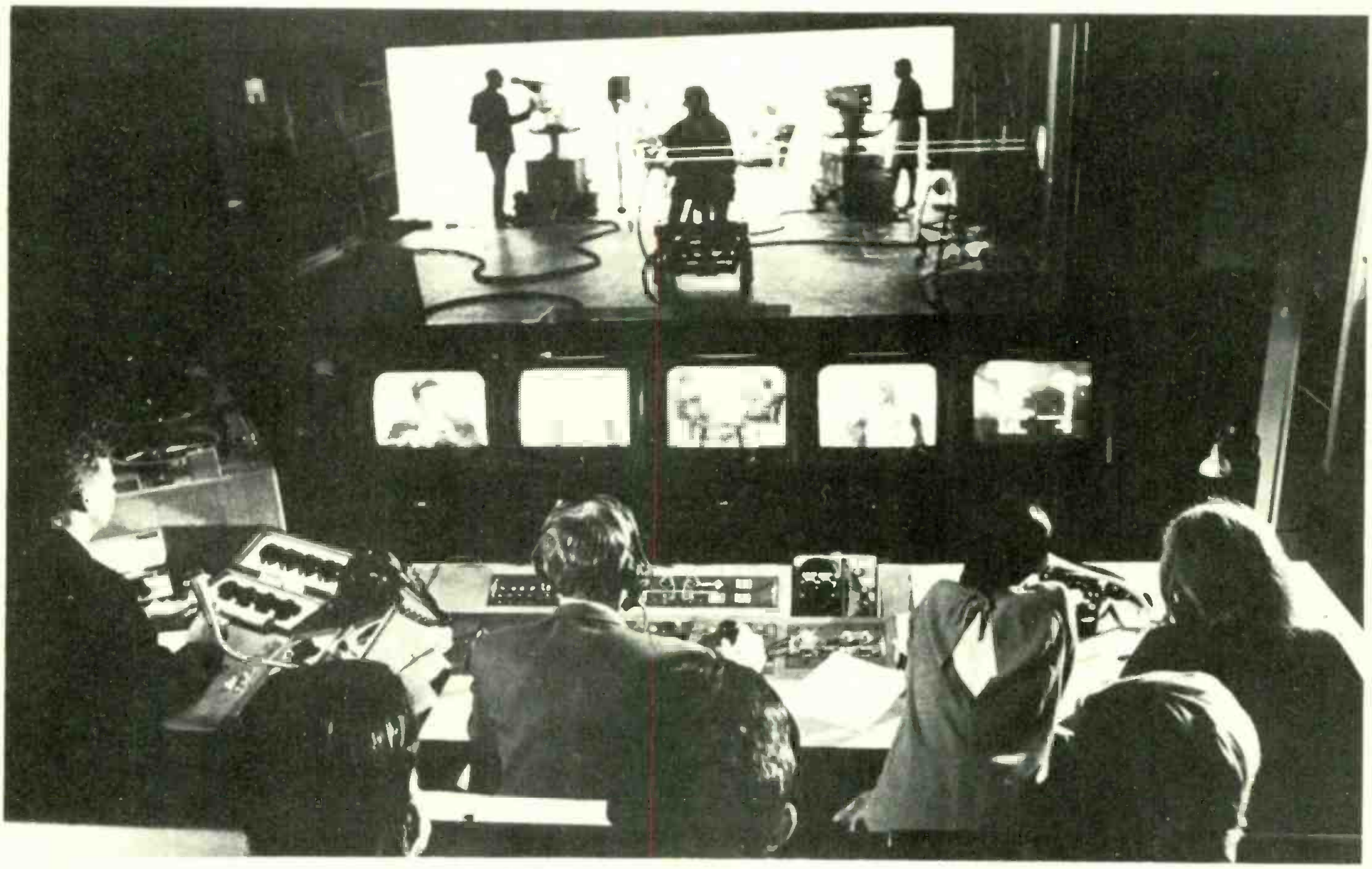
WW—109 FOR FURTHER DETAILS

BBC trains TV producers from overseas...

At the BBC's Overseas Training Studio at Woodstock Grove, Shepherds Bush, London, training courses are held for television producers, vision mixers and other overseas broadcasting staff. Many of the recordings made during these courses are on Scotch Helical Scan Video Tape. The use of video tape for the recording of training productions enables them to be played back immediately. In this way students can see the results of their work and benefit from criticism by professional producers and others. While these training productions are on closed circuit television, the BBC also makes use of Scotch 'Quadrature' Tape for many of its broadcast telerecordings.

The new Helical Scan Video Tape has an improved, low noise oxide formulation designed to give broadcast quality performance on helical scan equipment. The video signal-to-noise ratio can exceed 45 db. and drop-outs are considerably reduced. There are two types. Type 351 has a 1 mil. polyester backing with a 210 microinch oxide coating and is available in ½" and 1" widths. Type 350 has a 1 mil. polyester backing with a 450 microinch oxide coating and is available in 1" and 2" widths.

More details? Certainly—just complete and post the coupon below for VIDEO TALK publications and for 'Scotch' video tape data sheets.



3M MINNESOTA MINING AND MANUFACTURING CO. LTD.

Manufacturers of 'Scotch' Instrumentation Tape, Professional Quality Magnetic Tape, Quadrature and Helical Scan Video Tape, Computer Tape.

3M and 'SCOTCH' are trade marks of Minnesota Mining & Manufacturing Company

TO: MR. G. C. WRIDE, 3M HOUSE, WIGMORE STREET, LONDON W1

Please send me technical details and specifications on 'Scotch' Video Tape

NAME ....

ADDRESS ....

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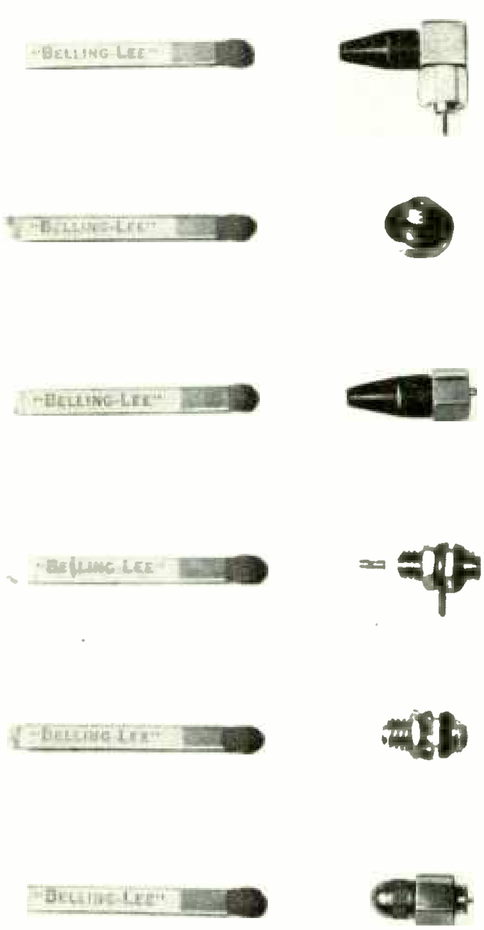
WW—110 FOR FURTHER DETAILS

Nothing matches Belling-Lee sub-miniature R F Connectors



- A low cost range of precision subminiature R.F. connectors.
- Impedance 50 ohms nominal.
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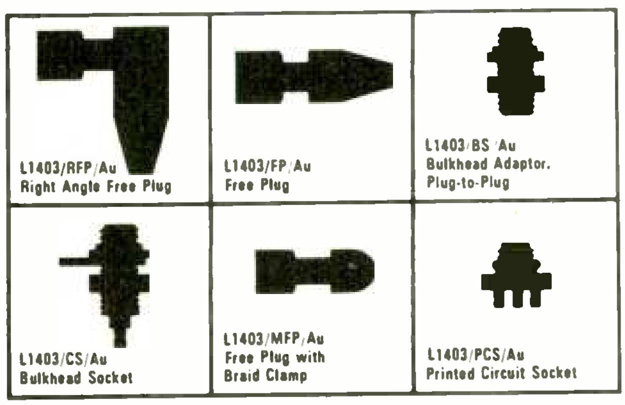
- Easily loaded with a variety of subminiature coaxial cables up to 0.067" overall.
- PTFE insulation and choice of gold or silver plated body.
- Three plugs and three sockets. Types available to suit all installation requirements.
- Available from stock.



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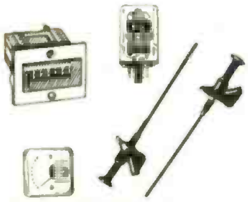
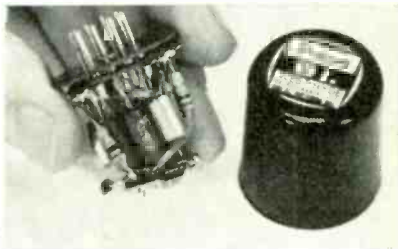
WH CONTIL AND PIDAM SYSTEMS



ACCESSORIES
A full range of accessories are available for PIDAM. Shown are the meter, scaled 0-9, at 35/6. Test prods insulated and flexible with fine steel clips at the tip, red or black at 13/-. High speed resetting counter including bezel and socket, with speed of over 40 operations per sec. 165/-. Plug-in Octal relay 24v. with two changeover at 17/6. Not shown. 8 range test meter, 45/-. Oscilloscope made for us by Advance, £25.

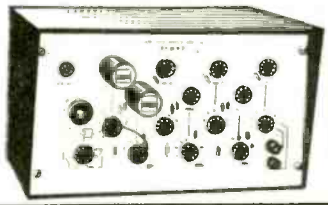
PIDAM (Plug-in Digital and Analogue Modules) perform all the usual logic functions, but, unlike other units, can be plugged in, using their B9A bases and can be quickly connected to the required configuration. To help learning, the module covers are easily removable for circuit examination and sets of components are available.
The 16 modules have an enormous range of use, from a single MONO for a tachometer, to over 300 units in a computer interface; nevertheless, their greatest asset is extreme simplicity. Design time is cut and elaborate breadboards superseded and any reader of "Wireless World" could with **PIDAM**, build up a low cost system for his own needs.

PIDAM PLUG-IN MODULES, PRICES
per module range from 9/6 to 28/- and all necessary accessories are supplied. A complete starting kit is only £20/19/6 (normally £23/12/6).

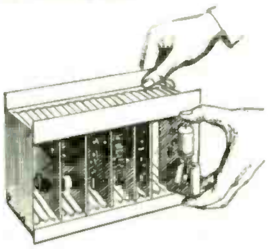


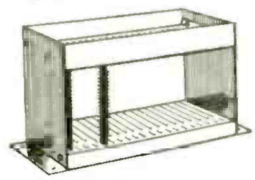
B1 (Bistable) module shows B9A base for ease of connection. Pins 7, 8, 9 are always power connections.

PIDAM BROCHURE
Send for this complete explanatory booklet showing detailed examples of use and circuit diagrams of all modules. Examples and circuits given include voice-operated switch alarms, flashers, tachometer, timers, batch counters, etc. 3/6 post free.



PIDEC
(Plug-in Digital Educational Circuit). This Pidec unit allows seven modules to be interconnected for demonstration or mock-up without soldering. Including internal power supplies. 370/-.





PRINTED CIRCUIT CHASSIS
Printed circuit chassis type "P" which fits into 1277 or 16127 case, or type "Q" which can be mounted on an aluminium chassis. Both types take up to 20 boards and connectors on ½in. centres. Prices from 45/6 down to 37/- for quantities.

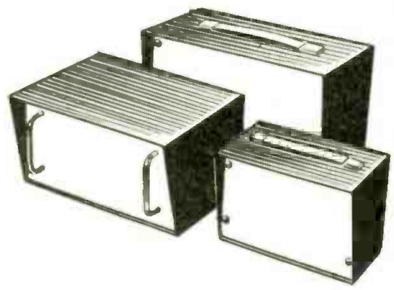
CONTIL CASES

Contil cases are mass-produced to give the lowest prices yet. In 21-gauge steel. Finished hammer blue, with 18-gauge front panel supplied with easy-to-strip protective covering for easy marking out. For ease of ordering Contil cases are described by their dimensions, i.e. 755 is 7×5×5in. Individually packed, inc. feet and screws.

Range of chromium-plated and Delrin handles available with matching chassis, spare Panels, etc.

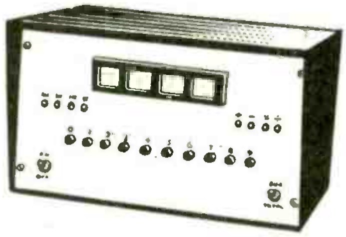
	ONE	FIVE
755	45/6	44/-
867 or 975	47/6	46/-
1277	53/-	51/-
16127	98/6	96/6
191010	133/-	130/-

Kit £11/19/- (normally £14/12/-).

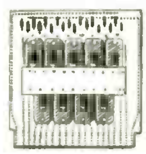


DIGITAL COMPUTER MODULES

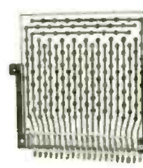
Digital computer modules are available including bistables flip flops comparators (coincidence gate) neon driver 5NOR 2NOR×2 5NAND, and RESET. Also available are neons for drive by transistors, display boards, divide boards, together with escutcheons that only require round holes.



DIVIDE BOARD
The Contil divide board can be used for decoding from 9 bistables giving a count up to 512. Includes resetting and decoding diodes and switches. Type "R" at 78/- each.



"A" board shows plugged into "M" 20-way connector with "S" board supports. Note: Power supply rails at right angles to signal rails "A" boards 8/6 each. 20-way "M" connector 9/-. "S" supports 3/- pair. Less for quantities.

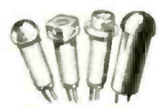


CONTIL LOW COST PRINTED CIRCUIT BOARDS

	ONE	TEN	FIFTY
Standard transistor board	8/6	7/6	7/-
Half board B9A	7/-	5/6	4/6
B7G or B9A boards inc. their four respective bases	9/6	8/6	8/-
Connectors, 20-way	9/-	8/6	8/-
10-way	5/-	4/6	4/-
"P" chassis to fit 1277 Contil	39/6	37/6	37/-

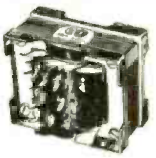
Printed circuit kit: including case, normally £14/8/6 for only £11/19/6.

We now supply Brightlife Fluorescent Starter Switches direct in minimum quantities of 50 off for 50/- C.W.O. only. Quantity prices down to 7d. As supplied to leading manufacturers in large quantities.

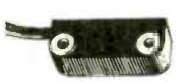


"BRIGHTLIFE" NEONS
25,000 hr. average life with high intensity and resistor in housing; either ⅜in. or ½in. dia. Standard units 160-250v. with 6in. lead variants. 10 at 2/6 each with 10 different caps. In quantity down to 1/8 each. Neon only, down to 5½d. each.

We now supply our standard neons in 110 volt nominal at the same prices.



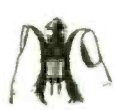
TRANSFORMERS
Two West Hyde transformers are available for transistorised equipment, one at 2 amps giving 6, 10, 15, 18 and 30v i.e., 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 with 12-0-12 and 15-0-15. The second at 1 amp. 6, 10, 18v. taps. Price 37/6 and 26/-. Additional type available, providing 2 amps as above and in addition supplies 100mA at 150, 80, 0, 80, 150 volts to supply indicator tubes, etc. Price 50/-.



REED SWITCH
The West Hyde Reed Switch works at up to 2,000 times a second for more than fifty thousand million operations. Ideal for: over and under speed monitors, counting, timing, switching, rev counting, etc. Hermetically sealed and moulded. Prices from 14/- each to 8/- each per thousand.

We now supply Q-Max sheet metal punches in ⅛in. sizes up to 1¾in. and ¼in. sizes up to 2in.

SUB-MINIATURE NEON



The smallest yet. Type "Q" overall dia. 5/16in., body length 7/10in. with resistor for mains, 3/6 each. Minimum quantity 10. Down to 2/9 each.

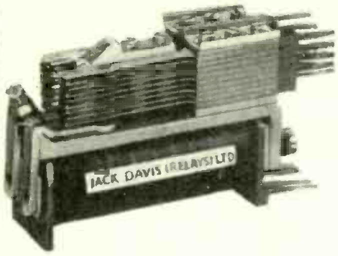
PLEASE NOTE
All products ex-stock for normal quantities. Return of post service. No S.A.E. Minimum order £1. Fully detailed leaflets available. All prices include postage and packing.

WH WEST HYDE

WEST HYDE DEVELOPMENTS LTD.
30 HIGH STREET, NORTHWOOD, MIDDLESEX
Tel: Northwood 24941

WW—114 FOR FURTHER DETAILS

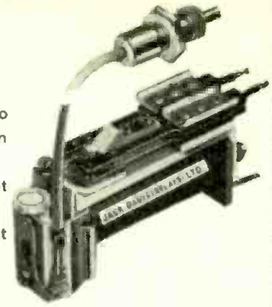
D.C. RELAY TYPE. R.3. TWIN



Twin coils and armatures. Two completely independent relays in one. A space and money saver!

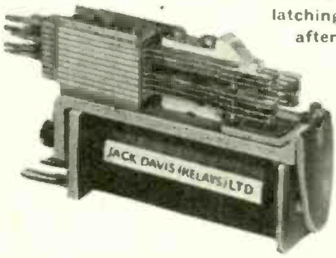
MECHANICAL RELAY LATCH

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.



RELAYS

THE REMANENCE RELAY



This is a 3000 type relay capable of latching in the energised position after the supply is removed until a suitable releasing current is applied in the opposite direction. This releasing current is controlled with a single coil, by reducing the operating current in reverse or with a double coil, via a pair of contacts employed on the relay to energise the second coil.

ELECTRO-MAGNETIC COUNTERS

MAJOR TYPE 6" × 1½" × 1 $\frac{3}{16}$". Counts when coil is energised. 3V DC—220V DC. Speed approx. 8 per second.

MINOR TYPE 4⅜" × 1" × 1". Counts when coil is de-energised 3V DC 110V DC Speed approx. 10 per second.

JACK DAVIS (RELAYS) LTD. 9/10, Mallow Street, London, E.C.1 Telephone: CLErkenwell 3661-2

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Floodlights, aerial arrays, flue stacks;
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Unifab Structures—the Tower People—provide uplift, easy on £. s. d.

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Phone: 051-546 3401.

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TELETON COMES TO THE U.K.

Already highly successful in Belgium, Germany, Switzerland, Holland, France, and Italy, we now proudly present the finest integrated Solid-State Hi-Fidelity Equipment for your approval. Ultra-modern designs have been created according to European technical standards and popular requirements. These outstanding products are supplied exclusively to us by MITSUBISHI Shoji Kaisha of Japan.

Superbly styled in oiled walnut, TELETON Tuner/Amplifiers include AM/FM Multiplex facilities, comprehensive filters, four inputs and up to fifty watts RMS output, at prices to suit even the most modest pocket.

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In addition there are over fifty other TELETON products in the range including Stereo Tape Recorders, Cassette Recorders, Transceivers, Stereo Loudspeakers, etc., competing favourably in quality and price. A home based Service Department implements a full 12 months Warranty.

TELETON units are available from high-class specialist dealers, or from selected wholesalers. Brochures and price lists are available to bona-fide trade enquirers. A display of our products may be seen in our Showroom by arrangement.

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Telephone: 01-636 6491

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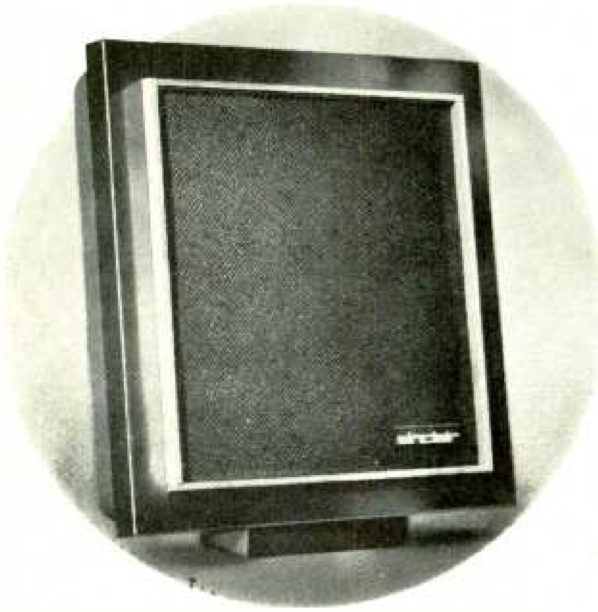
HIGH-FIDELITY DESIGNS FROM SINCLAIR



A BRILLIANTLY EFFICIENT LOUDSPEAKER

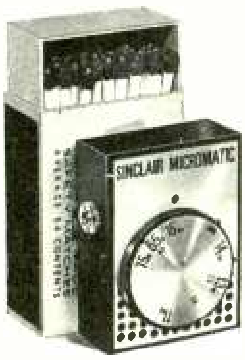
When Sinclair Radionics decided to design and manufacture a new loudspeaker, it was required from the start that its performance should be worthy of to-day's best high fidelity standards and be so reasonably priced that the greatest numbers could afford it. By using ultra-low resonant materials to form its acoustically contoured housing, outstandingly brilliant performance resulted. Furthermore, the unusual form of the Q.14 meant it could be used as a free-standing shelf speaker, as a wall-corner sound radiator or flush mounted singly or in multiple units on a flat surface such as a wall. The correctness of the design of the Q.14 has amply proven itself since within a few months of its introduction, it is already amongst the four most demanded loudspeakers irrespective of price. Independent laboratory tests have already shown that the Q.14 has amazingly good performance characteristics. As a judge of good sound yourself, your ear will confirm this instantly. At its price, there is nothing to stop you changing to Sinclair at once.

- **RESPONSE—Exceptionally smooth from 60 to 16,000 Hz**
- **MAXIMUM LOADING—In excess of 14 watts.**
- **IMPEDANCE—15 ohms.**
- **SIZE AND FINISH—9½in. square × 4½in. deep. Matt black with solid aluminium bar embellishment.**
- **ALL-BRITISH MANUFACTURE**

Tested and guaranteed in fitted carton. (Your money and postage refunded if not satisfied.)

£6.19.6

SINCLAIR MICROMATIC



the smallest radio in the world

. . . PLAYS ANYWHERE

As easy to take with you as the wrist watch you wear. The Micromatic is amazingly powerful and better than ever in quality now that its output feeds to the hi-fi quality magnetic earpiece supplied with it. It tunes over the medium wave band bringing in RADIO 1 and many other stations to make it the best of all personal radios ever. This smaller-than-a-matchbox radio is in a tiny black case with aluminium front panel and matching slow-motion tuning control.

Complete kit with ear piece, instructions, etc. **49/6** *Ready built with earpiece.* **59/6**

MALLORY MERCURY CELL RM.675 (2 required) 2/9.

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Should you not be completely satisfied with your purchase when you receive it from us, your money will be refunded in full at once and without question. **FULL SERVICE FACILITIES AVAILABLE TO ALL SINCLAIR PURCHASERS.**

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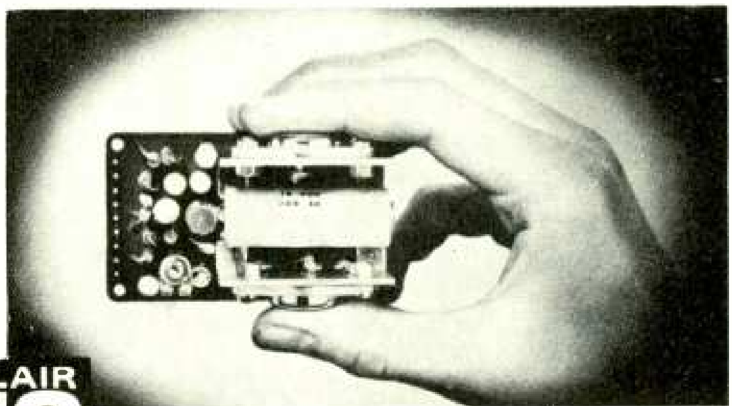
IDEAL FOR BATTERY OPERATION



SINCLAIR Z.12

COMBINED 12 WATT HI-FI AMP & PRE-AMP

No contructor's transistor amplifier has ever achieved such success as the Sinclair Z.12. It favours the user in so many ways—with fantastic power-to-size ratio, with far greater adaptability, with freedom to operate it from batteries or mains power supply unit (the new PZ.4 is ideal for this) and with the opportunity to obtain superb stereo reproduction for very little outlay. Countless thousands of Z.12s are in use throughout the world in hi-fi installations, electronic guitars and organs, P.A. installations, intercom, systems etc. This true 12-watt amplifier is supplied ready built, tested and guaranteed together with the Z.12 manual which details a number of control circuits enabling you to match the Z.12 to your precise requirements. For complete listening satisfaction, use your Z.12 system with Q.14 loudspeakers. It assures superb quality with substantial savings.

Built, tested and guaranteed. **89/6**

SINCLAIR STEREO 25

De luxe pre-amp/control unit for Z.12 or other stereo systems. Brushed and polished aluminium front panel 6¼in. × 2¼in. Ready built. **£9.19.6**

PZ.4 STABILISED HEAVY DUTY POWER UNIT

Designed specially for Z.12 assemblies. Delivers 18 V.D.C. at 1.5 amps. from A.C. mains supply. **99/6**

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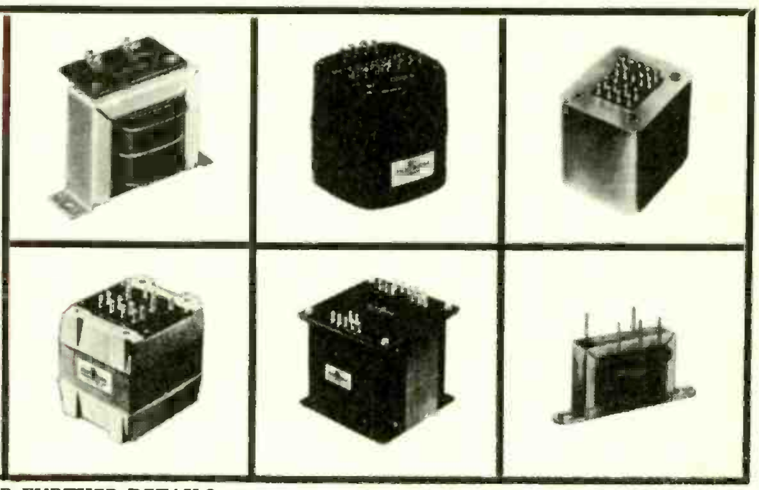

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Now available 1968 Data Book

136 pages of data, including for the first time, colour-coded sections for quick reference—covering comparables and equivalents and all current Mullard semiconductors, valves, tubes and components for Radio, TV, Audio and HiFi applications.

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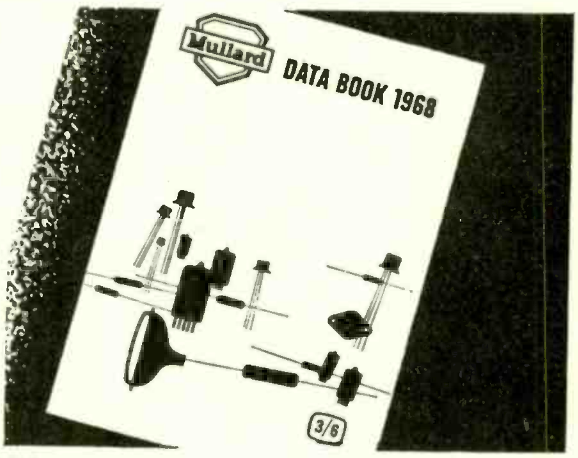

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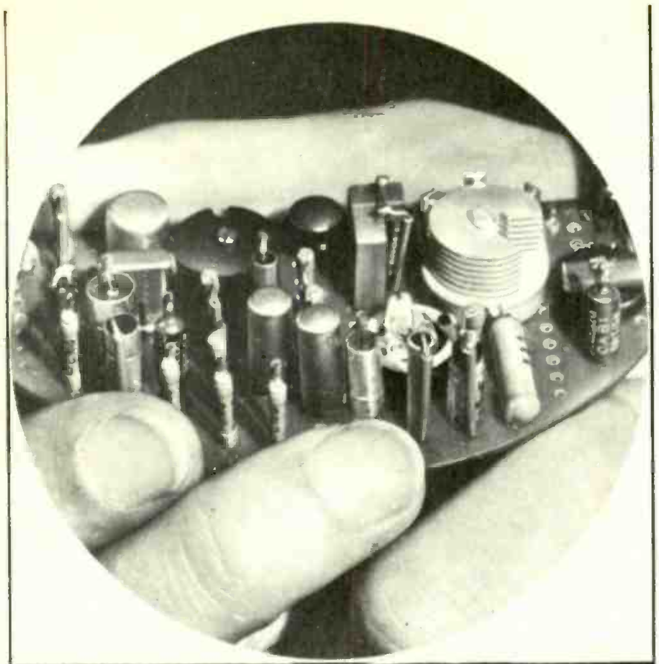

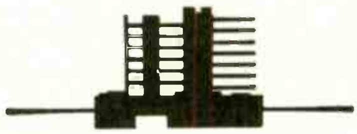

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'Take any Audio Technica Cartridge . . . and you take an important step towards PERFECTION in Stereo Reproduction'

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8 BUSH LANE, CANNON STREET, LONDON, E.C.4. Telephone 01-626 4711

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These comprise two crystal controlled AM receivers and can be operated independent of each other on one spot frequency in the band 60-100 Mc/s., with built-in monitor speaker. They are housed in one metal cabinet, size 21½ × 12½ × 18½in. and ready for immediate mains operation (200-250 v. 50 c/s.). Supplied BRAND NEW in original crate, complete with spares and manual, £20. Carr. 50/-.
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BC-221 FREQUENCY METERS
Complete with crystal and valves. In perfect working order but WITHOUT calibration charts. £9/19/6. Carr. 10/6.

X'TALS
100/1,000 Kc/s. 10X size 3-pin, as used in Class D Wavemeter. Brand New, boxed. 21/- each. Post 1/-.
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MARCONI TF-801A/1. Covers 10 to 310 Mc/s. (4 bands). DIRECTLY calibrated. Int. Mod. at 400, 1,000 and 5,000 c/s. Attenuated or force output. Guaranteed overhauled, accurate and in perfect working order. £35. Carr. £1.

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MARCONI TF-195M. Covers 10 cps. to 40 kc/s. in two sweeps. 0 to 20 kc/s. and 20 to 40 kc/s. Output 2 watts into 600 or 2,500 ohms. Panel meter indicates output voltage. A.C. mains operation 100 to 250 volts. First class condition. Fully tested. £20. Carr. 30/-.

AMERICAN HEADSET TYPE HS-30-U 600 impedance. BRAND NEW and boxed, 15/-. postage 2/6.

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MARCONI TF-142E. This instrument measures the percentage of total harmonic distortion in the fundamental frequency range 100 to 8,000 c/s. The lowest scale engraving is 0.05%. Will handle 2 watts (continuous) and will give satisfactory readings with only 1 mW input. Mains operated. Output impedance 600 ohms. Very good condition. £29. Carr. 20/-.

MICROAMMETERS
R.C.A. 0-500 microamps. 2½in. circular flush panel mounting. Dials are engraved 0-15, 0-600 volts. As used in the American version of the No. 19 set. BRAND NEW and boxed 15/-. P. & P. 1/6.

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Knobs, Medium size, Set of 8	10/-
Knobs, Large size	5/6
Condenser (3×4 mfd.). Post 4/6	12/6
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MINIATURE RELAYS
240 v. A.C. coils. Contact assembly "makes" and 1 C.O. 5 amps. Size 2×1⅞×1in. Unused and removed from brand new equipment 8/6 post paid.

MOVING COIL PHONES. Finest quality Canadian with chamois ear-muffs and leather-covered headband. With lead and jack plug. Noise excluding and supremely comfortable. 22/6. As above but complete with moving coil microphones 25/-. DLR-5 Low impedance headphones with attached throat microphone. 12/6. All these items BRAND NEW. Postage extra 2/6.

CINTEL NUCLEONIC SCALERS
Nos. 36402 and 36411. Unused with handbook. List Price £300/£320. Our Price £65.

PACKARD-BELL PRE-AMPLIFIER
Fitted with 6SL7GT and 28D7 Valves. Brand new and boxed with manual. 12/6. Postage 4/6.

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H1B Audio Signal Generator	**£30**	**0**
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TT1S Transistor Tester	**£37**	**10**
VM76 AC/DC Valve Voltmeter	**£72**	**0**
VM77C AC Millivoltmeter	**£40**	**0**
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VM79 UHF Millivoltmeter (transistorised)	**£125**	**0**

These are current production, manufactured in U.K. by Advance Electronics Ltd. (not discontinued models). Showing a saving of approximately 33⅓% on nett trade price. BRAND NEW, all in original sealed carton. Carr. 10/- extra per item. Special offer of 10% discount for schools and technical colleges, etc.

WIRELESS SET No. 76
A compact CW only crystal controlled transmitter. Consists of a Pierce crystal oscillator (807) and a Power Amplifier (807). Both are cathode keyed by means of a relay. Six switched crystal channels are available in the frequency range of 2 to 12 Mc/s. (Crystals not included.) Aerial current is indicated on a panel meter and two spare valves are supplied. Operates from 12 v. car battery via internal rotary transformer. RF output 9 watts. Contained in steel case 12×12×8in. Weight 30 lbs. Ideal for 80 or 40 meters or cheap enough for breakdown. Good condition and working order. Circuit included. £4/5/-. Carr. 10/-.

HRO RECEIVER £30
The octal valve version. In mint condition. Complete with all nine general coverage coil sets covering 50 kc/s. to 30 Mc/s. Instruction Booklet and circuit, but less external power supply. Carriage 30/-. Complete manual available at 30/- extra.

PRICES NOW REDUCED CINTEL EQUIPMENT. ELECTROLYTIC CAPACITANCE AND INCREMENTAL INDUCTANCE BRIDGE No. 36601
A modern instrument, all solid state, which accurately measures the capacity of electrolytic condensers from 0.1μF to 1,000μF under operating conditions. Leakage current and polarizing voltage are separately metered. Inductances from 100 mH to 100 H can also be measured with current up to 100 mA. A.C. mains operation. Unused with handbook. List price £220. Our Price £70.
WIDE RANGE CAPACITANCE BRIDGE. No. 1864. A matching instrument to the above. All solid state. Mains operation. Measures from 0.002pF to 100μF. Unused with handbook. List Price £250. Our Price £75.

MARCONI TEST EQUIPMENT
PORTABLE FREQUENCY METER TYPE TF.1026 SERIES
TF.1026/4 2,000/4,000 Mc/s., TF.1026/5 1,800/2,200 Mc/s., TF.1026/6 3,800/4,200 Mc/s., TF.1026/7 1,700/2,100 Mc/s., TF.1026/9 2.425/2.525 Mc/s. £40 each.
WIDE BAND MILLIVOLTMETER TYPE TF.1371
100μv to 300 mv in five ranges. 30 c/s. to 30 mc/s. £45.
VACUUM TUBE VOLTMETER TYPE TF.1300
A.C. measurement 0.05 to 100 v., 20 c/s. to 300 Mc/s. D.C. measurement 0.1 to 300 v. Each over 5 ranges. Will also measure ohms, 50Ω to 5mΩ in 2 ranges. £45.
SENSITIVE VALVE VOLTMETER TYPE TF.1100
100μv to 300 v. A.C. in 12 ranges. 10 c/s. to 10 Mc/s. Can also be used as a wide-band amplifier. £50.
DELAY GENERATOR TYPE TF.1415.
Provides sweep-delaying facilities when used in conjunction with the TF.1330 (series) or similar oscilloscope. Alternatively, it may be used independently as a general purpose delay generator. £35.

TF.867.A	Standard Signal Generator	£200
TF.890.A/1.	R.F. Test Set	£150
TF.1020.A/2	R.F. Power Meter	£50
TF.1066.B/2	U.H.F. F.M. Signal Generator	£200
TF.1067	Heterodyne Frequency Meter	£65
TF.1102	Amplitude Modulator	£40
TF.1221	Heterodyne Unit	£125
TF.1274	V.H.F. Bridge Oscillator	£40
TF.1275	V.H.F. Bridge Detector	£40
TF.1350/1	Power Unit for TF.1346/1	£40
TF.1400	Double Pulse Generator	£100

Detailed technical specifications supplied upon request. Offered BRAND NEW at fraction of original cost.

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Shop hours 9-6 p.m. (9-1 Thursday). Open all day Saturday.

PCR-1 RECEIVERS
Covers 860-2080 metres, 190-570 metres, 5.6-18 Mc/s. 1 R.F. and 2 I.F. stages, 6 valves. Internal speaker, requires external Power supply. Circuit supplied. Fully tested prior to despatch. £7/19/6. Carr. 10/6. Fuller details upon request. Brand new external Power Supply Units, Vibrator Unit for operation from 12v. car battery, for caravans or boats 15/6 or A.C. Mains Units £2. Carr. 5/6.

AR.88 VIBRATOR POWER SUPPLY UNIT. Operates from 6-8 volt D.C. supply. Output 300 volts, 90 ma. Brand new, boxed, complete with leads. 15/-. postage 7/6.

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12 volts D.C. 4 amps output. A.C Mains operation 200-245 volts 50 c/s. Brand new. Boxed, £20. Carriage 10/6.

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SIGNAL GENERATOR CT-218 (FM/AM). MARCONI TF 937.
Covers 85 Kc/s. to 30 Mc/s. in 8 switched ranges. Effective length of film scale is 50ft. Output level variable in 1 dB steps from 1μV to 100mV (75Ω). Also 1V Outputs down to 0.1μV from an outlet at 7.5Ω. Int. mod. at 400 c/s., 1 Kc/s., 1.6 Kc/s. and 3 Kc/s. FM at frequencies above 394 Kc/s. Variable mod. depth and deviation. Crystal calibrator 200 Kc/s and 2 Mc/s. Monitor speaker for beat detection. Fully metered, blower cooled, Panclimatic. A.C. mains 100 to 150 and 200 to 250 volts, 45 to 100 c/s. 17 × 20½ × 17½in. Weight 117 lbs. Fully tested and guaranteed. Fraction of original cost. £65. Carr. 50/-.

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T.C.C. METALMITE 350 v. D.C. wkg. 0.1 mfd. (CP37N); 0.05 mfd. (CP35N); 0.91 mfd. (CP.32N) all at 5/6 doz. or 32/6 per 100.
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Primary 5.5 kV. Secondary 22 kV. 0.5 to 2.5/sec. Pulse. Brand new and boxed £5. Postage 7/6.

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Non inductive. 4 decades—70,000 ohms resistance. Accuracy 0.01%. 350 v. maximum voltage. Brand new and boxed. £30. Carr. 10/-.

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Vacuum impregnated, interleaved. E.S. screen, universal mounting. Size 4 × 3½ × 2½in. ALL BRAND NEW. 24/- each. Post 4/6.
Type 1. 250-0-250 v. 80 mA. 6.3 v. 3.5 a., 6.3 v. 1 a., tapped at 2 a.
Type 2. As above but 350-0-350 v. 80 mA.
Type 3. 30 v. 2 a., tapped at 12, 15, 20 and 24 v. to give 3-4-5-6-8-9-10 v., etc.
Type 5. 0-6-9-15 v. 4 a. Ideal for chargers.

LOW CAPACITANCE BRIDGE
MARCONI TF. 1342. Range 0.002 pF. to 1,111 pF. Accuracy 0.2%. Three terminal transformer ratio arm bridge allows "in situ" measurements. Internal oscillator frequency 1,000 c/s. 12 × 17 × 8½in. Weight 15¾ lbs. A.C. mains 200 to 250 and 100 to 150 v. 40-100 c/s. With leads and handbook. **ABSOLUTELY BRAND NEW.** List Price £120. Our Price £45.

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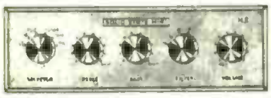
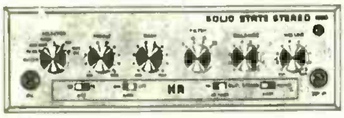
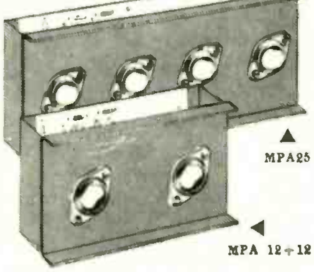
POWER AMPLIFIERS — PRE-AMPLIFIERS
POWER SUPPLIES—BRITISH MADE



MP3

SP6-2





MPA25

MPA 12+12

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★ A	5 watt mono for 3 to 5 ohm speakers	£10.3.0
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★ 8	20 watt mono/stereo for 12 to 16 ohm speakers.	£24.0.0
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Ask for Brochure 15.

6-Transistor MW/LW Car Radio 12 volt operated. 3 watt output. Push-button, wavechange. Supplied built, boxed, ready to use with Speaker and Baffle. Car fixing kit and manufacturers' current guarantee. Special Bargain Offer. Positive or Negative Earth. De Luxe Five Push-button version £11/19/6. PP 4/6

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BUILD A QUALITY TAPE RECORDER WITH MARTIN RECORDAKITS

★ TWO-TRACK Deck £10/10- Amplifier £14/19/6. Cabinet and speaker 7 gns. Complete kits with MICROPHONE and 7in. 1,200ft. tape, spare spool. Today's Value. £45 **29** Gns. P.P. 18/6

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GARRARD DECKS

all the LATEST MODELS

COMPLETE RANGE IN STOCK FROM **£5.19.6**

Send for illustrated Brochure 16&17

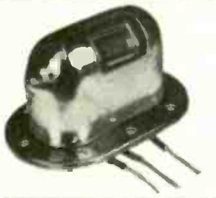
SERVICES TYPE 4185 SOUND RECORDING APPARATUS

(Boosey and Hawkes Model 49)

Complete wire recorders primarily designed for aircraft use but suitable for any 21 or 29 volt 1.4 amp. D.C. supply. Supplied complete with wire and Instruction Leaflet.

Brand New 89/6. Carriage 5/- ½ lb. Reels of Wire 15/-.

GRAVINER FIRE DETECTOR UNIT



Containing 931A Photo Multiplier and Network with Cold Cathode Relay—totally enclosed in metal case $4 \times 3 \times 2\frac{1}{2}$in. Original price £74.

OUR PRICE, BRAND NEW £6 each, with data sheet. Limited quantity available.

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15 WATT
Input 12-14 volts D.C. at 2 amps. Output 240 volts 50 c/s 15 watts Transformer TT51a.

40 WATT
Input 12-14 volts D.C. at 5 amps. Output 240 volts 50 c/s 40 watts or 300 volts about 7-8 watts. Transformer type TT57.

● COMPLETE KIT OF PARTS WITH CHASSIS & HEATSINKS

15 WATT	40 WATT
67/6	97/6
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Also READY BUILT AND TESTED 128 gns. Deferred terms available. DEPOSIT £36.8.0 and 12 monthly payments of £9. Total £144.8.0.

KIT of PARTS Deferred terms: DEPOSIT £29/19/- 12 monthly payments of £7. TOTAL COST £113/19/-. ORGAN COMPONENTS We carry a comprehensive stock of organ components for TRANSISTOR AND VALVE FREE PHASE designs. Brochure 10.

TOTAL COST TO BUILD 99 GNS.

★ Build this instrument stage by stage in your own home.
★ A truly portable instrument for all enthusiasts.
★ Fully TRANSISTORISED POLYPHONIC, British design.
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COMPLETELY NEW 1968 LIST OF 1000 types available from stock. Send for your FREE COPY TODAY (List No. 36).

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24 page Illustrated Brochure as above including CIRCUITS & DATA LISTING 2000 DEVICES, 1/- post paid.

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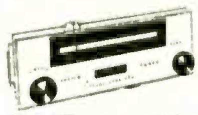
MARTIN FM TUNER



- Mullard 6-Transistor design.
- Tuning range 88 to 108 Mc/s.
- Response 30 c/s to 15,000 c/s.
- Automatic frequency counter.
- Factory built and aligned units—just interconnect.
- 9 Volt Battery Operated. (12 mA)

Send for Brochure No. 8.
Total cost £14/14/-. P.P. 2/6

FOR USE WITH ANY VALVE OR TRANSISTOR AMPLIFIER

BUILD A:—
INTEGRATED CIRCUIT F.M. TUNER

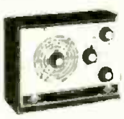
Using the R.C.A. CA3014 Module utilising 15 transistors and diodes. **Total cost of all parts 99/6, post 2/6** Circuit and layout diagrams 1/- (free with parts). Ask for List 40A.

PRECISION WIREWOUND GEARED PRESET CONTROLS

Gearing approximately 46 turns of end screw to cover full track. Low noise.
Full sealed with 3-lead out wires or tags and two hole fixing. Overall size $1\frac{1}{2} \times \frac{1}{2} \times \frac{5}{8}$in. Made by M.E.C. Ltd.
SIZES AVAILABLE
10, 20, 50, 100, 200, 250, 500 ohm. 1K, 2K, 5K, 10K, 20K, 25K, 50K, 100K ohm. 10/- each.

SALFORD 193A XTAL CHECKER

110/250v A.C. In new condition. £12.10.0 plus carriage 10/-

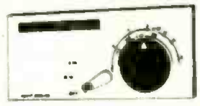


NEW MODELS
NOMBREX
TRANSISTORISED
Test Equipment

MODEL	PRICE	Leaflet No.
22 Power Supply	£14	22
30 Audio Generator	£19/10/-	24
31 R.F. Generator	£12/10/-	25
32 C.R. Bridge	£10/10/-	26
33 Inductance Bridge	£20	29
27 Signal Generator	£10/10/-	14
66 Inductance Bridge	£18	14

Send for descriptive illustrated Brochure
All units POST PAID including Battery

M&/LW QUALITY TRANSISTOR RADIO TUNER



Ask for Brochure 5

Fully tunable superhet with excellent sensitivity and selectivity. Output up to ½ volt peak. Complete with front panel, etc. 9 volt operated. For use with any amplifier or tape recorder.

TOTAL COST TO BUILD **£3.19.6** P.P. 2/6

VHF FM TUNER

87/105 Mc/s Transistor Superhet. Geared tuning. Terrific quality and sensitivity. For valve or transistor amplifiers. $4 \times 3\frac{1}{2} \times 2\frac{1}{2}$in. Complete with dial plate. 5 Mullard Transistors, plus 4 Diodes. Ask for Brochure 3.

TOTAL COST TO BUILD **£6.19.6** P.P. 2/6

FM STEREO DECODER

7 Mullard Transistors, Printed Circuit Design with Stereo Indicator. For use with any valve or transistor FM. Uses pot cores to Mullard design and ger. and silicon transistors.

As used by B.B.C. and G.P.O.

COMPLETE KIT PRICE **£5.19.6** P.P. 2/6

Ask for Brochure 4.

PORTABLE GEIGER COUNTERS

FOR MEASUREMENT OF RADIO-ACTIVITY. Supplied complete with instructions, haversack, cables and probe. List price £70. **OUR PRICE, NEW, TESTED,** COMPLETE WITH BATTERIES

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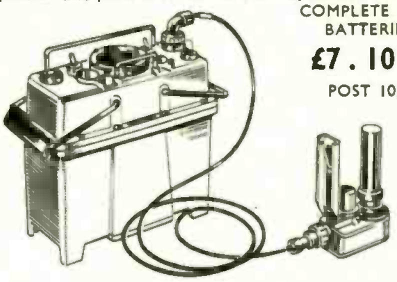
POST 10/-.



SPARE BATTERIES 15/- PAIR. POST 5/-

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★150 pages of components and equipment.

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Lasky's Radio

DON'T MISS THIS!

Lasky's Birthday Draw

The following 85 numbers have been drawn for prizes in our 35th Birthday Draw. Please refer to Page 12 of our Catalogue for details of entry if your number (on the Front Page of your Catalogue) is among those listed here:—

000013	001333	002101	006768	021414	028455	030844	038212
000092	001415	002230	006900	021444	028490	030982	039414
000823	001510	002313	011717	021500	029030	031010	039565
000899	001582	002414	012603	023466	029131	032013	043472
000927	001711	002479	012777	024444	029444	033417	046782
000929	001777	003060	013626	024818	029686	034111	047111
000974	001800	003166	013750	024950	029875	034717	047388
001054	001900	005000	015000	026515	029900	035900	048001
001274	001911	005016	016001	027000	029999	036000	
001288	001922	005161	019020	027009	030166	037017	
001292	001991	005615	020003	028010	030744	038111	

The first 10 correct entries to be opened will receive £5 Lasky's Gift Vouchers, the next 25 will receive £1 vouchers and the next 50 will receive 10/6 Vouchers.

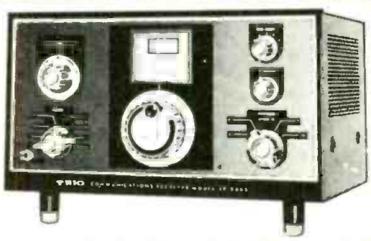
Note: Members of Lasky's Radio staff and relatives are expressly excluded from entry in this competition.

HAVE YOU GOT YOUR LASKY'S CATALOGUE?

FREE Second Great Reprint Issue Now Ready
Just send your name, address and 1/- for post only

COMMUNICATION RECEIVERS

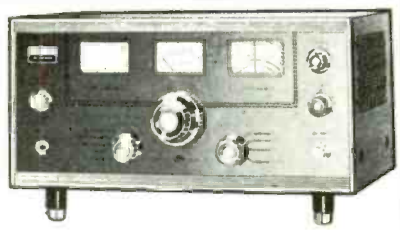
TRIO JR-500SE



This high performance receiver is made especially to cover the amateur bands and utilises a crystal controlled double heterodyne circuit for extra sensitivity and stability. **Brief spec.:** Covers all the amateur bands in 7 separate ranges between 3.5 and 29.7 Mc/s. Circuit uses 7 valves. 2 transistors and 5 diodes plus 8 crystals, output 8 and 500 ohm and 500 ohm phone jack. **Special features:** Crystal controlled oscillator ● Variable BFO ● VFO ● AVC ● ANL ● S meter ● SSB-CW ● Stand-by switch ● Special double gear dial drive with direct reading down to 0 kH. ● Remote control socket for connection to a transmitter. Audio output 1 watt. For use on 115/250 V A.C. Mains. Superb modern styling and control layout—finished in dark grey. Cabinet size 7 × 13 × 10in. Weight 18 lb. Fully guaranteed, complete with instruction manual and service data.

Lasky's Price £61.19.0 Carriage and Packing 12/6.

TRIO 9R-59DE



Brief Spec.: 4 band receiver covering 550 Kc/s to 30 Mc/s continuous and electrical band spread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. **Special features:** SSB-CW ● ANL ● Variable BFO ● S meter ● Sep. band spread dial ● IF frequency 455 Kc/s ● audio output 1.5 W ● Variable RF and AF gain controls. For use on 115/250 V AC. Mains. Beautifully designed control layout finished in light grey with dark grey case. Size: 7 × 15 × 10in. Weight 19 lb. Fully guaranteed, complete with instruction manual and service data.

Lasky's Price £36.15.0 Carriage and Packing 12/6.

CONSTRUCTORS BARGAINS

THE SKYROVER DE LUXE

7 transistor plus 2 diode superhet. 6 waveband portable receiver covering the full Medium Waveband and Short Waveband 31-94M and also 4 separate switched band spread ranges. 13M. 16M. 19M. and 25M. with Band Spread Tuning for accurate Station Selection. The coil pack and tuning heart is factory assembled, wired and tested. Superhet 470 Kc/s. Mullard Transistors. Uses 4 U2 batteries. 5in. Ceramic Magnet P.M. Speaker. 500 MW Output. Telescopic Aerial and Ferrite Rod Aerial. Tone Circuit in wood cabinet, size 11¼ × 6¼ × 3in. covered with washable material, plastic trim and handle. Car aerial socket fitted.

Can now be built for **£8.19.6** Post 5/- extra.

H.P. Terms: 60/- dep., 11 mths. at 12/9. Total H.P.P. £10/0/3.

Data 2/6. Refunded if you purchase parcel. Four U2 batts. 3/4 extra. All components avail. separately. A simple additional circuit provides coverage of the 1100/1950M. Long Waveband. All necessary components with construction data. Only 10/- extra. Post Free. This conversion is suitable for receivers already constructed.

LASKY'S PRECISION PANEL METERS

Made in Japan by HIOKI. Fully guaranteed. Sizes are of front panel. Special quotes for quantities. Add 1/6 post on each.

Type MK-38A 1¾in. sq.		Type MK-45A 2in. sq.		Type KR-52 3 × 2¼in.		Type KR-65 3½ × 3in.		Type MK-65A 3in. sq.	
1 mA DC	29/6	1 mA DC	25/-	1 mA DC	47/6	1 mA DC	36/-	1 mA DC	36/-
5 mA DC	22/6	5 mA DC	25/-	5mA DC	32/6	5 mA DC	35/-	5 mA DC	35/-
300V DC	22/6	300V DC	25/-	300 V DC	32/6	300 V DC	35/-	300 V DC	35/-
50µA	36/-	500µA	25/-	50µA	56/-	50µA	59/6	500µA	39/6
500µA	27/6	1 mA S Meter	35/-	100µA	47/6	100µA	49/6	1 mA S Meter	37/6
1 mA S Meter	29/6			500µA	37/6	500µA	42/6		
				1 mA S Meter	39/6	1 mA S Meter	39/6		

TEST EQUIPMENT

TMK Model 500

A compact and reliable instrument designed for use in the production, servicing and maintenance of electronic, radio and T.V. equipment. Measures a wide range of voltages, currents, resistance and audio power. **Specification:** Movement sensitivity 30µA. D.C. volts range: 0-0.25, 1, 2.5, 10, 25, 100, 250, 500, 1,000 volts at 30K OPV. A.C. volts ranges: 0-2.5, 10, 25, 100, 250, 500, 1,000 volts at 15K OPV. dB scale: 6 ranges −20 to +56dB. D.C. current: 0-50µA, 5, 50, 500mA. 12A. Resistance ranges: 0-60K, 6, 60M/c. Test buzzer for continuity testing. Size 6¾in. × 3¾in. × 2¼in.

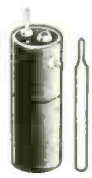
Lasky's Price £8.17.6 Post Free

Model C-1000 Mili Tester

A really tiny meter with "big" meter performance. Brief Specification: Movement sensitivity 400 µA: DC volts ranges: 0-10, 50, 250, 1,000 volts, +3% fsd at 1K OPV. AC volts ranges: 0-10, 50, 250, 1,000 volts +4% fsd at 1K OPV. DC current: 0-1, 100 mA. Resistance range: 0-150K ohms. Size 2¼in. × 3½in. × 1in.

Lasky's Price 39/6 Post 2/6

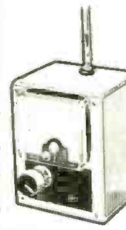
TRANSISTOR SIGNAL INJECTOR MODEL C-3003



Self-contained 1¼in. dia. 5in. long, with light and test probe. For fault finding in radios, amplifiers, etc. Complete with batteries and extension probe.

Lasky's Price 29/6 Post Free

FIELD STRENGTH METER

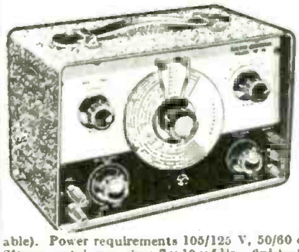


Designed for checking the radiation from adjacent transmitter. A sensitive and compact unit that requires no battery or other power supply. Frequency range: 1 to 250 Mc/s. Telescopic aerial extends to 9½ in. In metal case. Size: 3½ × 2½ × 2 in., with 1¼in. square meter, also earpiece for audible check. Magnet in base, for attaching the meter to metal shelf, car body, etc.

Lasky's Price 45/- Post 2/6

NEW SPECIALISED TEST GEAR

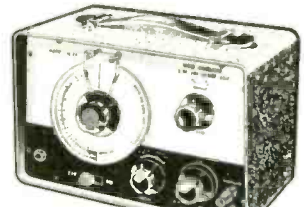
RF SIGNAL GENERATOR Model TE-20



A new high quality factory tested and callibrated RF Signal Generator offering a full frequency range cover of 120 Kc/s to 260 Mc/s in 6 bands plus one harmonic band. Dual High/Low RF output terminals provided and separate variable Audio output. Etched circular scale—accuracy ± 2%—read against hair-line on perspex cursor. Power "on" pilot light fitted. **Brief Specification:** Frequency range (6 fundamental bands) A. 120-320 Kc/s. B. 320-1,000 Kc/s. C. 1-3.4 Mc/s. D. 3.2-11 Mc/s. E. 11-38 Mc/s. F. 36-130 Mc/s. Harmonic Band 130-260 Mc/s. Frequency accuracy ± 2%. Output—RF (high) 100,000µV max., RF (low) 100µV max. Audio output 400 c.p.s., 8V approx. (adjustable). Power requirements 105/125 V, 50/60 c/s A.C. Valve line-up: 12BH7A, 6AR5 and selenium rectifier. Strong metal case size: 7 × 10 × 5½in., finished in grey crackle with leather carrying handle. Complete with test leads and instruction book.

Lasky's Price £12.10.0 Post 5/-

AUDIO GENERATOR Model TE-22



A new factory tested and callibrated low distortion Sine wave and Square wave Audio Generator suitable for use with most oscilloscopes. **Brief Specification:** Frequency range-Sine wave 20 c/s to 200 Kc/s in 4 switched ranges 20-200 c/s. 200-2 Kc/s. 2 Kc/s-20 Kc/s. 20 Kc/s-200 Kc/s. (Two scales 10-90 and 20-200 on etched circular dial with hair-line cursor) Square wave range 60 c/s to 30 Kc/s. (read on same scales as Sine waves). Frequency response 60 c/s-150 Kc/s ± 1.5 dB. Distortion less than 2%. Output voltage: load impedance 1 M/ohm-7 V. (max.). load impedance 10 K/ohm-5 V. (max.). Variable output amplitude control. Valve line-up: 6BM8, 12AT7, 6X4. Power requirements 105/125 V. or 220/240 V., 50/60 c/s A.C. Strong metal cabinet size 7 × 10½ × 5½in., finished in grey crackle with leather carrying handle. Power "on" pilot light fitted. Complete with test leads and instruction book.

Lasky's Price £15.0.0 Post 5/-

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An essential item for all service workshops and laboratories. An extremely sophisticated instrument permitting a far more accurate degree of measurement than normal test meters and also compared to any other Peak-Peak VVM at present available. **Brief Specification:** D.C.V. range 0-1.5, 5, 15, 50, 150, 500, 1,500 V. A.C.V. (2 ranges) 0-1.5, 5, 15, 50, 150, 500, 1,500 V. R.M.S., 0-1.4, 4, 14, 40, 140, 400, 1,400, 4,000 V.P.-P. Resistance: × 10, 100—1K—10K—100K—1M—10M (0.2 ohms—1,000 M/ohms). Decibels −10 db to +65 db. Power requirements 105/125 V, 220-240 V., 50/60 c/s A.C. Valve line-up: 12AU7, 6AL5. Strongly made, cabinet size: 8½ × 6 × 5¼in. with carrying handle. Complete with standard probe and instruction book.

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Carr. 17/6

24½ Gns.

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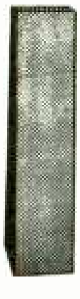

Covered in two-tone Rexine/Vynair ideal for vocalists and Public Address. 15 ohm matching.

Type C48. 25-30 WATTS. Fitted four 8in. high flux 7 watt speakers. Overall size approx. 42 × 10 × 5in. Or Deposit 44/- and 9 monthly payments 34/9. (Total £18/1/6) **15 Gns.** Carr. 10/-

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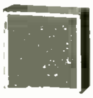

In teak veneered cabinets.

10 Watt Model. Gauss 12,000 lines, 3 or 15 ohms. **5 Gns.**

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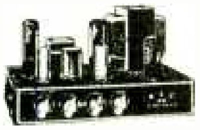

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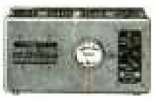

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250-0-250v. 100mA, 6.3v. 3.5a.	21/9
250-0-250v. 100mA, 6.3v. 2a, 6.3v. 1a.	22/9
350-0-350v. 80mA, 6.3v. 2a, 0-5-6.3v. 2a.	23/9
250-0-250v. 100mA, 6.3v. 4a, 0-5-6.3v. 3a.	32/9
300-0-300v. 100mA, 6.3v. 4a, 0-5-6.3v. 3a.	32/9
300-0-300v. 130mA, 6.3v. 4a, 0-5-6.3v. 1a. Suitable for Mullard 510 amplifier	39/9
350-0-350v. 100mA, 6.3v. 4a, 0-5-6.3v. 3a.	32/9
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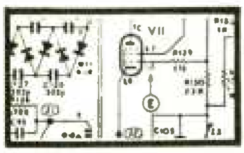
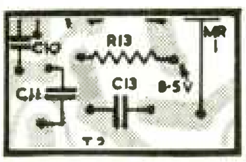
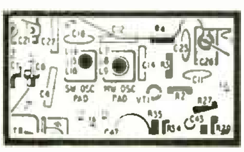


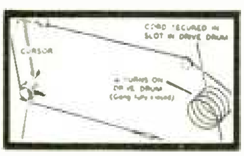
Circuits diagrams



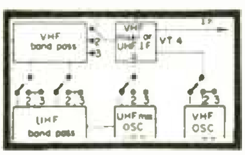
Printed panel diagrams



Component layout diagrams



Drive-cord diagrams



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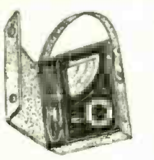

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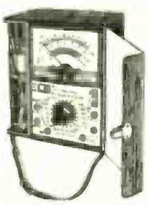

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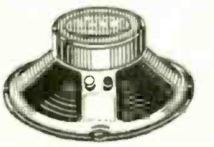

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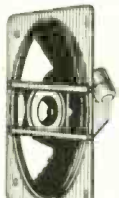

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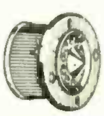

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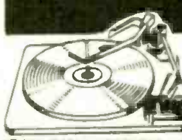
Enjoy Stereo Sound as you have never heard it before. **MODEL TTC. G1111** as illustrated. Soft padded earphones. Adjustalbe headband. Impedance 8 ohms per phone. Frequency range 25-13,000 cps. With 5ft. lead. Price **69/6.** P. & P. 4/6. Other similar types available. AKAI, ASE8S, 8 ohms. **26/6/-.** CORAL E102 16 ohms. **25/19/6**; EAGLE SE1, 16 ohms. **79/6**; T.T.C. Stethoscope, 8 ohms, **49/6.** P. & P. 4/6 each.

GARRARD DECKS

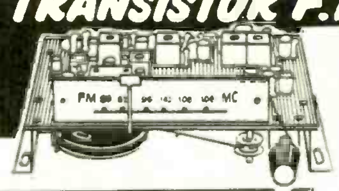


3000 with Sonotone 9TAHC Stereo Cartridge	£8 19 6
3000 with Sonotone 9TAHC Diamond Stereo Cartridge	£9 19 6
AT60 Mk. I less cartridge	£10 19 6
AT60 Mk. II less cartridge	£12 19 6
AT60 Mk. II with Decca Deram Stereo Cartridge	£17 14 0
SP.25 Mk. II less cartridge	£10 19 6
SP.25 Mk. II with Decca Deram Stereo Cartridge	£15 14 0
AP75 less cartridge	£22 11 6
LAB.80 Mk. II less cartridge	£24 19 6

All plus P. & P. 12/6.
Mono Cartridge **17/6** extra. Stereo Cartridge **22/6** extra.

TEAK FINISH PLINTHS with perspex cover 6½gns. (for LAB80 8½gns.). P. & P. 12/6. Agents for Thorens, Dual Goldring, etc.

TRANSISTOR F.M. TUNER



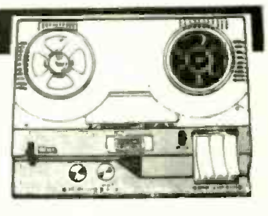
Multiplex adaptor for Stereo Radio Reception **£5.19.6**

Save £2.2.0

6 Transistor FM tuner. Frequency range 88-108 Mc/s. Size 6x4x2½in. Ready built for use with most amplifiers. 9v. battery operation. Complete with instructions. List price 9 gns.

LIND-AIR PRICE
7 gns.
P. & P. 4/-.

MAGNAVOX-COLLARO 363 TAPE DECKS



The very latest 3-speed model—1⅞, 3¾, 7½ i.p.s. available with either 2 track or 4 track head. Features include: Pause control; digital counter, fast forward and rewind; new 4 pole fully screened induction motor; interlocking keys. Size of top plate 13½ × 11 × 5½in. deep below unit plate. For 200/250 v. A.C. mains 50 c.p.s. operation. New, unused and fully guaranteed.

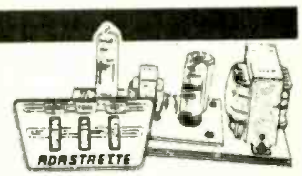
2 track model **£10/10/0** 4 track model **£13/9/6**

Carriage and Packing 7/6.

MARTIN TAPE AMPLIFIERS

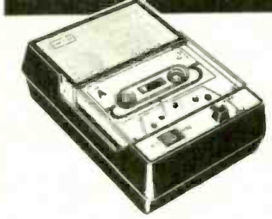
FOR USE WITH ABOVE TAPE DECKS.
2 track model. **£14/19/6**; 4 track model, **£15/19/6**. Carriage and packing 7/6.

2-3 WATT AMPLIFIER



An ideal basis for building your own portable record player. Just add speaker and turntable and you will have an above-average model for a mere fraction of the cost. 2-3 watt printed circuit, with control panel on flying lead. On, OFF, TONE CONTROL AND VOLUME, colourful escutcheon. Brimar valves: EZ80, ECL82 and composite installation booklet. Price **85/-** P. & P. 3/6.

BARGAIN OFFER! FANTAVOX CASSETTE TAPE PLAYER



Specially designed to replay the well-known and popular Musicassettes—prerecorded tape cassette offering a wide choice of all types of music from pop to classical. Up to 40 minutes of quality reproduction through built-in speaker. Simple off/play and volume controls. Fully transistorised operating on 6 pen-light batteries. Modern compact styling with ear-piece socket and wrist strap. Size 6½ × 4½ × 2in.

LIND-AIR PRICE £9.19.6 Carr., Pkg. & Ins. 5/-

ORGAN BUILDERS! N.P.N. Sil. Planar Transistors. All Tested, 1/6 each or £5.0.0 per 100.

TRANSISTOR BARGAIN SALE! NEW STOCK AT UNBEATABLE PRICES!

OC44, OC45, OC81D now only	1/6 each!	£6.0.0 per 100
OC71, OC72 equivalent	1/- each!	£3.0.0 per 100
ASY22 Switching Transistors	2/6 each!	£10.0.0 per 100

2N753 N.P.N. Silicon Planar, 300mW. 250Mc/s. High speed switching .. 2/6 each!
BSY28 N.P.N. Silicon Planar, Epitaxial, 300mW. 300Mc/s .. .. 2/6 each!
BSY65 N.P.N. Silicon Planar, Epitaxial, 800mW. 100Mc/s .. .. 2/6 each!
AFZ12 P.N.P. Germanium Alloy Diff. low noise V.H.F. amplifier .. 2/6 each!
Complete sets of transistors for radio:
2G344A/2G345A/2G345B/2G371A/2G378A/2G378A + diode .. .. 10/- only!
GET120, 2 watts. Heat sink included .. .. 2/6 each!
Transistor Driver Transformers .. .. 2/6 each!
Transistor Output Transformers (suitable for our kits above) .. .. 2/6 each!
OC28 .. .. 5/- each!
BYZ13, 6 amp rectifiers .. .. 2/6 each!
Light sensitivity transistors similar to OCP71 .. .. .. 2/- each!
UNMARKED, UNTESTED TRANSISTORS TO CLEAR .. .. 7/6 for 50!
Silicon diodes. Make excellent detectors. Also suitable for keying electronic organs, 1/- each; 20 for 10/-.
BY100 type rectifiers. SPECIAL REDUCED PRICE! ONLY 2/6 each; 24/- doz.; £7.10.0 per 100; £50.0.0 per 1,000.

ELECTROLYTIC CONDENSER FANTASTIC SELECTION;

		20+4		275 volts	10d
		32+32		275 volts	1/6
64µF 275 volts	1/3	8+16		450 volts	1/9
800µF 15 volts	1/2	50+50		275 volts	2/-
500µF 25 volts	10d	40+40+20		275 volts	2/1
50/50/50, 350V	2/7	150/350, 300V	4/-	2,000/2,000, 25V	4/6
100/200/200/50, 275V	4/-	250/250, 325V	4/-	250µF, 50V	10d
100/100,50V	3/2				

0.25µF	3 volt	5µF	25 volt	64µF	2.5 volt
1µF	350 volt	6µF	3 volt	64µF	9 volt
1.25µF	16 volt	8µF	3 volt	100µF	3 volt
2µF	3 volt	8µF	6 volt	100µF	6 volt
2µF	9 volt	8µF	50 volt	100µF	9 volt
2µF	70 volt	8µF	275 volt	150µF	12 volt
2µF	150 volt	10µF	25 volt	200µF	3 volt
2µF	350 volt	16µF	150 volt	200µF	4 volt
2.5µF	16 volt	20µF	3 volt	250µF	2.5 volt
2.5µF	25 volt	20µF	6 volt	250µF	9 volt
3µF	3 volt	20µF	9 volt	320µF	2.5 volt
3µF	25 volt	20µF	15 volt	250µF	9 volt
3.2µF	6.4 volt	25µF	6 volt	350µF	10 volt
3.2µF	64 volt	25µF	12 volt	400µF	2.5 volt
4µF	4 volt	25µF	25 volt	400µF	15 volt
4µF	12 volt	30µF	6 volt	500µF	4 volt
4µF	25 volt	30µF	10 volt	500µF	6 volt
4µF	100 volt	40µF	3 volt	640µF	2.5 volt
5µF	6 volt	50µF	9 volt	750µF	12 volt

All at 1/- each, 9/- per dozen. Mixed Packets of 20 (our selection) 10/-.

PAPER CONDENSERS

0.001µF	500 volt	0.02µF	600 a.c.	0.25µF	350 volt
0.001µF	1000 volt	0.02µF	350 volt	0.5µF	350 volt
0.002µF	500 volt	0.1µF	350 volt	0.5µF	500 volt
0.005µF	750 volt				

All at 15/- per 100. 3/- per dozen. Mixed Bags of 100 (our selection) 10/-.

MULLARD POLYESTER CAPACITORS. ALL HALF PRICE

0.0022µF	400 volts	4d	0.15µF	160 volts	7d
0.0018µF	400 volts	4d	0.22µF	160 volts	7d
0.0015µF	400 volts	4d	0.27µF	160 volts	8d
0.001µF	400 volts	4d	0.056µF	125 volts	7d
0.01µF	400 volts	4d	1µF	125 volts	1/6
68pF Tubular pulse ceramic		6d each			

VERY SPECIAL VALUE! Silver Mica, Ceramic, Polystyrene Condensers. Well assorted. Mixed types and values, 10/- per 100.

RESISTORS. Give-away offer! Mixed types and values, ¼ to ½ watt,
6/6 per 100 or 55/- per 1,000.
Also ½ to 3 watt close tolerance. Mixed values, 7/6 per 100; 55/- per 1,000.

WIRE-WOUND RESISTORS
1 watt, 3 watt, 6 watt, 6d each, 7 watt and 10 watt 9d each.

CONNECTING WIRE. THIN, P.V.C. INSULATED
10yd, 1/-; 100yd, 7/6; 500yd, 25/- (post 4/6); 1,000yd, 40/- (post 6/-).

VALVES. BRAND-NEW AND BOXED. ROCK-BOTTOM PRICES;

DY87	6/9	EY51	6/9	PCL85	8/5
EABC80	7/-	EY86	6/9	PCL86	8/5
ECC82	7/4	EY87	6/9	PFL200	11/8
ECC83	7/4	PABC80	7/1	PL36	10/1
ECL80	7/1	PC97	10/6	PL81	8/5
ECL86	8/5	PCC84	7/4	PL83	8/5
EF80	7/1	PCC89	10/6	PL84	6/6
EF85	7/1	PCF80	8/5	PL500	12/6
EF183	9/5	PCF86	10/1	PY32	9/-
EF184	9/5	PCL82	8/5	PY81	6/9
		PCL83	9/10	PY82	4/9
		PCL84	8/5	PY800	6/9

A further 10% discount will be given on lots of 50 of any one type.

RECORD PLAYER CARTRIDGES
Sonotone Mono, 10/-; Acos GP67/29 Mono, 15/-; Acos GP91/35C Stereo compatible, 20/-; Acos GP94/1 Stereo, 25/-. All with needles.

Signal Injector Kit, 10/-. Signal Tracer Kit, 10/-.

VEROBOARD. All sizes in stock.

2½in × 1in	0.15 matrix	1/1	17in × 3¾in	0.15 matrix	14/8
2½in × 3¾in	0.15 matrix	3/3			
2½in × 5⅝in	0.15 matrix	3/11	5in × 5⅝in	0.1 matrix	3/11
3¾in × 3¾in	0.15 matrix	3/11	3¾in × 2½in	0.1 matrix	3/9
3¾in × 5in	0.15 matrix	5/6	5in. × 3¾in	0.1 matrix	5/2
17in × 2½in	0.15 matrix	11/-	3¾in × 3¾in	0.1 matrix	3/11

SPECIAL OFFER!
Cutter and 5 Boards 2½in × 1in, 9/9. Cutter only, 7/6. Pin Insert Tool, 9/6. Terminal Pins. Packet of 36, 3/6.

BARGAIN OFFER!
Few only Multimeters, 1,000 Ω per volt, 45/-; 20,000 Ω per volt, 80/-.

Orders by post to:—

G. F. MILWARD, 17 PEEL CLOSE, DRAYTON BASSET, Staffs.

Please include suitable amount to cover postage. Stamped addressed envelope must be included with any enquiries.
For customers in the Birmingham area goods may be obtained from Rock Exchanges 231 Alum Rock Road, Birmingham 8. (All POST orders to Drayton.)

All overseas enquiries & orders please address to:

COLOMOR (ELECTRONICS) LTD.

170 Goldhawk Rd., London, W.12. Tel. (01) 743 0899

MARCONI SIGNAL GENERATOR TYPE TF 801B/3/S

Frequency range 12-485 Mc/s in five ranges. Directly calibrated frequency dial. Output waveform: C.W. sine wave A.M., pulse A.M. (from ext. source only). Internal modulation frequency 1,000 c/s. Output: a, normal—continuously variable directly calibrated from 0.1µv-0.5 v.; b, high—up to 1 v. modulated for 2 v. unmodulated, output impedance 50 ohms. Fine frequency tuning control, carrier on/off switch, built-in crystal calibration for 2 Mc/s and 10 Mc/s. Stabilised voltage supply. In excellent "as new" condition. Laboratory checked and guaranteed. £115. Carr. 30/-. including necessary connectors, plugs and instruction manual.

MARCONI SIGNAL GENERATOR TF 801/A/1. 10-300 Mc/s. in 4 bands. Internal at 400 c/s. 1 kc/s. External 50 c/s to 10 kc/s. Output 0-100 db below 200 mV from 75 ohms source. £85. P. & P. 20/-, including necessary connectors, plugs, and instruction manual.

MARCONI SIGNAL GENERATOR TYPE TF 144G. 85 kc/s.-25 Mc/s. Excellent laboratory tested condition, with all necessary accessories with instruction manual, £45. P. & P. 15/-.

SIGNAL GENERATOR PORTABLE TS 13/AP, with self-contained wavemeter and power monitor. Freq. 9305-9445 Mc/s. Peak power output, C W pulsed 50µW per ½ F.S.D. Pulsing 1-2µsec. wide, delay 5,200µsec. PRR 350-4,000 c/s. £50. P. & P. 20/-.

BC 221 FREQUENCY METERS. 125-20,000 kc/s. Accuracy 0.01%. Complete with individual Calibration book. In brand new condition with headphones and instruction book. £45. P. & P. 20/-. Mains P.S.U. for above, £11/10/-. Carriage 5/-. Stabilised PSU for above £16 Carriage 5/-.

TEST SET TS 12AP STANDING WAVE INDICATOR EQUIPMENT. Used for testing 3 cm. circuit components. Should be used with a suitable signal source such as above described TS 13 Signal Generator. £25. P. & P. 10/-.

MARCONI VIDEO OSCILLATOR TF 885A. Sine wave output 25 c/s to 5 Mc/s in 2 bands, Squarewave output 50 c/s to 150 c/s in 2 bands. Freq. accur. ±2% ±2 c/s. Power supply 100/125/200/250 v. A.C. £75. Carriage 40/-.

SIGNAL GENERATOR TYPE TS 418. Signal frequency 400-1,000 Mc/s. direct calibration. Pulse rate 40-400 c (X1 or X10), pulse delay variable, less than 3µsec. to more than 300µsec. Pulse width variable less than 1µsec. to more than 10µsec. Polarity—internal or external sources, positive or negative pulses. AM & CW. Output attenuator 0.2µV to 200mV continuously variable. In fully tested condition, £150. Carriage paid.

PRECISION VHF FREQUENCY METER TYPE 183. 20-300 Mc/s with accuracy 0.03% and 300-1,000 Mc/s with accuracy 0.3%. Additional band on harmonics 5.0-6.25 Mc/s with accuracy + −2×10-⁴. Incorporating calibrating quartz 100 kc/s + −5×10-⁶ 120/220 v. A.C. mains. £85. Carriage £2.

PHASE MONITOR ME-63/U. Manufactured recently by Control Electronics Inc. Measures directly and displays on a panel meter the phase angle between two applied audio frequency signals within the range from 20-20,000 c.p.s. to an accuracy of ±1.0°. Input signals can be sinusoidal or non-sinusoidal between 2 and 30 v. peak. In excellent condition together with handbook and necessary connector. £45, Carriage 30/-.

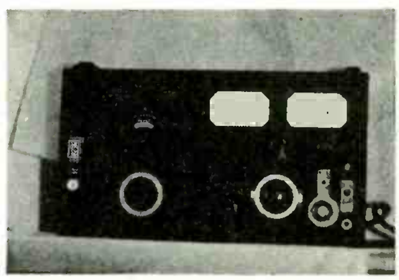
V.H.F. CIRCUIT MAGNIFICATION METER TYPE TF 886A. Apart from directly reading Q in the range 15-170 mc/s (in 4 bands) this instrument may be used for indirectly measuring induction of coils, phase defects of capacitors, dielectric losses, etc. by resonance methods. Magnification ranges 6-180; 150-450; 400-1,200. Test Circuit Capacitor 12 to 85pF calibrated in 1pF divisions, with additional interpolating dial. Power supply 200 to 250 v. and 100 to 150 v. £95. Carriage 30/-.

NOISE GENERATOR MARCONI TYPE TF 1106. The TF 1106 provides standard noise outputs for determining the noise factor of A.M. & F.M. receivers at any frequency from 1 to 200 mc/s. It is calibrated directly in noise factor, making measurements a routine operation. Noise output calibration 0-30 in four ranges. Accuracy ±0.5 dB. Frequency range 1-200 mc/s. Output impedance 52 or 71 ohms. Power supply 100-125 v. or 200-250 v. £55.

AVO VALVE TESTER, with instruction book, £45. Carriage 30/-.

END OF RANGE ITEMS
Offered at special low prices as only a few left, all are in fully tested guaranteed condition.
VALVE VOLTMETER TS 428B/1. £10/10/-. P. & P. 5/-.

BOONTON STANDARD SIGNAL GENERATOR MODEL 80. Frequency 2-400 Mc/s. in 6 ranges. AM., 400 and 1,000 c/s. and external modulation. Provision for pulse modulation. Piston type attenuator 0.1µ-100 mV separate meter for modulation level and carrier level. Precision flywheel tuning. 117 v. A.C. input. With instruction manual, £95. Carriage 30/-.



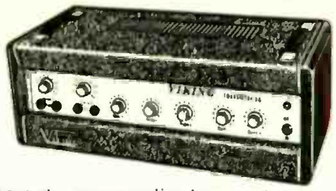
P. C. RADIO LTD.

170 GOLDHAWK ROAD, W.12

SHEpherd's Bush 4946

VIKING AMPLIFIER

50 WATT AMPLIFIER



An extremely reliable general purpose valve amplifier. Its rugged construction yet space age styling and design makes it by far the best value for money.

TECHNICAL SPECIFICATIONS

4 electronically mixed channels, with 2 inputs per channel, enables the use of 8 separate instruments at the same time. The volume controls for each channel are located directly above the corresponding input sockets.

SENSITIVITIES AND INPUT IMPEDENCES

CHANNEL 1 4mV. AT 470K. } These 2 Channels (4 inputs) are suitable for
CHANNEL 2 4mV. AT 470K. } microphone or guitars.
CHANNEL 3 200mV. AT 1m. } Suitable for most high output instruments
CHANNEL 4 200mV. AT 1m. } (gram, tuner, organ etc).

INPUT SENSITIVITY RELATIVE TO 10W OUTPUT.
TONE CONTROLS ARE COMMON TO ALL INPUTS.
BASS BOOST +12 dB AT 60 Hz/s. **BASS CUT** −13 dB AT 60 Hz/s. **TREBLE BOOST** +11 dB AT 15 KHz/s. **TREBLE CUT** −12 dB AT 15 KHz/s.
WITH BASS AND TREBLE CONTROLS CENTRAL −3 dB POINTS ARE 30 Hz/s. AND 20 KHz/s.

POWER OUTPUT

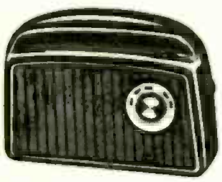
FOR SPEECH AND MUSIC	50 WATTS RMS.	100 WATTS PEAK.
FOR SUSTAINED MUSIC	45 WATTS RMS.	90 WATTS PEAK.
FOR SINE WAVE	38.5 WATTS RMS.	NEARLY 80 WATTS PEAK.

TOTAL DISTORTION AT RATED OUTPUT 3.2% } AT 1 KHz/s.
TOTAL DISTORTION AT 20 WATTS 0.15% }
OUTPUT TO MATCH INTO 8 OR 15 OHMS SPEAKER SYSTEM.
NEGATIVE FEED BACK 20 dB AT 1 KHz/s.
SIGNAL TO NOISE RATIO 60 dB.
MAINS VOLTAGES. Adjustable from 200-250 V A.C. 50-60 Hz/s. A protective fuse is located at the rear of unit.
VALVE LINE UP: Double purpose ECC83 x 3, EL34 x 2 and GZ 34.

PRICE
27 gns.
P. & P. 20/-

STAR SR 150 COMMUNICATIONS RECEIVER

Frequency range 535 kc/s—30 Mc/s four wave bands, four valve plus metal rectifier superhet circuit incorporates B.F.O. band spread tuning, "S" meter external telescopic aerial—ferrite aerial, built-in 4in. speaker, easy to read dial. For 240v. A.C. operation, complete brand new with full instruction manual. £17/17/- + 10/- p. & p.



NEW! The DORSET
TRANSISTOR PORTABLE RADIO
with BABY ALARM Facilities

Special offer—Power Supply Kit to purchasers of Dorset Portable Radio parts incorporating mains transformer, rectifier and smoothing condenser, AC mains 200/250v. output 9v. 100mA...... 9/6 extra. 600 milliwatt solid state 7 transistor plus diode and thermistor.
Completely modulised high quality portable radio featuring complementary N.P.N. and P.N.P. output stage.

PRICE:
£5.5.0 Plus 7/6 P. & P.
Circuit and parts list 2/6, free with parts.

The comprehensive easy-to-follow drawings supplied make this the easiest-ever transistor radio set of parts, with the following features:

- ★ Simple connections to only 6 tags on the R.F./I.F. module, 3.I.F stages, osc. coil and 3 transistors which, with their associated components are completely wired.
- ★ Only 4 connections on the A.F. module to complete the 4 transistor 600 milli-watt solid state amplifier.
- ★ Pre-aligned R.F./I.F. module built and tested.
- ★ A.F. module built and tested.
- ★ Fully tunable over M.W. and L.W. bands. M.W. 540-1,640 Kc/s. (557-183 metres). L.W. 150-275 Kc/s. (2,000-1,100 metres).
- ★ Intermediate Frequency 470 Kc/s.
- ★ Sensitivity: M.W. at 1 Mc/s 10 microvolts plus or minus 3 dB. L.W. at 200 Kc/s. 40 microvolt plus or minus 4 dB.
- ★ High Q internal ferrite rod aerial on both wavebands.
- ★ Class "B" modulised output stage with thermistor controlled heat stabilization. Class "B" output stage ensures long battery life. Current drain is proportional to the output level. Total current drain of the receiver under no signal conditions is 10-12 mA. At reasonable listening level 20-30 mA.
- ★ Extension sockets for car aerial input, tape recorder output (independent of volume control) and Ext. Speaker.
- ★ All components (except speaker) mount on the printed circuit board. Easy to follow instructions. Size of cabinet 12in. long, 8in. high and 3in. deep.
- ★ Fingertip controls.

BRESGES Geared Motor

240 V. A.C. Mains 50 Hz. 0.49 amp (65 watt). Ungeared speed 2,750 R.P.M. Geared speed 80 R.P.M. Constant Gear ratio 35:1. Reversible. Spindle dia. 12 mm. (0.473in.). Spindle length 1⅛in. 7½in. long × 4⅞in. wide × 4⅞in. deep. Cost £20, our price £7/19/6. 7/6 P. & P.

RADIO AND T.V. COMPONENTS (ACTON) LTD

21A HIGH STREET, ACTON, LONDON, W.3.
SHOP HOURS 9 a.m. to 6 p.m. EARLY CLOSING WEDNESDAY.
Terms C.W.O. Goods not despatched outside U.K. All enquiries stamped add. envelope.
323 EDGWARE ROAD, LONDON, W.2. Early closing Thursday.
PERSONAL SHOPPERS ONLY.
All orders by post must be sent to our Acton address.

'ELEGANT SEVEN' MK III

SPECIAL OFFER

- ★ De luxe wooden cabinet size 12¼×8¼×3½in.
- ★ Horizontal easy to read tuning scale printed grey with black letters, size 11½×2in.
- ★ High "Q" ferrite rod aerial.
- ★ I.F. neutralization on each separate stage.
- ★ D.C. coupled push pull output stage with separate A.C negative feedback
- ★ Room filling output 350 mW.
- ★ Ready etched and drilled printed circuit board back printed for foolproof construction.
- ★ Fully comprehensive instructions and point-to-point wiring diagram.
- ★ Car aerial socket.
- ★ Fully tunable over medium and long wave. 168-535 metres and 1,250-2000 metres.
- ★ All components, ferrite rod and tuning assembly mount on printed board.
- ★ 5in. P.M. Speaker.
- ★ Parts list and circuit diagrams 2/6 free with parts.

ONLY
£4.9.6 Plus 7/6 P. & P.

Buy yourself an easy to build 7 transistor radio and save at least £10. Now you can build this superb transistor superhet radio for under £4/10/-. No one else can offer such a fantastic radio with so many de luxe star features.

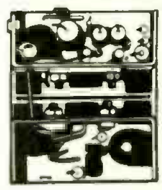
Power supply kit to purchasers of "Elegant Seven" parts, incorporating mains transformer, rectifier and smoothing condenser. A.C. mains 200/250 volts. Output 9 v. 100 mA. 9/6 extra.

FIRST QUALITY PVC TAPE

5¾in.	Std.	850ft.	9/-	5in.	L.P.	850ft.	10/6
7in.	Std.	1,200ft.	11/6	3in.	T.P.	600ft.	10/6
3in.	L.P.	240ft.	4/-	5in.	T.P.	1,800ft.	25/6
5¾in.	L.P.	1,200ft.	11/6	5¾in.	T.P.	2,400ft.	32/6
5¾in.	D.P.	1,800ft.	18/6	7in.	T.P.	3,600ft.	42/6
7in.	L.P.	1,800ft.	18/6	4in.	T.P.	900ft.	15/-

POST & PKG. ON EACH 1/6.
4 OR MORE POST FREE.

X101. **10 WATTS (RMS) SOLID-STATE HI-FI AMP. WITH INTEGRAL PRE-AMP.** Its great versatility ranges from a simple Intercom. to a modern HI-FI STEREO AMPLIFIER (two are required for Stereo).



The X101 is a brilliant new addition to our highly successful range of products. Its professional performance and advanced solid-state circuitry techniques ensures reliability combined with high fidelity reproduction, at an unbeatable price of 49/6 + 2/6 p. & p. **SPECIFICATIONS: R.M.S. POWER OUTPUT:** 13W (music power), 10W (SINE WAVE). **SENSITIVITY:** for rated output 1MV into 3K ohms load. **FREQUENCY RESPONSE:** minus 3 dB points are 20 Hz and 40K Hz. **TOTAL DISTORTION:** @ 1K Hz for rated output 1.5%; for 5W output 0.35%. **OUTPUT IMPEDANCE:** 3 ohms (3-15 ohms may be used). **SUPPLY VOLTAGE:** 24V D.C. @ 800 mA (6-24V may be used) output at 14V D.C. supply with 3 ohms speaker. 7 watts. **SIZE:** 2½in. × 3in. × 1⅛in. THE FULLY COMPREHENSIVE INSTRUCTION MANUAL DOES NOT ONLY SHOW THE BASICS, SUCH AS CIRCUIT DIAGRAM AND CONNECTIONS, BUT ALSO GIVES PRACTICAL EASY-TO-UNDERSTAND DETAILED INFORMATION ABOUT THE X101. STANDARD EQUALISATION NETWORKS ARE GIVEN FOR MOST TYPES OF CONVENTIONAL INPUTS, THEY INCLUDE: **TAPE HEAD, MAG. P.U., XTAL P.U., TUNER, MIC., ETC. CONTROL ASSEMBLY** (including resistors and capacitors): 1. VOLUME, PRICE 5/-; 2. TREBLE, PRICE 5/-; 3. COMPREHENSIVE BASS AND TREBLE, PRICE 10/-.
POWER SUPPLIES FOR THE X101: P 101/M (for Mono) 35/-, p. & p. 2/6., P 101/S (for Stereo), 42/6, p. & p. 2/6.
A High Quality, Monaural Pre-amp PR101/M and Control Unit, particularly suitable for use with the X101 if a ready-built, comprehensive, multi-input system is desired. **CONTROLS. Selector Switch, Tape Speed Equalisation Switch** (3¾, 7½ and 15 i.p.s.), **Volume, Treble, Bass, 3 position scratch filter and 3 position rumble filter. SPECIFICATION: Sensitivities for 200 mV ouput @ 1KHz. Tape Head:** 3 mV (@ 3¾ i.p.s.). **MAG. P.U.:** 2 mV. **CER. P.U.:** 80 mV **RADIO:** 100 mV. **AUX.:** 100 mV TAPE/REC. OUTPUT: 100 mV. Equalisation for each input is correct to within ±2 dB (RIAA) from 20 Hz-20KHz **TONE CONTROL RANGE.** BASS ±13 dB @ 60 Hz. TREBLE: ±14 dB @ 15 KHz. **TOTAL DISTORTION** (for 200 mV output): <0.02%. **SIGNAL NOISE:** >−60 db. **SUPPLY VOLTAGE:** 24 v. D.C. 59/6, plus 2/6 p. & p.
A STEREO VERSION (PR 101/S) WILL BE ANNOUNCED SHORTLY.

THE CLASSIC

HIGH QUALITY SOLID-STATE AMPLIFIER (MONO). **SPECIFICATION:** Switched inputs for **TAPE HEAD, MAG. P.U., CER. P.U., RADIO and AUX. MAINS INPUT,** 220-250 V. A.C. 50 Hz. THE CLASSIC IS THE COMBINATION OF THE ABOVE DESCRIBED ITEMS (X101, P101/M and PR101/M) ON ONE COMMON CHASSIS. ITS PERFORMANCE AND SPACE AGE STYLING, MAKES IT THE IDEAL CHOICE FOR THE VALUE-CONSCIOUS HI-FI ENTHUSIAST.
Available within 4 weeks, 8 gns. **P. & P. FREE.**

600 mW SOLID STATE
4-TRANSISTOR AMPLIFIER

Features NPN and PNP Complementary Symmetrical Output Stage. 2¼ × ⅞ × ⅞in. Speaker output impedance 12 ohms.

Frequency response −3dB points 90 c/s. and 12 kc/s. Price 15/- plus 1/- P. & P. 7×4 speaker to suit, 19/6, plus 2/- P. & P.

3 TO 4 WATT AMPLIFIER

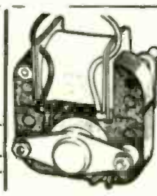
3-4 watt Amplifier, built and tested. Chassis size 7×3½×1in. Separate bass, treble and volume control. Double wound mains transformer, metal rectifier and output transformer for 3 ohms speaker. Valves ECC81 and 6V6, £2/5/- plus 5/6 P. & P.

2½ WATT ALL TRANSISTOR AMPLIFIER

A.C. mains 240v. Size 7in. × 4½in. × 1½in.
Frequency response 100 c/s—10 Kc/s.
Semi conductors, two OC 75's, two AC 128's and two stabilizers AA129.
Tone and volume controls on flying leads. £2/10/- + P. & P. 3/6.
Suitable 8in. × 5in. 10,000 line high flux speaker. 18/6 plus 2/- P. & P.

BSR TAPE DECKS 200/250v. A.C. mains

Type TD2, Tape speed 3¾ twin track, £6/19/6.
Type TD10, 2-track, 3 speed, plus rev. counter, £7/19/6.
Type TD10, 4-track, 3 speed, plus rev. counter, £9/5/-. P. & P. on each type, 7/6.



AC MAINS MOTOR

1400 R.P.M.
230/250 V.

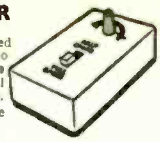
Price 9/6 P. & P. 3/-

MINIATURE WAFER SWITCHES

4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole, 6 way—1 pole, 12 way. All at 3/6 each. 36/- dozen, your assortment.

WATERPROOF HEATING ELEMENT
26 yards length 70W. Self-regulating temperature control. 10/- post free.

DRILL CONTROLLER



Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. 19/6, plus 2/6 post and insurance. Or available made up 32/6, plus 2/6 P&P

SENSITIVE HAND MICROPHONE

Dynamic type. Low impedance, moving ion, fitted in unusually neat plastic head with anti microphonic coupling to handle. Extra small size but very sensitive. 15/- each.

B7G Valve Holders with bottom screen—ptfe insulation finest for HF and VHF, 1/- each, 10/- doz.

Fractional H.P. Motor. 240 v. 50 c.p.s.—open construction ideal for ventilation fan—blower, heater, etc.

Clock Motor 230 v. 50 c.p.s. synchronous—self-starting 6/6.

Pentode Output Transformer—Standard size 40-1, ex equipment, but o.k., 4/3 ea., 48/- doz., post paid.

E.H.T. Condenser .1 mfd 5 kV., 8/6 each.

Neon Mains Tester 1/3 each, 12/- dozen.

Power Pack Transformer. 12 v. ½ amp. 240 v. primary, 9/6 each.

MAINS TRANSFORMER. Upright mounting with primary tapped 200, 220, 240 v. H.T. secondary is 250-0-250 v. at 100 mA. and it has two L.T. secondaries of 6.3 v. 1½ amp.—unused (removed from equipment). 15/- plus 3/6 post and insurance.

SUPERTONE G.C.V.

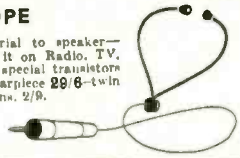
Saves you work—
It's partly built

Like its predecessors this latest Companion has full fi performance—such as only a good wooden cabinet and bifiux speaker can give, and due to its being partly built you will have it going in an evening. Note these features.

- 7 Transistors, superhet circuit.
- Two-tone Cabinet, size 11 × 8 × 3in.
- All circuit requirements—Push-pull output—A.V.C. and feed back, etc.
- Printed circuit board all wired only connections, e.g. to Volume control W.C. Switch and Tuning Condenser.
- Pre-aligned IF stages complete with full instructions.

Price only £4/9/6 plus 6/6 post and insurance.

RADIO STETHOSCOPE



Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio, TV, amplifier, anything—complete kit comprises two special transistors and all parts including probe tube and crystal earpiece 29/6—twin stetoset instead of earpiece 7/6 extra—post and ins. 2/9.

SPECIAL BARGAINS

50 OHM 50 WATT WIRE WOUND POT-METER. 8/6 each.

1 MEG MINIATURE. Pot-meter Morganite standard. ⅛in. spindle 1/- each, 9/- per dozen.

1 MEG MINIATURE Pot-meter Morganite preset screw-driver control. 9d. each, 8/- per dozen.

PRE-SET 100K by Welwyn with intrical bakelite knob, 1/- each, 9/- per dozen.

100K POT-METER. Miniature type with double pole switch and standard ¼in. spindle, by Morganite. 2/- each, 18/- per dozen.

BLANKETSTAT GLASS. Enclosed, normally closed circuit, will open should blanket overheat. 4/6 each.

THERMAL RELAY. Can be used to delay the supply of HT while heaters warm up, or will enable 15 amp. loads to be controlled by miniature switches or relays. Regular list price over £2, price 7/6 each.

SIEMENS HIGH SPEED RELAY. Twin 1,000 ohm coils. Platinum points changeover contacts—Ex equipment. 8/6 each.

TOGGLE SWITCH BARGAIN. 10 amp. 250 v. normal one hole fitting. 2/9 each, or 30/- per doz.

ELECTRIC LOCK. 24 v. coil, but rewindable to other voltages. 4/6 each.

COMPRESSION TRIMMERS. Twin 100 pF. 1/- each, 9/- per dozen.

PRECISION WHEATSTONE BRIDGE. Opportunity to build cheaply. 100K wire wound pot. 15 w. rating, only 5/-.

SHEET PAXOLIN. Ideal for transistor projects. 2 panels each 5in. × 8in. 5/-.

3in. PM LOUDSPEAKER. 3 ohm. 12/6. 80 ohm. 13/6.

TRANSISTOR FERRITE SLAB AERIAL with medium and long wave coils. 7/6 each.

SLIDE SWITCH. Sub miniature double pole changeover. 2/- each. 18/- per dozen.

Vacuum Cleaner Flex. Non-kinkable ribbed rubber, most pliable but very tough, 24/36 Cores. Normally 1/9 per yard, offered at £3 per 100 yard coil, post and insurance 8/6.

Sub-Miniature Silicon Diodes. General purpose type with gold-plated leads. 1/- each or 7/6 per dozen.

MESSAGE TAPES. 225ft. Tape on 3in. spools, normally 4/6 each, we offer 4 tapes for 12/6.

WHITE CIRCULAR FLEX. Ideal for lighting drops, twin made by BICC. Usually 8d. yd. 100 yd. coil for 30/-, plus 6/- postage.

EDGEWISE CONTROL Morganite, as fitted many transistor radios. 2K or 5K with switch. 2/6 each or 24/- per dozen.

12V INVERTER. Full transistorised for operating a 20-watt fluorescent tube, size 6in. long × 1½ × 1½. £3/10/-. Post and insurance 3/-.

SILICON RECTIFIER equiv. BY100 750 mA. 400 V. 10 for 20/-.

MINIATURE PICKUP for 7in. records made by Cosmocord, crystal cartridge with sapphire stylus only. 3/9 or 36/- doz.

TELESCOPIC AERIAL for radio or transmitter, chrome plated, 6 section extends from 7½in. to 47in. 7/6 each, £4 doz.

MIDGET NEONS for mains indicators, etc. 1/3 each or 12/- doz.

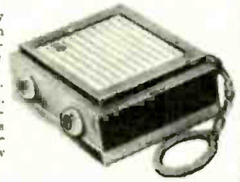
MIDGET RELAY twin 250 ohm coils, size approx. 1½in. × 1in. × 1in. 4 pairs change-over contacts. 7/6 each.

P.O. TYPE RELAY. Twin 200 ohm coils, size approx. 3in. × 2in. × ¾in. 4 pairs changeover contacts. 8/6 each.

PRINTED CIRCUIT BOARD, EDGE CONNECTOR, solder terminations. 32 contacts, standard spacing for veroboard, etc. 6in. long but easily cut. 7/6 each. 80/- doz.

1,000 W. FIRE SPIRAL, replacement for most fires. 1/3 each, 12/- doz.

THIS MONTH'S SNIP



MICRO-SONIC 7 transistor Key chain radio in very pretty case, size 2⅝in. × 2⅛in. × 1⅛in.—complete with soft leather zipped bag. Specification: Circuit: 7 transistor superheterodyne. Frequency range: 530 to 1600 Kc/s. Sensitivity: 5 mv/m. Intermediate frequency 465 Kc/s., or 455 Kc/s. Power output: 40 mW. Antenna: ferrite rod. Loudspeaker: Permanent magnet type. In transit from the East these sets suffered slight corrosion as the batteries were left in them but when this corrosion is cleared away they should work perfectly—offered without guarantee except that they are new 19/6, plus 2/6 post and ins., less batteries.

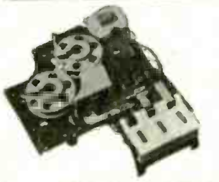
FLUORESCENT CONTROL KITS

Each kit comprises seven items—Choke, 2 tube ends, starter, starter holder and 2 tube clips, with wiring instructions. Suitable for normal fluorescent tubes or the new "Grolux" tubes for fish tanks and indoor plants. Chokes are super-silent, mostly resin filled. Kit A—15-20 w. 19/6. Kit B—30-40 w. 17/6. Kit C—80 w. 17/6. Kit D—125 w. 22/-. Kit E—65 w. 19/6. Kit MF1 is for 6in., 9in. and 12in. miniature tubes. 19/6. Postage on Kits A and B 4/6 for one or two kits then 4/6 for each two kits ordered. Kits C, D and E 4/6 on first kit then 3/6 for each kit ordered. Kit MF1 3/6 on first kit then 3/6 on each two kits ordered.

MAINS TRANSISTOR POWER PACK

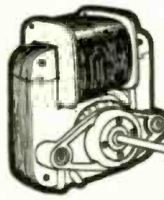
Designed to operate transistor sets and amplifiers. Adjustable output 6 v., 9 v., 12 volts for up to 500 mA. (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and Instructions. Real snip at only 16/6, plus 3/6 postage.

BATTERY OPERATED TAPE DECK



With Capstan control. This unit is extremely well made and measures approx. 6 x 5 x 2in. deep. Has three piano key type controls for Record, Playback and Rewind. Motor is a special heavy duty type intended for operation off 4/5 volts. Supplied complete with 2 spools ready to install. Record, Replay head is the sensitive M4 type intended for use with transistor, amplifier. Price £4/15/-. Post and insurance 4/6.

MAINS MOTOR

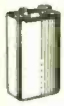


Precision made—as used in record decks and tape recorders—ideal also for extractor fan-blower, heater, etc. New and perfect. Snip at 9/6. Postage 3/- for first one then 1/- for each one ordered. 12 and over post free.

RECORD PLAYER SNIP

The "Princess" 4 speed automatic record changer and player engineered with the utmost precision for beauty, long-life, and trouble free service. Will take up to ten records which may be mixed, 7in.-10in. or 12in.—Patent stylus brush cleans stylus after each playing and at shut off, the pick-up locks itself into its recess a most useful feature with portable equipment—other features include pick-up height adjustment and stylus pressure adjustment. This truly is a fine instrument which you can purchase this month at only £5/19/6, complete with cartridge and ready to play. Post and insurance 7/6 extra.

RELAY SWITCHES. These enable micro switches, delicate thermostats or other low current devices to control up to 30 amps.—ideal to switch thermal storage heaters—motors, etc., made by the famous A.E.I. group these are listed at £25 each—you can buy if you hurry at a very keen price of 39/6 each and we will include diagrams and data Mounted on panel size approximately 6 × 7 × 2in. deep.

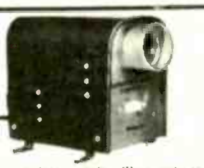


PP3 Eliminator. Play your pocket radio from the mains! Save £s. Complete component kit comprises 4 rectifiers—mains dropper resistances, smoothing condenser and instructions. Only 6/6 plus 1/- post.

PHOTO-ELECTRIC KIT

All parts to make light operated switch/burglar alarm/counter, etc. Kit comprises printed circuit. Laminated Boards and chemicals. Latching relay Infra-red sensitive Photocell and Hood, 2 Transistors, cond., Terminal block. Plastic case. Essential data, circuits and P.C. chassis plans of 10 photo-electric device including auto. car parking light, modulated light alarm. Simple invisible ray switch—counter—stray light alarm—warbling tone electronic alarm—projector lamp stabiliser, etc., etc. Only 39/6, plus 2/- post and insurance.

PHOTO ELECTRIC CONTROL SYSTEM

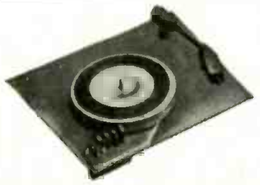


Comprises a light source unit with optional Infra Red filter and lens system to focus the light. Also a photo-electric Relay control unit. Both are housed in metal cases for bench or wall mounting and there is a sensitivity control as well as mains on-off switch. The outfit works from 230/240 A.C. Mains. Can be used as a simple on-off switch by breaking the beam of light (invisible if Infra Red filter is used and as such it will operate as a burglar alarm, or will open doors, etc. Also in conjunction with a counter or other equipment it will perform many functions in the factory or warehouse. Price £9/19/6, plus postage and insurance, 8/-.

ALL PRICES GREATLY REDUCED

Type No.	Price	Type No.	Price	Type No.	Price
2N1727	15/-	OA5	5/-	OC75	3/-
2N1728	10/-	OA10	6/-	OC76	3/-
2N1742	25/-	OA47	3/-	OC77	7/-
2N1747	25/-	OA70	2/-	OC78	3/-
2N1748	10/-	OA79	2/6	OC78D	3/-
AC107	9/-	OA81	2/6	OC81	3/-
AC127	4/-	OA85	2/6	OC81D	3/-
ACY17	8/6	OA90	2/6	OC82	3/-
ACY18	5/6	OA91	2/6	OC82D	3/-
ACY19	6/6	OA200	3/3	OC83	4/-
ACY20	5/6	OA202	4/3	OC84	4/6
ACY21	6/-	OC20	12/6	OC139	8/6
ACY22	4/6	OC22	10/-	OC140	12/6
AF114	4/-	OC23	8/-	OC170	5/-
AF115	4/-	OC24	15/-	OC171	4/-
AF116	4/-	OC25	8/-	OC200	9/-
AF117	4/-	OC26	7/6	OC201	12/6
AF118	4/-	OC28	8/-	OC202	13/6
AF139	12/6	OC29	17/3	OC203	12/6
AF186	17/6	OC35	10/-	OCP71	15/-
AFZ12	15/-	OC36	15/-	ORP12	8/6
ASZ21	15/-	OC38	12/6	ORP60	10/-
BC107	14/6	OC42	6/6	SBO78	6/6
BY100	4/6	OC44	3/-	SB305	8/6
BYZ13	7/6	OC45	3/-	SB251	10/-
MAT100	6/6	OC46	3/-	ST140	3/-
MAT101	7/6	OC70	3/-	ST141	4/6
MAT120	6/6	OC71	3/-		
MAT121	6/6	OC72	3/-		

RECORD PLAYER KIT



4 speed, gram. motor with lightweight pick-up, motor electronically balanced and free from wow and flutter. Speed change by push button—16, 33, 45, 78 r.p.m. Price including mono cartridge, 49/6. 2 Valve amplifier 32/6. Elliptical Speaker, 9/6. Cartridge extra mono 10/6, stereo 15/-, plus 4/6 post and insurance. FREE THIS MONTH HARDWOOD PLINTH if you order complete kit.

THERMOSTATS

Type "A" 15 amp. for controlling room heaters, greenhouses, airing cupboard. Has spindle for pointer knobs. Quickly adjustable from 30-80°F. 9/6 plus 1/- post. Suitable box for wall mounting 5/-. P. & P. 1/-.

Type "B" 15 amp. This is a 17in. long rod type made by the famous Sunvic Co. Spindle adjusts this from 50-550°F. Internal screw alters the setting so this could be adjustable over 30° to 1000°F. Suitable for controlling furnace, oven kiln, immersion heater or to make flame-start or fire alarm 8/6 plus 2/6 post and insurance.

Type "D". We call this the Ice-stat as it cuts in and out and around freezing point. 2/3 amps. Has many uses, one of which would be to keep the loft pipes from freezing, if a length of our blanket wire (16 yds. 10/-) is wound round the pipes. 7/6. P. & P. 1/1.

Type "E". This is standard refrigerator thermostat. Spindle adjustments cover normal refrigerator temperature. 7/6 plus 1/- post.

Type "F". Glass encased for controlling the temp. of liquid—particularly those in glass tanks, vats or sinks—thermostatis held (half submerged) by rubber sucker or wire clip—ideal for fish tanks—developers and chemical baths of all types Adjustable over range 50° to 150°F. Price 18/-, plus 2/- post and insurance.

SOLID STATE IGNITION

Big things are claimed of Electronic ignition systems and if you would like to try for yourself a circuit was described in "Practical Electronics" (Sept., 1966). This requires a silicon controlled rectifier, four transistors and other components available as a kit. Price £6/15/- post free

GANGED POTS

Standard type and size with good length of spindle—made by Morganite. List price is 10/- each but if you act quickly you can have them at 12/- doz. (or 1/6 each if less than doz.). Following values in stock all "lin"—100K—100K—500K—500K all new and unused. Post 2/9 on 1st doz. then 1/- per doz. 6 doz. or more post free.

CASSETTE LOADED DICTATING MACHINE

Battery operated and with all accessories. Really fantastic offer a British made £31 outfit for only £6/19/6 brilliantly designed for speed and efficiency—casette takes normal spools, drops in and out for easy loading—all normal functions—accessories include:—stethoscopic earpiece—crystal microphone has on/off switch—telephone pick-up—tape reference pad—DON'T MISS THIS UNREPEATABLE OFFER—SEND TODAY £6/19/6 plus 7/6 post and insurance. Footswitch 18/6 extra. Spare Cassettes at 7/6 each, three for £1.

When postage is not definitely stated as an extra then orders over £3 are post free. Below £3 add 2/9. Semi-conductors add 1/- post. Over £1 post free. S.A.E. with enquiries please.

Be first this year

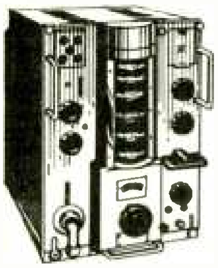
SEED AND PLANT RAISING

Soil heating wire and transformer. Suitable for standard size garden frame. 19/6, plus 3/6 post and ins.

ELECTRONICS (CROYDON) LIMITED

(Dept. W.W.), 102/3 TAMWORTH RD., CROYDON, SURREY *(Opp. W. Croydon Stn.)*
also at **266 LONDON ROAD, CROYDON, SURREY.** ***S.A.E. WITH ENQUIRIES PLEASE***

ADMIRALTY B.40 RECEIVERS

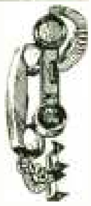


Just released by the Ministry. High quality 10 valve receiver manufactured by Murphy. Coverage in 5 bands 650 Kc/s-30 Mc/s. I.F. 500 Kc/s. Incorporates 2 R.F. and 3 I.F. stages, bandpass filter, noise limiter, crystal controlled B.F.O. calibrator, I.F. output, etc. Built-in speaker, output for phones. Operation 150/230 volt A.C. Size 19½ × 13½ × 16in. Weight 114 lb. Offered in good working condition. £22/10/-, carr. 30/-. With circuit diagrams. Also available B41 L.F. version of above. 15 Kc/s-700 Kc/s. £17/10/-, carr. 30/-.

F.M. WIRELESS MICROPHONE

94-104 Mc/s. Transistorised Operates from 9 v. battery. Complete with additional secret tie-clip microphone. List £12/10/-. ONLY £6 15/-, P. & P. 2/6.

TRANSISTORISED TWO-WAY TELEPHONE INTERCOM



Operative over amazingly long distances. Separate call and press to talk buttons. 2-wire connection. 1000s of applications. Beautifully finished in ebony. Supplied complete with batteries and wall brackets. £5/19/6 pair. P. & P. 3/6.

TWO-WAY RADIOS

SUPERB QUALITY, BRAND NEW & GUARANTEED

3 TRANSISTORS £6 15 - PAIR.
4 TRANSISTORS £6 19/6 PAIR.
6 TRANSISTOR £8 12 6
6 TRANSISTOR DE-LUXE LAFAYETTE £12/10/- PAIR.
10 TRANSISTOR £22/10/- PAIR.

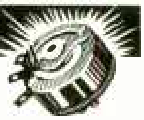
13 TRANSISTOR 500 MW 2-channel 30 Gns. PAIR.

POST EXTRA.

MARCONI TEST EQUIPMENT

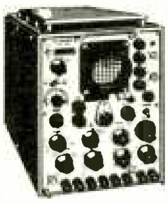
EX-MILITARY RECONDITIONED.
TF 144G STANDARD SIGNAL GENERATORS 85 Kc/s-25 Mc/s. £25, carr. 30/-.
TF.329G. "Q" METER. BRAND NEW, COMPLETE WITH ALL ACCESSORIES, £75, carr. 30/-.
T.F.195M. BEAT FREQUENCY OSCILLATOR. 0-40 kc/s, 200/250 v. A.C. £20, carr. 30/-.
All above offered in excellent condition fully tested and checked.
TF. 1100 VALVE VOLTMETER. Brand New. £50. TF. 1267 TRANSMISSION TEST SET. Brand New, £75. TF. 675F/1 PULSE GENERATOR. Brand New. £45.

POWER RHEOSTATS



High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range available ex-stock. Single hole fixing, ¼in. dia. shafts. Bulk quantities available.
25 WATT. 10/25/50/100/250/500/1000/1500/2500 or 5000 ohms. 14/6. P. & P. 1/6.
50 WATT. 10/25/50/100/250/500/1000/2500 or 5000 ohms. 21/-. P. & P. 1/6.
100 WATT. 1/5/10/25/50/100/250/500/1000 or 2500 ohms. 27/6. P. & P. 1/6.

SOLATRON CD711S.2. DOUBLE BEAM OSCILLOSCOPE



An extremely high quality oscilloscope originally costing £400. Switched beam. Identical Y1, Y2 Amplifiers D.C. to 9 Mc/s. Sensitivity 3mV/CM to 100 V/CM. Time base 10μ/sec. to 10 M/secs. Calibrator. X amplifier D.C. to 2.5 Mc/s. Z Modulation. 110/200/250 v. A.C. Supplied in good working order. £65, carriage £2, or available as received from Ministry unserviced £50, carriage £2. (Handbooks £2 extra.)

MODEL ZQM TRANSISTOR CHECKER

It has the fullest capacity for checking on A, B and Ico. Equally adaptable for checking diodes, etc. Spec.: A: 0.7-0.9967. B: 5-200. Ico: 0/50 micro-amps. 0.5 mA. Resistance for diode 200Ω+1 MEG. Supplied complete with instructions, battery and leads. £5 19/6. P. & P. 2/6.

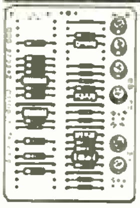
SOLARTRON MONITOR OSCILLOSCOPE TYPE 101.

An extremely high quality oscilloscope with time base of 10Ω/sec. to 20 m sec. Internal Y amplifier. Separate mains power supply 200/250V. Supplied in excellent condition with cables, probe, etc., as received from Ministry. £8 19 6. Carriage 30/-.

LAFAYETTE TE-46 RESISTANCE CAPACITY ANALYSER

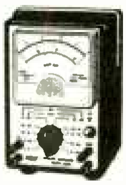
2 pf-2,000 mfd. 2 ohms-200 megohms. Also checks impedance turns ratio, insulation. 200/250 v. A.C. Brand New. £15. Carr. 7/6.

PRINTED CIRCUITS



Five assorted printed circuit boards with transistors, diodes, resistors, condensers, etc. Guaranteed minimum 20 transistors. Ideal for experimenters. 5 Boards for 10/-. P. & P. 2/-.

T.E.40 HIGH SENSITIVITY A.C. VOLTMETER



10 meg. input 10 ranges: .01/.03/.1/.3/1/3/10/30/100/300 v. R.M.S. 4 cps.-1.2 Mc/s. Decibels—40 to +50 dB. Supplied brand new complete with leads and instructions. Operation 230 v. A.C. £17/10/-. Carr. 5/-.

UNR-30 4 BAND COMMUNICATION RECEIVER

Covering 550 Kc/s-30 Mc/s. Incorporates variable BFO for CW/SSB reception. Built in speaker and phone jack. Metal cabinet. Operation 220/240v. A.C. Supplied brand new, guaranteed with instructions. £12 10 -. Carr. 7/6.

LAFAYETTE LA-224T TRANSISTOR STEREO AMPLIFIER

19 transistors, 8 diodes, IHF music power 30 watts at 8 ohms. Response 30-20,000± 2. dB at 1 w. Distortion 1%, or less. Inputs 3 mV and 250 mV. Output 3-16 ohms. Separate L. and R. volume controls. Treble and bass controls. Stereo phone jack. Brushed aluminium, gold anodised extruded front panel with complementary metal case. Size 10¼in. × 3⅞in. × 7¼in. Operation 115/230 volt A.C. £25. Carr. 7/6.

HUSIDEN DH04S 2-WAY STEREO HEADSETS

Each headphone contains a 2½in. woofer and a ⅞in. tweeter. Built-in individual level controls. 25-18,000 c.p.s. 8 Ωimp. with cable and stereo plug. £5/19/6, P. & P. 2/6.

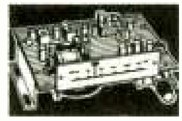
GARRARD DECKS THREE SPECIAL OFFERS!

Brand new and guaranteed.
A70 Mk. II less cartridge £12 12 0 Carr. 7/6
LAB 80 Mk. II less cartridge. £23 10 0 Carr. 7/6
401 Transcription less cart. £27 6 0 Carr. 7/6

LAFAYETTE HI-FI STEREO HEADPHONES

★ Air cushioned headband ★ Soft rubber ear pads ★ Frequency response. 25 to 15,000 cycles. ★ High sensitivity. Impedance 8 ohms per phone. Supplied complete with all cables, wires, overhead junction box and 3-connection plug P. 79/6. & P. 2/6.

★ TRANSISTORISED FM ★ TUNER



6 TRANSISTOR HIGH QUALITY TUNER SIZE ONLY 6in. × 4in. × 2½in. 3 I.F. stages. Double tuned discriminator, ample output to feed most amplifiers. Operates on 9 volt battery. Coverage 88-108 Mc/s. Ready built ready for use. Fantastic value for money. £6/7 6. P. & P. 2/6. STEREO MULTIPLEX ADAPTORS. 5 Gns.

Variable Voltage TRANSFORMERS

Brand new, guaranteed and carriage paid.
High quality construction. Input 230 v. 50/60 cycles.
Output full variable from 0-260 volts. Bulk quantities available.
1 amp.—£5 10 -; 2.5 amp.—£6 15 -; 5 amp.—£9/15/-;
8 amp.—£14 10 -; 10 amp.—£18/10/-; 12 amp. £21; 20 amp.—£37.

SILICON RECTIFIERS

200 v. P.I.V. 200mA	2/6
200 v. P.I.V. 6 amp.	5/6
400 v. P.I.V. 3 amp.	7/6
1,000 v. P.I.V. 3 amp.	7/6
400 v. P.I.V. 6 amp.	5/6
400 v. P.I.V. 8 amp.	7/6
1,000 v. P.I.V. 650 mA.	6/6
800 v. P.I.V. 500mA.	5/6
800 v. P.I.V. 5 amp.	7/6
400 v. P.I.V. 500mA.	3/6
70 v. P.I.V. 1 amp.	3/6
150 v. P.I.V. 165mA.	1/-
150 v. P.I.V. 25 amp.	10/-
700 v. P.I.V. 100 amp.	35/-

Discount for quantities. Post extra.

THYRISTOR SILICON CONTROL RECTIFIERS

400 P.I.V. 3 amp.	7/6
100 P.I.V. 5 amp.	13/6
200 P.I.V. 5 amp.	15/6
400 P.I.V. 5 amp.	17/6

SINCLAIR EQUIPMENT

Z12. 12 watt amplifier	89/6
PZ4. Power supply Unit	99/6
STEREO 25. Pre-amplifier	£9 19/6
Q.14 Speakers	£6/19/6
Micromatic Radio Kit	49/6
Built	59/6
Micro FM Radio Kit	£5 19/6

ALL POST PAID.

SPECIAL PACKAGE DEAL!
2 Z12 amps. PZ4 Power Supply. Stereo 25. Preamplifier £22

R.C.A. AR88 SPEAKERS

8", 3 ohm speakers in metal case Black crackle finish to match our 88 Receivers. Available Brand New and Boxed with leads. 59/6. Carr.-7/6.

S.T.C. 1 WATT ZENER DIODES

BRAND NEW. LIST 17/6 each
Available 2.4/2.7/3/3.9/4.3/13/16/18/20 30 33 v. 5/- each type. P. & P. extra.

TRIO COMMUNICATION RECEIVER MODEL 9R-59DE

4 band receiver covering 550 Kc/s to 30 Mc/s. continuous and electrical band spread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. SSB-CW ● ANL ● Variable BFO ● S meter. ● Sep. band spread dial ● IF 455 Kc/s ● audio output 1.5 W. ● Variable RF and AF gain controls. 115/250 V. A.C. Mains. Beautifully designed. Size: 7 × 15 × 10in. With instruction manual and service data. £37 10/0. Carriage 12/6.

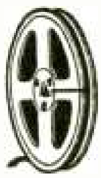
DUBILIER NITROGEL CONDENSERS.

Brand new. 8 mfd. 800v. 8/6, P. & P. 2/-; 2 mfd. 5,000 v. 42/6, P. & P. 5/-.

AMERICAN RECORDING TAPES

First grade quality American tapes. Brand new and guaranteed. Discounts for quantities.

3in. 225ft. L.P. Acetate	3/6
3¼in. 600ft. T.P. Mylar	10/-
5in. 600ft. Std. plastic	8/6
5in. 900ft. L.P. acetate	10/-
5in. 1,200ft. D.P. Mylar	15/-
5in. 1,800ft. T.P. Mylar	32/6
5¾in. 1,200ft. L.P. acetate	12/6
5¾in. 1,200ft. L.P. Mylar	16/-
5¾in. 1,800ft. D.P. Mylar	22/6
5¾in. 2,400ft. T.P. Mylar	32/6
7in. 1,200ft. Std. acetate	12/6
7in. 1,800ft. L.P. acetate	15/-
7in. 1,800ft. L.P. Mylar	20/-
7in. 2,400ft. D.P. Mylar	25/-
7in. 3,600ft. T.P. Mylar	45/-



Postage 2/-. Over £3 post paid.

AUTO TRANSFORMERS

0/115/230v. Step up or step down. Fully shrouded.
500 W. £3/10/0, P. & P. 6/6
1,000 W. £5/10/0, P. & P. 7/6
1,500 W. £6/10/0, P. & P. 8/6
3,000 W. £7/10/0 P. & P. 12/6
7,500 W. £15/10/0, P. & P. 20/-.

RECORDING HEADS

Reuter ¼-track. As fitted to Collaro Mk. IV and Studio Decks. High imp. record play back, low imp. erase. Brand new. 19/6 pair. MINIFLUX ¼-track set of 3. 29/6. Post extra.

MAGNAVOX 363 3-SPEED TAPE DECKS
4-track £13/10/0. 2-track stereo £12/10/0. Carriage Extra.

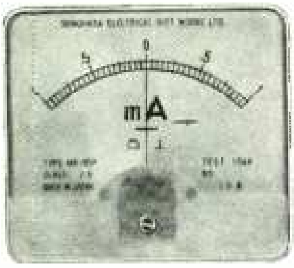
G. W. SMITH & Co. (Radio) Ltd.
3-34, Lisle St., W.C.2.

ALSO SEE OPPOSITE PAGE

SEW PANEL METERS

Send S.A.E. for full lists. Other ranges available. Please include postage. Special quotations for quantities.

CLEAR PLASTIC METERS



Type MR 52P. 2½in. square fronts.

50µA	59/6	10V. D.C.	37/6
50-0-50µA	49/6	20V. D.C.	37/6
100µA	49/6	50V. D.C.	37/6
100-0-100µA	45/-	300V. D.C.	37/6
500µA	42/6	15V. A.C.	37/6
1 mA	37/6	300V. A.C.	37/6
5mA	37/6	S Meter 1mA	39/6
10mA	37/6	VU Meter	59/6
50mA	37/6	1 amp. A.C.*	37/6
100mA	37/6	5 amp. A.C.*	37/6
500mA	37/6	10 amp. A.C.*	37/6
1 amp	37/6	20 amp. A.C.*	37/6
5 amp	37/6	30 amp. A.C.*	37/6

Type MR 85P. 4¼in. × 4¼in. fronts.

50µA	69/6	15 amp	49/6
50-0-50µA	59/6	30 amp	49/6
100µA	59/6	20V. D.C.	49/6
100-0-100µA	59/6	50V. D.C.	49/6
200µA	55/-	150V. D.C.	49/6
500µA	52/6	300V. D.C.	49/6
500-0-500µA	49/6	15V. A.C.	49/6
1mA	49/6	300V. A.C.	49/6
1-0-1 mA	49/6	S Meter 1mA	55/-
5mA	49/6	VU meter	69/6
10mA	49/6	1 amp. A.C.*	49/6
50mA	49/6	5 amp. A.C.*	49/6
100mA	49/6	10 amp. A.C.*	49/6
500mA	49/6	20 amp. A.C.*	49/6
1 amp.	49/6	30 amp. A.C.*	49/6
5 amp.	49/6		

Type MR.38P. 1 21/32in. square fronts.

50µA	37/6	750mA	25/-
50-0-50µA	35/-	1 amp	25/-
100µA	35/-	2 amp	25/-
100-0-100µA	32/6	5 amp	25/-
200µA	32/6	3V. D.C.	25/-
500µA	37/6	10V. D.C.	25/-
500-0-500µA	25/-	20V. D.C.	25/-
1mA	25/-	50 D.C.	25/-
1-0-1mA	25/-	100V. D.C.	25/-
2mA	25/-	150V. D.C.	25/-
5mA	25/-	300V. D.C.	25/-
10mA	25/-	500V. D.C.	25/-
20mA	25/-	750V. D.C.	25/-
50mA	25/-	15V. A.C.	25/-
100mA	25/-	50V. A.C.	25/-
150mA	25/-	150V. A.C.	25/-
200mA	25/-	300V. A.C.	25/-
300mA	25/-	500V A.C.	25/-
500mA	25/-	S meter 1 mA	29/6
		VU meter	38/6

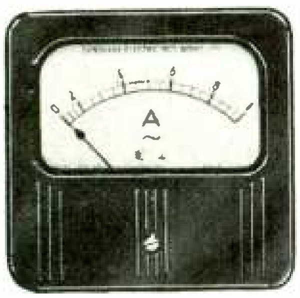
Type MR.65P. 3½in. × 3½in. fronts.

50µA	65/-	20V. D.C.	39/6
50-0-50µA	52/6	50V. D.C.	39/6
100µA	52/6	150V. D.C.	39/6
100-0-100µA	49/6	300V. D.C.	39/6
500µA	45/-	15V. A.C.	39/6
1mA	39/6	50V. A.C.	39/6
5mA	39/6	150V. A.C.	39/6
10mA	39/6	300V. A.C.	39/6
50mA	39/6	500V. A.C.	39/6
100mA	39/6	S meter 1mA	45/-
500mA	39/6	VU meter	65/-
1 amp	39/6	50mA A.C.*	39/6
5 amp	39/6	100mA A.C.*	39/6
10 amp	39/6	200mA A.C.*	39/6
15 amp	39/6	500mA A.C.*	39/6
20 amp	39/6	1 amp. A.C.*	39/6
30 amp	39/6	5 amp. A.C.*	39/6
50 amp	39/6	10 amp. A.C.*	39/6
10V D.C.	39/6	20 amp. A.C.*	39/6
		30 amp. A.C.*	39/6

Type MR.45P. 2in. square fronts.

50µA	42/6	10V. D.C.	27/6
50-0-50µA	39/6	20V. D.C.	27/6
100µA	39/6	50V. D.C.	27/6
100-0-100µA	35/-	300V. D.C.	27/6
500µA	29/6	15V. A.C.	27/6
1mA	27/6	300V. A.C.	27/6
5mA	27/6	S meter 1mA	35/-
10mA	27/6	VU meter	42/6
50mA	27/6	1 amp. A.C.*	27/6
100mA	27/6	5 amp. A.C.*	27/6
500mA	27/6	10 amp. A.C.*	27/6
1 amp	27/6	20 amp. A.C.*	27/6
5 amp	27/6	30 amp. A.C.*	27/6

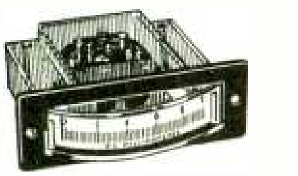
BAKELITE PANEL METERS



Type MR.65 3½in. square fronts.

25µA	67/6	5V. D.C.	32/6
50µA	45/-	10V. D.C.	32/6
50-0-50µA	42/6	20V. D.C.	32/6
100µA	42/6	50V. D.C.	32/6
100-0-100µA	42/6	150V. D.C.	32/6
500µA	39/6	300V. D.C.	32/6
1mA	32/6	50V. A.C.*	32/6
1.0.1mA	32/6	50V. A.C.*	32/6
5mA	32/6	150V. A.C.*	32/6
10mA	32/6	300V. A.C.*	32/6
50mA	32/6	1 amp. A.C.*	32/6
100mA	32/6	5 amp. A.C.*	32/6
500mA	32/6	10 amp. A.C.*	32/6
1 amp.	32/6	20 amp. A.C.*	32/6
5 amp.	32/6	30 amp. A.C.*	32/6
15 amp.	32/6	50 amp. A.C.*	32/6
30 amp.	32/6	VU meter	59/6
50 amp.	32/6		

*Moving iron, all other moving coil.



NEW RANGE OF "SEW" EDGEWISE METERS

MODEL PE70. Dimensions 3 17/32 × 1 11/32 × 2⅝in. deep overall. Available as follows:

50 microamp	57/6	200 microamp	52/6
50-0-50 microamp	55/-	500 microamp	49/6
100 microamp	55/-	1 milliamp	45/–
100-0-100 microamp	52/6	300 volt A.C.	45/–
		VU meter	62/6

Post extra.

TE-20RF SIGNAL GENERATOR

Accurate wide range signal generator covering 120 kc/s.-260 Mc/s. on 6 bands. Directly calibrated. Variable R.F. attenuator. Operation 200/240 v. A.C. Brand new with instructions **£12/10/-**.

P. & P. 7/6. S.A.E. for details.

AVOMETERS

Supplied in excellent condition fully tested and checked. Complete with prods, leads and instructions.

Model 47A	£9/19/6
Model 7	£13/10/0
Model 8	£18/0/0
Model 9	£20/0/0

P. & P. 7/6 each.

CATALOGUE

- ★ ELECTRONIC COMPONENTS
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- ★ COMMUNICATION EQUIPMENT
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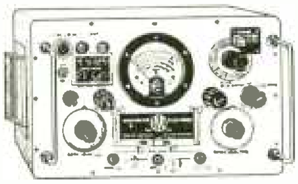
AVO CT.38 ELECTRONIC MULTIMETERS



High quality 97 range instrument which measures A.C. and D.C. Voltage. Current, Resistance and Power output. Ranges D.C. volts 250mV-10,000 v. (10 megΩ-110megΩ input). D.C. current 10µA 25 amps. Ohms: 0-1,000 megΩ. A.C. volt 100 mV-250 v. (with R.F. measuring head up to 250 Mc/s). A.C. current 10µA-25 amps. Power output 50 microwatts-5 watts. Operation 0/110/200/250 v. C. Supplied in perfect condition complete with circuit lead and R.F. probe **£25**. Carr. 15/-.

AVO CALIBRATION TEST UNIT TYPE CT.155. For use with CT.38 Multimeter. Gives 7 standard voltages 250 mV./1 v./2.5 v./10/25/100 v. A.C. and 250 millivolts D.C. from internal standard cell. Operation 0/110/200/250 v. A.C. Brand new **£7/10/-**. P. & P. 10/6.

MULTIMETERS *for EVERY purpose!*

NEW MODEL 500. 30,000 O.P.V. with overload protection Mirror scale. 0 / .5 / 2.5 / 10 / 25 / 100 / 250 / 500 / 1,000 v. D.C. 0 / 2.5 / 10 / 25 / 100 / 250 / 500 / 1,000 v. A.C. 0/50µA / 5 / 50 / 500 mA. 12 amp. D.C. 0 60/K6. Meg./60 Meg. Ω. **£8/17.6.** Post paid.

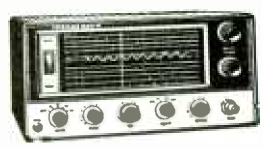
MODEL TE-70. 30,000 O.P.V. 0/3/15/60/300/600/1,200 v. D.C. 0/6/30 / 120 / 600 / 1,200 v. A.C. 0/30µA / 3/30 / 300 mA. 0/16K/160K/1.6M/16 Meg. Ω. **£5/10/-.** P. & P. 3/-.

MODEL TE 80. 20,000 O.P.V.
0 / 10 / 50 / 100 / 500 / 1,000 v. A.C. 0/5/25/50/250 / 500 / 1,000 v. D.C. 0-50µA. 5/50/500 mA. 0/6K/60 K/600K/6 Meg. **£4/17 6.** P.P. 3/-.

MODEL AS-100D. 100KΩ/VOLT 5in., mirror scale. Built-in meter protection. 0 / 3 / 12 / 60 / 120 / 300 / 600 / 1,200 v. D.C. 0/6/30/120/300/600 v. A.C. 0/10µA/6/60/300MA/12 Amp. 0/2K / 200K / 2M / 200MΩ. −20 to +17 dB. **£12/10/-.** P. & P. 3/6.

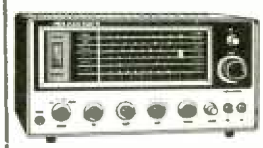
MANY OTHER MODELS AVAILABLE FROM AS LOW AS 39/6.

NEW LAFAYETTE MODEL HA700 AM/CWSSB AMATEUR COMMUNICATION RECEIVER



8 valves, 5 bands incorporating 2 MECHANICAL FILTERS for exceptional selectivity and sensitivity. Frequency coverage on 5 bands 150-400 Kc/s., 550-1,600 Kc/s. 1.6-4.0 Mc/s. 4.8-14.5 Mc/s., 10-5-30 Mc/s. Circuit incorporates R.F. stage, aerial trimmer, noise limiter, B.F.O. product detector, electrical bandspread, S meter, slide rule dial. Output for phones, low to 2KΩ or speaker 4 or 8 ohms. Operation 220/240 volt A.C. Size 7⅝in. × 15in. × 10in. Supplied brand new and guaranteed with handbook. **36 GNS.** Carr. 10/-. S.A.E. for leaflet.

LAFAYETTE MODEL HA-500 SSB/AM/CW 80 THROUGH 6 METER RECEIVER



New outstanding Ham Bands only receiver covering the 80/40/20/15/10/6 metre bands. Incorporates 10 valves, product detector, two mechanical filters, S Meter, dual conversion on all bands, crystal calibrator, V.F.O. noise limiter, aerial trimmer, I.F.s 2,608 Mc/s. and 455 Kc/s. Output 8 ohms and 500 ohms. Operations 220/240 volts A.C. Supplied brand new and guaranteed with handbook **42 Gns.** Carr. 10/-. 100 Kc/s. crystal, 35/-.

G.W. SMITH & CO (RADIO) LIMITED

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

OPEN 9 a.m. to 6 p.m. every day Monday to Saturday. [illegible] supplied.

Wilkinsons FOR RELAYS

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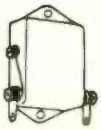
BUILT TO YOUR REQUIREMENTS—QUICK DELIVERY

COMPETITIVE PRICES—VARIOUS CONTACTS

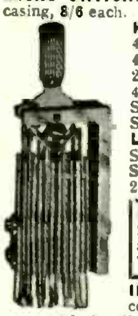
DUST COVERS—QUOTATIONS BY RETURN

LARGE STOCKS OF MINIATURE SEALED RELAYS, DETAILED LIST ON REQUEST

LEDEX SOLENOID DRIVEN WAFER SWITCHES. SIZE 5S. From **90/-**. 11 Way and off, 3 to 24 Pole; also 4 Pole 12 Way and 54 Pole on/off. Commutating switch section and control wafers available.
PRESSURE TRANSDUCERS SE152A 20 P.S.I. with Transformer **£15.**
LINEAR TRANSDUCERS IT-1-4F **£3.**
MINIATURE BUZZERS (as illus.), 12 volt with tone adjuster, **7/6.**



HIGH NOTE BUZZERS 24 v. A.C./D.C. with tone adjuster, 2¾in. dia. Bakelite case. **10/6.** Post 2/-.
SUBMINIATURE MICRO SWITCHES HONEYWELL 11SM1-TN13. S.P.D.T. Size: .781in. + .250in. + .356in., **6/6** each.
MICRO SWITCH. Burgess MK4BR, robust die cast casing, **8/6** each. Post 9d.



KEY SWITCHES (3 position)
4 C Non Lock/4 C Non Lock, **16/6.**
4 C Non Lock/6 C Lock, **20/-.**
2 C Lock/2 C Lock, **12/6.**
4 C Lock/4 C Lock, **17/6.**
Stop/4 C Lock, **12/6.**
Stop/8 C Lock **17/6.**
Low Capacitance 8 C Muirhead, **17/6.**
Stop/2 C Lock, **7/6.**
Stop/4 C Non Lock, **10/6.**
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RECTIFIER UNIT A.C. to D.C. Input 200/250 v. A.C. Output 6 v. D.C. at 15 amps, full regulation. Meter, Fuses, Westinghouse, **£8/10/-.** Carr. 20/-.

IMHOF MAINS BLOWERS. For cooling 19in. rack mounted equipment, with glassfibre filter and directional duct, **£12.** Blower only **£10.**
DOUBLE HEADPHONES with sound powered earpieces and cord. Type DHR, **17/6.** Post 2/6.

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ASZ20	7/-	2N698	5/-	SX68	4/6	OA10	3/-
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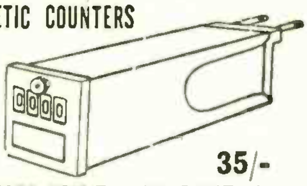
OC44	3/6	2N1997	5/-	SX641	3/-	OAZ 242	4/6
OC45	3/-	2N1305	3/-	Z810A	3/-	VR525A-B	6/-
OC71	3/-	2N1613	4/-	ZT83	11/6	ECC81	4/-
OC200	7/-	2N1596	29/-	18131	2/-	E88CC	12/-
28002	15/-	V30-30P	15/-	DD006	6/-	12BH7	7/6

SMALL MAGNETIC COUNTERS

3½ + 1in., 10 counts, per second with 4 figures. The following D.C. voltages are available, 6 v., 12 v., 24 v., 50 v. or 100 v.



35/-

MULTI-INDICATORS KGM Type M5. DIGITS 0 to 9 illuminated by 28 v. .08 amp. cartridge cap lamps, **50/-** each.

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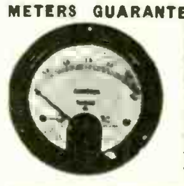
RATIO ARM UNITS. Sullivan 600Ω +600Ω, **50/-.**

METERS GUARANTEED. Complete list available



Microamps 0/100 2¼in. MC	**40/-**
Microamps 0/500 2in. M.C.	**25/-**
Microamps 0/500 2¼in. MC	**37/6**
Milliamps 0/50 2¼in. MC	**35/-**
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Volts 5/0/5 2½in. MC....	**25/-**
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Volts 0/5 A.C. 3½in. MI....	**55/-**
Volts 0/10 A.C. 3½in. MCR	**70/-**

HOUR COUNTERS 99999·9· 230 volts A.C. 3½in. flush round, **£5.**
Microamps 0/50 scaled in Milli Rontgens 2¼in. MC **45/-**
Millivolts 350/0/350 (3.5/0/3.5) MilliA 2¼in. MC **35/-**
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PORTABLE AMMETERS, 0/3 A.C./D.C. 3in., **35/-, p.** 3/-.
AVOMETERS. Model 7. **£13/10/-,** post 7/-.
FREQUENCY METERS. 45/55 cycles per second. 230 volts: 6in. Flush Round. Brand new, **£10/10/-.**
CELL-TESTING VOLTMETERS. 3-0-3 volts D.C. In leather case with prods. **35/-** each. Post 3/6.
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VM76 **Valve Voltmeter**
R.F. measurements in excess of 100 mHz and d.c. measurements up to 1,000V with accuracy of ±2%. D.c. range—300 mV-1 kV f.s.d. A.c. range—300 mV-300 V r.m.s. Resistance in 8 ranges, 0.02-500 Megohms.
Manufacturer's price £90: Our price £72

VM78: **A.C. Millivoltmeter**
Transistorised. 1 mV-300 V in 12 ranges. Freq. 1 c/s-1 Mc/s. Input impedance 2 Megohms 60 pf. Calibrated in r.m.s. for sine wave and input dB.
Manufacturer's price £70: Our price £55

TT1S: **Transistor Tester (CT472)**
Suitable for measuring medium and low powered transistors. Current gain (B) can be measured in range 10 to 500 for p.n.p. and n.p.n. types, either in circuit using the clip-on probes provided. Small, compact instrument.
Manufacturer's price £57: Our price £37/10/-

VM79: **UHF Millivoltmeter**
Transistorised. A.c. range 10 mV-3 V f.s.d., 10 ranges. D.c. current range 0.01 μA-0.3 mA f.s.d. 10 ranges. Resistance 1 Ohm-10 Megohms in 7 decade ranges. Complete with probe.
Manufacturer's price £180: Our price £125

J1B: **Audio Signal Generator**
15 c/s-50 kc/s in 3 ranges. Output 600 Ohms, 0.1 mW-1 W (0.25-24 V), variable. Attenuation 20 dB-600 Ohms (Attenuator is incorporated), output 10 mW (2.5 V). 100-250 V a.c.
Manufacturer's price £46: Our price £30

J2B: **Audio Signal Generator**
Same specification as for the J1B except that this model has an additional 2 in. meter calibrated 0-40 V a.c.
Manufacturer's price £50: Our price £35

H1B: **Audio Signal Generator**
15 c/s-50 kc/s in 3 ranges. Sine wave 200 μV-20 V r.m.s. Square wave 1.4 mV-140 V peak to peak (approx.). 100-250 V a.c.
Manufacturer's price £42: Our price £30

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TS155c/UP (as new): price **£75** each, carr. £1.

CT53. Freq. range 8.9-300 Mc/s. with Calibration chart. Output 1μV-100 mV. internal square wave and sinewave modulation at 100 c/s., external modulation 50 c/s-10 Kc/s., 230 v. A.C. Complete with chart, etc., price **£27/10/-** ea., carr. £1.

MARCONI TF801A/1 Freq. 10-300 Mc/s., 4 bands, output 200 mV, Attenuator 0-110dB. Input 75 ohms. **£65** each, carr. £1.

MARCONI TF516-F/1: Covering 10-18 Mc/s., 33-58 Mc/s., 150-300 Mc/s. **£12/10/-** each, carr. £1.

MARCONI CT218: price **£65** each, carr. 30/-.
CT.480 and 478: 1.3-4.2 Mc/s., F.M. or A.M., price **£75** each, carr. 30/-.

HRO RECEIVER. Model 5T. This is a famous American High Frequency superhet, suitable for CW, and MCW., reception crystal filter, with phasing control. AVC and signal strength meter. Freq. range 50 kc/s. to 30 mc/s., with set of nine coils. Receiver only in working order, **£18/10/-**, carr. 15/- each. Set of nine coils, **£12/10/-**, available only with set. Power unit for HRO 100/240 v. A.C., **£2/15/-**, carr. 10/-.

SPECIAL OFFER: Complete HRO SET (Receiver, Coils and Power Unit) for **£30**, plus 30/- carr.

HRO-M-SETS available with UX type valves; secondhand cond., with 5 coil and power unit, **£20** each, carr. 30/-.

COMMAND RECEIVERS: Model 3-6 Mc/s. and 6-9 Mc/s., as new, price **£5/10/-** each, post 5/-.

BC-433G COMPASS RECEIVER: Freq. 200-1,750 Kc/s. in 3 bands, suitable for aircraft, boats, etc. Complete with 15 valves, power supply input 24 v. D.C. at 2 amps. Receiver only **£5** each. Carr. 15/-.

RECEIVER TYPE S.27: UHF: freq. 35-143 tunable Mc/s., AM/FM 100/250 A.C. **£25** secondhand cond., **£50** as new, 30/- carr.

AIRCRAFT RECEIVER TYPE 1392: freq. 100-150 Mc/s. tunable, with power unit for 200/250 v. A.C. mains. In serviceable cond., **£10** each, carr. 25/-.

ROTARY TRANSFORMERS: 24 v. input, 175 v. at 40mA output, 25/-, plus 2/- post. 12 v. input, 225 v. at 100 mA output, 25/-. plus 3/- post (All the above are D.C. only).

ROTARY CONVERTERS: Type 8a, 24 v. D.C., 115 v. A.C. @ 1.8 amps. 400 c/s 3-phase, **£6/10/-** each, 8/- post. Converter 12 v. D.C. input, 110 v. A.C. 60 c/s output, **£15** each, £1 carr.

AVO MULTIRANGE No. 1 ELECTRONIC TEST SET: **£25** each, carr. £1.

AVOMETERS: Model 47A, **£9/19/6** each, 10/- post. Model 7x, **£13/10/-** each, 10/- post. Excellent secondhand cond. (Meters only). (Batteries and Leads extra—at cost).

OSCILLOSCOPE Type 13A, 100/250 v. A.C. Time base 2 c/s.-750 Kc/s. Bandwidth up to 5 Mc/s. Calibration markers 100 Kc/s. and 1 Mc/s. Double Beam tube. Reliable general purpose scope, **£22/10/-** each, 30/- carr.
COSSAR 1035 OSCILLOSCOPE, £30 each, 30/- carr.
COSSAR 339 OSCILLOSCOPE, double beam, **£10** each, 30/- carr.

RELAYS: Relay Unit (with 9 American relays) 24 v. D.C., 250 ohm coils. heavy duty, M. & B. 30/- each, 4/- post. GPO Type 600, 10 relays @ 300 ohms with 2M and 10 relays @ 50 ohms with 1M., £2 each, 6/- post.

CALIBRATION TACHOMETER Mk. II: Maxwell Bridge Type 6C/869, **£25** each, £2 carr.

ROTAX VARIAC & METER UNIT: Type 5G.3281. Reading 0-40 v., 0-40 mA and 0.5 amps., all on 275 deg. scales, **£30** each, £2 carr.

MARCONI IMPEDANCE BRIDGE, TF-373: inductance 5μh-100H in 5 ranges capacity 5pF-100μF in 5 ranges, resistance .05 meg.-1 meg., power supply 250 v. A.C., **£37/10/-** each, carr. 15/-.

HEWLETT PACKARD TYPE 400C: 115 v. 230 v. input 50/60 c/s. Freq. range 20 c/s-2 Mc/s. Voltage range: 1mV-300 v. in 12 ranges. Input impedance 10 megohms. Designed for rack mounting, **£30** each, carr. 15/-.

TCS MODULATION TRANSFORMERS, 20 watts, pr. 6,000 C.T., sec. 6,000 ohms. Price 25/-, post 5/-.

AR88 SPARES. Antenna Coils L5 and 6 and L7 and 8. Oscillator coil L55. Price 10/- each, post 2/6. By-pass Capacitor K.98034-1, 3 × 0.05 mfd. and M.98034-4, 3 × 0.01 mfd., 3 for 10/-, post 2/6. Trimmers, 95534-502, 2-20 p.f. Box of 3, 10/-, post 2/6. Block Condenser, 3 × 4 mfd., 600 v., **£2** each, 4/- post. Filter Choke, L45 and 50, K901433-501, 25/- each, 4/- post.

CONDENSERS. 10 mfd. 1,000 v., 12/6, post 2/6. 8 mfd., 1,200 volts, 12/6, post 3/-. 8 mfd. 600 volts., 8/6 post 2/6. 0.25 mfd., 2 kv., 4/- post 1/6.

AUTOMATIC PILOT UNIT Mk. 2. This complex unit of diodes and valves, relays, magnetic clutches, motors and plug-in amplifiers, with many other items, price **£7/10/-**, £1 carriage.

TELEPHONE EQUIPMENT:

DESK TELEPHONES with dial, in excellent secondhand cond. **£2/10/-** a pair, 10/- post.

TELEPHONE WIRE: 220 yds., £1 a roll, post 6/-.

GPO TERMINAL BLOCKS, 7/6 each, **FUSE AND PROTECTOR,** 7/6 each. Post on both 2/6.

TELEPHONES (PORTABLE) TYPE "F". Suitable for all outdoor activities up to a range of 5 miles. Price **£7/10/-** each, as new, complete with carrying case. Price **£5/10/-** each, secondhand. Carr. 10/-.

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FREQUENCY METERS: 1M 13 or BC-221; 125-20,000 Kc/s., **£25** each., carr. 15/-. TS.175 U, **£75** each, carr. £1. TS323/UR; 20-450 Mc/s., **£75** each, carr. 15/-. FR-67/U: This instrument is direct reading and the results are presented directly in digital form. Counting rate: 20-100,000 events per sec. Time Base Crystal Freq.: 100 Kc/s. per sec. Power supply: 115 v., 50/60 c/s., **£100** each, carr £1.

CT.49 ABSORPTION AUDIO FREQUENCY METER: freq. range 450 c/s-22 Kc/s., directly calibrated. Power supply 1.5 v.-22 v. D.C. **£12/10/-** each, carr. 15/-.

AMERICAN EQUIPMENT: Power supply, PP893/GRC 32A; Filter D.C. Power Supply F-170/GRC 32A; Cabinet Electrical CY 1288/GRC 32A; Antenna Box Base and Cables CY 728/GRC; Mast Erection Kits, 1186/GRC; Receiver type 27 8B; Directional Antenna CRD.6; Comparator Unit, CM.23; Directional Control CRD.6, 567/CRD and 568/CRD; Azimuth Control Units, 260/CRD. Test Set URM.44, complete with Signal Generator TS.622/U, **£100** each, £2 carr.

CATHODE RAY TUBE UNIT: With 3in. tube, colour green, medium persistence complete with nu-metal screen, **£3/10/-** each, post 7/6.

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TACAN. Trans./Receiver, same as ARN21, British made, STC, TR9171 complete with five 2C39As with associated valve-holders. As new price, **£25.** Used condition, **£15,** carriage £1.

APNI ALTIMETER TRANS. REC., suitable for conversion 420 Mc/s., complete with all valves 28 v. D.C. Dynamotor and 3 relays, 11 valves, price **£3** each, carr. 10/-.

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6F23	14/-
6F24	12/-
6F25	14/-
6F28	13/-
6F32	3/-
6F33	15/-
6GV8	10/6
6H6	3/-
6J4	9/-
6J4WA	12/-
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6L18	6/-
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6P1	11/-
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6SH7	4/-
6SJ7	7/-
6SK7	6/-
6SL7GT	6/-
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6SQ7	7/-
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6T8	6/6
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7H7	6/-
7K7	10/-
7Q7	9/-
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12AT6	4/6
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12AU6	5/-
12AU7	5/6
12AV6	5/6
12AV7	8/-
12AW6	20/-
12AX7	5/6
12AY7	10/-
12B4A	9/-
12BA6	6/-
12BE6	5/6
12BH7A	6/-
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12C8	4/6
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ECL84	11/-
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EF9	8/-
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EF39	6/-
EF40	8/6
EF41	8/6
EF42	11/-
EF50	4/-
EF80	4/6
EF83	9/6
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PY81	5/6
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UBF80	6/-
UBF89	7/6
UBL21	10/-
UC92	6/-
UCC84	9/-
UCC85	6/6
UCF80	9/6
UCH21	9/6
UCH42	9/-
UCH81	6/3
UCL81	9/-
UCL82	7/6
UCL83	9/-
UF41	9/-
UF42	9/-
UF43	8/-
UF80	6/6
UF85	7/3
UF86	9/-
UF89	7/-
UL41	8/6
UL84	6/6
UM4	10/-
UM80	5/-
UU5	8/-
UU8	7/-
UU9	7/6
UU10	8/-
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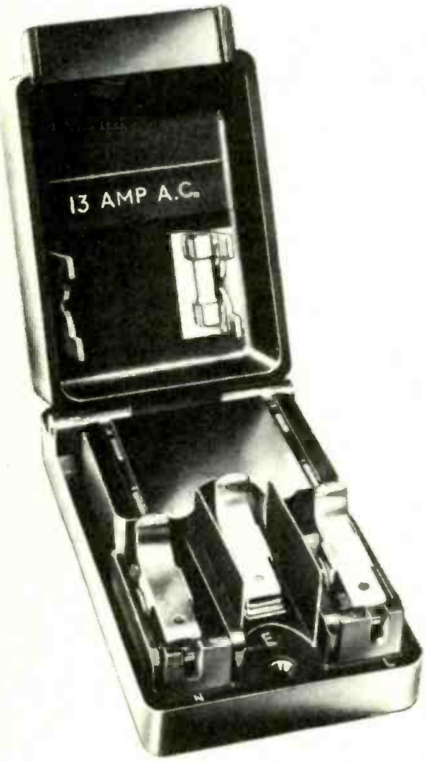

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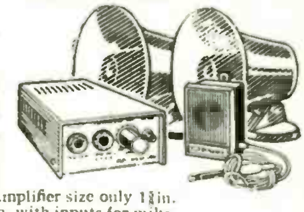

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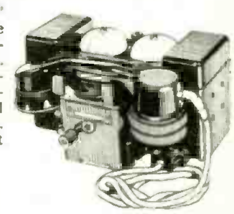

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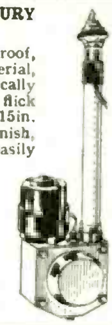

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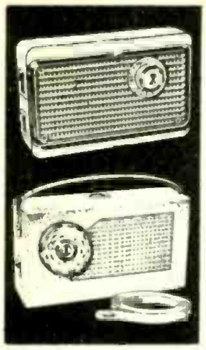

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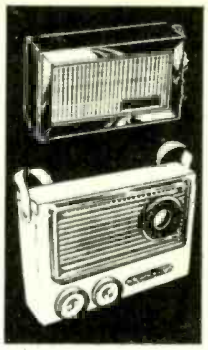

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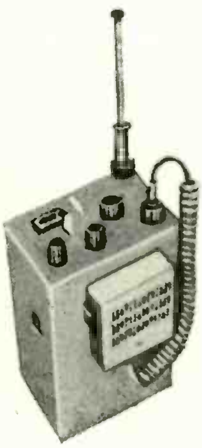

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MODERN DESK PHONES, 2 tone grey or black, with internal bell and handset with 0-1 dial, **£4/10/-.** P.P. 7/6.
WIRELESS SET No. 38 A.F.V. Freq. range 7.3 to 9.0 Mc/s. Working range ½ to 2 miles. Size 10½ × 4 × 6½in. Weight 6½lb. Includes power supply 8lb.—and spare valves and vibrator also tank aerial with base. **£6** per pair or **£3** single. P.P. 25/-.
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suitable for navigation or Scope conversion, price from £5. S.A.E. for details.

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Solve your communication problems with this new **4-Station Transistor Intercom** system (**1 master** and 3 subs), in de luxe plastic cabinets for desk or wall mounting. Call/talk/listen from **Master** to **Subs** and **Subs** to **Master**. Operates on one 9 v. battery. On/off switch. Volume control. Ideally suitable to modernise Office, Factory, Workshop, Warehouse, Hospital, Shop, etc., for instant inter-departmental contacts. Complete with 3 connecting wires, each 66ft. and other accessories. Nothing else to buy. P. & P. 7/6 in U.K.

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Same as 4-Station Intercom for two-way instant conversation. Ideal as Baby Alarm and Door Phone. Complete with 66ft. connecting wire. Battery **2/6.** P. & P. 3/6.

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(1 MASTER & 6 SUB-STATIONS) in strong metal cabinets. Fully transistorised. 3½in. Speakers. Call on Master identified by tone and Pilot lamp. Ideally suitable for Office, Hotel, Hospital and Factory. Complete with 50 yards cable and batteries. Price **21 gns.** P. & P. 12/6 in U.K.

Transistor TELEPHONE AMPLIFIER

Why not increase efficiency of Office, Shop and Warehouse with this incredible De-Luxe Portable Transistor **TELEPHONE AMPLIFIER** which enables you to take down long telephone messages or converse without holding the handset. A useful office aid. A must for every telephone user. Useful for hard of hearing persons. On/off switch. Volume Control. Operates on one 9 v. battery which lasts for months. Ready to operate. P. & P. 2/6 in U.K. Add 2/6 for Battery. Full price refunded if returned in 7 days.

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BOX NUMBERS: Replies should be addressed to the Box number in the advertisement, c/o Wireless World, Dorset House, Stamford Street, London, S.E.1.
No responsibility accepted for errors.

Advertisements accepted up to APRIL 5 for the MAY issue, subject to space being available.

SITUATIONS VACANT

TV Field Service Engineer. £1,000. London area. 5-day week.—Phone Mr. Simmons, Edgware 7291. [1997

A FULL-TIME technical experienced salesman required for retail sales; write giving details of age, previous experience, salary required to—The Manager, Henry's Radio, Ltd., 303, Edgware Rd., London, W.2. [67

RADIO and tape recorder testers and trouble shooters required; canteen, excellent rates of pay, 8 a.m. to 5 p.m., 5-day week.—Elizabethan Electronics, Ltd., Crow Lane, Romford, Essex. Tel. Romford 64101. [1999

WEST London Aero Club invite "A" and "B" licensed engineers with capital and/or necessary equipment to commence Radio Workshop. Alternative propositions may be considered. Write full details to—White, Waltham Airfield, near Maidenhead, Berks. [68

THE Royal Free Hospital, Gray's Inn Rd., London, W.C.1.—Electronic engineer required to take charge of electronics workshop. Duties will be to maintain and modify medical electronic equipment and to build new apparatus for clinical projects. Further particulars may be obtained by telephoning Mr. Williams 837 6411, Ext. 12. A good salary will be paid.—Applications, stating age, qualifications and experience and giving the names of two referees to the Administrator. [1993

TECHNICAL Officer, Home Office.—Post for man or woman aged at least 26 as Technical Officer Grade II in the Instruments Division of the Central Research Establishment, Aldermaston, Berks. Duties: concerned with maintenance, servicing, and development of instruments used in analytical chemistry, e.g., chromatographs and spectrographs, the design and production of research rigs. Qualifications: O.N.C. in Mechanical or Electrical Engineering or equivalent or higher qualification; wide range of mechanical and electrical experience in the development of experimental rigs essential; experience of electronics an advantage. Salary: £1,283-£1,490. Promotion prospects. Non-contributory pension.—Write: Civil Service Commission, Savile Row, London, W.1, for application form, quoting S/6879/68. Closing date 5th April, 1968. [1995

THE Agricultural Research Council Radiobiological Laboratory has a vacancy for an Assistant Experimental Officer or Experimental Officer in its Electronics Section which is responsible for the provision and operation of equipment used in tracer studies both with stable and radioactive isotopes. The successful candidate will assist in the development and construction of equipment, and should have experience of pulse techniques, linear amplifiers, analogue and digital circuitry, data recording and processing. Minimum qualifications: pass degree or, if under 22, G.C.E. 'A' level in two subjects, or equivalent. Salary in scale A.E.O. £584 (at age 18) to £1,243 (maximum starting salary at age 26 or over £1,017); E.O. £1,365 to £1,734.—Apply, with names of two referees to the Secretary, Agricultural Research Council Radiobiological Laboratory, Letcombe Regis, Wantage, Berkshire, by 16th April, 1968. [1996

THE General Post Office has vacancies for Radio Operators II at its Coast Radio Stations. Applications are invited from men between 21 and 35 years of age who must hold either the Postmaster General's First or Second Clas Certificate of Competence in Radiotelegraphy or an equivalent certificate issued by a Commonwealth Administration or the Irish Republic. The posts, which will be temporary in the first instance, carry a salary scale of £730-£1,075, depending on age at entry, but successful applicants will be eligible to enter the open competitive selection for permanent appointment to be held in the spring of this year. Applicants should write to: The Inspector of Wireless Telegraphy, Union House, St. Martin's-le-Grand, London, E.C.1, or telephone London HEAdquarters 5628 for further information. (S.T.D 01-432 5628.) [1994

BOOKS, INSTRUCTIONS, ETC.

MANUALS, circuits of all British ex-W.D. 1939-45 wireless equipment and instruments from original R.E.M.E. instructions; s.a.e. for list, over 70 types.—W. H. Bailey, 167a, Moffat Road, Thornton Heath, Surrey. CR4-8PZ. [66

TAPE RECORDING ETC.

TAPE to disc transfer, using latest feedback disc cutters; EPs from 21/-; s.a.e. leaflet.—Deroy, High Bank, Hawk St., Carnforth, Lancs. [70

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REPAIRS.—Our modern service department equipped with the latest test equipment including a wow and flutter meter and multiplex stereo signal generator is able to repair Hi Fi and tape recording equipment to manufacturers' standard.—Telesonic Ltd., 92, Tottenham Court Rd., London, W.1. 01-636 8177. [21

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METALWORK, all types cabinets, chassis, racks, etc., to your own specification, capacity available for small milling and capstan work up to 1in bar.—PHILPOTT'S METALWORKS, Ltd., Chapman St., Loughborough. [17

ARTICLES FOR SALE

S.38E Hallicrafter communications receiver, bandspread AM/CW, £25.—2, Clifton Rd., Wokingham. [217

VACUUM pumps, gauges, etc. recorders, general scientific and laboratory equipment, catalogue.—V. N. Barrett & Co., Ltd., 01-654 6470. [69

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DRAUGHTSMEN, PRODUCTION ENGINEERS

We have over 500 registered vacancies for above types of engineers in the Home Counties and South England areas. If you have had at least 2 years' experience in British Industry and require a job which offers first class prospects, top salaries and interesting work.

Phone (any time day or night) or write to:—

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RADIO & TELEVISION SERVICING
RADAR THEORY & MAINTENANCE

Vacancies regularly exist in industry for men with good knowledge of Radio, TV and Radar. Our one-year day courses provide effective training. Shorter day courses available for men with experience.

Write for details to: The Secretary, London Electronics College, 20 Penywern Road, Earls Court, London, S.W.5. Tel.: 01-373-8721.

The Civil Service
Professional and Technical appointments

RADIO AND ELECTRONIC ENGINEERS
BOARD OF TRADE (CIVIL AVIATION)

Qualified engineers required as Assistant Signals Officers in the field of Civil Aviation for the provision and installation of advanced electronic equipment—including the latest type of radar, telecommunications, navigational aids, etc.

QUALIFICATIONS: Degree with 1st or 2nd class honours in Electrical Engineering or Physics, or have passed all examinations for M.I.E.E., A.M.I.E.R.E. or A.F.R.Ae.S.

AGE: 23 and normally under 35 on 31st December 1968 (extension for Forces and Overseas Civil Service).

SALARY (Inner London): On the scale £1,160-£2,092 depending on age and qualifications. Pensionable appointments. Good prospects of promotion.
(Reference: S/85/ASO)

EXECUTIVE ENGINEERS AND ASSISTANT EXECUTIVE ENGINEERS
POST OFFICE

EXECUTIVE ENGINEERS are required for research, development and design work for electronic telephone exchanges, satellite communications, submarine telephony, novel line and radio transmission systems, electro acoustics, mechanical aids and postal mechanisation. Most of these posts are in London.

There are also posts in engineering management to direct and control the provision and maintenance of communications installations and plant. These posts are available in London and in a number of provincial centres.

ASSISTANT EXECUTIVE ENGINEERS are required in London and provinces for work on the development and design of communications systems and postal service equipment.

QUALIFICATIONS: **Executive Engineer**: Degree or Dip. Tech. in Mechanical or Electrical Engineering, or Physics or Applied Physics, or have achieved Corporate Membership of the I.E.E., I.Mech.E., or I.E.R.E. Final year students may apply. **Assistant Executive Engineer**: G.C.E. (or equivalent) pass in English language, and one of the following: H.N.D. in Electrical or Mechanical Engineering or Applied Physics; a pass in (or exemption from) Parts 1, 2 and 3 of the examinations of I.E.E., or I.Mech.E.; a pass in (or exemption from) Sections A and B of the I.E.R.E. examinations; a pass in (or exemption from) Parts 1 and 2 of the examination of the Council of Engineering Institutions, in subjects acceptable to one of the Institutions named above.

SALARIES (national): **Executive Engineer**: £906 (at 21)-£1,677 (at 34 or over)-£1,884. **Assistant Executive Engineer**: £734 (at 18 or under)-£1,097 (at 25 or over)-£1,631.
Salaries increased for officers serving in London. Non-contributory pension. Promotion prospects to higher grades with maxima of £2,484 and £3,105.

AGE: **Executive Engineer**: At least 21 and under 35 on 31st December 1968. (Some extensions for service in H.M. Forces or Overseas Civil Service.) **Assistant Executive Engineer**: At least 17½ and under 27 on 31st December 1968. Applications for both posts from well qualified older candidates will be considered.
(Reference: S/353)

APPLICATION FORMS are obtainable from the Secretary, Civil Service Commission, Savile Row, London, W.1. Please quote appropriate reference.

Product Test Technicians

Career Opportunities with IBM Manufacturing

We need high calibre men to fill vacancies created by promotion and programme expansion.

The Job

Is to commission the latest IBM products and systems in production at the Scottish plant, near Greenock, and requires an intimate knowledge of the equipment under test, which can include computers, punched card and tape peripherals, magnetic disk and tape storage, high and low speed printers, visual display units and multiplexors. The products have to be tested thoroughly, and all faults traced and rectified. The work is interesting and absorbing, and the prospects for the right man are good.

Training

Will be a mixture of formal and "on the job" instruction. We will teach you all you need to know about IBM equipment—providing your basic knowledge is to the required level.

Pay and conditions

Men selected for this work will start at not less than £1,050 per annum. We can pay more for proven ability and good relevant experience.

Benefits include a non-contributory pension, immediate free life assurance and full sickness pay for up to 26 weeks in any 12 months. The 254,000 square feet plant is modern and situated in a pleasant rural valley. There is a subsidised restaurant.

Working conditions are excellent and there are good recreational facilities in the area. IBM will help you find somewhere to live and pay your removal expenses.

The man

Will be at least 18 and probably less than 30 and have a strong electronic background, with experience in, for example, the testing of electronic products, maintenance of radio, radar or TV or similar work in the armed forces.

He will probably have, or be near to attaining, a qualification such as HNC, ONC, first class PMG, final RTEB, or final City and Guilds (Course Nos. 47, 48, 49, 57, 300). A knowledge of transistor circuitry and the use of oscilloscopes will be a distinct advantage.

If you have what we need, and are keen to join a vigorous, expanding and up-to-the-minute industry, please write, giving details of your age, experience and qualifications, and quoting ref No. PT/WW/336 to: Personnel Selection Officer, IBM United Kingdom Limited, P.O. Box 30, Spango Valley, Greenock.

IBM

STAFFORDSHIRE COUNTY COUNCIL

Education Department

FIELD SERVICE ENGINEERS

(Two additional Posts)

Applications are invited from suitably qualified and experienced persons for these posts. Ability to maintain, repair and demonstrate all types of audio visual equipment, is essential.

Applicants should hold the final R.T.E.B. certificate in Television and Telecommunication engineering and have had considerable experience in the servicing of radio and television receivers, record players, tape recorders, and sound film projection equipment.

Applicants must possess a current driving licence.

The Salary will be in accordance with Technical Grade III (£860-£1,020 per annum). The posts are superannuable.

Assistance may be given in approved cases towards removal expenses and a lodging allowance may be payable.

Further particulars and forms of application may be obtained from The Director of Education (Admin.) County Education Offices, Earl Street, Stafford, to whom completed applications should be returned within 14 days of the appearance of this advertisement.

INSTRUCTOR

required to lecture on theory and practice of Radio and Television. Marine Radio/Radar background desirable but not essential. Apply BST, 20 Penywern Road, Earls Court, London, S.W.5, giving details of qualifications.

AVO Valve Characteristic Meter Mk. IV. as new. £77; 1035 Mk. III scope on trolley. Telecheck 1322. £44; offers considered.—Box 216, W.W.

THE world's smallest wireless microphone rifle. bullet size. using hearing aid type battery. £7/10; shirt button size ultra sensitive microphone 20/-.—Box W.W. 220. Wireless World.

QUANTITIES of Barretter valves. CL33. CY31 and CIC. wanted. new and boxed: have for exchange new 6AQ5 EL84. 6BR7 and ECC8 valves. or will buy for cash.—Harringay Photographic. 435, Green Lanes. London. N.4. 01-340 5241. [1910

B.B.C.2, TV. RADIO. TAPE REC. SERVICE SPARES. UHF/625. modify your set to B.B.C.2. Manufacturers conversion kits & tuners. list available. Philips 625 conversion kit. new. including 7 valves & circuit. £4/18/6 (less valves 39/6). p/p 6/-. GEC/Sobell Dual 405/625 IF amp and output chassis. new. incl. circuit 38/6. p/p 4/6. Ferguson 625 IF amp chassis. new. incl. 6 valves 55/- (less valves 17/6). p/p 4/6. New UHF tuners. incl. valves 32/6 (less valves 12 6) or transistorised 70/-. p/p 4/6. New VHF tuners. GEC transistorised 70/-. A.B., Philips. Dual standard. Brayhead 3003 30/-. Cyldon C 20/-. K-B. 16Mc/s or 38Mc/s 10/-. p/p 4/6. Many others available. Fireball tuners. push button tuners. used. 17/6. p/p 4/6. TV Signal Boosters. transistorised. Pye Labgear B1/B3 and UHF battery 75/-. UHF mains 97/6. UHF masthead 105/- post free. L.O.P.Ts.. scan coils. frame output transf.. mains droppers. etc.. for all popular makes. CRTs 14. 17. 19 inch from £4/5 (callers only). Tape recorder belts. heads. motors. etc. Salvageed components. largee selection transformers. scan coils. turrets. etc. Enquiries invited. C.O.D. despatch available.—MANOR SUPPLIES. 64. Golders Manor Drive. London. N.W.11; callers. 589b. High Road. North Finchley. N.12 (near Granville Road). HIL. 9118 (day). SPE. 4032 (evg.). Early closing Thursday 1 p.m. [60

Science Research Council

RADIO AND SPACE RESEARCH STATION

Ditton Park, Slough, Bucks

Experimental Officers/Assistant Experimental Officers

Experimental/Assistant Experimental Officers are required to assist in work on the propagation of radio waves through the ionosphere and troposphere. Duties will include the design and development of apparatus and analysis of the results of experiments. Current work includes studies of the upper atmosphere and ionosphere with apparatus in rockets and satellites, investigation of wave propagation through the ionosphere and troposphere using an 82-foot steerable aerial, study of the propagation of millimetre and sub-millimetre radio waves, and use of lasers for studies of the lower atmosphere. Programmers are also required for duty with a large computer now being installed.

Qualifications:
University or C.N.A.A. degree H.N.C. or equivalent qualification. If under age 22, five G.C.E. passes including two science or mathematical subjects at "A" level (or equivalent).

Salaries
A.E.O. between £584 and £1,243.
E.O. between £1,365 and £1,734.
Send for details to:—
The Secretary, S.R.C. Radio and Space Research Station, Ditton Park, Slough, Bucks.

36th (Eastern) Signal Regiment (Volunteers)

T & AVR WANSTEAD E 11

Vacancies exist for volunteer technicians to service and repair modern Army communication equipment (Radio and Line) in Electronic Workshops. Training given, but Int. Cert. C. & G. in Telecommunications desirable. Full Army rates of pay. Bounties up to £85 per annum. Camp in Germany every three years. Training night every Thursday, 19.30-21.30 hrs.

Contact Capt. (T.O.T.) K. A. Christian, ERD, Signals House, Selsdon Road, Wanstead, E.11. Tel. 01-989-5131. Similar vacancies exist at CAMBRIDGE, BRENTWOOD, GILLINGHAM NORWICH, BEDFORD and COLCHESTER

RADIO TECHNICIANS

A number of suitably qualified candidates are required for unestablished posts, leading to permanent and pensionable employment (in Cheltenham and other parts of the U.K. including London). There are also opportunities for service abroad.

Applicants must be 19 or over and be familiar with the use of Test Gear, and have had practical Radio/Electronic workshop experience. Preference will be given to candidates who can offer "O" level and GCE passes in English language, Maths and/or Physics, or hold the City and Guilds Telecommunications Technical Intermediate Certificate or equivalent technical qualifications.

Pay according to age, e.g. at 19—£828, at 25—£1,076 (highest age pay on entry).

Prospects of promotion to grades in salary range £1,159-£1,941. There are a few posts carrying higher salaries.

Annual leave allowance of 3 weeks 3 days rising to 4 weeks 2 days. Normal Civil Service sick leave regulations apply.

Application forms available from:—

Recruitment Officer (RT).
Government Communications Headquarters.
Oakley, Priors Road.
Cheltenham, Glos.

BOROUGH POLYTECHNIC

Borough Road, London, S.E.1

The Borough Polytechnic is centrally situated in London, between Waterloo and London Bridge stations. In association with other colleges, it has been proposed for designation as "The Polytechnic of the South Bank, London,"

Applications are invited for the appointment of:—

TWO SENIOR LECTURERS

in the Department of Electrical and Electronic Engineering. This Department will be completely rehoused in the summer of 1969 in a large building, now nearing completion.

It is intended that appointments shall date from 1st September, 1968. Candidates should hold honours degrees in Electrical Engineering and preferably also be corporate members of the I.E.E. or I.E.R.E. They should have relevant industrial or research experience in addition to teaching experience.

Candidates able to offer the following subjects, up to at least final degree level, are particularly sought:—

HIGH VOLTAGE ENGINEERING (Ref. E.13)

COMMUNICATION ENGINEERING (Radio and Line Communication) (Ref. E.14)

SALARY SCALE (for Senior Lecturers in London):—

£2,350 p.a. rising by annual increments of £60 and £65 to £2,665 p.a.

Further details and application forms are obtainable from The Clerk to the Governing Body, Borough Polytechnic, Borough Road, London, S.E.1 with whom completed applications should be lodged within two weeks of receipt, but not later than 15th April, 1968.

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To become a successful IBM Data Processing Customer Engineer, you need more than engineering qualifications. You need to be able to talk confidently and well to any level of customer management, and to have a pleasing personality in your work. As a DPCE, you work in direct contact with your customers, on some of the world's most advanced data processing equipment.

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You will get thorough training on data processing equipment throughout your career. Starting salaries depend on experience and aptitude, but will not be less than £1,100 a year. Salary increases are on merit—you could be earning £1,900 within 3-5 years. Drive and initiative are always well rewarded at IBM; promotions are made on merit and from within the company.

If you are between 21 and 31 and would like this chance to become part of a rapidly expanding and exciting computer industry, write to IBM.

However, if you are between 18 and 21, IBM can offer you the chance of a challenging career as a Junior Customer Engineer.

You need five G.C.E. 'O' levels, an aptitude for mechanics, a good understanding of electrics, a clear logical mind, and the ability to get on well with people.

Send details of training, experience and age to Mr. D. J. Dennis, IBM United Kingdom Limited, 389 Chiswick High Road, London W4, quoting reference E/WW/262.

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TELEVISION FAULTFINDERS

We have vacancies for experienced television faultfinders in our Production Test Departments. R.T.E.B. Final Certificate or equivalent qualifications or experience are required, a knowledge of transistor circuitry will be an advantage. These positions will be staff appointments with all the expected benefits.

Applications to:

Works Manager,
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Chessington, Surrey (near Ace of Spades).
Phone: 01-397-5411

THE CITY UNIVERSITY

Applications are invited for the post of

EXPERIMENTAL OFFICER

in the

LASER APPLICATIONS GROUP

Applicants should possess at least a Higher National Certificate and have considerable practical ability. The officer will be responsible for the practical development of electro-optic crystal modulators under a research contract and will receive full initial training.

The appointment will be for three years with a prospect of permanency.

Salary scale: £1,300 × £75 to £1,450 p.a.

Apply in writing, stating qualifications and experience, to Professor P. F. Soper, Department of Electrical and Electronic Engineering, The City University, St. John Street, London, E.C.1.

WESTMINSTER 10 spindle fully automatic transformer winding machine, automatic paper interleaving and provision for parting off coils by rotating blade. exceptional condition; very reasonable.—102. Parrswood Rd., Manchester 20. Tel. Rusholme 3553. [209

A Better deal for cash customers. We do not provide interest free credit but offer a generous discount of 15% for cash. Equipment despatched brand new in sealed cartons on receipt of remittance with order. Agents for all leading makes. Demonstrations. service guidance.—Write or 'phone. Callers welcome. Open all day Saturday. Thursday half day.—Audio Services. Ltd.. 82. East Barnet Rd.. New Barnet. Herts. Tel. Barnet 6605. [20

ARTICLES WANTED

RETAILER requires surplus items.—Lists to Henniker & Kerr. 44. Ashley Terrace. Edinburgh [214

WANTED privately. an Eddystone communications receiver. prefer Model 940HF but consider other model.—Tel. 874 8656 evenings. 736 4834 daytime. [215

WANTED, all types of communications receivers and test equipment.—Details to R. T. & I. Electronics. Ltd.. Ashville Old Hall. Ashville Rd.. London. E.11. Ley. 4986. [63

GRANADA TELEVISION

Electronic Engineers for Operational Television

We have a number of vacancies at the TV Centre in Manchester for men with a good knowledge of television engineering to work in all aspects of Granada's production and transmission operations.

These cover studio sound and vision, videotape, telecine, transmission switching and maintenance of equipment.

Entry points and salaries depend on experience and qualifications and the grades open are Assistant Engineer at £1566 pa and Engineer at £1857 pa.

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Housing prospects in the Manchester area are excellent and we will give assistance with housing and removal expenses. Generous Granada Group Pension and Life Assurance Scheme.

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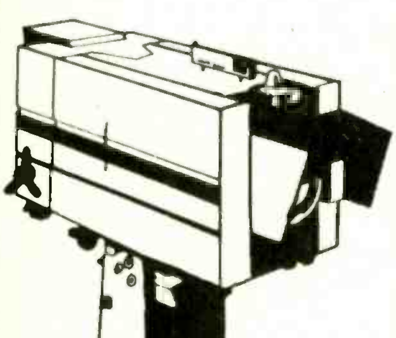

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BSY25	7/6	OC149	3/6	2N1309	7/6	OA81	1/9
		OC170	3/-	2S303	2/6	OA182	2/-
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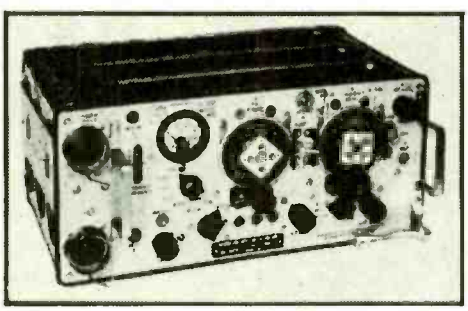
This is one of the Latest Releases by the Govt. of an extremely recent R/T set covering 2-8 Mc/s in two switched Bands, containing 13 Valves (3 EL32s in TX Output) which can be used for Morse CW or R/T. Also has Netting Trimmer, BFO, RF & EF Controls, Switched Meter for checking all parts of set, Size 17in. x 8in. x 12in. Power required LT 12 volts DC, HT 325 Volts D.C. **Supplied Brand New and Boxed with Headphones & Mike, also Two Spare Valves** and Circuit of set. **Few only at £5/10/-**, Carr. 30/-. New Plug in Power Supply made by us for either 12 volts D.C. Input £5/10/- or 200/250 Volts A.C. **£3/17/6.**

LARGE QUANTITY OF SARAH V.H.F. TRANS/RECEIVERS AVAILABLE FOR IMMEDIATE EXPORT.

General information. This set is normally carried in the life jacket of Airmen, it is a complete miniature lightweight radio Trans/Receiver, which is used to give a Beacon plus two way speech communication in the event of finding themselves in the sea. It comprises a Transmitter-Receiver, a speech unit, a coding unit and a power supply either Battery OR Transistor. These three items are permanently interconnected and all units are completely sealed and watertight using a combined speaker/Mike, Press to talk or listen buttons, Fold up aerial, a total of three Valves are used, power required 6.3 Volts LT 90 Volts and 435 Volts DC RT. Frequency 243 Mc/s. Transmitter output pulse power—Beacon 15 Watts, Talk 3 Watts. **Supplied in maker's boxes** in Grade 1 condition singly at **45/-**, post 5/- with circuit. New batteries if available **7/6** each.



FAMOUS ARMY SHORT-WAVE TRANSRECEIVER MK. III

This set is made up of 3 separate units: (1) a two valve amplifier using a 6V6 output valve; (2) (some only, not built in the very latest models) a V.H.F. transreceiver covering 229-241 Mc/s using 4 valves; (3) the mainshort wave transmitter/receiver covering in two switched bands, just below 2 Mc/s-4½ Mc/s, and 4½ Mc/s-8 Mc/s (approx. 160-37.5 metres) using 9 valves. For R.T., C.W. and M.C.W. The receiver is superhetrodyne having 1 R.F. stage, frequency changer, two I.F. (465 Kc/s) signal detector, A.V.C. and output stage. A B.F.O. included for C.W. or single side-band reception. T.X. output valve 807, other valves octal bases. Many extras, e.g. netting switch, quick flick dial settings, squelch, etc. Power requirements LT 12 volts, HT receiver 275 volts D.C. HT transmitter 500 volts D.C., size approx. 17½ x 7½ x 11ins. Every set supplied in new or as new condition in carton with book including circuits, only **£4/10/-** or Grade 2 slightly used **50/-**, or Grade 3 used but complete, **35/-**. Carr. ALL 15/-. WE MAKE A MAINS 200/250 VOLT POWER UNIT in louvred metal case to plug direct into set power socket to run (1) receiver, **70/-** post 5/-. (2) TX and RX, **£6/10/-**, post 7/6. (3) 12 volt D.C. P.U. (original) fair condition, **40/-**, Carr. 5/-. A charge of 10/- to unpack and test the receiver of these sets is made only if requested. Headphones & Mike, **15/-**, new and boxed.

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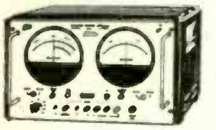

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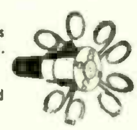

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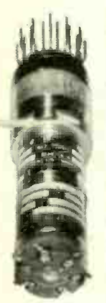

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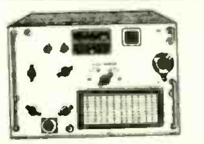

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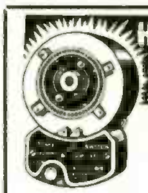

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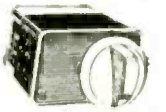

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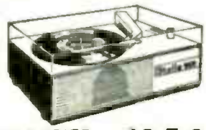

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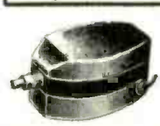

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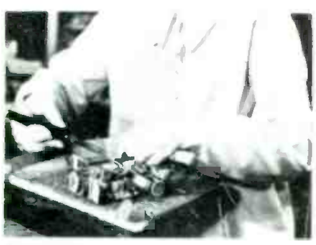
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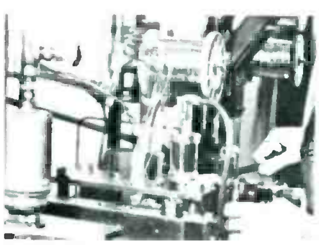
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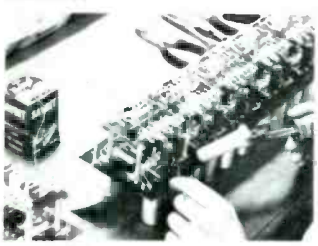
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